Cedar River Watershed
Habitat Conservation Plan

For the Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species

City of Seattle

April 2000

CEDAR RIVER WATERSHED
HABITAT CONSERVATION PLAN

FOR THE ISSUANCE OF A PERMIT TO ALLOW INCIDENTAL TAKE OF THREATENED AND ENDANGERED SPECIES

City of Seattle

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Technical Appendices for the Cedar River Watershed Habitat Conservation Plan. April 2000.

Resource Maps for the Cedar River Watershed Habitat Conservation Plan. April 2000.

Issued May 27, 1999

Response to Public Comments on the Public Review Draft of the Environmental Assessment/ Environmental Impact Statement for the Proposed Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species. May 1999.

Environmental Assessment/Final Environmental Impact Statement for the Proposed Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species. May 1999.

Issued December 10, 1998

Draft Cedar River Watershed Habitat Conservation Plan for the Proposed Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species. Public Review Draft, December 1998.

Environmental Assessment/Draft Environmental Impact Statement for the Proposed Issuance of a Permit to Allow Incidental Take of Threatened and Endangered Species. Public Review Draft, December 1998.

Resource Maps from the Cedar River Watershed Habitat Conservation Plan and Environmental Assessment/Environmental Impact Statement. Public Review Draft, December 1998.

Executive Summary for the Draft Cedar River Watershed Habitat Conservation Plan and the Draft Environmental Assessment/Environmental Impact Statement. Public Review Draft, December 1998

Technical Appendices for the Cedar River Watershed Habitat Conservation Plan and Environmental Assessment/Environmental Impact Statement. Public Review Draft, December 1998.

List of Resource Maps

All of the maps for the Cedar River Watershed Habitat Conservation Plan are contained in a separate document entitled “Resource Maps for the Cedar River Watershed Habitat Conservation Plan.” The numbering scheme/order is arranged by map category and does not necessarily reflect the order in which they are discussed in the particular documents.

Acronyms and Abbreviations

Acronyms and Abbreviations used in the Text

ACOE	United States Army Corps of Engineers
AFM	Anadromous Fish Mitigation
BIBI	Benthic Index of Biological Integrity
BLM	Bureau of Land Management
BMPs	Best Management Practices
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHU	Critical Habitat Unit; used in reference to the spotted owl
CMAI	Culmination of Mean Annual Increment
CML	Chester Morse Lake
CPUE	Catch Per Unit Effort
CRAFC	Cedar River Anadromous Fish Committee
CRIFC	Cedar River Instream Flow Committee
CWA	Cascades Water Alliance
dbh	diameter at breast height
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act (of 1973)
FEMAT	Forest Ecosystem Management Assessment Team
FERC	Federal Energy Regulatory Commission
FRI	Fisheries Research Institute
GIS	Geographic Information Systems
HCP	Habitat Conservation Plan
IA	Implementation Agreement
ID Team	Interdisciplinary Team
IF	Instream Flows
IFA	Instream Flow Agreement
IFIM	Instream Flow Incremental Methodology
IHN	Infectious Hematopoietic Necrosis
IHNV	Infectious Hematopoietic Necrosis Virus
IRPP	Instream Resources Protection Program
ITP	Incidental Take Permit
kV	Kilovolt
LMA	Landsburg Mitigation Agreement
LWD	Large Woody Debris
MGD	Million Gallons per Day
MW	Megawatt
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ODFW	Oregon Department of Fish and Wildlife
PCT	Precommercial Thinning
PEM	Palustrine Emergent (wetlands)
PHS	Priority Habitats and Species

PMF	Probable Maximum Flood
PPI	Parr Production Index
PSS	Palustrine Scrub/Shrub (wetlands)
RCW	Revised Code of Washington
RM	River Mile
SDWA	Safe Water Drinking Act
SEPA	State Environmental Policy Act
SIS	Stand Information System
SMA	Special Management Area
SNAP	Scheduling and Network Analysis Program
SPS	Stand Projection System
SPU	Seattle Public Utilities; formerly the Seattle Water Department (SWD)
SWD	Seattle Water Department
SWTR	Surface Water Treatment Rule
T&E	Threatened and Endangered (species)
TOC	Total Organic Carbon
TSI	Tacoma-Seattle Intertie
USDA	United States Department of Agriculture
USDC	United States Department of Commerce
USDI	United States Department of the Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	Unites States Geological Survey
WAC	Washington Administrative Code
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife
WDNR	Department of Natural Resources (Washington State)
WDOE	Washington Department of Ecology
WDOH	Washington Department of Health
WDW	Washington Department of Wildlife
WM	Watershed Management
WUA	Weighted Usable Area
WWIRPP	Western Washington Instream Resources Protection Program

Acronyms and Abbreviations used in the Watershed Assessment Prescriptions

CHA	Channel Hazard Areas
H	Hydrology
HLP	High Landslide Potential (areas)
HSEH	High Erosion Hazard (areas)
IG	Inner Gorges
RE	Road Erosion
SORZ&W	Streams, Riparian Zones, Wetlands and Open Water Bodies
WQ	Water Quality

List of Technical Appendices

Bound with HCP

Appendix 1. Implementation Agreement for the City of Seattle's Cedar River Watershed Habitat Conservation Plan. April 21, 2000.

Bound separately

Original Appendices Issued December 1998:

Appendix 2. Cooperation Agreements between the City of Seattle and the State of Washington for the Cedar River Interim Sockeye Salmon Restoration Project.

Appendix 3. Sockeye Salmon Escapement Goal for the Cedar River. Washington Department of Fisheries. May 16, 1977.

Appendix 4. Potential Sockeye Salmon Escapement for the Cedar River Above Landsburg. Washington Department of Fisheries. July 1997.

Appendix 5. Analysis of Water Quality Impacts of Allowing Anadromous Fish Above Landsburg. CH2M HILL. 1996.

Appendix 6. Landsburg Fish Passage Facilities Planning Report. Montgomery Watson. 1996.

Appendix 7. Sockeye Hatchery Conceptual Design. Montgomery Watson. 1996.

Appendix 8. Estimated Accretion Flows in the Cedar River.

Appendix 9. Long Range Regional Water Conservation Plan. Seattle Water Department. Conservation Office. 1996.

Appendix 10. Water Shortage Contingency Plan. Seattle Water Department. 1993.

Appendix 11. City of Seattle Water Claim for the Cedar River.

Appendix 12. City of Seattle Ordinance #114632. Cedar River Watershed Secondary Use Policies.

Appendices Issued April 2000 with Final HCP:

List of Supporting Documents

(1) The Cedar River Watershed Assessment

- Basin Condition Reports, Prescriptions, and Restoration Opportunities (Seattle Water Department 1995)
- Stream Channel and Fish Habitat Assessment for the Cedar River Watershed (Cupp and Metzler 1995)
- Mass Wasting and Surface Erosion Assessment (Foster Wheeler Environmental Corp. 1995c)

(2) Workshops

- Cedar River Watershed Bull Trout Workshop Meeting Minutes, November 18, 1994 (Foster Wheeler Environmental Corp. 1995d)
- Cedar River Watershed Conservation Biology Workshops: Meeting Minutes - August 24, 1995, and October 16, 1995 (Foster Wheeler Environmental Corp. 1995a)

(3) Scoping Report for the Cedar River Watershed Habitat Conservation Plan Environmental Assessment/Environmental Impact Statement (Seattle Public Utilities 1997)

(4) Mayor's Recommended Changes to the Draft Cedar River Watershed Habitat Conservation Plan. May 1999.

(5) City of Seattle City Council Resolution 29977, July 12, 1999, with Exhibit A ("Adopted Changes to the Cedar River Watershed Habitat Conservation Plan").

(6) City of Seattle City Council Resolution 30091, December 14, 1999.

(7) Cascades Environmental Services. Inc. 1991. Final report: Cedar River instream flow and salmonid habitat utilization study. Report prepared for Seattle Water Department, Seattle, Washington, by Cascade Environmental Services, Inc., Bellingham, Washington.

NOTE ON LYNX

On March 24, 2000, the Canada lynx (*Lynx canadensis*) was listed as threatened under the Endangered Species Act (Fed. Reg. Vol. 65, No. 56, pp. 16052-16086. The listing occurred after the Habitat Conservation Plan (HCP) documents had been finalized, and the status of the lynx has not been updated in this HCP. The lynx is a species covered by the HCP and the incidental take permit, and mitigation is provided as described in Chapter 4 of the HCP. The U. S. Fish and Wildlife Service completed a biological opinion for the lynx in its process to approve the HCP and incidental take permit.

1. INTRODUCTION TO THE CITY OF SEATTLE'S HABITAT CONSERVATION PLAN

Chapter 1 Contents

1.1 Development of the Habitat Conservation Plan

1.1.1 Cooperative Development

The City of Seattle (City) has prepared a multi-species Habitat Conservation Plan (HCP) to comply with the federal Endangered Species Act (ESA: 16 U.S.C. 1531 et seq.) and to address a variety of related natural resource issues. The plan will cover the City's 90,545-acre Cedar River Municipal Watershed and the City's water supply and hydroelectric operations on the Cedar River, which discharges into Lake Washington. In general, the City's HCP is not an HCP for planned development, but rather it is a set of mitigation and conservation commitments related to ongoing water supply, hydroelectric power supply, and watershed management activities.

The HCP is based on a decade of studies and the results of over 5 years of analysis and negotiations with five state and federal agencies as documented in an Agreement in Principle, dated March 14, 1997. The Agreement in Principle addresses not only issues under the Endangered Species Act (ESA) but also related issues under state law and tribal treaties, and issues with the U.S. Army Corps of Engineers (ACOE). The ACOE manages lake levels in Lake Washington, and navigational traffic between Lake Washington and Puget Sound, through operation of the Hiram Chittenden Locks (Ballard Locks) and Lake Washington Ship Canal.

The City's commitments regarding these related issues are included in and are part of this HCP and associated Implementation Agreement (Appendix 1), and the agreements with other agencies are represented in the related draft Instream Flow Agreement and draft Landsburg Mitigation Agreement, which are Appendices 27 and 28 of this HCP, respectively. The Instream Flow Agreement covers minimum and supplemental instream flows, operation of an instream flow commission, supplementation of minimum flows, and water conservation improvements at the Ballard Locks. The Landsburg Mitigation Agreement covers mitigation for the blockage to anadromous fish posed by the Landsburg Diversion Dam, where the City diverts water for municipal and industrial supply, as well as the effects of the intake structure.

The Instream Flow Agreement and the Landsburg Mitigation Agreement are intended to resolve issues about river flows and fish passage at Landsburg related to a variety of interests of the different signatory parties in addition to the ESA.

Although the Muckleshoot Indian Tribe (the Tribe) has not signed any of the agreements related to the HCP, the City attempted to address many of the issues raised by the Tribe during negotiations, and the Tribe participated in the development of the proposed instream flows and mitigation for the Landsburg blockage to fish. The City and Services continue to seek the Tribe's agreement on issues related to instream flows and the blockage to fish passage posed by the City's Landsburg Diversion Dam.

1.1.2 Purpose of the City's HCP under the Endangered Species Act

With several exceptions, Section 9 of the ESA (16 U.S.C. 1538(a)(1)(B)) prohibits the *take* of any endangered species and defines take as follows: "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. 1532(18)). The USFWS has further defined "harm" to mean "an act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 C.F.R. 17.3).

In 1982, Congress amended the Endangered Species Act to allow taking of listed species "if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity" (16 U.S.C. 1539(a)(1)(B)). A nonfederal landowner (often referred to as an *Applicant*) may apply for an "incidental take permit," which may be granted if an applicant has an approved "conservation plan" (now commonly referred to as HCP) for the listed species. In approving the 1982 amendments to the ESA that created Section 10, Congress also expressed its intent that HCPs be long-term, multispecies plans that cover not only listed species but also unlisted species, as long as those species are treated as if they were listed [H.R. Rep. No. 835, 97th Cong., 2d Sess. 29 (1982)]. Congress also recognized that HCPs should provide to nonfederal property owners seeking HCP permits economic and regulatory certainty regarding the overall cost of species mitigation over the life of the permit, but that HCPs should also make provisions for circumstances and information that could change over time that might require revisions to an HCP [H.R. Rep. No. 835, 97th Cong., 2d Sess. 29 (1982)]. This regulatory certainty has often been referred to as *no surprises*.

On February 23, 1998, the USFWS and NMFS (the Services) jointly published a final rule for the No Surprises Policy for HCPs (Fed. Reg. Vol. 63, No. 35, Pp. 8859-8873), in part to implement the above stated intent of Congress when it passed the 1982 amendments to the ESA (see Section 2.3.2 for more information on this rule). Under the final rule, the Services will only provide assurances to applicants for the species that are listed on an incidental take permit and adequately covered in the HCP and specifically identified on the permit.

More recently (March 9, 1999), the Services published a Notice of Availability for a "Draft Addendum to the Final Handbook for Habitat Conservation Planning and Incidental Take Permitting Process" (Fed. Reg., Vol. 64, No. 45, pp. 11485-11490), which provides additional guidance for HCPs and incidental take permits. The draft addendum emphasizes five points for the preparation of HCPs, including the need for:

- Adequate monitoring, based on measurable biological goals, to obtain the information necessary to ensure compliance with the HCP, properly assess the impacts from an HCP, verify that the biological goals of the HCP are being reached, and provide information for adaptive management.

- Incorporation of adaptive management to allow for changes in mitigation strategies that may be necessary to reach the long-term biological goals of the HCP and to ensure that conservation strategies are producing the desired results, particularly where there are significant biological data gaps.

- Development of measurable biological goals, which can be based on habitat or species, as a framework for monitoring and adaptive management.
- Appropriate terms for the duration of HCPs that take into account both the biological impacts resulting from the proposed activity and the nature or scope of the actions addressed in the HCP.
- Increased public participation in the process to develop HCPs, and a minimum 60-day public comment period for most HCPs.

In summary, an HCP is a long-term plan authorized under Section 10 of the ESA (16 U.S.C. 1539) to conserve species listed as threatened and endangered under the ESA or unlisted species also covered by the plan. Section 10 authorizes an applicant to negotiate a conservation plan with the secretaries of the Interior and Commerce to minimize and mitigate any impact to threatened and endangered species while conducting otherwise lawful activities. Section 10 authorizes incidental take of individuals of species populations covered by an approved HCP, including those caused by the disturbance of the habitat of such species, provided that an incidental take permit has been issued. Through recent rules and guidance, the Services have stated that an HCP is intended not only to provide regulatory certainty to applicants but also to include provisions that will work in the manner intended and meet the conservation goals of the plan through incorporation of clear goals, monitoring, and adaptive management.

Besides meeting the requirements of the ESA and its environmental stewardship responsibilities in general, the City has obligations to customers of Seattle Public Utilities to deliver an adequate supply of high quality drinking water, and to the customers of Seattle City Light to deliver reasonably priced electricity. Through the HCP, the City seeks to provide certainty for both current operation and future planning related to its water supply and hydroelectric utilities on the Cedar River, while providing for the conservation of species potentially affected by those public utilities.

The City's HCP was developed to offset any harm caused to individual listed and selected unlisted species by promoting conservation of populations as a whole. It specifies conservation objectives, provides for substantial monitoring and for adaptive management regarding key issues, and incorporates public participation during implementation.

This HCP is part of an application for incidental take permits for both listed species and unlisted species that are addressed by the HCP and covered by the permit. Using information included in the HCP and other information, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) conducted a biological assessment and jeopardy analysis of the City's HCP, under Section 7 of the ESA, to determine whether the proposal complies with the ESA. Pursuant to the analysis and findings by the Services, the resulting incidental take permits define the limits to incidental take of those species addressed by the HCP for which sufficient information exists to issue the permit. The permits allow limited incidental take for listed species and the equivalent of incidental take of unlisted species covered by the HCP. The City will implement the HCP to minimize and mitigate the impacts of incidental take to the maximum extent practicable.

In addition, the City has developed an HCP that should provide a net benefit for the species covered. The City's HCP should thus contribute to the recovery of any covered species that are currently listed or that could be listed during the term of the HCP, and could reduce, at least to some extent. the likelihood that some species might become listed in the future.

1.1.3 Response to Public Concerns

This HCP was under development for more than 5 years. In that time, the City has received considerable public comment, and HCPs in general have received considerable attention from scientists (Mann and Plummer 1997) and the public (Luoma 1998; Defenders of Wildlife 1998). In this HCP, the City has attempted to address many of the issues raised by scientists and the public. A draft HCP issued December 10, 1999, along with a National Environmental Policy Act (NEPA) Environmental Assessment (EA)/Draft State Environmental Policy Act (SEPA) Environmental Impact Statement (EIS) further address these concerns, for both the HCP and alternatives that were under consideration. This final HCP follows issuance of a revised NEPA EA/Final SEPA EIS.

The formal public review and comment period for the draft HCP and associated environmental documents ran from December 10, 1998 until March 1, 1999, a total of 78 days. During this period, the City conducted four public workshops that were attended by over 1,000 people, as well as two formal SEPA hearings and numerous question and answer sessions with the public. Hundreds of written comments were received on the HCP and environmental documents.

In response to these public comments, the Mayor of Seattle proposed substantial changes to the draft HCP, which were described in documents released in May 1999 for public review, concurrent with release of the revised NEPA EA/Final SEPA EIS. In June 1999, the Seattle City Council held a public hearing on potential changes to the draft HCP. In July 1999, the Seattle City Council adopted the Mayor's recommended changes by City of Seattle Resolution #29977, with some modifications to those recommendations. In December 1999, the Seattle City Council made several additional changes to the HCP as a result of meetings between the Mayor and the Muckleshoot Indian Tribe, amending the July resolution through adoption of Resolution #30091. This final HCP was prepared pursuant to instructions from the Seattle City Council regarding changes to the draft HCP in these two resolutions and to update information that changed after the time the draft HCP was issued.

1.2 Geographic Area Covered by the HCP

The "covered lands" for this HCP include all lands that the City owns on which the permit for this HCP authorizes incidental take of covered species (Section 1.4). As described in Section 1.3, the HCP applies to City activities ("covered activities") that are carried out or authorized by the City on covered lands and on any additional lands and waters to which the HCP's conservation measures apply. Such City activities include all City operations, facilities, and activities on the Cedar River in conjunction with its water supply, hydroelectric power generation, and land management activities, as defined in Section 1.3. (Note that the terms "covered lands" and "covered activities" are legal terms, which are specifically defined in the Implementation Agreement (Appendix 1)).

The covered lands include the Cedar River Municipal Watershed in Washington State, totaling approximately 90,546 acres and shown on Map 2 and Figure 1.2-2, and the Cedar

River upstream of the Landsburg Diversion Dam and water intake, as influenced by the City's operations described in Section 1.3. The Cedar River discharges into Lake Washington at the city of Renton (Map 2). City operations in the municipal watershed influence the reach of the Cedar River between the Landsburg Diversion Dam and Lake Washington, which is 21.8 river miles in length.

The City of Seattle owns essentially all of the Cedar River Municipal Watershed. Most of the watershed is forested, primarily with conifers. The approximate current age distribution of forested lands in the municipal watershed is given in Figure 1.2-1 and Map 4. Nearly 14,000 acres of the watershed is unharvested native forest, which is termed "old-growth forest" in this HCP. All of this old-growth forest is believed to be between 190 and 800 years old. Elevations in the municipal watershed range from about 550 ft to about 5,500 ft. Lower elevation forests are dominated by Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*). Middle to upper elevations are dominated by Pacific silver fir (*Abies amabilis*), and the highest elevations by mountain hemlock (*Tsuga mertensiana*).

Figure 1.2-1. Ages of forest stands in the Cedar River Watershed.

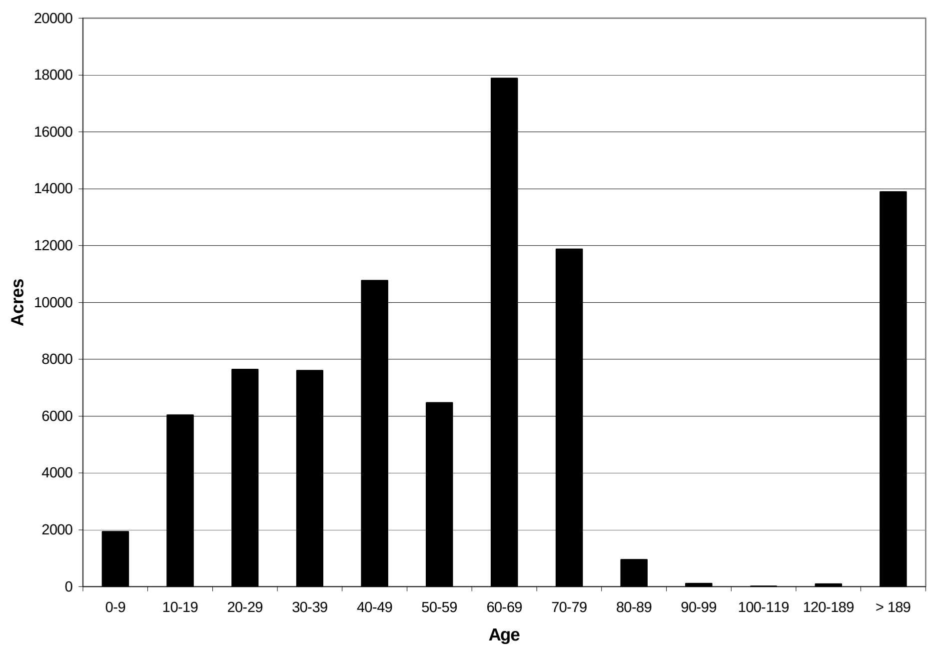
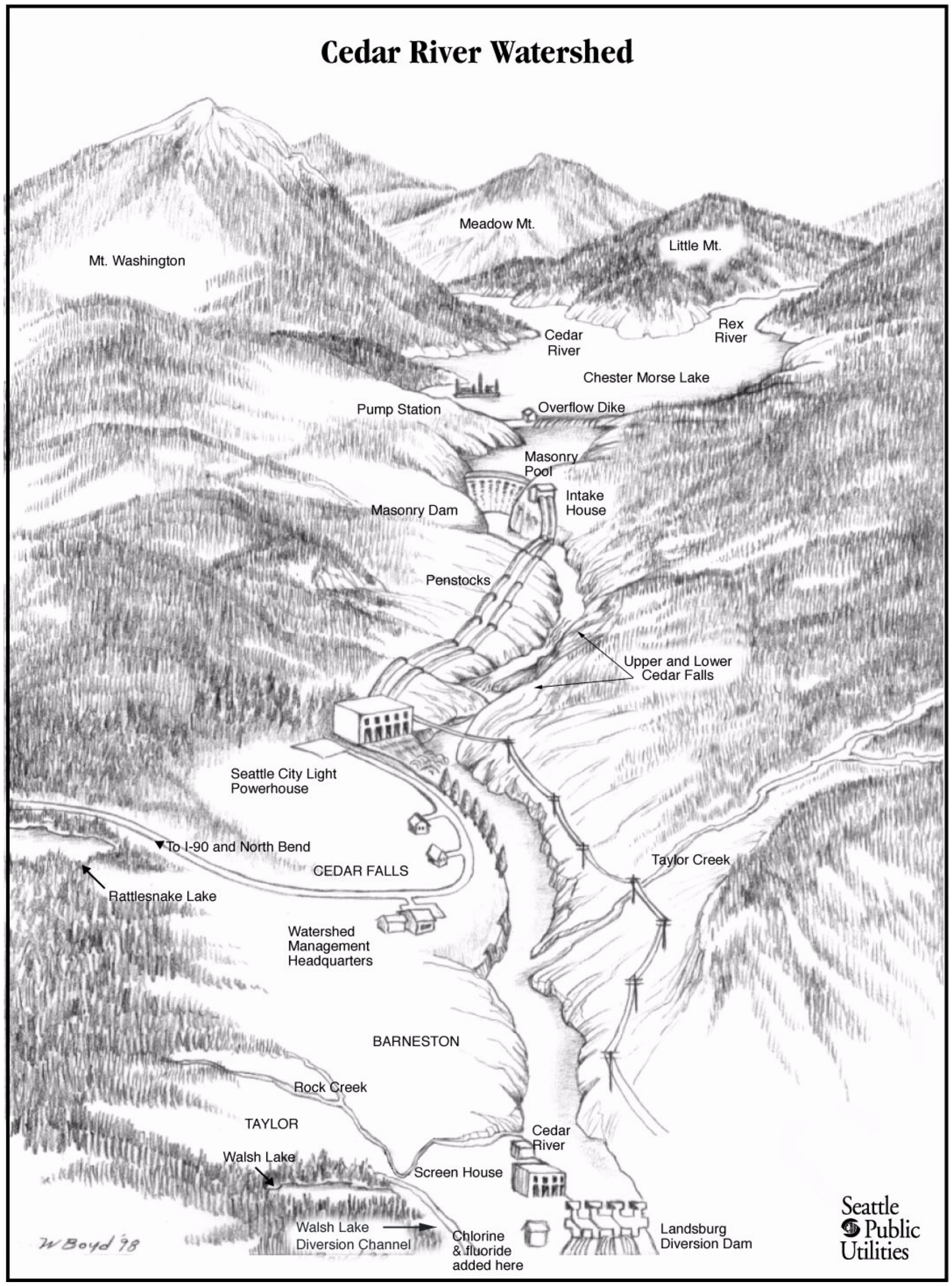


Figure 1.2-2. The Cedar River Municipal Watershed.



1.3 City Activities Covered by the HCP

Covered activities for the HCP include activities carried out or authorized by the City on Covered Lands (Section 1.2) and on any additional lands and waters to which the conservation and mitigation measures in the HCP apply. Covered activities include all City operations on the Cedar River in conjunction with its water supply, hydroelectric power generation, and land management activities, including all attendant facilities at the Landsburg Diversion Dam and within the municipal watershed, but not facilities outside the municipal watershed. Seattle Public Utilities manages the water supply, with its attendant facilities, as well as the land in the municipal watershed. Seattle City Light manages the hydroelectric plant, with its attendant facilities, in conjunction with water supply operations.

Water supply activities include management of the reservoir complex, including the Overflow Dike, which impounds Chester Morse Lake, and the Masonry Dam, which impounds the Masonry Pool to the west of the lake (Map 2; Figure 1.2-2). Water is withdrawn from the Cedar River for municipal and industrial supply, including aquifer recharge, just upstream of the Landsburg Diversion Dam at the water intake operated by Seattle Public Utilities. The intake for the City's hydroelectric power plant is located at the Masonry Dam, and the plant is located downstream at Cedar Falls, within the municipal watershed. The Masonry Dam, Overflow Dike, and Landsburg Dam are operated conjunctively for water supply, hydroelectric power generation, flood control, and instream flow maintenance. Water supply activities include operation and maintenance of water diversion, water treatment, and fish handling and artificial propagation facilities located at Landsburg.

The application of the term "covered activities" as it applies to the waters downstream of Landsburg is restricted specifically to the impacts of City operations and facilities on species using those waters and covered by this HCP, and does not apply to the impacts of activities by other public agencies or private parties.

In general, covered activities downstream of Landsburg include mitigation, conservation, research, and monitoring activities carried out under the HCP and the related agreements (an Instream Flow Agreement and a Landsburg Mitigation Agreement, Appendices 27 and 28, respectively). Covered activities do not include operation and maintenance of facilities used to transmit, treat, and distribute water after it is diverted and treated at Landsburg. Covered activities do not include water supply activities associated with sources of supply other than the Cedar River, other than Cedar River operations that are needed to conjunctively operate the multiple sources of supply.

Covered municipal watershed management activities include forest practices as described in the Washington State Forest Practices Act (RCW 76.09) and Forest Practices Rules and Regulations (WAC 222-08), including timber harvest, thinning, reforestation, and mechanical brush control; repair, reengineering, decommissioning, and maintenance of forest roads, including use of gravel pits and other rock sources, as well as maintenance and replacement of culverts and bridges; and sale of forest products. Construction of new watershed roads is also a covered activity, provided that no more than 5 miles of new roads are constructed, and provided that there is a net reduction in total road miles in the municipal watershed.

Other covered watershed activities include actions to protect and restore watershed habitats, both aquatic and upland; cultural resource management and educational programs within the municipal watershed, including a public tour and field trip program and construction of educational and cultural facilities such as the planned educational resource center at Cedar Falls; scientific research, both by City staff and outside scientists; a public recreation program at several locations; and other activities or facilities identified elsewhere in this HCP. Educational and recreational activities in the municipal watershed are considered covered activities under the HCP, provided that such activities do not materially increase levels of take from those existing at the time of permit issuance. Additional details of many Covered Activities within the municipal watershed are given in Section 4.2.2, in the subsection entitled “City Operations and Activities within the Municipal Watershed.”

The *evaluation* of the potential permanent use of dead storage in Chester Morse Lake for enhanced instream flows and future water supply (Section 4.5.6) is a covered activity under the HCP and incidental take permit, but the Cedar Permanent Dead Storage Project itself (Section 4.4.2) is not a covered activity. Implementation of the Cedar Permanent Dead Storage Project would require an amendment to the incidental take permit under Section 12.2 of the Implementation Agreement (Appendix 1).

During the term of the HCP, facilities within the municipal watershed, including facilities at Landsburg, may be significantly modified, reconstructed, or constructed by the City for reasons that do not relate to the conservation and mitigation measures in the HCP. The City agrees to notify the Services prior to such currently undescribed construction activities if there is a potential for take of Covered Species (Section 1.4) and to consult with the Services regarding measures to avoid or mitigate take. The City agrees to notify the Services prior to such construction activities related to the Masonry Dam, hydroelectric facilities, and the water intake at Landsburg, and prior to construction of any new bridges over the Cedar River between lower Cedar Falls and Landsburg.

1.4 Species Covered by the HCP

1.4.1 Species Addressed in the HCP

The City’s HCP addresses 83 species, including all 7 species currently listed as threatened or endangered and 76 unlisted species that could be listed as threatened or endangered during the term of the HCP. All these species either are known to use or may use the types of habitat that are found within the boundaries of the covered lands or that are under the influence of the covered activities. As described below, the incidental take permit will include all of these species that are adequately addressed in the HCP and for which sufficient information exists. Species included on the incidental take permit are referred to as “Covered Species,” as described below. Species addressed in the HCP but not included on the incidental take permit are termed “Plan Species,” as described below in Section 1.4.2 and in the Implementation Agreement (Appendix 1).

Currently listed species that are known to occur in the municipal watershed include the northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), bull trout (*Salvelinus confluentus*), and bald eagle (*Haliaeetus leucocephalus*). Currently listed species that may occur, but are not known to occur, in the municipal watershed include the grizzly bear (*Ursus arctos*), gray wolf (*Canis lupus*), and chinook salmon (*Oncorhynchus tshawytscha*), which now occurs in Cedar River below the Landsburg Diversion Dam and will likely occur within the municipal watershed after fish passage facilities are constructed under the HCP.

The HCP includes habitat-based conservation and mitigation strategies for all species addressed in the HCP (Chapter 3), and species-specific conservation and mitigation strategies for the 14 species of greatest concern, which include all currently listed species. As described in Chapter 3, the species addressed in the HCP include resident and anadromous salmonid fishes, and a variety of amphibians, birds, mammals, and invertebrates.

1.4.2 Covered Species and Post-termination Mitigation

During the public review of the HCP and the review of the City's application for an incidental take permit, the Services made a determination that all of the 83 species addressed in the HCP could be included on the incidental take permit (i.e., the Covered Species). Covered Species are listed in Exhibit A to the Implementation Agreement (Appendix 1). This determination of the list of Covered Species was based on whether sufficient information exits for each of the 83 species and whether the HCP adequately addresses each species under the ESA.

During their review of the City's application for an incidental take permit, the Services prepared biological opinions for the Covered Species. During their review, the Services identified in the biological opinions any species for which the HCP could not be shown to provide a continuous net conservation benefit. If the incidental take permit is suspended or revoked under terms of the Implementation Agreement, the Implementation Agreement (Appendix 1, §§ 6.3 and 6.4) provides that no post-termination mitigation can be required for any species for which it can be shown that HCP will provide a continuous net conservation benefit (termed "pay-as-you-go" species). For species that do not qualify as "pay-as-you-go," post-termination mitigation may be required if the Services demonstrate that any take of such species at the time of termination has not been substantially mitigated according to permit conditions. Species addressed in the HCP that the Services determined to qualify as "pay-as-you-go species" are listed in Exhibit B to the Implementation Agreement (Appendix 1).

1.5 Adjacent Ownership

The properties immediately adjoining the 80-mile boundary of the Cedar River Watershed remain largely in timberland (Map 3). Two current trends on these adjoining properties have special significance for the HCP.

First, along nearly the full length of the watershed's northern boundary, recent and proposed property transactions are consolidating public ownership of the properties adjoining the watershed. Under the overall auspices of the Mountains to Sound Greenway Project, a highly visible civic forum and planning process, various public and private parties have taken bold steps to preserve a mostly forested corridor along Interstate 90 between the edge of the metropolitan area (near Issaquah) and the crest of the Cascade Mountains. More specifically, King County has acquired a large tract at the northwestern end of the watershed (the Mahnke property) from a private developer and intends to manage it as a working forest. King County and the state have jointly acquired portions of Rattlesnake Ridge, on the northern boundary of the watershed northwest of Rattlesnake Lake. This 1,800-acre area is called the Rattlesnake Mountain Scenic Area, and is managed by the County. Finally, the U.S. Forest Service (USFS) has acquired many of the inholdings in its "checkerboard" ownership along the watershed's northern and northeastern boundary through the Huckleberry Land Exchange with Weyerhaeuser, and may acquire more land in this area in an exchange with Plum Creek Timber Company.

Most of the southern boundary of the watershed adjoins the Green River Watershed, the source of Tacoma's water supply. Although in multiple ownerships, this property is managed under agreements designed to give protection to Tacoma's water supply.

Although, the significant trend of consolidation in public ownership will generally increase recreational activity near the watershed, a change that can be managed in terms of the City's access concerns, it also portends more compatible land use on adjacent properties compared with the two most likely alternative scenarios: industrial forest management and development. From the standpoint of the HCP, consolidated public ownership along the northeastern edge of the watershed should have a positive long-term effect of maintaining and improving connectivity between the important habitat areas north and south of the I-90 corridor. This connection is presently narrow along an east-west axis, and still partially in checkerboard ownership, and may otherwise pose a limitation on the migration of wildlife along the north-south alignment of the Cascade Mountains. Similarly, recent public acquisitions along the northwestern boundary of the watershed should preserve and enhance habitat linkages to the Tiger Mountain area.

The second major trend on adjacent lands is along the western and southwestern boundary, where timberland and pastures are generally being converted to residential development. While this trend will pose challenges for watershed protection programs, it only accentuates the importance of the commitments to preserve habitat within the municipal watershed as growth and development in the metropolitan area pushes eastward and envelops the lower end of the watershed.

The City's HCP also covers effects of the City's facilities and operations upon the flows in the Cedar River downstream of the Landsburg Diversion Dam. In contrast to the single ownership and highly protected habitat along the river in the municipal watershed, the 22-mile reach from Landsburg Dam to the river's mouth at Renton is in many ownerships and jurisdictions and has been substantially manipulated by humans. Some 64 percent of the stream course has been armored by rip rap or diking or both, and some of it has been rechanneled. Over the years, these modifications have allowed considerable development in the historical floodplain in the form of residences and other structures, as well as public facilities. While King County exercises the primary planning role in this area, the river flows through the City of Renton, and lands adjacent to the river are in hundreds of individual ownerships. In this highly diffused context, programs of habitat improvement are expected to be difficult to coordinate and implement.

1.6 Content of HCP Document

This HCP sets forth commitments by the City with regard to (1) watershed management and restoration; (2) anadromous fish mitigation (for blockage to fish passage at the Landsburg Diversion Dam); (3) instream flows; and (4) monitoring and research. The City commits to fund the activities in the HCP at a total of approximately $79 million, in 1996 dollars, over the life of the HCP.

The remaining chapters in this document describe the context for development of the HCP; information used to design the conservation strategies; the conservation and mitigation strategies for the covered species; the manner in which monitoring and research are used to address uncertainties; the manner in which the public and outside scientists will be involved in implementation of the plan; and the alternatives considered. The following is an overview of the content of the remainder of this HCP.

Chapter 2 (Planning context) provides background on the context in which this HCP is being prepared. It describes current standards and conditions that apply, existing plans, applicable constraints on the City, and planning objectives that can be used as benchmarks with which to understand and compare the proposed conservation strategies. Chapter 2 provides information on:

- City responsibilities with respect to water supply, watershed management, and related operations on the Cedar River;
- Applicable laws and regulations, including the ESA, related to drinking water, fish and wildlife, and forestry; and
- Pertinent City ordinances, environmental initiatives, and regional efforts related to fish and wildlife.

Chapter 3 (Biological Data and Other Information Used to Develop the HCP) provides information that the City used to prepare the HCP, including information about the species and habitats addressed in the HCP, both in the region and within the Permit Area. This information, along with the objectives and constraints described in Chapter 2, provides the basis for the mitigation and conservation strategies presented in Chapter 4. Chapter 3 provides:

- Descriptions of existing habitats in the municipal watershed and Cedar River below Landsburg Dam;
- Information from the literature on the life history, habitat needs, and status of the species addressed by the HCP;
- Information about the municipal watershed, including studies, analyses, assessments, and technical workshops, and the results of habitat inventories and surveys for particular species in the watershed;
- Descriptions of inventories and databases used;
- Descriptions of modeling efforts related to stream flows and forest management; and
- Results of analyses of drinking water quality risks needed to develop mitigation strategies for anadromous fish species.

In addition, the review of information identifies significant uncertainties that are addressed either in the mitigation and conservation strategies, in the research and monitoring program described in Chapter 4, or in the adaptive management process described in chapters 4 and 5.

While chapters 1 though 3 present background information for the HCP, chapters 4 and 5, exclusively, represent the City’s commitments under the ESA. Chapter 4 (Conservation and Mitigation Strategies) presents the conservation and mitigation strategies for the species and habitats addressed in the HCP. It provides the rationale for those strategies in view of the objectives of the HCP and the information used, explaining how the strategies will avoid, minimize, or mitigate take of covered species. Chapter 4 presents:

- Conservation and mitigation strategies for species and habitats that are, or may be, present in the Cedar River Municipal Watershed;
- Conservation and mitigation strategies for anadromous fish species downstream of the Landsburg Diversion Dam with respect to regulation of instream flows to provide habitat;
- Conservation and mitigation strategies for anadromous fish species related to the blockage to upstream passage posed by the Landsburg Dam, including mitigation for four species;
- A monitoring program designed to track compliance, effectiveness of mitigation strategies, and trends in the condition of habitats and key species populations;
- A research program designed to answer key questions, provide needed information for future decisions, and test important assumptions underlying conservation strategies; and
- A summary of effects of the HCP and the activities allowed under the incidental take permit.

Chapter 5 (Implementation of the HCP) provides information on implementation of the HCP, including information on:

- The term of the plan and timing of activities;
- Funding and management of costs;
- Oversight, with involvement of the public and outside scientists; and
- The process for implementing adaptive management.

Chapter 6 (Alternatives to the Proposed Taking) presents an overview of alternatives to the proposed taking that were considered, and the reasons why each of the alternatives was not pursued.

All literature references cited in the text are described in the Bibliography.

The Glossary defines many technical terms used in the text, and defines how other terms are used specifically for this HCP.

The Technical Appendices provide substantial additional information relevant to the HCP. Appendix 1 (the Implementation Agreement) is bound with this HCP, but all other appendices to the HCP (2-38) are bound as a separate document entitled “Technical Appendices for the Cedar River Watershed Habitat Conservation Plan.” These appendices include the results or summaries of the results of key studies, analyses, assessments, data compilations, and workshops. Topics include anadromous and resident fish, water quality, fish and wildlife habitat, species surveys, environmental studies, reservoir operations, instream flow modeling, facility designs, and pertinent City ordinances and planning documents. Eight new appendices were added to the 30 technical appendices issued with the Draft HCP.

Color maps are included in a separate map document entitled “Resource Maps for the Cedar River Watershed Habitat Conservation Plan.” The number of maps was reduced from the original draft, which included maps for the alternatives addressed in the NEPA EA/SEPA EIS.

Numerous supporting documents were used to develop the HCP, but their number and bulk precluded distribution with the HCP and appendices. A list of some of these documents is provided in the front material to the HCP.

1.7 Alternatives To The HCP

As discussed in detail in Section 2.3.3, evaluation of alternatives to the HCP is required under Section 10 of the ESA and also as part of environmental review requirements under both NEPA and SEPA. Alternatives to the proposed taking for the watershed management, anadromous fish mitigation, and instream flow components of the HCP are discussed in Chapter 6. In addition, Chapter 6 also summarizes the reasons why implementation of these alternatives is not being pursued. Detailed descriptions and analyses of alternatives evaluated under NEPA and SEPA can be found in the “Draft Environmental Assessment/Environmental Impact Statement for the Cedar Watershed Habitat Conservation Plan” (SPU 1998) and in the Revised NEPA EA/Final SEPA EIS (SPU 1999). As described further in Chapter 2, the Environmental Assessment is the federal environmental document prepared under the National Environmental Policy Act, for which the USFWS is the lead agency. This same document also serves as an Environmental Impact Statement under the State Environmental Policy Act, for which the City is the lead agency.

2. PLANNING CONTEXT

Chapter 2 Contents

2.1 Introduction to Planning Context

Chapter 2 provides background on the context in which this HCP was prepared. It describes current standards and conditions that apply, existing plans, applicable constraints on the City, and planning objectives for the HCP. This information can be used to develop benchmarks with which to understand and compare the proposed conservation and mitigation strategies presented in Chapter 4.

Chapter 2 provides several kinds of information. Background information is given on City responsibilities and activities in terms of supplying water and electricity from facilities on the Cedar River; regulating stream flows in the Cedar River through water diversion and dam operation; and managing the municipal watershed. Information is given on current water supply yield, water supply planning, water conservation, and Seattle Public Utilities' (SPU's) customer base. Some historical information is given on managing river flows and the municipal watershed.

The Endangered Species Act and related federal, state, and local laws are described in the context of the City's broad planning objectives for the HCP, which are described at the end of this chapter. Related laws include state laws pertaining to blockages in streams that prevent fish passage, the Safe Drinking Water Act, the State Forest Practices Act, and City ordinances pertaining to watershed management and anadromous fish.

Existing City initiatives related to fish and wildlife, as well as related regional initiatives, are described to provide context for the HCP. The HCP builds upon these efforts, some of which were initiated more than a decade ago.

2.2 Responsibilities of the City of Seattle

2.2.1 Introduction

The City of Seattle is responsible for providing a safe and adequate supply of water to the homes and businesses in the City and, through supply contracts with other jurisdictions, to most of the metropolitan area. This responsibility is accompanied by very high standards of water quality for protection of public health and reliability in meeting a wide range of basic needs, including fire protection and many residential and commercial uses. The City is also responsible for providing reliable electric service to residents and businesses in Seattle and adjoining areas. The City is obligated to provide these basic services at a fair and affordable cost. In addition, because of the actual and potential impacts that its water supply and hydroelectric generation facilities and operations have on the environment, the City is required by laws and established policy to minimize such impacts through very high standards of environmental protection, restoration, and other mitigation.

To meet its water supply responsibilities, the City owns and operates a complex system of water storage, treatment, transmission, and distribution facilities. In addition to its first and largest source of supply on the Cedar River, the City has added other sources and water system facilities to meet growing needs in the metropolitan area. In the early 1960s, a second major surface water source was constructed on the South Fork Tolt

River, and in 1987 the Highline Well Field went into service to provide additional capacity for seasonal peaking and emergencies. The City provides retail water service through an 1800-mile distribution pipe network to approximately 595,000 residents as well as businesses within the city limits and certain adjacent areas. In addition, the City provides wholesale water service under long-term contracts to 26 neighboring cities, towns, and special districts. These individual water utilities together distribute water to approximately 690,000 residents as well as businesses within their service areas.

To meet its electric service responsibilities, the City generates hydroelectric power from its own facilities and purchases power generated elsewhere. In this overall supply context, the City's Cedar Falls hydroelectric plant in the Cedar River Municipal Watershed generates about 1 percent of the electricity in the City's system. Because this plant is small, and because its storage facilities are used jointly for water supply purposes and are operated primarily to meet water system and stream flow needs, most of the discussion in this section and the HCP in general relates to the water supply system. In those cases where facilities used solely for hydroelectric power generation (the tunnel and penstocks from the dam and the power plant itself) constitute potential or actual impacts on habitat conditions, those facilities and their operations and impacts are discussed.

To meet its responsibilities for environmental protection, the City strives to integrate its strong environmental values into all aspects of its activities, including facility construction and operation, through specific policies and programs. In 1989, following a major public planning process, the City adopted management policies for the Cedar River Municipal Watershed that preserve the remaining old-growth forest, lead to significant restoration of streams and upland areas damaged by historical logging practices, and greatly expand then-existing research, monitoring, and environmental education programs (Section 2.3.10). In addition, the City has implemented an aggressive water conservation program that includes a combination of investments in water saving improvements (e.g., low volume toilets), water system improvements that reduce losses, rate design changes that increase incentives to conserve, and public education initiatives on both the importance of conservation and methods to achieve it (see Appendix 9). Between 1990 and 1995, conservation programs reduced water demand by about 8 percent, and conservation savings are expected to exceed 20 percent by 2005 (Appendix 9). The remainder of this section describes in further detail how the City's responsibilities for water supply and environmental protection come together to form the context for this HCP.

2.2.2 Ownership and Management of the Cedar River Municipal Watershed

The City of Seattle began diverting water from the Cedar River in 1901 to meet its municipal and industrial water supply needs. This water source was attractive to the emerging city because it provided a gravity water supply, especially important following the Great Seattle Fire of 1889, and because its then-remote location on the western slopes of the Cascades provided a very high quality source of water. From the outset, the City pursued available opportunities to protect the watershed and source water quality and to minimize water treatment requirements and costs. Such early measures included sanitary restrictions through land acquisitions and agreements with other land owners, fire control programs, and municipal reforestation programs. The Cedar River Municipal Watershed was essentially closed to unsupervised access in about 1917, and the last inhabitants who were not City employees left the watershed in 1946. Throughout this period and beyond, the City continued to acquire fee ownership of watershed properties from homesteaders, private timber companies, and other governments. In 1996, through a large land exchange with the U. S. Forest Service (USFS), the City increased its watershed ownership to over 90,500 acres, or essentially all of the land within the hydrographic boundary upstream of its water supply intake, as well as additional land outside the hydrographic boundary needed for overall watershed protection.

Today, the watershed remains closed to unsupervised access. The entire perimeter is posted against trespass and patrolled by a staff of watershed inspectors, and all points of road entry are gated and locked. Those portions of the boundary located near residential development and public roads are fenced. A permit system, with strict sanitary and other protective requirements, is used to administer access under policies based on state and federal drinking water protection requirements and the City's watershed management policies. As a result, and particularly with unrelenting eastward development of the metropolitan area, the watershed has become an important forest refuge for many species of fish and wildlife, and the Cedar River that flows from it provides high quality water for fish populations downstream.

2.2.3 Water Supply and Hydroelectric Power Generation Facilities

The original configuration of the Cedar River supply system included a diversion dam (1900) at Landsburg, 21.8 miles upstream from the present outlet of the river into Lake Washington, and a timber crib dam (1902) located immediately downstream of the natural outlet of Cedar Lake, later renamed Chester Morse Lake (Figure 1.2-2; Map 2). In 1914, Masonry Dam was completed approximately 2 miles downstream of the crib dam. Major elements of the diversion dam were reconstructed during the 1930s, and the timber crib dam was replaced in 1988 by a structure of more modern construction, now known as the Overflow Dike. In 1987, a large emergency spillway was constructed in this 215-ft high Masonry Dam.

Since its original construction in 1900, the Landsburg Diversion Dam has blocked upstream passage of anadromous fish. The Masonry Dam and the Overflow Dike are both located upstream of natural barriers to fish passage (lower and upper Cedar Falls; Figure 1.2-2).

The diversion dam at Landsburg is operated in a run-of-river mode, passing all flows over the dam in excess of water supply needs. During periods of high turbidity in the river, or during facility maintenance, diversion may cease altogether. The dam is too small to provide significant storage. However, operators at the facility can manipulate the gates and intake valves to achieve some flow re-regulation, such as dampening peaks or mitigating downramping events that could strand young fish on gravel bars.

The reservoir formed behind Masonry Dam is called Masonry Pool. Water levels in Masonry Pool can fluctuate between elevations 1500 and 1570 ft. The pool is at its lowest during late summer and early fall, especially during drought conditions, and may approach 1570 ft during severe storm and runoff events in the fall and winter. At water levels above elevation 1546 ft, which is the elevation of the spillway crest of the Overflow Dike, Masonry Pool and Morse Lake form a single body of water. When 4-ft high flashboards are in place in the spillway of the Overflow Dike, the two reservoirs can be separated up to elevation 1550 ft. Separation of the two reservoirs retains more water in the Cedar River system by reducing the amount of seepage from Masonry Pool (see below). These reservoirs provide the significant storage needed to provide reliable year-round supply for instream and out-of-stream uses. In addition to the water readily available through gravity flow from these reservoirs, Chester Morse Lake contains a significant amount of water below the level of its outlet (approximately elevation 1,532 ft). In severe droughts or system emergencies, this water can be tapped using temporary pumps mounted on barges anchored near the Overflow Dike.

Facilities used specifically for the hydroelectric power generation project include a powerhouse and the means to convey water to it from the Masonry Dam. The powerhouse contains two 20,000 horsepower turbines and two generators that, together, have a peak capacity of 30 megawatts. The maximum flow through each unit is 350 cfs. Each unit is also equipped with an emergency bypass gripper, which provides flow continuation under most emergency shutdown situations. Under the powerhouse, each turbine returns flow to the river through a concrete walled tailrace. Water is conveyed to the powerhouse from the Masonry Dam first through a gate house at the dam, and then through an 11-ft diameter concrete-lined tunnel and two 7,500-ft long, 78-inch diameter steel penstocks (Figure 1.2-2).

The hydroelectric power plant operations are generally subject to the needs of water supply, instream flows, and flood control. When the turbines are operated, they run in a flow-stable mode and do not follow electrical loads. During periods of low flows, the Cedar Falls Powerhouse is shut down.

Impacts from prior construction and current operation of the hydroelectric project include changes to the river channel downstream of Masonry Dam (because of an altered flow regime and loss of gravel recruitment), fish entrainment into the project intake at Masonry Pool, lower flows and reduced aquatic habitat in the bypass reach (between the powerhouse and Masonry Dam), and injury to upstream migrants at the powerhouse tailrace. The HCP contains measures that reduce or mitigate for these potential impacts on fish habitat.

Water can be released from the upstream reservoirs in various ways. Most commonly, releases are made through the hydroelectric power plant. When the need arises to release more than the flow capacity of the hydroelectric plant, a 48-inch diameter Howell-Bunger valve located at the base of Masonry Dam can be operated. During flood events, still higher flows can be released through the service spillway or emergency spillway gates at Masonry Dam. Water stored in Masonry Pool also seeps into a natural moraine aquifer at rates that are dependent on water levels in the reservoir. The majority of this seepage flow eventually finds its way back to the Cedar River, but some is lost to the Snoqualmie River Basin.

2.2.4 Management of the Reservoir

Reservoir operating levels follow an annual cycle, which is presented in its most simplified form here. For clarity, this discussion describes Masonry Pool and Chester Morse Lake as a single reservoir.

The water year begins on October 1st, when the reservoir is typically near its lowest elevation (Figure 2.2-1). Releases from the reservoir are made to provide adequate instream flows and water supply. With the return of the fall rains, typically in November, the reservoir level rebounds, and the management of the reservoir is driven more by flood risk. Throughout the winter, reservoir levels are intentionally held up to about 17 ft below the summer target refill level to maintain a volume capacity, or flood pocket, to be able to absorb storm runoff. The volume of the actual flood pocket varies by year and date. The flood pocket that is maintained at any given time depends on a variety of factors, including recent and expected hydrological conditions, such as storms; current snowpack; projected water supply conditions; downstream water and flow needs; and other meteorological, hydrological, and system conditions.

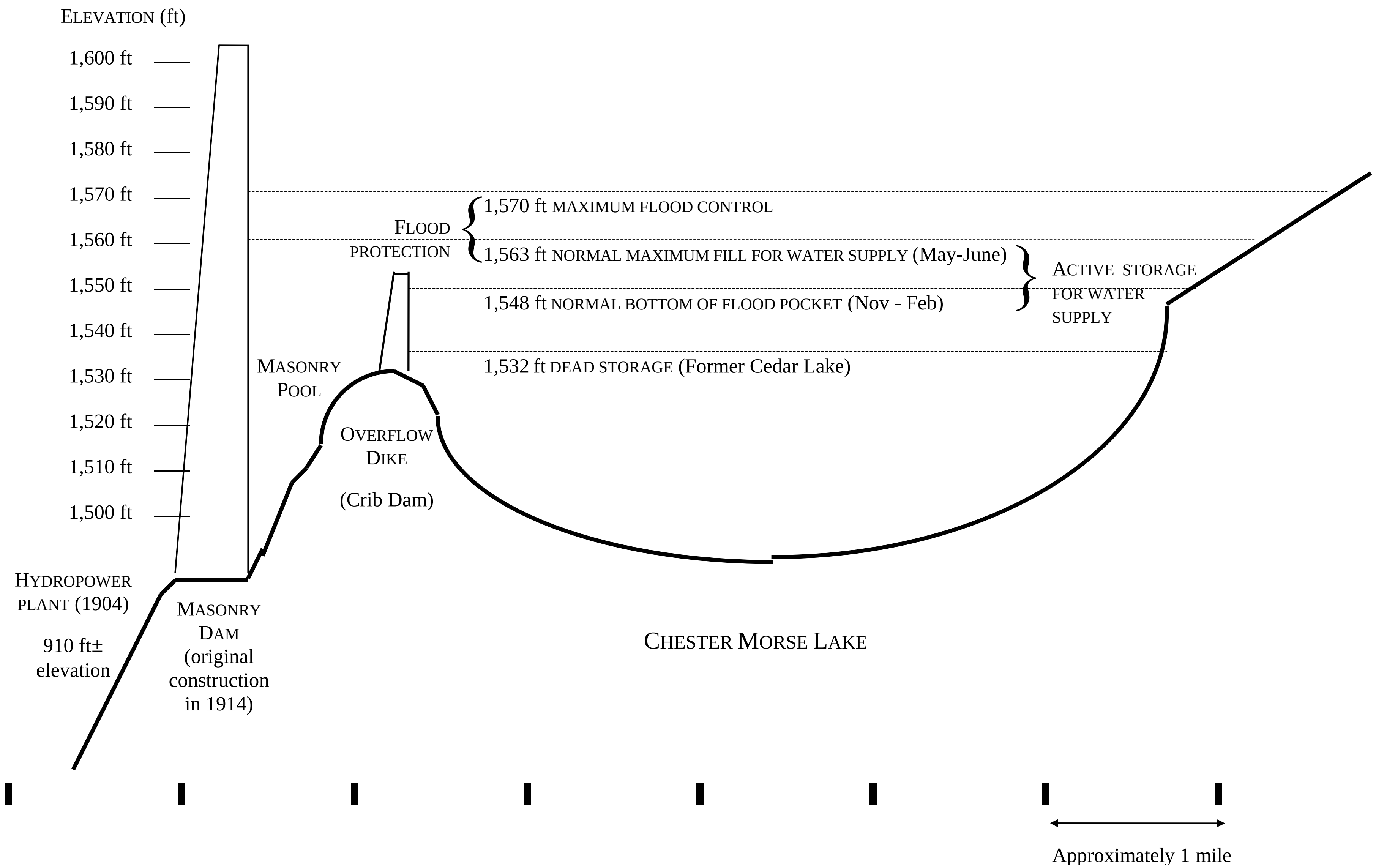
The spring refill period occurs between March and June, and is dependent on catching the spring snow water runoff from the mountains. Ideally, summer begins with a full reservoir. The reservoir is considered full if the elevation of the lake on or around June 1 is between 1560 and 1563 ft. Because of concerns over leakage and stability of the moraine, higher lake elevations are maintained only during relatively short flood events. As the summer progresses, reduced natural inflow to the reservoir and increased water consumption cause the reservoir level to drop. By fall, chinook and sockeye salmon spawning require increased streamflows, often necessitating significant releases from storage.

Management of the reservoir involves a continuous process of determining the amount of water to be released and the reservoir level to be attained. The decision-making process involves the recognition of the multiple objectives that the project strives to meet. The City operates these facilities primarily not only as a water supply source but also as a hydroelectric power supply project. Another operating objective is to maintain target instream flow levels to benefit downstream fish populations, even when water releases from storage must be employed to serve this purpose. Fish and wildlife species resident in the reservoir are also considered, as reservoir levels and fluctuations can affect them. Flow into Lake Washington and its water control facilities at the Ballard Locks are other key considerations. Finally, although the dams were not financed or built for flood control purposes, dam management strategies include flood control operations to benefit the lives of people and their property, as well as fisheries resources, downstream of the dams. These multiple objectives result in competing purposes for the limited amount of water storage behind the City's dams during any given season. Reservoir and river operations form the backbone of managing the region's water supply. These operations are particularly challenging because of three defining aspects of Seattle's supply system: (1) the system must be operated to meet multiple objectives, not just water supply; (2) there is a tremendous amount of hydrologic uncertainty that must be managed; and (3) the system, and people and animals dependent on it, have significant vulnerability to adverse conditions resulting from natural events or failures in managing the system well.

It is because all three of these defining aspects are present that management of the system is as challenging as it is. If any one of these three aspects did not exist, water supply management would require much less balancing of competing needs, less precise operation, less reliance on forecasting skill, and less tightly linked planning, policy, and operations. For example, if the sole objective of the system were to provide drinking water supply, rather than the actual multiple objectives, even the challenges presented by hydrologic uncertainty and the vulnerabilities of the sole beneficiaries (the water supply customers) could be largely mitigated by operating the system to optimize for the single purpose. In another example, if the water system had greater capacity and flexibility (e.g., enormous reservoirs, supply well in excess of demand), and its beneficiaries and downstream fisheries were less vulnerable, then the existence of multiple objectives and uncertain hydrology would not matter as much. In reality, the storage capacity of the reservoir is relatively small in comparison to the size of the contributing watershed.

Finally, if the hydrology affecting the system were perfectly predictable, the system could, in turn, be operated with certainty. In this imaginary world of hydrologic certainty, the tension between competing uses, as well as the vulnerabilities of users and fisheries to adverse conditions, would be much less an issue because operations planning would not have to accommodate possible but unlikely extreme events like droughts, floods, and poor snowpack. Water availability could be maximized (increased), therefore water allocation would be less contentious, and risk would be reduced.

Figure 2.2-1. Reservoir levels.



Reservoir management, then, is an ongoing process of balancing multiple objectives under changing and uncertain conditions. The HCP contains many commitments by the City that impose more systematic ground rules and safeguards in this ongoing process.

2.2.5 The City's Water Claim and its Relationship to Instream Flows

When the City first began to divert water from the Cedar River in 1901, Washington State was still 16 years away from adopting its first statutory water code. Thus, at the time Seattle's Cedar River water rights were first established, the common law doctrine of prior appropriation governed water rights matters. Eventually the state established both a permit process for granting new water rights, and an adjudication process for resolving disputes concerning such attributes of water rights as quantities and priority dates. In accordance with a new claim registration statute enacted in 1967, the City documented its water claim on the Cedar River in 1974, indicating a priority date of 1888 and a right to divert an annual average of up to 300 million gallons per day (mgd) for municipal and industrial use, with daily diversions that could exceed 300 mgd at certain times of the year. However, like most water right claims in Washington state, the City's claim has not gone through an adjudication process, which is a legal proceeding where the court determines if a water right is valid and vested.

A statute enacted in 1969 first authorized the state water management authority (now the Department of Ecology) to establish minimum water flows to protect fish. Such flows are established through promulgation of regulations, but the legislature stated that they "shall in no way affect existing water and storage rights and the use thereof." (RCW 90.22.030.)

In 1979, the WDOE established by rule an instream flow regime for the Cedar River (WAC 173-508-060). Despite its position that its water right is, by virtue of its seniority, superior to the minimum flow established by WDOE in 1979, the City is committed to ensuring that Cedar fisheries are protected. As indicated elsewhere in this HCP (see sections 2.3.9 and 3.3.2), the City has been working for the last decade with federal and state resource agencies, and the Muckleshoot Indian Tribe, to develop a technically based instream flow regime for the Cedar River. The City and other parties to the Instream Flow Agreement that is part of this HCP (Appendix 27) wish to resolve remaining technical differences about what flows are appropriate, and to establish long term certainty for purposes of both resource protection and water supply planning. While attempting to reach agreement on long-term flow regime, the City has, in recent years, attempted to follow the 1979 WDOE flow regime, both as a water supply planning assumption and as an operating target.

Sections 2.3.9 and 3.3.2 provide more detailed discussions on past instream flow studies and regulations.

2.2.6 Firm Yield

One of the City's objectives for this HCP is to develop an instream flow regime that improves habitat conditions in the Cedar River and, at the same time, protects the City's existing water supply capacity on the Cedar River and enables the City to continue meeting its municipal and industrial water supply responsibilities. The City, like other water suppliers, most typically measures its source capacity in terms of "average annual firm yield." This intentionally conservative measure is used as a planning tool to represent the volume of water that would be reliably available under all but the very most adverse circumstances from a given source or network of sources (when conjunctive use of multiple sources is possible). The average annual firm yield is the amount of water that can be firmly counted upon for availability when doing source development planning. Comprehensive water system planning also seeks to make efficient use of non-firm supply capacity, which is available at a lower standard of reliability, and can be used, in some circumstances, for backup and emergency sources, as well as for occasional uses, such as groundwater recharge.

Average annual firm yield is, more precisely, the average daily quantity of water *reliably* available throughout the year for water supply purposes under defined system operations and constraints. "Reliably available" means that it would have been available on a continuous basis in 98 percent of the years for which we have hydrologic and meteorologic records (about 64 years), and thus can be projected to be available in the future with the same frequency, assuming that the variability of future weather and hydrologic conditions matches past conditions. A minimum streamflow requirement would be one of the operational constraints that is factored into the firm yield calculation, because it places constraints on a utility's ability to divert water. Such streamflow requirements are typically expressed as river flows that must be met in the river at a specified location, or measurement point.

The minimum amounts, and the frequency of years over the long term at which specified amounts must be present at those locations, can vary among different flow agreements depending on the specifics of how the flow requirements are established. In some recent minimum flow regimes, including the 1979 WDOE rule for the Cedar River described above, dual sets of flow requirements are established. One set of streamflows applies in "normal" years – i.e., under the hydrologic conditions which can be expected to occur in 90 percent of years -- and another set applies for "critical" years – i.e., for the remaining 10 percent of years when the most adverse conditions prevail. The flow regime proposed for the Cedar in this HCP reflects this normal/critical approach, as well as other features to benefit fish that capitalize on hydrologic variability.

It is important to note what average annual firm yield as a planning tool is *not*.

- It is *not* a predictor of the total amount of water that would be available in any one year. Additional water, above the amount of average annual firm yield, would always be available except in a worst-case year, and that is an important feature of this measure as a planning tool.

- It is *not* a predictor of real time operations. This concept is a planning tool that is the product of a computerized model that benefits from perfect hindsight of 65 years of weather. It therefore does not represent the real-time operating uncertainty resulting from the unpredictability of such things as when fall rains will come, what the winter snowpack will be like, or whether a larger or smaller flood pocket will be needed.

- It is *not* a predictor of how often water use restrictions will be needed. Firm yield based on a 98 percent reliability standard might be thought to imply that such restrictions will only be used in the 2 percent worst case years. However, minimum instream flow regimes require that significant water use restrictions be imposed prior to switching from normal flows to critical flows (as noted above, this can be expected to occur in 10 percent of years). The City's Water Shortage Contingency Plan (Appendix 10) anticipates the need for water use reductions on a more frequent basis and provides specific methods to fit the circumstances. Finally, it has been the City's practice in most years to publicly urge special care during the summer high-demand period and during the fall period, when draw down of storage in the reservoir, the need to elevate flows for spawning salmon, and residual dry season water use all occur together as water resource managers await the unpredictable start of fall rains.

Water suppliers need a conservative planning tool like average annual firm yield because of the long lead times required to plan and develop new water sources, and because of the limited options suppliers usually have during drought conditions. Less conservative measures, such as average amounts of water diverted from the supply source, do not adequately represent the system's baseline capacity.

Existing annual average firm yield from the Cedar River can be estimated by modeling the effect of the instream flow regime established by WDOE in 1979 and adjusting for its non-binding effect on the City. The flow regime is referred to as the Instream Resource Protection Program (IRPP) flows, reflecting the state program under which it was established. If the IRPP flow regime were strictly applied and followed by the City, the resulting average annual firm yield would be 92 MGD. The City has not always met these flow targets. The non-binding effect of these flows is difficult to quantify. Modeling done as part of development of this HCP, based on actual flows since 1979, places the firm yield at 5 MGD higher than would be the case under strict adherence to the IRPP flow regime, thus about 97 MGD.

Using a different methodology, the City's 1992 Water Supply Plan estimated, for planning purposes and in lieu of a negotiated instream flow regime, a 10 MGD allowance above the yield resulting from strict adherence to the IRPP flow curves. If this effect is estimated at 5-10 MGD, then the City's current baseline firm yield from the Cedar River is between 97 and 102 MGD (92 MGD plus 5 and 10 MGD, respectively).

The instream flow regime proposed in this HCP (Section 4.4), which would be implemented by the City as a binding commitment, would provide an average annual firm yield of 97 MGD from the Cedar River.

SPU has recently developed a computer model that can calculate the firm yield of the combined Cedar River, South Fork Tolt River, and Highline Well Field supply sources. This new model accounts for the *conjunctive use* benefits of the combined system. The conjunctive use model indicates that the system-wide firm yield, based on facilities existing or in place by year 2000, is 171 MGD under either the HCP or the IRPP instream flow curves. Thus, this more comprehensive methodology also indicates that the flow regime proposed in this HCP would result in no change in average annual firm yield under the HCP with reference to current operating conditions.

2.2.7 Long Range Water Supply Planning

Long-range water supply planning is an ongoing activity that adapts to changes in the way the region addresses issues of environment, governance, and the well-being of the community. It is a complex process, incorporating demand and supply forecasting, reliability standards, economics, and political and regulatory issues. Comprehensive, up-to-date presentations of the state of water supply planning are periodically developed by water utilities. In the City's case, comprehensive water supply plans, addressing both local and regional water planning needs, were adopted by the City Council in 1980, 1986, and, most recently, in 1993. The next water supply plan is due for submittal to Washington State Department of Health (WDOH) for approval in 2001. WDOH has statutory authority to oversee the process to ensure that there will be a safe and adequate supply of drinking water available to the public. WDOE has statutory authority regarding water rights, establishment of minimum instream flows, and protection of the quality of surface water and groundwater.

It should be noted that comprehensive water supply planning is even more important now than it was several decades ago, because of the substantial amount of population growth projected for the region. Despite the aggressive programs for water conservation described below, it is clear that meeting this growth will require both additional supplies and the most efficient use of existing supplies (see the City's Long Range Water Conservation Plan, Appendix 9, and the Conservation Potential Assessment, Appendix 31). Meeting this demand will certainly require application of a coordinated, cooperative, conjunctive use model, preserving all options for flexible management of supplies, and creative approaches, such as use of "recycled" water. In the effort to meet regional water needs, Seattle's role is significant but complex.

For over 100 years, the City has had a dominant role in planning for the water needs of the region. Today, Seattle's role as a regional water provider and decision-maker may be changing. New and complex utility relationships are forming to assume responsibility for meeting future growth in regional water demand. The City is presently working with existing purveyors and the Cascade Water Alliance (CWA), a group made up largely of jurisdictions that are currently served by the City under the terms of a wholesale water purveyor contract, to craft a new approach to resource management and governance of the Seattle water system. However the governance discussions evolve, Seattle's customer base and its ongoing water rights and ownership of the Cedar River, Tolt River, and Highline Well Field supply systems, will ensure its continued participation in regional water supply planning.

Even larger than the Seattle/CWA planning area is the three-county area. In some significant ways, regional water supply planning transcends county boundaries and recognizes the interplay that needs to occur between major urban water systems located in adjacent watersheds. Many planners envision a future where the Seattle, Tacoma, and Everett water supply systems are interconnected and operated in a coordinated fashion to assure an ability to deliver water efficiently and to more effectively meet environmental responsibilities. Seattle, the CWA, Tacoma, and the South King County Regional Water Association are working towards making the Tacoma-Seattle Intertie (TSI) and cost-effective water conservation the next major regional water supply increments. Before finalizing the configuration of the TSI, both project-specific and programmatic environmental impact statements will be prepared, ensuring full SEPA compliance.

Making more efficient use of existing water resources though conservation and reuse has proven to be an economical and environmentally responsible way to meet the region's growing demand for water. Over the past decade, conservation measures and education has reduced regional water demand by over 15 percent, without customer sacrifice or hardship. These demand reductions have allowed SPU greater operational flexibility to increase and fine tune the timing of instream flows during sensitive spawning and fry-emergence times in the Tolt and Cedar rivers.

The regional long-range water conservation plan, completed in 1995, is a commitment by SPU to pursue conservation, both as a stewardship responsibility and as the most readily available and least costly utility source of supply for the next several years (Appendix 9). No matter which long term-water supply project is selected, conservation will continue to be a key component of our long-term water supply strategies. The City has conducted a Conservation Potential Assessment (Appendix 31), which profiles the range of water conservation opportunities available to the City's retail and wholesale customers at differing levels of investments and over differing time periods. As a result of that Assessment, the City has created a long-term water conservation program that it will implement in both its direct retail and wholesale service areas. The goal of the program is to reduce average per capita consumption by 10% within a ten-year time frame. From an administrative standpoint the program will consist of expansion of current conservation programs and development of new conservation programs to achieve the desired savings.

Future supply projects may or may not be operated conjunctively, or in concert, with existing water sources such as the Cedar and Tolt rivers. In either case, the potential impacts to these resources would be carefully evaluated and disclosed. While the TSI and parallel cost-effective water conservation are the leading candidates for the next incremental supply for the region, other potential projects include: Cedar Permanent Dead Storage (described in sections 4.4 and 4.5.6), Lake Youngs Drawdown, Additional South Fork Tolt Reservoir Drawdown, the Snoqualmie Aquifer, Lake Washington Reuse, North Fork Tolt Diversion, and more aggressive conservation and water reuse projects.

The Cedar River Watershed HCP, when implemented, would define a portion of the baseline for all future water supply planning efforts. The HCP contains a set of commitments, including instream flows, to protect fish in the Cedar River, regardless of the direction that long-range water supply planning takes. The HCP resolves several long-standing issues that have complicated long-range water supply planning. Mitigation for the anadromous fish blockage at Landsburg Dam will be resolved through a set of fish passage, supplementation, and other mitigation commitments. The instream flow requirements for the Cedar River have long been a source of uncertainty for the City and other agencies in planning for the future (Section 2.2.6). In particular, the ACOE has wanted instream flow assurances for their planning efforts surrounding their responsibilities with the Lake Washington Ship Canal Project, in view of the fact that the discharge from the Cedar River constitutes about half the water entering Lake Washington.

Even with the best long-range water planning, the potential always exists for a water shortage. A shortage situation could be the result of a drought, flood, or other system emergency. A Water Shortage Contingency Plan, which is intended to guide the department in the event of a likely or actual water shortage, is updated by SPU as part of the Water Supply Plan process. The Water Shortage Contingency Plan (Appendix10) is based on a multi-phased approach to reduce water usage, with Advisory, Voluntary, Mandatory, and Rationing stages. Specific actions are suggested for each phase, although implementation is intended to be flexible, as appropriate to the specific situation for which it is invoked. In addition to the formation of an internal water shortage management team to advise the director of SPU in the event of a shortage, the plan also includes establishing an advisory committee on which a variety of key interests would be represented.

2.3 Related Laws, Requirements, and Planning Programs

2.3.1 Introduction

The following sections describe the applicable laws and regulations that apply, or may apply, to the HCP planning effort, as well as various municipal and regional planning efforts related to fish and wildlife. The HCP also addresses some issues under state law as well as the Endangered Species Act, builds upon some of the City's prior environmental initiatives, and complements important regional planning efforts focused on anadromous fish.

The City's HCP is being prepared under the Endangered Species Act (ESA), and is subject to the National Environmental Policy Act (NEPA) and the State Environmental Policy Act (SEPA). Of particular importance to Seattle Public Utilities is the need to ensure that the HCP does not impair the City's ability to comply with the federal Safe Drinking Water Act.

In addition to these laws and their implementing regulations, a variety of other federal, state, and local laws may also pertain to the HCP. Some of these laws, such as the state law regarding blockages to fish passage, are addressed in the legal agreements other than the HCP Implementation Agreement (see sections 1.1 and 5.1, and appendices 27 and 28). The City must also comply with provisions of the Washington Forest Practices Act (Section 2.3.12), which establishes standards for protection of natural resources.

At the federal level, a Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b) and a Final Recovery Plan for the Threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California (USDI 1997a) have been prepared (Section 2.3.4). At the state level, the Washington Department of Fish and Wildlife (WDFW) adopted a Wild Salmonid Policy (Section 2.3.6) in late 1997 that sets new directions for protection and recovery of salmonid fishes in the state.

In mid-1997, the Cedar River Basin Nonpoint Pollution Action Plan was completed. This plan was developed with participation of many agencies, including King County, the City, the Muckleshoot Indian Tribe, the City of Renton, the Boeing Company, the ACOE, and many other agencies and interested parties. The basin plan is an important planning document for the Cedar River Basin that established significant goals for habitat protection and restoration for salmonids on the Cedar River below Landsburg (King County 1998).

King County, the City, the Muckleshoot Indian Tribe, and many other agencies and interested parties have also begun cooperating in an important effort to determine the cause of decline of sockeye salmon in Lake Washington. These Lake Washington ecological studies could be expanded to other salmonid species in the future, which are also at depressed levels in the basin, and could lead to additional efforts to recover sockeye and other salmonid species that would complement the City's HCP. Most recently, King County, adjacent counties, and local municipalities have joined in efforts to prepare a plan that will deal with the NMFS's March 24, 1999, listing of Puget Sound chinook salmon as threatened under the Endangered Species Act (Fed. Reg., Vol. 64, No. 56, pp. 14307 –14328).

The City's HCP builds on three of the City's own environmental initiatives that were ongoing before the development of this HCP began. First, technical studies and multiagency negotiations to develop a technically sound instream flow regime for fish in the Cedar River began in 1986. Second, following several years of work with the state, the Muckleshoot Indian Tribe, and fishing interests, the Seattle City Council passed Ordinance #115204 in 1990 that directed a comprehensive mitigation settlement regarding the blockage to anadromous fish posed by the Landsburg Diversion Dam. Third, in 1989, the Seattle City Council passed Ordinance #114632, establishing new directions for managing the Cedar River Municipal Watershed, including an emphasis on protection and restoration of fish and wildlife habitats, and threatened or endangered species.

2.3.2 Endangered Species Act

The federal Endangered Species Act (ESA; 16 U.S.C. 1531 et seq.) was passed by Congress in 1973. The stated purposes of the ESA are "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species" (16 U.S.C. 1531(b)), and to act on specified relevant treaties and conventions.

The Secretary of the Interior, with the USFWS acting on the Secretary's behalf, oversees administration of the Endangered Species Act. The Secretary of Commerce, acting through NMFS, is the listing authority for marine mammals and most anadromous fish. The ESA lists several factors that individually can be the basis for listing a species as endangered or threatened, including "the present or threatened destruction, modification, or curtailment of its habitat or range; . . . the inadequacy of existing regulatory mechanisms; [and] other natural or manmade factors affecting its continued existence" (16 U.S.C. 1533(a)(1)(A), (D), (E)).

Once either Secretary has listed a species of fish or wildlife as endangered, the ESA lists several activities that are prohibited, including the "take of any such species" (16 U.S.C. 1538(a)(1)(B)). "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. 1532(18)). The USFWS has further defined "harm" to mean "an act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 C.F.R. 17.3). Under Section 4 of the ESA (16 U.S.C. 1533(d)), the listing Secretary may apply, and usually has applied, the same prohibitions of activities to threatened species as those regarding endangered species.

If a plant is listed as endangered, activities that are prohibited on nonfederal lands include to "remove, cut, dig up, or damage or destroy any such species on any [nonfederal] area in knowing violation of any law or regulation of any state" (16 U.S.C. 1538(a)(2)(B)).

In 1982, Congress amended the Endangered Species Act to allow taking of listed species "if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity" (16 U.S.C. 1539(a)(1)(B)). A nonfederal landowner may apply for an Incidental Take Permit. The applicant is required to submit a conservation plan (now commonly called an HCP) to the Secretary as part of the application. The Act uses the terms "conserve" and "conservation" to mean "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary" (16 U.S.C. 1532(3)).

According to the Habitat Conservation Planning Handbook (USDI 1996e, pg. 3-5), "Under the Endangered Species Act [Section 10(a)(2)(A)] and Federal regulation [50 CFR 17.22(b), 17.32(b)(1), and 222.22], a conservation plan submitted in support of an incidental take permit application must detail the following information.

- Impacts likely to result from the proposed taking of the species for which permit coverage is requested;
- Measures the applicant will undertake to monitor, minimize, and mitigate such impacts; the funding that will be made available to undertake such measures; and the procedures to deal with unforeseen circumstances;
- Alternative actions the applicant considered that would not result in take, and the reasons why such alternatives are not being utilized; and,
- Additional measures FWS or NMFS may require as necessary or appropriate for purposes of the plan."

According to the Handbook (USDI 1996e, pp. 7-2 through 7-6), the incidental take permit must be issued by the Services if the HCP and supporting information are statutorily complete and the following criteria are met:

- The taking will be incidental;
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of the taking;
- The applicant will ensure that adequate funding for the HCP and procedures to deal with unforeseen circumstances will be provided;
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild;
- The applicant will ensure that other measures that the Services may require as being necessary or appropriate will be provided; and
- The Services have received such other assurances as may be required that the HCP will be implemented.

Because granting an Incidental Take Permit is a federal action, a conservation plan is subject to a biological assessment and jeopardy analysis, as set forth in Section 7 of the ESA (16 U.S.C. 1536(c) and (a)).

The USFWS, acting on behalf of the Secretary of the Interior, has listed as threatened three species known to occur on City land in the Cedar River Municipal Watershed covered by this HCP: the northern spotted owl, the marbled murrelet, and the bald eagle. Several other listed species may occur, but are not known to occur, in the municipal watershed, including the peregrine falcon (endangered), gray wolf (endangered), and grizzly bear (threatened).

In the 1982 amendments to the Endangered Species Act that created Section 10, Congress also expressed its intention for a broad use of conservation plans (H.R. Rep. No. 835, 97th Cong., 2d Sess. 29 (1982)). Congress intended that conservation plans be used to "provide long-term commitments regarding conservation of [multiple] listed as well as unlisted species and long-term assurances" to applicants, and that provisions for imposing "further mitigation requirements" be specified in the plan. Congress also intended that, should an unlisted species become listed during the term of an HCP, "no further mitigation requirements should be imposed if the [habitat] conservation plan addressed the conservation of the species and its habitats as if the species were listed." Realizing that circumstances and information might change over time, Congress also expected that any plan approved for a long-term permit would contain a procedure by which the parties would deal with unforeseen circumstances.

On February 23, 1998, the USFWS and NMFS (the Services) jointly published a final rule for the No Surprises Policy for HCPs (Fed. Reg. Vol. 63, No. 35, Pp. 8859-8873), in part to implement the above stated intent of Congress when it passed the 1982 amendments to the Endangered Species Act. The final No Surprises Policy provides regulatory assurances to the holder of an Incidental Take Permit issued under section 10 of the ESA that no additional mitigation will be required of the permit holder with respect to species adequately addressed by the plan, unless "unforeseen circumstances" arise after the permit is issued indicating that additional mitigation is needed for a given species covered by a permit.

The final rule also requires that HCPs identify potential "changed circumstances" that may arise during plan implementation and include measures to respond to those changed circumstances. As defined in the final rule, "Changed circumstances means changes in circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and the [USFWS *or* NMFS] and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)."

Unforeseen circumstances are defined under the final rule as "changes in circumstances affecting a species or geographic area covered by a conservation plan that could not reasonably have been anticipated by plan developers and the Service at the time of the conservation plan's negotiation and development, and that result in a substantial and adverse change in the status of the covered species." If unforeseen circumstances do occur during the term of the HCP, the final rule states that the Services "will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed upon for the species covered by the conservation plan without the consent of the permittee."

The rule also states that if additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances, the Services ". . . may require additional measures of the permittee where the conservation plan is being properly implemented, but only if such measures are limited to modifications within conserved habitat areas, if any, or to the conservation plan's operating conservation program for the affected species, and maintain the original terms of the conservation plan to the maximum extent possible." The rule also states that "Additional conservation and mitigation measures will not involve the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the conservation plan without the consent of the permittee."

The Services have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available. If additional mitigation measures are subsequently deemed necessary to provide for the conservation of a species that was otherwise adequately covered under the terms of a properly functioning HCP, the obligation for such measures does not rest with the HCP permittee, except as described above. Changes to the HCP could be accomplished by reallocation of resources within the HCP, or mitigation could be provided by the Services.

More recently (March 9, 1999), the Services published a Notice of Availability for a "Draft Addendum to the Final Handbook for Habitat Conservation Planning and Incidental Take Permitting Process" (Fed. Reg., Vol. 64, No. 45, pp. 11485-11490), which provides additional guidance for HCPs and incidental take permits. The draft addendum emphasizes five points for the preparation of HCPs, including the need for:

- Adequate monitoring, based on measurable biological goals, to obtain the information necessary to ensure compliance with the HCP, properly assess the impacts from an HCP, verify that the biological goals of the HCP are being reached, and provide information for adaptive management.
- Incorporation of adaptive management to allow for changes in mitigation strategies that may be necessary to reach the long-term biological goals of the HCP and to ensure that conservation strategies are producing the desired results, particularly where there are significant biological data gaps.
- Development of measurable biological goals, which can be based on habitat or species, as a framework for monitoring and adaptive management.
- Appropriate terms for the duration of HCPs that take into account both the biological impacts resulting from the proposed activity and the nature or scope of the actions addressed in the HCP.
- Increased public participation in the process to develop HCPs, and a minimum 60-day public comment period for most HCPs.

2.3.3 Environmental Review of the HCP

Environmental review of the Cedar River Watershed Habitat Conservation Plan is regulated by three pieces of legislation, including NEPA (42 U.S.C. 4321 et seq.), SEPA (RCW 43.21C), and City of Seattle's SEPA Ordinance, Environmental Policies and Procedures (Seattle Municipal Code Chapter 25.05).

NEPA requires full public disclosure and analysis of the potential environmental impacts of proposed federal actions that significantly affect the quality of the human environment.

The ESA also requires opportunity for public comment on proposed federal actions. Public disclosure fulfills dual purposes by educating the public regarding activities of the federal government while simultaneously ensuring federal officials make informed decisions on environmental actions. NEPA achieves these goals by requiring the preparation and publication of an environmental review document which compares the effects of the proposed federal action against those effects that might occur under the No Action Alternative and other alternatives to the proposed action.

Issuance of an Incidental Take Permit under Section 10 of the Endangered Species Act for this HCP constitutes a federal action subject to NEPA compliance. This federal action involves both the USFWS on behalf of the Secretary of the Interior and NMFS on behalf of the Secretary of Commerce. As lead agencies under NEPA, the Services have determined that an Environmental Assessment (EA) is the appropriate type of document to disclose and analyze the potential environmental effects of issuing an Incidental Take Permit based on the terms of this HCP.

It is important to distinguish between the requirements for an Incidental Take Permit as set forth under the ESA and the detailed analysis required under NEPA. To comply with the requirements of the Incidental Take Permit, this HCP must explain the potential impacts of City operations on the species addressed in the HCP , the planned measures to minimize and mitigate to the maximum extent practicable those impacts where the impacts cannot be avoided, and other measures as necessary. The HCP under the ESA must also describe alternatives to the proposed taking and explain why those alternatives are not considered feasible (see Chapter 6 of the HCP). In contrast, NEPA requires a broader analysis that examines additional environmental impacts of the proposal beyond just the effects to the species addressed. In addition, NEPA requires consideration of reasonable alternatives, including a No Action Alternative which represents no change from current practices. In this case, the NEPA analysis of the No Action Alternative would compare the effect of issuing an Incidental Take Permit based on an approved HCP to what would occur without the permit, and therefore without implementation of the HCP.

Once the environmental review document has been prepared, in this case an EA, NEPA requires that the document be published and made available for public review and comment. The Services must consider and respond to public comment that is within the scope of the proposed action before making a decision on whether or not to issue an Incidental Take Permit. The Services have the option of either responding to comments in writing or in changes to the EA where appropriate. In certain instances, responding to public comment may require the Services to consider new information not considered in the EA.

Ultimately, under NEPA, the Services must consider whether, on a net basis, the effects of issuing the Incidental Take Permit are significant. If the Services conclude that effects are not significant or that the HCP appropriately addresses (mitigates) potentially significant effects, then the Services prepare a decision document called a Finding of No Significant Impact. If the Services determine through the environmental review process that the effects are significant, then the Services must prepare an Environmental Impact Statement (EIS).

SEPA sets forth requirements for state and local government actions that are similar to those of NEPA for federal actions. These include an analysis of environmental impacts of the proposal and consideration of reasonable alternatives along with a public disclosure process. Under SEPA, the lead agency for this HCP is the City of Seattle. The City of Seattle SEPA Ordinance found under Seattle Municipal Code Chapter 25.05 spells out the City's local processes for meeting SEPA requirements. Entering into the legally binding Implementation Agreement (Appendix 1) constitutes the local government action under SEPA. As lead agency, the City of Seattle has determined that the preparation of an EIS is the appropriate document for meeting requirements for environmental review pursuant to SEPA. It is the City's intent to comply with SEPA through preparation of a draft EIS, a thorough public review effort that includes a public hearing as required by State Municipal Code Chapter 25.05, and a Final EIS.

There is a great deal of overlap between NEPA and SEPA. Additionally, both acts allow state agencies and local governments to jointly prepare one environmental review document and conduct one public process with the lead federal agencies. In fulfillment of NEPA requirements (40 C.F.R. 1500-1508) this document will represent an EA, and under SEPA rules (WAC 197-11) the document will fulfill the requirements for an EIS. Federal NEPA regulations state that "[f]ederal, [s]tate, or local agencies, including at least one federal agency, may act as joint lead agencies" to prepare required environmental review documents (40 C.F.R. 1501.5 (b)). SEPA rules also allow for the combination of documents where appropriate to comply with both SEPA and NEPA as specified in Washington Administrative Code 197-11-640. As a result, the USFWS, NMFS, and the City of Seattle agreed to serve as joint lead agencies to prepare one environmental review document, an NEPA Environmental Assessment (EA)/Draft SEPA Environmental Impact Statement (EIS), followed by a revised EA/Final EIS, to fully evaluate the City's HCP for the Cedar River Watershed.

To satisfy both federal and state requirements for public disclosure, a joint scoping process was held for the preparation of the EA/Draft EIS. The results of the scoping process are described in the EA/Draft EIS. A complete record of scoping comments received from federal, state, and local agencies, the Muckleshoot Indian Tribe, and members of the public can be found in the full scoping report (Seattle Public Utilities 1997). Following review of public comments on the EA/draft EIS, the Services determined that a Finding of No Significant Impacts (FONSI) was appropriate and that no NEPA EIS was required.

2.3.4 Federal and State Plans and Rules for Recovery of the Northern Spotted Owl and Marbled Murrelet

The HCP design and strategies were influenced by federal and state plans and rules for the recovery of the northern spotted owl and marbled murrelet. Much of the discussion that follows is excerpted from a review of these plans and rules included in the Habitat Conservation Plan for the Washington State Department of Natural Resources (WDNR 1997).

Since the listings of the northern spotted owl and the marbled murrelet, the federal government has published a draft recovery plan for the northern spotted owl (USDI 1992b) and a final recovery plan for the marbled murrelet (USDI 1997a) that target conditions on federal and nonfederal lands for recovery of the listed species. In addition, the Secretary of the Interior can issue regulations (called Special 4(d) rules) regarding conservation of listed species on nonfederal lands. Such a rule has been proposed for the northern spotted owl, and because it would affect land within the Cedar River Municipal Watershed, a brief discussion of that draft 4(d) rule is also included.

The Endangered Species Act requires the Department of the Interior to prepare and implement recovery plans for all listed species, unless the Secretary of the Interior determines that the preparation of a recovery plan would not benefit a species (16 U.S.C. 1533(f)). Recovery plans generally establish target conditions on federal and nonfederal land for the species or populations in question that would constitute ecological recovery of that species (Rohlf 1989, p. 87). Regulations implementing the ESA's requirements for a biological assessment and jeopardy analysis define recovery as "improvement in the status of a listed species to the point at which listing is no longer required under the criteria set out in Section 4(a)(1) of the Act" (50 C.F.R. 402.02). In order to achieve such conditions, not only would the population need to be of satisfactory size, but the factors that led to the species' listing would need to be reduced to the point where they no longer posed a threat to the species (Rohlf 1989, p. 101).

DRAFT RECOVERY PLAN FOR THE NORTHERN SPOTTED OWL

A Draft Recovery Plan for the Northern Spotted Owl was issued in 1992 (USDI 1992b) and revised following the public comment period, but it has not yet received final approval. As of this time, the Department of the Interior has not published any further discussion of the Recovery Plan, nor has the plan's official status been resolved.

Included in the Draft Recovery Plan is an extensive discussion of management recommendations for nonfederal landowners. These recommendations, developed by the federal Northern Spotted Owl Recovery Team, are based on an analysis of where habitat on federal lands alone would be insufficient to achieve recovery objectives for the spotted owl (USDI 1992b).

Additionally, pursuant to the ESA, Critical Habitat for the northern spotted owl was designated in 1992 by the USFWS.

Specific Critical Habitat Units (CHUs) were designated, but only on federal land. The municipal watershed contained federal lands at that time, and CHU WA-33 incorporated some of those federal lands, as well as land outside the watershed. As described in Section 2.3.11, the City acquired all federal land in the watershed through a Congressionally directed land exchange that was completed in 1996. Deed restrictions were established by the Cedar River Land Exchange Act of 1992 that prohibit the City from harvesting timber on the former federal lands within the CHU, with some very limited exceptions relating to protection of water quality and development of habitat in previously harvested stands.

Section 4.2.2 in this HCP contains a discussion of conservation strategies for the northern spotted owl, based on the federal recovery team's recommendations, that the City considered in developing this HCP.

NORTHWEST FOREST PLAN

In response to the controversy surrounding the management of federal forest lands in the Pacific Northwest, the federal government developed the "Forest Plan for a Sustainable Economy and a Sustainable Environment," once known as the "President's Forest Plan," and now referred to as the “Northwest Forest Plan.” The main issue leading to the development of the Northwest Forest Plan was the future of existing old-growth forests. Because the City’s mitigation for incidental take of spotted owls is designed to complement recovery activities on federal land, a discussion of the Northwest Forest Plan is included here.

Since 1989, numerous lawsuits and several court injunctions have severely restricted new and existing timber sales on lands managed by the USFS and the Bureau of Land Management (USDA 1994). Federal district courts have ruled that these agencies failed to comply with federal law. In particular, separate court decisions have stated that the USFS failed to comply with the National Forest Management Act, the Endangered Species Act, and the National Environmental Policy Act, and that the Bureau of Land Management did not meet its obligations under the National Environmental Policy Act (Thomas et al. 1993; FEMAT 1993).

In western Washington, the USFS has jurisdiction over federal lands available for timber harvest. Since 1960, federal legislation has repeatedly directed the USFS to manage its lands in a manner conducive to healthy populations of fish and wildlife. And, since 1991, several separate rulings in federal courts have reaffirmed this directive.

In April 1993, President Clinton convened the President’s Northwest Forest Conference in Portland, Oregon, in order to resolve the conflicting ecological, social, and economic issues surrounding forest management on federal forest lands in Washington, Oregon, and northern California (USDA 1994). As a result of the conference, the Forest Ecosystem Management Assessment Team, commonly known as FEMAT, was organized by the federal government to develop a range of options for a management plan for federal lands within the range of the northern spotted owl. FEMAT was asked to identify management alternatives that would attain the greatest economic and social contributions from the forests and also meet the requirements of the applicable laws and regulations, including the Endangered Species Act, the National Forest Management Act, and the National Environmental Policy Act. FEMAT was also instructed to develop alternatives for long-term management that would maintain or restore the following:

(1) Habitat conditions for the northern spotted owl and marbled murrelet that would provide for the viability of each species;

(2) Habitat conditions to support viable populations, well distributed across their current range, of species known to be associated with old-growth forests;

(3) Rearing habitat on USFS, Bureau of Land Management, National Park Service, and other federal lands to support the recovery and maintenance of viable populations of anadromous fish species and other fish species considered “sensitive” or “at risk”; and

(4) A connected old-growth forest ecosystem on federal lands within the region under consideration (FEMAT 1993).

The options that were considered varied in four main respects: (1) the quantity and location of land placed in some form of reserve; (2) the activities permitted in reserve areas; (3) the delineation of areas outside of reserves; and (4) the activities permitted outside of reserves.

Based on the FEMAT report, a new EIS was developed that identified Option 9 from FEMAT as the preferred alternative, which became Alternative 9 in the EIS. The Record of Decision for the Final Supplemental EIS on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl (i.e., the Northwest Forest Plan) was issued on April 13, 1994, and took effect 30 days after publication in the Federal Register.

The plan was challenged immediately by both environmental groups and the timber industry. On December 21, 1994, U.S. District Court Judge William Dwyer ruled that the federal agencies responsible for the plan acted within the bounds of the law and that the Northwest Forest Plan was lawful (Seattle Audubon Society v. Lyons 871 F. Supp. 1291, W.D. Wash. 1994). Judge Dwyer's decision was upheld on appeal in the Ninth Circuit Court to Appeals, but as of fall 1998 litigation was still pending the District of Columbia District Court.

DRAFT 4(D) RULE FOR THE NORTHERN SPOTTED OWL

The Department of the Interior initiated the preparation of a 4(d) rule for conservation of the northern spotted owl on nonfederal lands when it proposed FEMAT's Option 9 as the basis for the Northwest Forest Plan for federal forest lands (Holthausen et al. 1994a). The premise on which the proposed rule is based is that federal lands would bear most of the burden for recovery of the spotted owl and that only a few key contributions from nonfederal lands would be needed. Therefore, relief from prohibitions on incidental take could be granted in some portions of the spotted owl's range (Fed. Reg. Vol. 60, No. 33, Pp.9484-9485). However, the USFWS has proposed that in particular portions of the spotted owl's range, supplemental support from nonfederal lands is still "necessary and advisable" for conservation of the species (Fed. Reg. Vol. 60, No. 33, Pp. 9484-9486).

On February 17, 1995, the USFWS published a draft 4(d) rule for the northern spotted owl that defines where incidental take restrictions would apply in Washington and California (USDI 1995a). The public comment period for the proposed rule ended June 3, 1996 (USDI 1996b). Until this rule is finalized, incidental take remains prohibited throughout Washington absent an approved (habitat) conservation plan and Incidental Take Permit issued under section 10 of the ESA.

The proposed 4(d) rule would establish six northern spotted owl Special Emphasis Areas (SEAs) in Washington in which incidental take prohibitions would continue to apply. These areas are designed primarily to protect northern spotted owl habitat on non-federal lands. In addition to the lands within the SEAs, any nonfederal lands that fall within a spotted owl circle (Section 3.4.1) surrounding a site center located on federal reserves established by the Northwest Forest Plan (USDA 1994) would also be subject to take restrictions for 2 years following adoption of the rule. After 2 years, the USFWS would examine the need to maintain habitat on nonfederal lands within federally sited owl circles. All owners of land outside of SEAs and federal owl circles would be required to maintain only 70-acre cores of suitable habitat around spotted owl site centers. Under the proposed 4(d) rule, the Cedar River Municipal Watershed contains 48,877 acres of the I-90 Corridor SEA. With exceptions, this land would not gain relief from current incidental take prohibitions.

The draft 4(d) rule proposes several types of landowner exemptions and opportunities for other agreements. As a landowner with holdings of more than 5,000 acres of forest land in a SEA, the City could adopt a Habitat Conservation Plan authorized under Section 10 of the Endangered Species Act (16 U.S.C. 1539(a)(1)(B)) and receive a permit for incidental take from the USFWS. Should the draft rule be adopted as a final rule without change, the City would still be required to maintain the rules regarding restrictions within 70-acre cores.

STATE RULES AND REGULATIONS FOR THE NORTHERN SPOTTED OWL

In 1993 the State of Washington began work to develop rules to address the impacts of state forest practices on the northern spotted owl. The primary purpose of these rules is to define critical wildlife habitat within the state for the northern spotted owl. Class IV-Special designation under the Forest Practices Act requires that certain forest practices proposed to occur in these habitat areas be evaluated relative to their potential to have substantial impacts on the environment. The effect of this requirement is the need to identify which forest practices are classified as Class IV-Special with respect to the northern spotted owl. On May 10, 1996, the State Forest Practices Board submitted a proposal to the federal government requesting that a proposed state northern spotted owl rule be considered as an alternative to the federal proposed 4(d) rule (USDI 1996b).

The proposed state rule was adopted as a final rule by the State of Washington on May 22, 1996 (WAC 222). The rule defines ten spotted owl special emphasis areas (SOSEAs), which contain critical wildlife habitat. The habitat goals of demographic support or dispersal support, or both, are identified for each SOSEA. With the exception of the Olympic Peninsula, state SOSEA boundaries are the same as the proposed federal SEA boundaries. The municipal watershed contains 48,877 acres of the state I-90 West SOSEA. This includes 25,501 acres identified for demographic support, and 23,376 acres identified for dispersal support for the northern spotted owl. The relationship of the SOSEA and the CHU related to the Cedar River Municipal Watershed is shown in Figure 3.5-2 in Chapter 3.

Because the state rule classifies forest practices within SOSEAs as Class IV-Special, certain forest practices proposed to occur in these areas must be evaluated relative to their potential to have substantial impacts to the environment. Such forest practices may include timber harvesting, road construction, and aerial spraying of pesticides, and are subject to environmental review under SEPA.

A review under SEPA involves a detailed analysis of a proposed action to determine if it will have a significant impact on the environment. Should a finding of significance be made, then an EIS must be prepared (Section 2.3.3). The state rule provides several exemptions to the SEPA trigger within the SOSEAs, including a Habitat Conservation Plan approved by the Secretary of the Interior under Section 10 of the ESA. The rule also includes disturbance restrictions inside SOSEAs during the nesting season that apply within 0.25 mile of a site center between March 1 and August 31, unless affected owls are not actively nesting.

Habitat and species conservation strategies developed for northern spotted owls in the municipal watershed are discussed in Section 4.2.2. These strategies incorporate the Forest Practices Board's rules and recommendations regarding the northern spotted owl.

FINAL FEDERAL RECOVERY PLAN FOR THE MARBLED MURRELET

On September 24, 1997, the USFWS announced the availability of the federal Final Recovery Plan (USDI 1997a) and a final designation of critical habitat for the marbled murrelet in Washington, Oregon, and California was made in 1996 (USDI 1996c).

Recovery plans are required by Section 4 of the Endangered Species Act (16 U.S.C. 1533(f)) to recommend actions considered necessary to protect or recover species listed by the federal government as threatened or endangered. The Recovery Plan for the marbled murrelet (USDI 1997a) was developed by a scientific team established in February 1993, with expertise in seabird ecology, conservation biology, and forest ecology. Assisting the core team were representatives of the affected states and other federal agencies. The plan includes information on (1) the biology, including habitat needs, of the species; (2) reasons for population decline and current threats; (3) current management; and (4) recommendations for recovery efforts for Washington, Oregon, and California.

The objectives identified in the Recovery Plan are "(1) to stabilize, then increase population size, changing the current downward trend to an upward (improving) trend throughout the listed range; (2) to provide conditions in the future that allow for a reasonable likelihood of continuing existence of viable populations; and (3) to gather the necessary information necessary to develop criteria for delisting the species" (USDI 1997a).

The cornerstone of the strategy included in the Recovery Plan is the Northwest Forest Plan, which specifically addresses marbled murrelets and their habitat on federal lands. The Northwest Forest Plan identifies for protection large reserve areas that should provide increased habitat for the murrelet over the next 50-100 years. Protection is also provided outside of the reserve areas around sites known to be occupied by marbled murrelets. The Recovery Plan also includes areas such as nonfederal lands that were not, or could not be, considered in the Northwest Forest Plan.

Actions identified as necessary to address the recovery objectives of the plan include:

- Establishing six Marbled Murrelet Conservation Zones (Zones) and develop landscape-level management strategies for each Zone.
- Identifying and protecting habitat in each Zone, including the marine environment, through implementation of the [Northwest] Forest Plan, designation of critical habitat, better us of existing laws, or other methods (e.g., HCPs), and developing management plans for these areas.
- Monitoring populations and habitat, and surveying potential breeding habitat to identify potential nesting areas (e.g., occupied sites).
- Implementing short-term actions to stabilize and increase the population that include maintaining potential suitable habitat in large contiguous blocks and buffer areas; maintaining habitat distribution and quality; decreasing risk of fire and windthrow; decreasing adult and juvenile mortality; reducing nest predation; increasing recruitment and initiating research to determine impacts of disturbance in both marine and terrestrial environments.

- Implementing long-term actions to stop population decline and increase population growth by increasing the amount, quality and distribution of suitable nesting habitat, decreasing fragmentation, protecting "recruitment" habitat, providing replacement habitat through silvicultural techniques, and improving marine habitat quality.

- Initiating research to develop and refine survey and monitoring protocols, refine population estimates, examine limiting factors, evaluate disturbance effects, and obtain additional life history data.

- Establishing a Regional Coordination body for the marbled murrelet research efforts, including data storage and retrieval in the databases and archives . . ." (USDI 1997a)

DESIGNATION OF CRITICAL HABITAT FOR THE MARBLED MURRELET

The USFWS designates as critical habitat those areas that have the physical and biological features necessary for the conservation of a listed species and that require special management. A final rule for designating critical habitat for the marbled murrelet was published May 24, 1996 (USDI 1996c).

There are approximately 3.9 million acres of land identified in the final rule in Washington, Oregon, and California, of which 78 percent (3.0 million acres) are federal lands included in the Northwest Forest Plan. In areas where federal lands alone were thought to be insufficient to support a well distributed population, an additional approximately 870,000 acres of state (812,200 acres), county (9,100 acres), city (1,000 acres), and private (48,000 acres) lands are identified. The final rule does not include areas such as critical habitat units which are covered by a legally operative Incidental Take Permit for marbled murrelets issued under Section 10(a) of the ESA. Although no identified critical habitat units are located within the watershed, the final rule states that some areas outside of the designated critical habitat units may contain elements important to the recovery of the species.

STATE RULES AND REGULATIONS FOR THE MARBLED MURRELET

In 1993, the State of Washington began work to develop rules to address the impacts of state forest practices on the marbled murrelet. The primary purpose of these rules is to define critical wildlife habitat for the marbled murrelet. The effect is to identify which forest practices are classified as Class IV-Special because of their potential for substantial impact on the marbled murrelet. The rules also establish SEPA policies, address survey protocols, create a cooperative habitat enhancement agreement process, and establish disturbance avoidance standards for marbled murrelets. On July 10, 1997, the state adopted the Marbled Murrelet Rule (WAC 222-10-042).

The main items in the rule include:

(1) Protection for all occupied marbled murrelet sites;

(2) Required surveys for landowners with both known occupied sites and suitable marbled murrelet habitat;

(3) Establishment of detection areas – the square-mile section of land in which a marbled murrelet is detected plus the surrounding eight sections;

(4) A list of five SEPA triggers that would put a forest practice into the Class IV-Special classification which would require further environmental review;

(5) Provisions for cost sharing of surveys between the landowner and the WDFW; and

(6) SEPA guidance to assist Washington Department of Natural Resources (WDNR).

Habitat and species conservation strategies developed for the marbled murrelet in the watershed are discussed in Section 4.2.2. These strategies incorporate the Forest Practices Board's rules and recommendations regarding the marbled murrelet.

2.3.5 Other Wildlife Statutes and Regulations

Other laws and regulations pertaining to wildlife may be relevant to this HCP, such as the federal Migratory Birds Treaty Act, the federal Bald and Golden Eagle Protection Act, the federal Clean Air Act, the federal Clean Water Act, and the state Shorelines Management Act. In addition, the state has statutes and regulations governing pollution and wildlife. The WDFW oversees state listings of endangered and threatened wildlife, and WDNR's Natural Heritage Program oversees state listings of plants. The Forest Practices Board issues regulations regarding forest practices involving critical wildlife habitat of state-listed species (Section 2.3.12).

If the WDFW determines that an animal species is seriously threatened with extinction in the State of Washington, then the agency director may request the State Fish and Wildlife Commission to designate that species as endangered (RCW 77.12.020(6)). The same authority is granted for designating animal species as threatened or sensitive (RCW 77.12.020 (5)). Species designated as endangered are listed under WAC 232-12-014, and protected species designated as threatened or sensitive are listed under WAC 232-12-011. As of the drafting of this HCP, 24 fish and wildlife species were listed as endangered in Washington State, 9 species were listed as threatened, and 2 species as sensitive. The complete regulations governing the state listing, delisting, and management of animal species are given in WAC 232-12-297. The WDFW is charged with writing recovery plans for endangered and threatened species that include target population objectives and an implementation plan for attaining the objectives. The agency has written no such plans that affect this HCP.

Revised Code of Washington (RCW) 79.70.030 authorizes WDNR to establish and maintain a natural heritage program that "shall maintain a classification of natural heritage resources," which, as defined in RCW 79.70.020, includes special plant species. The Natural Heritage Program assigns endangered, threatened, or sensitive status to plants that face varying risks of extinction. The most current list of vascular plants can be found in a report titled Endangered, Threatened & Sensitive Vascular Plants of Washington (WDNR 1994). A plant listed by the Natural Heritage Program is not protected through regulations, although the Natural Heritage Program does work with landowners to encourage voluntary protection. No plant species that can be expected to occur in the Cedar River Municipal Watershed are on the Natural Heritage Program list.

2.3.6 Management of Fisheries Resources

In the State of Washington, fisheries resources are co-managed by the WDFW and the Western Washington Treaty Tribes. The Lake Washington Basin is the usual and accustomed fishing grounds for the Muckleshoot Indian Tribe, which is the signatory Tribe that co-manages these fisheries resources. Components of managing fisheries resources includes stock assessment, harvest, production, and habitat management. The fish species most intensively managed by the state and Tribe in the Lake Washington Basin and Cedar River Basin are the anadromous salmonids. In the Lake Washington Basin these are most commonly represented by steelhead trout and chinook, coho, and sockeye salmon.

All four of these salmonid species spawn in the Cedar River below the Landsburg Diversion Dam (Sections 3.5.8 - 3.5.11). The HCP includes measures to allow steelhead trout and chinook and coho salmon to spawn above the Landsburg diversion (Section 4.3). Mitigation for the sockeye salmon spawning migration barrier at the Landsburg diversion is also discussed in Section 4.3.

WILD SALMONID POLICY

The remainder of this section discusses the Wild Salmonid Policy, which provides guidance to the state and Tribe regarding management of the salmonid resources in the Cedar River Basin and Lake Washington Basin. This HCP's mitigation and conservation strategies for the fisheries resources in both the municipal watershed (Section 4.2) and in the Cedar River downstream of the Landsburg Dam (sections 4.3 and 4.4) are consistent with this new policy.

The Wild Salmonid Policy was adopted by the Washington Fish and Wildlife Commission on December 5, 1997, to direct and guide efforts to rebuild and sustain wild salmonids. Two documents make up the policy: (1) the Policy of WDFW and Western Washington Treaty Tribes Concerning Wild Salmonids and (2) the Additional Policy Guidance on Deferred Issues Concerning Wild Salmonid Policy (Washington Fish and Wildlife Commission 1997). Bern Shanks, the former director of WDFW, asserted that, for its part, the State of Washington would use both documents to manage fisheries resources ((Shanks 1997).

The joint policy was adopted by the Western Washington Treaty Tribes and the WDFW, whereas the additional policy guidance was adopted only by the WDFW. The joint policy adopted by both the state and the Tribes contains agreed-upon policy statements, performance standards, and action strategies that are needed for the protection and recovery of salmon and the needs and goals of the Tribes and other citizens. The additional guidance clarifies WDFW's policy direction and efforts regarding wild salmonids.

The Wild Salmonid Policy defines a wild fish stock as a stock that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage (whether or not the parent stock was native to the river or region). This is the same definition that is used throughout the City's HCP for wild salmonid stocks. (The only species addressed in this HCP that is represented by a stock not native to the Cedar River is the sockeye salmon (*Oncorhynchus nerka*), which is native to and present in the Lake Washington Basin. Introduced from Baker Lake in Washington, the current stock in the Cedar River is now reproducing in the wild (Section 3.5.8). Because the Cedar River sockeye stock is introduced, NMFS has determined that it does not constitute an Evolutionarily Significant Unit (ESU) under the ESA, and thus is not eligible for listing as threatened or endangered (Fed. Reg., Vol. 63, No. 46, pp. 11749-11771; Waples, 1998).)

The joint policy adopted by both the state and the Tribes contains guidelines developed to protect, restore, and enhance wild salmonids and their ecosystems, and to sustain a variety of consumptive and non-consumptive uses, including ceremonial, subsistence, commercial, and recreational fisheries, and cultural and ecological values. The policy contains fourteen management principles that will be implemented by the Tribes and the WDFW in consultation with affected stakeholders.

The joint policy adopted by both the state and the Tribes addresses two specific guidelines regarding hatchery production of fish that are relevant to the implementation of this HCP. The first guideline, Spawner Escapement Policy, states that, "where hatchery fish are cultured to augment the naturally produced population in a stream, spawning of hatchery origin adults beyond what is needed for broodstock will be evaluated through a case by case analysis of the effects on the naturally spawning stock characteristics. However, the goals would be to develop harvest strategies that focus on harvest of fish produced in hatcheries, and to develop hatchery production strategies that protect naturally spawning populations."

The second guideline, Cultured Production/Hatcheries Policy, states that naturally spawning populations will be protected, rehabilitated, and reestablished using "integrated principles of genetic conservation, ecology, hatchery production, and fish management." This will be accomplished by using "programs of stable, cost-effective artificial production to provide significant fishery benefits while having no significant adverse impacts on the long-term productivity of naturally spawning salmon and their ecosystems." In addition, each hatchery program will be required to operate in accordance with a plan that describes the specific operation components, production goals, measures to control risk, monitoring and evaluation, and performance audits.

In the City's HCP, the mitigation and conservation strategies developed for anadromous fish (sections 4.2.2, 4.3, and 4.5) are consistent with the goals and policies of the Wild Salmonid Policy.

MANAGEMENT OF FLOWS

The relationship of the City's water claim to the state's authority to establish instream flows is discussed in Section 2.2.5.

2.3.7 State Law Concerning the Blockage of Fish Passage

Washington State law contains several statutes that apply to structures that impede fish passage. Collectively, these statutes prohibit human-made obstructions to fish passage, and regulate the repair of and mitigation for these obstructions.

An obstruction is defined by the state as "a dam or other obstacle in or across a waterway that denies free passage of fish at any time," which includes "(a) the inability of fish to expeditiously discover the entrance to a fishway or other device installed to assist their passage; (b) the inability of fish to freely pass through a fishway or other device provided to assist their passage; or (c) the absence of a fishway or other device to assist the passage of fish" (WAC 220.120.030).

The installation of bridges and other crossing structures over streams and rivers, which may be obstructions to fish passage, is regulated by the State Hydraulic Code Rule (WAC 220.110.070). The purpose of this statute is to "ensure free and unimpeded fish passage for adult and juvenile fishes and [to] preserve spawning and rearing habitat." The code contains criteria for the upper limits of water velocities, flow depth, and hydraulic drops with which a structure should be designed so that it will not obstruct migrating trout and salmon. A provision is also included in the code that requires the owner of a bridge or crossing structure to make repairs if it becomes a hindrance to fish passage.

In addition, two other state statutes restrict fish passage impedance by obstructions other than crossing structures. Under RCW 77.16.210, the owner or manager of an obstruction is required to provide passage of game fish around the structure. Passage can be provided by a fishway (fish ladder) or a fish protective device that allows the free passage of fish around the obstruction.

RCW 75.20.060, which also mandates the remediation of fish obstructions, states that the fishway must be approved by the director of WDFW. Further, the approved fishway needs to be maintained in an effective condition and continuously supplied with sufficient water to freely pass fish. A provision within this same title contains a statute governing mitigation if fish passage around the obstruction cannot be provided (RCW 75.20.090). This statute allows a hatchery or fish cultural facility to be provided if fish passage is impractical, and also requires approval by the director of WDFW.

The statutes discussed here are relevant to the HCP Watershed management conservation strategies and anadromous fish conservation strategies. The watershed management mitigation and conservation strategies (Section 4.2) include a commitment by the City to upgrade, replace, or remove culverts which block fish passage. The anadromous fish conservation strategies (Section 4.3) include several elements to mitigate the fish obstructions created by the diversion dam on the Cedar River at Landsburg.

REGIONAL AND LOCAL ANADROMOUS FISH CONSERVATION PLANNING EFFORTS

Anadromous fish and their habitats in the Lake Washington Basin (of which the Cedar River is a part) are currently receiving considerable attention from state, Tribal, and local governments, as well as concerned citizens throughout the region. A number of projects designed to protect and restore fish populations and habitat are in various stages of development and implementation. These projects range from the headwater areas to the outlet of Lake Washington at the Ballard Locks. The City's Cedar River HCP has been designed to link with and complement these efforts.

KING COUNTY BASIN PLANNING INITIATIVES

King County has sponsored substantial planning initiatives in a number of the important subbasins of the Lake Washington Basin in an effort to protect water quality and fish habitat. The first step in this process is a comprehensive, landscape-scale assessment of current physical and biological features and conditions in each subbasin. This information is used to develop land-use prescriptions and habitat restoration recommendations that target the protection of water quality and fish habitat while attempting to manage the effects of flooding on human facilities and activities. The assessments and recommendations are compiled in a basin plan for each subbasin. Implementation of the plan is guided, at least in part, by basin councils comprised of interested citizens, state and Tribal fish resource managers, and local government officials. Substantial resources have been directed toward public education and outreach during plan development and implementation. Consequently, the basin planning process provides an excellent vehicle for including the public in habitat protection and restoration efforts.

Basin plans have been completed for the Cedar River, Issaquah Creek, Bear Creek, and the East Lake Sammamish Plateau. The Cedar River Basin Plan is of particular interest in relationship to the City's HCP. This plan describes conditions and makes recommendations for the lower one-third of the Cedar River subbasin, which is the portion of the basin downstream of the City's ownership boundary. The plan recommends a comprehensive set of land use and surface water management prescriptions and has identified over 80 fish habitat protection and restoration opportunities throughout the lower basin (King County 1993, 1998). Several key habitat acquisitions and restoration projects have already been completed. Additional projects are contingent upon securing funding and the cooperation of property owners, and conducting further feasibility analyses.

The City plays a significant role in the Cedar River Basin in managing its water and electric utilities, and the Cedar River Municipal Watershed, which constitute about two-third of the area of the basin. Thus, this HCP has an important relationship with the Cedar River Basin Plan. The HCP includes provisions for instream flows to protect fish habitat, including funding for habitat restoration projects in the lower basin (Section 4.4); funding for anadromous fish mitigation, including funding for habitat restoration projects in the lower basin (Section 4.3); measures to protect and restore habitats in the municipal watershed (Section 4.2), and relevant research and monitoring (Section 4.5).

MUNICIPAL INITIATIVES

A large number of municipal governments occur within the Lake Washington Basin. Many of these governments support surface water management utilities and other entities that strive to protect water quality and aquatic habitat within the boundaries of their respective jurisdictions. In an effort to better coordinate these activities, King County recently sponsored a process that brings these entities together in a cooperative regional initiative that is tackling the challenges of protecting and restoring water quality and fish habitat while improving flood management practices.

Two separate forums have been created in the Lake Washington Basin as a result of this process: The Cedar River/Lake Washington Forum and the Lake Sammamish Forum. Each forum is focused on issues within its respective subbasin; however, both forums recognize the intimate linkage between the subbasins and are making efforts to coordinate their activities within the Lake Washington Basin as a whole. The forums have identified key habitat protection and restoration activities throughout the Lake Washington Basin and are presently attempting to reach agreement on project priorities and funding mechanisms.

ADDITIONAL COLLABORATIVE FISH CONSERVATION EFFORTS

In 1989, the Washington State Legislature passed Senate Bill 5156 (SB 5156) to create a vehicle for resolving a long-standing dispute between the City of Seattle and the State of Washington over the effects of the migration barrier created by the Landsburg Diversion Dam on Cedar River sockeye salmon. According to the provisions of SB 5156, as codified in RCW 75.52.110, the state will consider that the City has, at a minimum, compensated for the lost sockeye salmon spawning habitat upstream of the Landsburg diversion if the City funds the planning, design, construction and operation of a spawning channel capable of producing "…at a minimum, fry comparable in quality to those produced in the Cedar River and equal in number to what could be produced naturally by the estimated 262,000 adults that could have spawned upstream of the Landsburg diversion" (RCW 75.52.120).

The legislation also established interagency technical and policy committees to oversee the planning, design, and construction of the project. Subsequent work by these committees, with support from James M. Montgomery Consulting Engineers Inc., established that the proposed mitigation facility must have an annual production capacity of 34 million fry to adequately compensate for the lost productive capacity upstream of Landsburg Dam (James M. Montgomery, Inc. 1990).

According to the provisions of SB 5156, the mitigation facility was to have been constructed in 1991. Although a comprehensive siting report (James M. Montgomery, Inc. 1990) and final EIS (Parametrix 1991) were completed prior to the legislative deadline, construction of a proposed spawning channel and hatchery were postponed as a result of emerging concerns over declines in the sockeye population and poor survival of juvenile sockeye in Lake Washington. Land use conflicts at the preferred location for the spawning channel also contributed to the delay in construction.

In response to this situation, the policy committee established by the legislation initiated a two-element program to improve their understanding of the factors controlling the survival of juvenile sockeye in Lake Washington, while attempting to maintain the population at a level from which it might readily recover. One element of the program was the construction and operation of an interim sockeye hatchery applying new fish culture techniques recently developed in Alaska to produce high quality, disease-free sockeye salmon fry (McDaniel et al. 1994). The interim hatchery is funded by the City of Seattle and operated by the WDFW. The program has three primary objectives which are: (1) to test the efficacy of the new Alaskan fish culture techniques with Cedar River sockeye; (2) to reduce the rate of decline in the population by increasing fry recruitment; and (3) to provide marked fry in support of the second element of the recovery program, the Lake Washington Ecological Studies.

The hatchery program has gradually expanded since 1991 and has been successful in consistently producing high-quality, disease-free fry for release into the Cedar River. Production peaked in 1997 with the release of over 14 million fry. Otolith samples of sockeye fry and adults have been collected to evaluate survival of fry released by the hatchery relative to fry produced through natural spawning. Samples have been collected since 1997, and otolith sampling is expected to continue. Samples are currently being analyzed by WDFW.

The Lake Washington Ecological Studies program is a suite of six major study components that are being implemented over a 5-year period to better understand the factors contributing to poor survival of juvenile sockeye salmon during their 14-month residence period in the lake. Technical leadership for the studies is provided by staff of WDFW with support from participating researchers and funders at the University of Washington, the Muckleshoot Indian Tribe, the City of Seattle, the City of Bellevue, King County, and the ACOE. In 1997, fundraising, administration, and coordination responsibilities for this program were placed in the hands of the Lake Washington/Cedar River Forum discussed above. At this time, the studies were expanded to address the factors influencing the survival of juvenile salmonids as they migrate through the Ballard Locks and to begin testing methods to improve downstream passage conditions. The data collection for the studies is scheduled to be completed in 1998, with final reports expected in 1999.

TRI-COUNTY EFFORT TO ADDRESS LISTING OF CHINOOK SALMON

Following the March 1998 proposal to list Puget Sound chinook salmon as threatened under the ESA, the County Executives of Pierce, Snohomish and King County assembled a collaborative effort among the local, state, federal, and Tribal governments to create a recovery plan for central Puget Sound. This response is one of several within the range of Puget Sound chinook, which includes 12 counties in the Puget Sound region. Puget Sound chinook were listed March 24, 1999, as threatened under the ESA.

While the Tri-county effort have been purely voluntary on the part of the participating governments, the Governor’s salmon recovery team and NMFS have focused attention on the Tri-county effort as critical to the strategy for assembling the necessary recovery actions for chinook salmon if NMFS should issue a final rule under section 4(d) of the ESA prohibiting take of chinook salmon. The governments participating in the Tri-county effort, including the City of Seattle, are focused on developing watershed-based plans, strengthening land use controls to protect habitat, and coordinating government activities with regard to various technical, scientific, funding, and legal issues.

2.3.8 Safe Drinking Water Act and the Surface Water Treatment Rule

INTRODUCTION

Public water systems are required to comply with the provisions of the federal Safe Drinking Water Act (SDWA, 42 U.S.C. sec. 300f et seq.) and its associated regulations, as developed and implemented by the United States Environmental Protection Agency (EPA) and the Washington Department of Health (WDOH). The SDWA was originally enacted by Congress in 1974, and it was reauthorized and amended in 1986 and 1996.

The most significant regulatory efforts from the SDWA and its amendments that have a direct bearing on the City’s HCP are the existing Surface Water Treatment Rule (SWTR) and the future Enhanced Surface Water Treatment Rule. Because the Cedar River water supply is a surface water supply, the City must meet certain regulatory standards at its raw water intake at Landsburg that were developed to protect public health. The City’s obligations under the SDWA and, more generally, to protect public health have been major constraints on developing this HCP. Of particular concern is the issue of passage of thousand of anadromous fish above the raw water intake at Landsburg. Upstream passage of anadromous salmon and trout has been effectively blocked since the Landsburg Diversion Dam was first constructed in 1901.

Because salmon die after spawning, the concern with passing these fish above the intake is explicitly related to the potential presence of thousands of fish carcasses in the river upstream of the Landsburg water intake. Because of this concern, the City conducted a risk assessment to serve as the basis for the decision as to whether to allow anadromous fish above Landsburg, and, if passage were to be allowed, whether to limit the number of fish to be passed (see Section 3.2.5 and Appendix 5).

It is important to note at the outset that this is not a simple issue of the cost of water treatment to deal with salmon carcasses. Even with expensive treatment, the risks to public health posed by hundreds of thousands of carcasses would be significant, and it is unlikely that the regulatory agencies would approve any plan that would create such risks.

Also of concern for compliance with the SDWA and protection of public health are decisions regarding municipal watershed management. The remainder of this section provides general background that is intended to help the reader of this HCP appreciate the public health issues that bear on how decisions in developing the HCP were made with respect to both watershed management and anadromous fish passage at Landsburg.

SURFACE WATER TREATMENT RULE AND THE CEDAR SYSTEM

The SWTR was promulgated in June 1989. It focuses on ensuring that adequate microbial protection via disinfection and filtration is provided to protect consumers of surface water sources from the effects of *Giardia* (a protozoan parasite) and viruses. It requires systems with surface water sources to install filtration treatment, unless 11 filtration avoidance criteria can be met. Meeting the 11 criteria demonstrates that the source water is of a high quality, that existing disinfection treatment is adequate to reliably and consistently kill *Giardia* and viruses, and that the quality of the water within the distribution system is maintained.

Seattle's Cedar River source met these 11 criteria in 1991, 1993, 1994, 1995, 1996, and 1997. In 1992, the Cedar did not meet 1 of the 11 filtration avoidance criteria. The exceeded criterion was for levels of fecal coliform in the raw water prior to treatment. The criterion requires that at least 90 percent of samples collected at least daily during any 6-month period must contain less than 20 fecal coliforms per 100 milliliters. The purpose of this criterion is to monitor the ongoing quality of the source water to validate that disinfection alone is sufficient to kill bacteria at these relatively low levels and other possibly associated pathogens or viruses of concern.

As a likely result of drought conditions during 1992 and an associated increase in wild animal activity in or near the mainstem of the Cedar River (because many of the tributaries had lower flows than normal, and some were dry), increased fecal coliform concentrations were detected in the source water. Treated water, as delivered to customers, continued to meet water quality regulations during this period.

As a result of this exceedance, an Agreed Order was executed between the City of Seattle and WDOH in 1994. The Agreed Order required Seattle to evaluate options for complying with the SWTR, and to provide a recommendation based on the evaluations, for WDOH's approval. Subsequently, detailed work plans were developed to implement the strategy.

The City of Seattle ultimately recommended the development of an ozonation facility to treat Cedar River water, with facilities master-planned to included particle removal (filtration) technologies at some time in the future if deemed appropriate and necessary. With input from the EPA, WDOH approved the facility. The details of the technical evaluations leading to this recommendation can be found in the Cedar River Surface Water Treatment Rule Compliance Study.

Ozonation is a disinfection technology that has been found to be very effective in killing both *Giardia* and *Cryptosporidium*, another protozoan parasite. *Cryptosporidium* is of particular concern to immune deficient individuals, such as the elderly. Ozonation technology has been used extensively in Europe for many years, but not as extensively in the United States until recently.

The SWTR does not specifically provide the option of remaining unfiltered following an exceedance of the fecal coliform criterion in the source water, although it does with some of the other criteria if unusual or unpredictable circumstances existed. Based on the City's extensive commitments to watershed ownership, protection, and management, and the unusual nature of the circumstances in 1992, WDOH and EPA agreed that it was appropriate to allow Seattle to investigate non-filtration options in addition to filtration options for complying with the SWTR.

PLANNED OZONE TREATMENT

Within the 1996 SDWA reauthorization, specific legislative language was included to allow states to consider alternatives to filtration for water systems with protected watersheds meeting several criteria. Section 106 of the SDWA contains the reference legislative language. This language provides the legal basis for WDOH to review and approve Seattle's recommendation of ozone disinfection for the Cedar River supply. The EPA must also concur with the approval, and there are significant ongoing requirements for source water protection, monitoring, and reporting with which Seattle will have to continue to comply.

During the development of the recommendation, various options were evaluated. These included the recommended option (ozone master-planned for future filtration and particle removal) and a filtration and particle removal facility built at the same time. The latter option still presumed the current high quality of raw water based on the continuation of the existing levels of watershed protection and control, including no significant change in anadromous fish passage above Landsburg that could degrade raw water quality. The capital and operations and maintenance (O&M) costs associated with these two options are identified in Table 2.2-1.

Table 2.2-1. Capital and operations and maintenance cost ranges for 275 MGD facility options.

	Capital Cost ($M)	Annual O&M ($M)
Ozone master-planned for	$101-$128	$3.3-$3.8

future filtration		
Filtration, including ozone	$208-$235	$6.8-$7.3

Based on the current schedule, the ozonation facilities on the Cedar River supply are anticipated to be on line in 2003 or 2004. No specific commitments have been made regarding the construction of particle removal technologies. Decisions related to the appropriateness and timing of such facilities would be based on the effectiveness of the City's efforts to protect and enhance the quality of the source, and on the effectiveness of the ozone and related treatment facilities to meet current and future source treatment and distribution system water quality regulations and goals.

2.3.9 History of Cedar River Fisheries Instream Flow Negotiations Prior to 1994

The modern conflict over instream flows for fish in the Cedar River originated in the late 1960s. During this period, runs of sockeye salmon into the river began to increase dramatically. Sockeye escapements grew from less than 25,000 fish per year in the early 1960s to over 200,000 fish per year in the latter part of that decade (Washington Department of Fisheries data in Stober and Hamalainen 1980). As a result of this spectacular increase in the numbers of fish, the Washington State Department of Fisheries (WDF) partially funded and cooperated with the U.S. Geological Survey (USGS) to complete the first instream flow study done on the Cedar River (Collings et al. 1970).

The regulation of instream flows affects habitat for anadromous fish in several ways that are often included in modern studies and negotiations regarding establishment of flow regimes on regulated rivers. Water velocity, water depth, substrate type (i.e., the type of bottom, such as gravel, cobbles, boulders, or mud), and cover for fish (such as streambanks, logs, or large boulders) are four important factors that all affect the quality of habitat. For example, species in which the adults are relatively small, such as sockeye, generally choose shallower, slower water than larger species, such as chinook. Fry and juveniles, because of their smaller size and weaker swimming ability, obviously require slower water than adults.

Water released from dams can affect all four of the factors listed above. The amount of water released obviously affects velocity and depth, and depth and velocity in turn can determine what substrates and cover are available.

Different species, and different life stages within species, choose sites in a flowing river for different functions, such as feeding, resting, hiding, and spawning. Fisheries biologists often aggregate these functions by life stage into *rearing* for juveniles, and *holding* and *spawning* for adults. The studies described below, including the USGS study in 1970, considered some or all of these factors for the different salmonid species of interest in the river.

In 1971, the WDOE used WDF's recommendations from the 1970 study to establish minimum instream flows in the Cedar River. These new flows were to be measured at the USGS gage in Renton. A key part of WDOE's new standards was the requirement of 480 cfs at certain times of year as the single discharge rate (level of flow) that provided maximum sockeye salmon spawning habitat.

The City of Seattle disagreed with the scientific basis of the results of the USGS's instream flow study and with WDOE's new minimum instream flows. Because of the disagreement, the City funded the Fisheries Research Institute (FRI) at the University of Washington to conduct a second Cedar River instream flow study (Stober and Graybill 1974) to develop a better technical basis for an instream flow regime. This new study used a methodology basically similar to the one used in the USGS study.

However, for the FRI study, one key difference was that sockeye spawning criteria were custom-developed for Cedar River fish by measuring depths and velocities in the Cedar River at 1,239 redds (nests). This procedure had not been done in the earlier USGS study. Instead, the USGS study used depths and velocities from the scientific literature that were recommended as design criteria for sockeye spawning channels (Clay 1961); these recommendations had been based upon field work performed in tributaries of the upper Colombia River (Chambers et al. 1955).

The primary result of the FRI study was a new recommendation of 250 cfs as the single flow, when measured at Renton, that provided the most sockeye salmon spawning habitat. WDFW disagreed with the results of this new study. Finally, in 1979, WDOE published its Instream Resources Protection Program (IRPP) and adopted new minimum flows for the Cedar River (WDOE 1979; WAC 173-508-060**)**.

Previously, the highest flow in the 1971 minimum flow regime was 480 cfs. In the new IRPP minimum flow standard, this number was reduced to 370 cfs. For the first time, the concept of a critical minimum instream flow was also introduced. A critical flow regime is a lower minimum instream flow standard for use in very dry years. It is typically designed to be implemented about once every 10 years. While the fisheries agencies and Muckleshoot Indian Tribe were not completely satisfied with these new IRPP flows, which they viewed as a compromise, they were much more satisfied than the City.

The City strongly disagreed with these new IRPP minimum instream flows at the time, because, in the City's view, the flows were not based on adequate and convincing technical data and arguments. The City reasserted its position that, in view of the circumstances summarized in Section 2.2.5, the state's new flow rule would not be binding on the City.

The City's Law Department has repeatedly asserted that the City's water claim (Section 2.2.5 and Appendix11) predates and is superior to the state's authority to establish instream flows binding upon the City in a manner that could affect its water right. On the other hand, the City recognizes that it has important environmental responsibilities as a manager of water resources on the Cedar River. Because of this recognition, the City has recently attempted to follow the IRPP flow regime as a planning assumption and an operating target.

In an attempt to resolve the dispute over minimum flows, the Cedar River Instream Flow Committee was formed in 1986. It was comprised of representatives from the City, WDF, Washington Department of Wildlife (WDW), WDOE, USFWS, NMFS, the Muckleshoot Indian Tribe, and the ACOE. The group decided to conduct a third Cedar River instream flow study using the relatively new Instream Flow Incremental Methodology (IFIM) (Section 3.3.2). The City funded this new study, and the agency and Tribal biologists were thoroughly involved in it. Their involvement included participation in consultant selection, study design, study implementation, and review of study results.

Cascades Environmental Services, a consulting firm, was selected to conduct the investigation. In addition to the standard IFIM study, Cascades Environmental Services was asked to investigate three additional topics: (1) gravel scour during high flows and the flows at which eggs in the gravel might be affected by scour (risk zone analysis); (2) the exact relationship between spawning flows and subsequent flows needed for successful egg incubation (effective spawning habitat analysis); and (3) an examination of how sockeye spawning habitat could be maximized by manipulating flow levels during the spawning season (cumulative spawning habitat analysis). Cascades Environmental Services completed all studies in 1990 and published their results in 1991 (Cascades Environmental Services 1991). Informal discussions and follow-up work ensued, and more formal negotiations between the City and the other parties began in 1994 in the context of this HCP. The results of these cooperative studies, with subsequent modeling, analysis, and negotiations, formed the basis for development of the instream flow regime proposed in this HCP (Section 4.4).

2.3.10 Municipal Watershed Management

BACKGROUND

When the City of Seattle decided to use the upper part of the Cedar River Basin for its municipal water supply in 1889, the area was owned by private individuals, companies, the State of Washington, and the federal government. The City's leaders soon adopted a strategy of complete ownership as the best means to protect the source of the region's water, and the City began acquiring ownership of the watershed in the 1890s.

As it gradually acquired ownership through purchase, exchange, and condemnation, the City entered into a series of agreements with other landowners, both formal and informal. The purpose of these agreements was to effect increasing control over human activities in the watershed to protect the raw water supply. Upon completion of a land exchange with the USFS in 1996, the City had acquired ownership of virtually the entire 90,500-acre Cedar River Municipal Watershed

The municipal watershed has been considered closed to the public since about World War I, and access has generally been by permit or with supervision. The parks operated by the City at Landsburg and Rattlesnake Lake are outside the hydrographic boundary for the drinking water supply, and are open to the public during daylight hours. As discussed in Section 2.2.2, all points of entry by road into the closed portion of the watershed now have locked gates, and the watershed boundary is posted against trespass. Watershed inspectors, aided by other watershed staff, patrol the boundaries and interior of the watershed, looking for trespassers and any problems that might pose a risk to the drinking water supply.

Closure of the watershed and the surveillance program are key parts of the program to protect this unfiltered, surface water source (Section 2.3.8). All activities within the closed portion of the watershed now either require a permit or must be supervised. In addition to water supply and hydroelectric operations, current activities allowed in the watershed include scientific research; public education; limited recreation at several sites outside the hydrographic boundary of the municipal watershed; management of cultural resources - both sites and artifacts; and limited timber harvest (with approval of the Seattle City Council).

HISTORY OF TIMBER HARVEST THROUGH 1985

Logging in the watershed began in the 1880s, and proceeded from the western lowlands to the crest of the Cascade Mountains, and from low elevation to high elevation as logging shifted from railroad-based to truck-based in the 1930s. Prior to 1900, little timber was harvested, but harvest in the early twentieth century was intensive. Records of early timber harvest in the watershed are poor, but estimates through 1985 are given in Table 2.2-2 below.

Table 2.2-2. Estimates of timber harvest in the Cedar River Municipal Watershed through 1985.

Period	# of Years	Acres	Volume (mmbf*)	Area/year (Ac/year)	Vol./year (mmbf/year)
Prior to 1900	–	2,479	–	–	–
1900-1923	24	29,684	2,800	1,237	116.6
1924-1943	20	13,405	1,000	670	50.0
1944-1961	18	9,055	544	503	30.2
1962-1985	24	16,628	788	693	32.8
TOTAL		** 68,772	** 5,132	800	59.7

* mmbf = million board feet (a standard unit of wood volume)

** Excludes harvest prior to 1900

Over the course of the past century, the City was responsible for harvesting roughly 10 percent of the total timber volume removed from the watershed. Net revenues from timber harvest averaged about $1 million per year during the 1960s and 1970s, and the revenues were used to fund a variety of water utility activities, effectively subsidizing water rates.

Until recently, virtually all harvest was of old-growth forest. Clearcutting was the normal harvesting method, and any snags or defective trees left at initial harvest were later removed as fire hazards. Landowners relied on natural regeneration until about 1924, when the City established a nursery and began reforesting areas that had burned or had failed to naturally regenerate as a result of severe site conditions.

Beginning in 1945, with the first cooperative agreement among landowners, the Cedar River Logging Agreement, the annual rate of harvest was set at 35 million board feet. In 1962, the City, the USFS, and remaining private landowners entered into a cooperative agreement for managing timber and protecting the watershed. In the agreement, annual cuts were again limited to 35 million board feet, based on a 100-year harvest rotation for sustained production. From 1962 through 1985, an average of about 690 acres per year – about 33 million board feet of timber – was harvested in the watershed. About 57 percent of this total was harvested by private timber companies, 33 percent by the USFS, and 10 percent by the City. Virtually all timber harvested was from old-growth forest.

SECONDARY USE ORDINANCE (1989)

In part because of public concern about continued harvest of old-growth forests in the watershed, in 1985 the Seattle City Council declared a moratorium on City timber harvest and initiated a comprehensive public review of municipal watershed management policies. The review was based on the assumption that the *primary* purpose of the watershed was the production of high quality drinking water. The review focused on *secondary* uses of the watershed that would be compatible with that primary purpose. A broad-based, 17-member advisory committee conducted the review. After 3 years and over 30 meetings, the committee made recommendations to the Seattle City Council in 1988.

In 1989, new policies were adopted by the City Council in Ordinance #114632 that largely reflected the recommendations of the advisory committee. The policies reaffirmed the primacy of protecting the major source of the region's drinking water by continuing the policy of closing the watershed to unsupervised activities. However, the policies included some new directions in management of the watershed, including an increased focus on fish and wildlife habitat protection, public education, and scientific research. Some significant elements of the policies relevant to this HCP include direction to:

- Establish a large ecological reserve that includes all old-growth forest and between 50 and 65 percent of the land owned by the City in 1989, in which only commercial thinning might be allowed;
- Manage the reserve to develop old-growth forest communities;
- Pursue acquisition of remaining land and valuable old-growth habitat in the City's two watersheds, including the national forest land in the Cedar River Municipal Watershed as a first priority;
- Conduct a long-term timber harvest program in second-growth forest outside the ecological reserve, using best management practices, to fund the land and habitat acquisition until completed;
- Conduct timber salvage operations to protect water quality;
- Continue to avoid use of herbicides and to prevent and suppress forest fires, in order to protect water quality;
- Protect threatened and endangered species, including the northern spotted owl;
- Identify opportunities for protecting and restoring fish and wildlife habitats;
- Encourage appropriate scientific research;
- Expand the public education program in the watershed and construct an interpretive center at Cedar Falls; and
- Prohibit public access for general recreation, for fishing, except in those areas open to the public, and for hunting.

Subsequent to the passage of Ordinance #114632, and after years of negotiations between the City and the USFS, Congress in 1992 directed that the USFS exchange its remaining land in the watershed for land the City had acquired in several national forests in Washington (Cedar River Watershed Land Exchange Act of 1992, Public Law 102-453, enacted October 23, 1992). In 1996, the deeds were finalized for this exchange, which gave the City the approximately 17,000 acres of remaining federal land in the watershed. The deeds, pursuant to the Cedar River Watershed Land Exchange Act of 1992, specify that no old-growth forest be harvested and that no harvest be conducted in the Northern Spotted Owl Critical Habitat Unit WA-33 in east end of the watershed, except for highly limited reasons. The deed restrictions also prohibit subsequent disposal of the federal land by the City, and the building of new roads on the federal land within the spotted owl Critical Habitat Unit (CHU).

CITY TIMBER HARVEST IN THE CEDAR RIVER MUNICIPAL WATERSHED SINCE 1985

During the period 1986-1999, less than 500 acres of second-growth timber has been harvested on City land in the watershed. All such harvest was authorized by Seattle City Council ordinances. Nearly all of this timber was harvested expressly to save old-growth forest, through sales to raise revenue for acquisitions, agreements to defer old-growth harvest on federal land, or timber exchanges to acquire old-growth from private landowners. All logging was in previously harvested, second-growth forest on flat terrain away from any streams. For these harvest units, the City attempted to implement the concepts of New Forestry, developed as an alternative to tree farming (Franklin 1989). In this approach, live trees and snags, as well as other biological legacies of the original native forest, were retained during harvest. The purpose of these harvest unit designs was to create structure in the regenerating stands similar to stands regenerated by natural disturbances, such as fire.

During the same period, about 2,300 acres was harvested by the USFS and about 1,300 acres by private timber companies. The last private harvest was in 1992, and the last USFS harvest was in 1994.

REMAINING OLD-GROWTH FOREST

After about a century of logging in the watershed, a little less than 14,000 acres of original, native forest remains. Some, though not all, of this forest would meet the ecological definition of old-growth forest (Franklin and Spies 1983). All of this native forest is more than 190 years old, and some approaches 800 years old. Most of this original native forest was generated by large-scale forest fires that occurred in the region about 350 and 700 years ago.

DRINKING WATER QUALITY AND WATERSHED MANAGEMENT

During the early part of the century, there were serious problems with the quality of the drinking water from the watershed. These problems – specifically the risk of human diseases such as typhoid – were largely related to human presence and activities in the watershed. Human activities primarily were associated with logging camps, sawmills, and towns, all of which lacked adequate sanitation. The first report recommending strict control over sanitation in the watershed was issued in 1912.

While timber harvest and construction of roads for a century have clearly produced negative impacts on surface waters and aquatic habitats in the watershed, the current quality of the raw water from the Cedar River Municipal Watershed is some of the best among the major municipal water supplies in the United States. The primary impact of logging on drinking water quality is an increase in turbidity, a measure of the amount of particulate matter (mostly soil) in the water. Turbidity levels in recent years have on the whole been low relative to regulatory standards.

A high level of turbidity is a concern largely because it interferes with the chlorine disinfection process, which is the primary means Seattle Public Utilities uses to inactivate bacteria of concern to human health. Virtually all of the recent concerns for turbidity levels at the raw water intake have been the result of storm events, which naturally cause increases in turbidity from stream bank erosion and, less frequently, landslides.

The two causes of recent turbidity increases at the Landsburg Dam water intake have apparently been natural soil conditions in the Taylor Creek subbasin in the lower watershed, which has very fine soils at the stream margins, and the failure of beaver dams in the lower watershed, which typically trap sediment. High turbidity loading to the reservoir is generally not a drinking water issue because particulate matter is diluted and settles out in the reservoir. However, during the 1990 “100-year” storm event, reservoir turbidity levels did become a concern.

It is likely that turbidity loading to the reservoir has been increased over natural conditions by the presence of poorly designed forest roads on steep slopes, some of which fail during storms, and high levels of sediment in tributaries to the reservoir as a result of past road problems and removal of streamside vegetation during timber harvest. Despite these effects, the rate of reservoir in-filling by sedimentation has been very low.

2.3.11 State Forest Practices Act

The Washington Forest Practices Act (RCW 76.09) and Forest Practices Rules and Regulations (WAC 222-08) are the principal means of state regulation of activities on the City’s forest lands. Administered and enforced by the WDNR, the Forest Practices Rules and Regulations set standards that address many issues including reforestation, clearcut size, road design standards (including culvert sizes and spacing), watershed analysis procedures, riparian area buffers, wetland protection, and rules for threatened and endangered species. Provisions within the Forest Practices Rules and Regulations ultimately influence fish and wildlife habitat by regulating how and when certain activities may take place on forest lands. The City’s Forest Management Guidelines (Appendix 13) usually exceed the requirements of the State Forest Practice Rules (Section 4.2).

The Forest Practice Rules have a special relationship to Habitat Conservation Plans regarding critical habitats. When applications for proposed forest practices are submitted to the WDNR, they are assigned to one of four classes established by the Forest Practices Board. Certain forest practices in “critical wildlife habitats” (state terminology) and “critical habitat” (federal terminology) of threatened and endangered species require the most sensitive designation, Class IV-Special (WAC 222-16-080). Forest practices classified as Class IV-Special are subject to environmental review under SEPA, Chapter 43.21 RCW. However, if the forest practices are “consistent” with a USFWS-approved conservation plan (HCP) and Incidental Take Permit for a particular species, they are not classified as a Class IV-Special practice because of their location in critical wildlife habitat, and no additional environmental review under SEPA is required.

2.3.12 Forest Management Plan

After the final HCP is approved, the City may prepare a companion Forest Management Plan for the Cedar River Municipal Watershed that is consistent with the final HCP. If prepared, the Forest Management Plan would reflect the objectives, constraints, and guidelines of the final HCP. It would also reflect any amendments made to City

Ordinance #114632, which specifies goals for watershed management, including timber harvest, and prescribes use of timber revenues. Consistent with the foregoing purposes, the Forest Management Plan would be a regularly updated document with more detail on implementation for: (1) forest inventory, timber stand projections, and harvest scheduling (if appropriate); (2) protection of cultural resources during timber harvest; (3) the silvicultural program, including reforestation and thinning to restore and improve habitat; (4) harvest monitoring (if appropriate); and (5) program costs.

2.4 HCP Planning Objectives

In preparing its HCP, the City developed a number of specific objectives related to the Endangered Species Act, other laws and regulations, constraints resulting from its public utility obligations, environmental stewardship, prior city initiatives, and sustainable management. Additionally, in response to recent attention to HCPs by the public and scientists, the City has modified some of the original objectives and incorporated others to address some of the key issues raised.

2.4.1 Overall Goal of the HCP

The overall goal of the HCP is to implement conservation strategies designed to protect and restore habitats of all species of concern that may be affected by the facilities and operations of the City of Seattle on the Cedar River, while allowing the City to continue to provide high quality drinking water and reasonably priced electricity to the region.

2.4.2 Objectives Related to the Endangered Species Act

The objectives of this Habitat Conservation Plan that are related to the Endangered Species Act include the following:

- Meet all requirements of the Endangered Species Act with respect to water supply operations, hydroelectric operations, and land management by the City in the Covered Area (as defined in the Implementation Agreement, Appendix 1);

- Meet all legal requirements for an Incidental Take Permit for species addressed in the HCP;

- Make an appropriate contribution to the conservation of unlisted species covered by the HCP and treat them as if they were listed, with the intent of reducing the likelihood that listing may become necessary for some species;

- Provide a net benefit, compared to current conditions, for both listed and unlisted species covered by the plan, contributing to the recovery of any species that is now or, in the future, may be listed as threatened or endangered;

- Obtain agreement that no additional commitment of resources would be required of the City should unlisted species covered by the HCP become listed during the term of the HCP;

- Develop scientifically sound conservation strategies for at-risk species and their habitats, and provide adequate monitoring to ensure the HCP is working as intended during its implementation; and

- Recognize uncertainty, and develop and implement an HCP that can be adaptive enough to (1) respond to changes in regulations or conditions, (2) incorporate and make use of the discovery of new scientific information, and (3) address contingencies, yet at the same time provide an improved degree of certainty for purposes of water supply planning.

2.4.3 Objectives Related to Instream Flows

The objectives of this Habitat Conservation Plan that are related to the Instream Flows include the following:

- Implement a beneficial instream flow regime, based on the best current scientific information, that will help provide high quality fish habitat throughout the potential range of anadromous fish in the Cedar River from Lake Washington to the natural migration barrier formed by lower Cedar Falls;

- Reduce the risks of stranding juvenile salmonids and dewatering salmonid redds to levels that will help promote the full recovery and persistence of anadromous salmonid populations in the Cedar River;

- Provide an instream flow regime that significantly improves existing habitat conditions for all four species of anadromous salmonids in the Cedar River over existing conditions; and

- Help support measures that will contribute to improving downstream migration conditions for juvenile salmonids at the Hiram Chittenden (Ballard) Locks.

2.4.4 Objectives Related to City Public Utility Functions and Constraints

Objectives of this Habitat Conservation Plan that are related to public utility functions and constraints include the following:

- Ensure the ability of the City to provide a reliable water supply of high quality drinking water to local residents, commercial and industrial users, and wholesale water customers in the region, and to provide reasonably priced electricity to customers;

- Maintain the existing water supply capacity from the Cedar River Municipal Watershed, as measured by average annual firm yield, and preserve the operational flexibility necessary to water supply operations;

- Develop and implement a program for managing instream flows that is consistent with the City of Seattle Water Shortage Contingency Plan (Appendix 10);

- Protect and improve the quality of the raw drinking water supplied from the City's Cedar River Municipal Watershed;

- Preserve flexibility to meet water needs for people and fish that may be identified in the future;

- Develop cost-effective conservation strategies that control overall costs of the HCP, yet accomplish its fundamental purposes; and

2.4.5 Objectives Related to Prior City Initiatives

Objectives of this Habitat Conservation Plan that are related to prior City initiatives include the following:

- Develop and implement an HCP that builds upon existing City of Seattle laws, regulations, policies, and initiatives, including but not limited to: (1) Ordinance #114632 (Appendix 12), which established specific policies for managing the Cedar River Municipal Watershed (Appendix 12); (2) Ordinance #115204, which directed negotiation of a comprehensive settlement for the blockage to anadromous fish at Landsburg Diversion Dam; and (3) development of a technically sound, multi-agency agreement on instream flows based on cooperative studies begun in 1986

2.4.6 Objectives Related to Mitigation for Fish Blockage at Landsburg Dam

Objectives of this Habitat Conservation Plan that are related to mitigation for fish blockage at Landsburg Diversion Dam include the following:

- Allow passage of selected species of anadromous fish upstream of the Landsburg Diversion Dam and water supply intake to the extent possible without jeopardizing the quality of the City's drinking water supply;

- Implement biologically sound, short- and long-term solutions that help provide for the recovery and persistence of healthy, harvestable runs of sockeye, coho, and chinook salmon and steelhead trout in the Cedar River in a manner that maximizes the reproductive fitness of these fish populations while minimizing genetic, ecological, and demographic risks to wild salmonid populations in the Lake Washington Basin; and

- Develop and implement anadromous fish restoration measures that fully mitigate for future impacts of the anadromous fish migration barrier created by the Landsburg Diversion Dam.

2.4.7 Objectives Related to Public and Scientific Concerns about HCPs

Objectives of this Habitat Conservation Plan that are related to public and scientific concerns about HCPs include the following:

- Involve the public, scientists, and other agencies in implementation of the HCP, including monitoring the effectiveness of the HCP;
- Address public concerns about such issues as protection of water quality and aquatic habitats, and contribute to the long-term survival and recovery of at-risk species;
- Use the best scientific information available to develop the HCP, conduct key studies where important information is lacking, and, where feasible, develop conservative strategies in cases for which risk is high;
- Use scientific and other technical information effectively in developing and implementing the HCP;
- Develop an HCP that provides a net benefit for species covered by the HCP and contributes to recovery of threatened and endangered species; and
- Provide adequate monitoring, based on measurable biological objectives, to ensure compliance with the plan; determine effectiveness of mitigation; track trends in habitats and key species populations; verify that the biological goals of the HCP are being met; and provide for flexible, adaptive management of conservation strategies.

2.4.8 Objectives Related to Sustainable Management

Objectives of this Habitat Conservation Plan that are related to sustainable management include the following:

- Develop an HCP that supports sustainable management of the watershed as a source of high quality drinking water and an adequate supply of municipal and industrial water;
- Develop an ecosystem-based HCP that provides for human use of natural resources, particularly for water supply, but sustains natural processes that create and maintain habitats for at-risk species; sustains small- to moderate-scale processes and disturbances important to a healthy watershed; maintains biological diversity with respect to species and communities; protects native species; and does not reduce the adaptive potential of species; and
- Incorporate an approach to watershed management that, as practicable, helps avoid catastrophic events such as forest fires that would jeopardize drinking water or habitats for at-risk species.

3. Information Used to Develop the City of Seattle's HCP

3.1 Introduction to Biological Data and Other Information Used in Developing Mitigation and Conservation Strategies

In preparing this HCP, the City consulted pertinent literature and other agencies for information relevant to developing the community-based and species mitigation and conservation strategies. Some of this information is summarized in the following sections of this chapter, but some is also discussed in Chapter 4 under the rationale for the different mitigation and conservation strategies. In addition, over the past 12 years, the City, with consultants and in cooperation with other agencies, has conducted and completed a large number of studies, analyses, workshops, and related efforts that provided information used in developing the conservation and mitigation strategies.

Section 3.2 summarizes information on fish and wildlife habitats. To provide context for much of the discussion in this HCP, basic information is given on the life cycle of fishes in the family Salmonidae (the salmon, trout, char, and whitefish). Terrestrial and aquatic habitats in the municipal watershed are described, studies of fish distribution in the municipal watershed are summarized, and aquatic habitats in the Cedar River below Landsburg are described.

Section 3.3 describes a series of studies, analyses, and workshops conducted by the City or its consultants to develop the HCP. Comprehensive, cooperative instream flow studies and analyses were completed to provide a basis for an instream flow regime designed to provide protection for anadromous salmonids. An intensive watershed assessment is described that was conducted to develop guidelines for watershed protection and to identify needs and opportunities for habitat restoration. A series of workshops are described that the City hosted on watershed forest management, bull trout, and anadromous fish mitigation. Also described are a drinking water quality risk assessment performed to evaluate passage of fish above the Landsburg water intake; a comprehensive forest inventory, computer modeling effort, and Geographical Information System (GIS) analysis that is the basis for forest habitat and timber revenue projections; and an aquatic habitat monitoring pilot study conducted to develop a long-term stream monitoring program.

Sections 3.4 through 3.6 provide information on the status, distribution, and biology of species addressed by the HCP. Detailed information is given for 14 species of greatest concern in the region, including all that are currently listed under the Endangered Species Act. Information is also given for all other species of concern that are addressed by this HCP.

Section 3.2 Contents

3.2 Fish and Wildlife Habitat in the Cedar River Basin

3.2.1 Introduction to Fish and Wildlife Habitat

The Cedar River Municipal Watershed contains a variety of habitat types and habitat conditions for regional fish and wildlife. The elevation and topography of the predominantly forested watershed ranges from the steep crest of the Cascades along its mountainous, eastern boundary to a low-elevation, rolling foothills landscape along its western edge. The Cedar River flows through this basin, continues past the western boundary of the municipal watershed, and flows approximately 22 additional miles to Lake Washington, which is connected to the ocean via the Ballard Locks and Lake Washington Ship Canal (Map 2).

The habitats within the Cedar River Basin have been influenced by major natural and anthropogenic events. The Puget Sound glaciers had a major influence on basin topography, geology, and hydrography of the municipal watershed (Section 3.2.2). In 1916, the ACOE diverted the course of the Cedar River into Lake Washington, from its original discharge into the Duwamish River, and created a new outlet to the lake when it constructed the Ballard Locks and Lake Washington Ship Canal (Chrzsastowski 1983).

In the Cedar River Basin below the Landsburg Diversion Dam, urbanization has been the major influence on aquatic habitats in recent decades, although timber harvest has also been ongoing. In the municipal watershed, timber harvest over the last 100 years has shaped the forested habitats now present, and affected aquatic habitats as well. Water resource management has affected aquatic habitats in the reservoir and the mainstem of the Cedar River below the Masonry Dam. Finally, the fact that the land within the municipal watershed has been managed as surface water supply for nearly a century has had major implications for current conditions in the municipal watershed and downstream in the mainstem.

Wildlife habitat and landscape conditions in the Cedar River Municipal Watershed are discussed in Section 3.2.2. This section focuses on forested habitat, which has been most heavily impacted by past timber harvest management activities. Other habitat types, such as wetlands, lakes, and cliffs are also described.

Section 3.2.3 gives general information on the life cycle of salmon, trout, char, and whitefish as background for the discussion of instream flows and measures to protect and restore stream habitats in the basin. Section 3.2.4 provides information on the status and distribution of fish species and their habitats within the municipal watershed, and Section 3.2.5 provides information on fish habitats in the mainstem of the Cedar River below the Landsburg Diversion Dam.

3.2.2 Terrestrial Habitat in the Cedar River Watershed

BACKGROUND

The ecological basis for the range of plant associations present in the Cedar River Watershed is firmly grounded in the geologic, glacial, and climatic history of the region (Franklin and Dyrness 1973). The distribution of habitat types across the landscape today is not only a product of that ancient history, but also a reflection of a legacy of land use, particularly commercial clearcut logging over the past 120 years (Table 3.2-1; maps 4 and 5). Fire, both naturally occurring and human-caused, has also exerted substantial influence on the successional development of many naturally regenerated stands and previously harvested second-growth forest stands as they now exist.

Managed second-growth coniferous forest that is typical of the public lands on the west slope of the Cascades predominates throughout a majority of the municipal watershed. This second growth exhibits a range of seral stages from recent clearcuts through mature forest. Only 13,889 acres of unharvested native forest, all at least 190 years of age, still remains in the municipal watershed, about 95 percent of which is in the eastern portion of the municipal watershed. Throughout this HCP, this unharvested native forest in the watershed is called old-growth forest.

Forests characteristic of three vegetative zones, based on climax stage, as described by Franklin and Dyrness (1973) are represented within the municipal watershed. The lower municipal watershed is included within the Western Hemlock (*Tsuga heterophylla*) Zone, largely below 2,000 ft. The greater elevation range of the upper watershed encompasses the Pacific Silver Fir (*Abies amabilis*) Zone at mid-elevations (2,000-4,300 ft) and the Mountain Hemlock (*Tsuga mertensiana*) Zone at the highest elevations (above 4,300 ft), especially along ridge crests. Forest vegetation dynamics within the Pacific Silver Fir Zone in the municipal watershed have been described by Long (1976). Vegetation in second-growth forest stands within the Western Hemlock Zone of the watershed has also been described by Long (1973) and by Scott and Long (1972).

In order to describe the existing terrestrial habitat and distribution within the municipal watershed, it is most effective to divide the watershed into two distinct natural regions, generally referred to as the upper and lower municipal watersheds. These designations are based primarily on substantial differences between the two areas relative to their major physiographic features, hydrologic drainage patterns, elevation and aspect, and substantial contrasts in topography, all of which have resulted directly from the divergent geologic and glacial histories of the two areas (see below). In addition to these environmental factors, the 120-year legacy of traditional logging activity carried out by multiple land owners has both dramatically and differentially influenced the myriad types and distribution of habitat types (especially forested types) as they now exist within the upper and lower watersheds.

Table 3.2-1. Acres of forest in different age classes within the upper and lower municipal watershed.

Forested Stand Age (years)[1,2]	Lower Municipal Watershed (acres)	Upper Municipal Watershed (acres)	Total Acres	Total Percent
0-9	1,037	900	1,937	2.1
10-19	600	5,435	6,035	6.7
20-29	669	6.969	7,638	8.4
30-39	2,323	5,281	7,605	8.4
40-49	3,179	7.588	10,767	11.9
50-59	3,239	3,231	6,470	7.1
60-69	11,417	6,462	17,879	19.7
70-79	11,094	777	11,871	13.1
80-89	950	0	950	1.0
90-99	99	13	112	0.1
100-119	12	0	12	0.0
120-189	91	0	91	0.1
Old Growth (>189)	734	13,155	13,889	15.3
Age undetermined	36	185	222	0.2
Sub-Total	35,481	49,996	85,477	94.4
Other Habitat Elements[2]				
Palustrine Scrub Shrub	201	264	464	0.5
Palustrine Emergent Wetland	44	192	236	0.3
Non-vegetated Habitat	25	1,217	1,242	1.4
Vegetated Talus and Felsenmeer	27	302	329	0.4
Upland Meadows and Persistent Shrub	1	203	203	0.2
Developed	319	26	346	0.4
Unclassified	19	15	33	0.0
Open Water	339	1,876	2,214	2.4
Sub-Total	975	4,094	5,069	5.6
Grand Total	36,456	54,090	90,546	100.0%

1 Primarily conifer or mixed conifer/deciduous, but also includes about 1,836 acres of deciduous forest (1,594 acres in lower municipal watershed, 242 acres in upper municipal watershed).

2 Mapped forested wetlands included with forested stands. Shown on Map 6, forested wetlands total 1,063 acres (749 acres in lower municipal watershed, 315acres in upper municipal watershed).

For the purpose of this discussion, the division between upper and lower sections of the municipal watershed is generally represented by the hydrographic boundary separating subbasins east of Cedar Falls, which drain northward into the Chester Morse Lake basin and upper reaches of the Cedar River, from those west and south of Cedar Falls, primarily the Taylor Creek subbasin, which drain into the Cedar River between Cedar Falls and the Landsburg Diversion Dam (Map 1). The upper and lower sections encompass approximately 60 percent and 40 percent, respectively, of the total 90,546-acre watershed.

PHYSIOGRAPHY AND GLACIAL HISTORY OF THE WATERSHED

The marked contrasts in the topography and surficial geology between the upper (eastern) and lower (western) sections of the watershed that are evident today dramatically reflect the origin of parent materials and the divergent glacial histories of the two areas. The combined effects of these geologic and topographic differences, interacting with a marine climate and a wide range of precipitation resulting from the orographic effects of the Cascade Mountains, has largely determined the potential for development of native vegetation communities across respective sections of the watershed landscape. The watershed elevation ranges from 543 ft at the Landsburg Diversion Dam to 5,414 ft at Meadow Mountain in the eastern portion of the watershed. Most of the lower municipal watershed, with the exception of the upper reaches of the Taylor subbasin, is situated below 2,000 ft elevation. In contrast, the upper watershed varies more broadly in elevation, ranging from approximately 900 ft near Cedar Falls to 5,400 ft at the Cascade Crest.

The geologic and topographic differences evident between upper and lower sections of the Cedar River Watershed are the result of the underlying bedrock formations and divergent glacial history of the two areas. A series of volcanic and volcaniclastic rock underlays the entire area of the municipal watershed (Frizzell et al. 1984). These volcanics include rhyolites, andesites, and minor basaltics. The volcaniclastics include flow breccias, conglomerates, siltstones, and pyroclasitic flow deposits. Most of the volcaniclastics are highly weathered.

The lower watershed has undergone repeated glaciation, the most recent activity during successive advances and retreats of the Puget Lobe of the Cordilleran ice sheet, a glacier that originated in British Columbia and extended over much of the Puget Sound Lowland (Mackin 1941; Crandell 1965; Rosengreen 1965). This ice sheet, which occurred between 23,000 and 14,000 years ago, is responsible for much of the present surficial geology of these lower elevations in western portions of the watershed. However, deposits from previous glacial episodes are also present, underlying the younger, more recent deposits.

The final retreat of the Puget Lobe of the Cordilleran ice sheet created a generally uniform topography, including small terraces and low gently rolling hills. Glacial meltwater channels are visible in several areas and glacial eratics are scattered throughout the landscape. Soil parent materials in this area consist mainly of glacial till and outwash, overlying siltstone, sandstone, and volcanic bedrock. Soils derived from these parent materials are typically coarse and well drained, providing moderate to high site class growing conditions for coniferous tree species, as well as understory shrub and herbaceous vegetation types.

In contrast, the geomorphology and topography of the eastern portion of the Cedar River Watershed is the result of alpine glaciation between 20,000 and 15,000 years ago (Rosengreen 1965; Hirsch 1975). The majority of the landscape is characterized by mountainous terrain consisting of both glacial U-shaped valleys, narrow valleys where streams have incised into the hillslopes, steep slopes (60-85 percent), glacial cirques, and broad river floodplains adjacent to Chester Morse Lake. Bedrock formations in this area include volcanic and volcaniclastic rocks of the Huckleberry Mountain Formation, with areas of intrusive igneous rock (Frizzell et al. 1984). Soils derived from these parent materials through differential weathering, movement, and deposition exhibit wide variation throughout the area. The valley bottoms have a veneer of glacial and alluvial deposits usually consisting of basal till and outwash. The wider variation of soil types, in combination with the greater elevation gradient and resultant orographically affected precipitation, has produced an array of both forested and non-forested habitat types across the landscape of the upper municipal watershed that is significantly more diverse than that found in the lower watershed.

FORESTED HABITAT IN THE LOWER WATERSHED

Introduction

About 95 percent of the landscape of the lower municipal watershed is occupied by forested habitat types, with only a few non-forested habitats (e.g., open water, palustrine wetlands, and rights-of-way) represented in any appreciable amounts (Table 3.2-1). The current forested landscape of the lower watershed is dominated by a relatively homogeneous canopy of second-growth coniferous or mixed coniferous/deciduous forest that has regenerated after the original timber harvest. Major species present include Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and red alder (*Alnus rubra*), with a minor presence of true firs (*Abies* spp.), Sitka spruce (*Picea sitchensis*), big leaf maple (*Acer macrophyllum*), and vine maple (*Acer circinatum*).

The spatial distribution and condition of forest stands visible today basically reflect the historic pattern of logging activity, primarily the harvest of old-growth forest, on the municipal watershed. Harvest began in the lower watershed during the 1880s and rapidly expanded throughout the lower elevations until the 1930s. Harvest of low-elevation forests declined during the next few decades as intensive activities shifted to higher elevations in the upper watershed, with the shift from railroad-based to truck-based logging operations (see below). Little, if any, harvest of second-growth forest was undertaken until a low level of scattered harvest units including some commercial thinning and windthrow salvage was carried out during the 1960s, 1970s, and early 1980s. Since 1985, only a few hundred acres of second growth, and no old growth has been harvested by the City (Section 2.3.10). In this same period, about 2,300 acres of old growth was harvested by the USFS, and about 1,300 acres by private landowners.

Old-growth Forest in the Lower Watershed

Only about 734 acres of unharvested native forest remain in the lower watershed. The old growth that does persist exists in relatively small, isolated stands that are surrounded and widely separated by continuous stands of young and mature second-growth forest. These stands are found at several different elevations (Map 5).

Second-growth Forest in the Lower Watershed

About 12,255 acres of the lower watershed is in 70-119 year old forest. Over 99 percent of the forest in that age class is between 70 and 99 years old. The 91 acres between 120 and 189 years represents remnant stands that were high-graded, leaving a mix of some older legacy trees with the new second growth.

The earliest logging activity took place in the middle reaches of the Taylor Creek and the lowest reaches of the Walsh Lake subbasins (Map 1), and in several areas both north and south of the mainstem of the Cedar River. Most stands in these areas that are a result of regeneration harvest are presently 60-89 years old and represent most of the older second-growth forest in the lower watershed. A total of 23,461 acres is in this age class in the lower watershed. Because soils within much of this area provide moderate to high-quality growing conditions, many stands in this area have the relatively large trees, vertical and horizontal structure, and higher snag densities of mature forest habitat.

Forest stands in the lower watershed that are between 40 and 79 years old, including by far the majority of age classes, are spread throughout the landscape, mostly at low and mid elevations. These even-aged stands occupy a relatively wide range of soil types that have mostly moderate, although varied, growing conditions. For the most part, forest development is well advanced in these stands. Some self-thinning has taken place below the canopy, and a limited understory is present in some stands. The degree of development of the shrub layer in these stands directly reflects the extent of canopy opening (and light penetration), which is a result of natural self-thinning or commercial thinning.

With few exceptions, forest stands in the lower watershed of age 20-39 years (totaling 2,992 acres) are mostly found in the upper reaches of the Walsh Lake and Taylor Creek subbasins (Map 1). These stands are typically dense, with nearly complete canopy closure in many cases. A sparse to moderate shrub layer is present in some stands, but development of an herbaceous layer is typically lacking.

Recent Timber Harvest in the Lower Watershed

Harvest of second-growth forest during the past 20 years in the lower watershed has been limited to a few clearcuts and windthrow salvage sales during the 1970s and early 1980s north of the Cedar River and along the southern boundary of the municipal watershed. In addition, approximately a dozen harvest units completed since 1985 are present in the lower Taylor Creek subbasin. These units were harvested with the New Forestry approach, which emphasizes the retention of biological legacies, such as large living trees and snags (Franklin 1989). The units have been replanted with a diversity of conifer species, and some have been precommercially thinned.

Shrub and herbaceous layer development varies widely throughout recently harvested stands depending on the relative degrees of ground disturbance, planting density, commercial thinning application, and canopy retention. One particularly significant difference between the traditional clearcut and salvage units and the New Forestry type of harvest units is that in the New Forestry units a percentage of the original overstory trees are retained. The trees are retained either in aggregate or dispersed patterns to foster the development of mixed-aged, biologically diverse stands, instead of even-aged, homogeneous stands regenerated by clearcutting.

Douglas-fir and western hemlock are the dominant species comprising both pure and mixed species stands throughout the lower watershed. Western hemlock dominates the mid-understory of most stands and is also the most commonly found and most prolific tree species naturally regenerating under existing canopies in second-growth forest stands. Shrub layers are usually dominated by vine maple, salal (*Gaultheria shallon*), and sword fern (*Polystichum munitum*) where canopies are relatively closed, and include salmonberry (*Rubus spectabilis*) and other *Rubus* species where canopies are more open. Mixed stands containing both coniferous and deciduous species are also present in many areas of the lower watershed, but are found mostly in forested wetland and riparian habitats. Pure hardwood stands, dominated by red alder, are infrequent and found mostly in especially wet or riparian areas.

Riparian Corridors in the Lower Watershed

The most extensive riparian habitat in the lower watershed exists adjacent to the main, low-gradient channel of the mainstem Cedar River between Cedar Falls and the Landsburg Diversion Dam. The floodplain of the Cedar River in this reach is relatively narrow and is dominated by pure and mixed stands of second-growth conifer forest. Historically, the City has managed the forests in this corridor, especially immediately adjacent to the river channel, in a manner that discourages deciduous forest species, such as red alder and cottonwood, and maintains conifers next to the river channel. This practice has resulted in a mature, conifer-dominated forest along most of the river course. Red alder is present in a patchy distribution either where natural disturbance has opened the canopy adjacent to the river channel or in some areas where the river frequently exceeds its banks during high and peak flows and covers portions of the floodplain. Conifer species most prevalent in this riparian corridor are Douglas-fir, western hemlock, Sitka spruce, and western red cedar.

Other streams in the lower watershed are substantially smaller in physical dimensions and annual discharge volume than the mainstem Cedar River. These streams are typically of low gradient over most of their length and only become steep in their relatively short, uppermost reaches. Most of the old-growth forest originally adjacent to these streams was completely removed when the area was harvested in the late 1800s and early 1900s, and consequently, the forest in these riparian corridors is presently in some stage of recovery.

Forest vegetation adjacent to many of the lower gradient stream reaches has regenerated since harvest and is presently 50-80 years old, with trees of large size. In these areas, conifer forest extends to the channel edge or completely spans the channel, and deciduous species are essentially excluded. However, in some reaches substrates are unstable, channels are meandering on narrow floodplains, and red alder repeatedly colonizes the stream corridors. Where red alder persists, the area it occupies is usually relatively narrow and not extensive. Site-specific conditions typically vary widely in these smaller stream channels and adjacent forest habitat varies accordingly (Cupp and Metzler 1995).

Ecological Considerations in the Lower Watershed

Lack of Biological Legacies and the Historical Effects of Fire in the Lower Watershed

One characteristic of the majority of forest stands throughout the lower watershed, with the exception of some of the oldest second-growth and remnant old-growth stands, is the conspicuous absence of biological legacies (large old-growth trees, snags, and logs) typical of stands regenerated after moderate natural disturbances (Spies and Cline 1988). The obvious lack of this type of ecological structure in the second-growth forest of the lower watershed can be directly attributed to a combination of historical logging techniques – including clearcutting, and slash burning and removal - and fires. Snags and logs not removed during original logging activities were either destroyed during these fires, which were frequent in the first 2 decades of the century, or they were later salvaged.

Natural lightning-caused fires have not played a major role during the last 100 years in determining either the types or the distribution of second-growth forest stands in the lower municipal watershed. However, human-caused fire has played a definite role in determining the structural diversity of most second-growth stands, as well as the timing of forest development in some cases.

Broadcast burning of slash was typically practiced as a form of site clearing and preparation after logging during the time when a majority of the lower watershed was being harvested. This standard practice removed or severely damaged much of the large woody debris present on the forest floor and destroyed most of the large snags originally present in the old-growth forests being harvested. These components are an integral component of naturally functioning forest ecosystems, especially old growth, and are extremely difficult to restore.

A second type of human-caused fire also affected the establishment and timing of successional development in many second-growth stands in the lower watershed, and as a result also affected their structural development to some degree. This type of fire was typically caused by ignition from trains passing through young regenerating stands. These fires also destroyed woody debris and snags, but more importantly, destroyed conifer regeneration and delayed stand development. As a result, some areas that should have stands at a more mature stage of development are younger and less developed than would otherwise be expected relative to the date of initial harvest.

An ecological benefit of human-caused fires might be that stands affected by fires of this type potentially develop greater structural diversity than planted or managed stands or stands developing in theses areas without such fires. Whatever the effects of fire within these second-growth forests, they are largely overshadowed by the cumulative effects of logging.

Lack of Diversity in Even-aged Stands in the Lower Watershed

Most second-growth forest stands in the lower watershed that have regenerated since initial harvest in the late 1800s and early 1900s have developed a uniform stand structure characteristic of even-aged stand management applications. Even-aged stands are typically of single species composition, with trees of relatively uniform height and diameter. Canopy foliage is consistently at the same height, and multiple layers of understory subordinate tree species are seldom present. The canopy in such stands effectively prevents sufficient light penetration to support shrub or herbaceous vegetation layers in the understory or on the forest floor. As a result, even-aged stands presenting these conditions are generally considered of lower habitat quality for most wildlife species than more biologically diverse, uneven-aged stands (Brown 1985a).

In contrast, uneven-aged stands typically contain multiple coniferous and deciduous tree species, multiple vegetative layers, an uneven canopy, more understory shrub and ground-level herbaceous vegetation, and generally a greater degree of vertical and horizontal internal structure. Because these features collectively provide more niches for a greater variety of wildlife species, uneven-aged forest stands are considered of higher quality as habitat for animals (Brown 1985a).

One of the major challenges of habitat management is the restoration of biological diversity to even-aged forest stands, especially because many components such as large snags and logs are essentially absent. Major investments of labor and finances have been used in many habitat restoration, research, and monitoring studies to determine the most efficient and effective methods to accomplish the task of replacing biological diversity in forest stands and restoring natural ecological function. Altering harvest methods to retain biological diversity and protecting habitat with reserve systems would appear to be a viable and efficient alternative to continued efforts at restoration (Franklin and Forman 1987; Franklin 1992).

NON-FORESTED HABITAT IN THE LOWER WATERSHED

Only small patches of non-forested habitat break the nearly homogeneous canopy of second-growth conifer forest in the lower municipal watershed. This non-forested area is comprised almost exclusively of open water, a few wetlands, several rights-of-way, and roads (maps 1 and 6).

Open Water in the Lower Watershed

Very few bodies of open water are present in the lower watershed (Map 6). Only two exist of appreciable size: Walsh Lake (69 acres) near the western watershed boundary and Rattlesnake Lake (111 acres) near Cedar Falls. Of the other bodies of open water present, none exceeds 5 acres in size.

Wetlands in the Lower Watershed

The major wetland habitats in the lower watershed are a small scrub-shrub system at the northern boundary and a larger more complex system surrounding and east of Walsh Lake (Map 6). The Walsh Lake complex includes emergent, scrub-shrub wetlands and an extensive forested wetland area along lower Rock Creek. A few smaller, less diverse areas of wetland habitat are dispersed within the lower watershed at Fourteen Lakes, Rattlesnake Lake, and at Barneston. Other small wetland areas exist, but are dispersed and not associated with larger complexes.

Rights-of-way in the Lower Watershed

Three power line rights-of-way, the Raver-Monroe line running north-south, the large Bonneville line at the southern border, and the small transmission line immediately adjacent to the 50 Road (Map 13), represent the only significant open, non-forested terrestrial habitat within the lower watershed. Apart from recently harvested areas, these small areas represent the majority of open habitat that provides any appreciable amount of grass-forb vegetation for grazing wildlife species. They also create travel corridors.

Roads in the Lower Watershed

The lower watershed contains approximately 290 miles of forest roads that act as travel corridors and foraging areas (edges) for many larger wildlife species and provide edge habitat for many smaller species. These roads are shown on Map 11 and discussed in Appendix 17. As indicated in Table 17-1 in Appendix 17, road densities in the lower watershed vary among subbasins from 2.8 to 5.4 miles per square mile.

FORESTED HABITAT IN THE UPPER MUNICIPAL WATERSHED

In contrast to the nearly unbroken second-growth forest canopy of the lower municipal watershed, the upper municipal watershed landscape displays a substantially wider range of seral stages, as well as more diversity within both forested and non-forested habitat types. As in the lower watershed, the forested landscape of the upper watershed is dominated by coniferous forest types, and the distribution and condition of forest stands reflects a characteristic pattern of logging activity. However, only traditional clearcut harvesting has been employed in the upper watershed, and no New Forestry units with green-tree retention have been established.

In contrast to the uniformly older second-growth forest of the lower municipal watershed, the forested landscape of much of the upper municipal watershed is largely a mix of recently harvested areas and unharvested old growth. The younger stands range from recent clearcuts through young second-growth forest, and the old-growth forest ranges from 190 to 850 years of age.   Further contrasting with the lower watershed is the more diverse range of non-forested habitats of the upper watershed, which includes Chester Morse Lake, Masonry Pool, other lakes and ponds, wetlands, talus and felsenmeer rock slopes, cliffs, and upland meadows interspersed throughout the forested landscape.

Major logging activity shifted from the lower watershed and began in the upper watershed by the early 1920s, within two decades of the development of Cedar Lake (now Chester Morse Lake) as the primary source of Seattle's water supply. Until the mid-1940s, logging of old-growth forest was concentrated around Chester Morse Lake and at the lowest elevations in the lower two-thirds of the Rex River drainage and the lower reaches of the upper Cedar River, east of the lake, up to an elevation of approximately 2,500 ft. From the mid 1940s through the 1960s, logging activity expanded eastward through the lower elevations of the Cedar River drainage into mid-reaches of the Rex River system, moved higher into many smaller tributary systems within the lake basin, and also moved into most major stream systems in eastern and southern sections.

In the 1970s and early 1980s, logging activity intensified and was concentrated in the upper, higher-elevation basins of both major and minor tributaries, including Boulder, Lindsay, Seattle, and Goat creeks and the Rex River, as well as in smaller basins along the northern boundary of the municipal watershed. While only harvest since 1985 by the City was in the lower watershed, some harvest of old-growth forest took place on USFS land between 1985 and the time when the land exchange with the City was completed in 1996, giving the City complete ownership of land within the municipal watershed (Section 2.3.10).

Old-growth Forest in the Upper Watershed

Of the 13,889 acres of unharvested native coniferous forest over 190 years old that remains within the municipal watershed, 13,155 acres (95 percent) lies within the upper watershed. Little of that unharvested native forest remains below an elevation of 2,500 ft, or west of the Cedar River delta in Chester Morse Lake. There are a few fragmented and isolated unharvested native stands in small upper drainage basins and scattered along the highest ridge lines, but the majority of the unharvested forest is located in relatively large, high-elevation, essentially roadless and contiguous blocks of habitat in the eastern one-third of the municipal watershed.

In most cases, broad expanses of relatively young second-growth forest either completely surround or separate adjacent blocks. These unharvested forest blocks are concentrated in areas that (1) surround Abiel and Tinkham Peaks along the northeastern boundary; (2) are immediately west of Meadow Mountain at the eastern boundary; (3) surround Goat Peak on the southeastern boundary; (4) surround Findley Lake; and (5) include the upper

Rex River basin. The considerable acreage formerly in USFS ownership in this area was included in the Critical Habitat Unit (CHU) intended to be protected for the benefit of the spotted owl (Northern Spotted Owl CHU WA-33: USDI 1992b), and also as a part of the federal late-successional reserve system in the Northwest Forest Plan (Section 2.3.4).

Most of the old-growth forest in the upper watershed is between 190 and 350 years old, but a few scattered stands, particularly in the upper Rex River basin, contain individual trees up to 850 years of age. All of these stands may be referred to as old growth from the perspective of chronological age. However, from the perspective of ecological function, they vary widely in the extent of development of both vertical and horizontal structural components that may meet old-growth definitions (e.g., see Bolsinger and Waddell 1993). Because it is likely that the relative state of development of these structural components within a stand determines its relative level of ecological function within a dynamic old-growth ecosystem, it is reasonable to assume that the relative habitat value also varies substantially throughout the unharvested forest of the upper watershed.

Many stands, especially on south-facing slopes, have high stem and canopy densities, relatively small diameter trees, and very limited understory development; others are more open and park-like. However, nearby stands of similar chronological age but under better growing conditions have fewer but larger trees, a partially open canopy, understory and shrub layer development, and large woody debris on the forest floor. Individual stands exhibiting more of the ecological characteristics and structural development of old growth are present in the upper Rex River basin, the North Fork of the Cedar River drainage, and the area surrounding Goat Peak.

Second-growth Forest in the Upper Watershed

Most second-growth coniferous forest below 2,500 ft in the Chester Morse Lake basin ranges in age from 40 to 69 years old and has regenerated under a variety of growing conditions. These variable conditions have produced stands that are of similar age but widely variable ecological structural development. The predominantly even-aged stands that are growing on deeper, level substrates (e.g., north of Masonry Pool) have mostly developed a closed canopy. However, openings have been created or maintained by natural thinning, windthrow or breakage, and disease. These openings allow light penetration and support development of a sparse to moderate shrub layer, but only limited herbaceous ground cover.

Stands of similar age on steeper, south-facing slopes with thin well-drained soils have developed more slowly (e.g., north of Chester Morse Lake), but have also attained a mostly closed canopy stage and are devoid of any appreciable shrub or herbaceous vegetative layers. Some stands in these areas are shaded because of their slope aspect or individual topographic position, or are located near streams or on less well-drained soil types. These stands tend to develop at a moderate rate, sustain substantial shrub and herbaceous layers, especially under canopy openings, and may typically be comprised of a mixture of both coniferous and deciduous tree species. Stands on gentler, north facing slopes within the basin typically exhibit similar structural characteristics.

A majority of stands in the lower two-thirds of the Rex River drainage and lower Boulder Creek that fall into the range of ages between 40 and 59 years present a structure in marked contrast to similar-aged stands in other areas of the upper watershed. Such stands in the Rex and Boulder drainages are extremely dense, with completely closed canopies that allow minimal light penetration. As a result, stands throughout this area of the watershed are effectively devoid of tree and shrub understory layers, and herbaceous vegetation is almost non-existent in stand interiors.

Second-growth Forest Habitat in the Cedar River Basin above Chester Morse Lake

Second-growth stands east of Chester Morse Lake in areas adjacent to the mainstem and North and South Forks of the Cedar River represent a mixture of age classes that range from 30 to 69 years. Most of this area, especially closer to the valley floor and riparian areas, represents good growing conditions. Some of the stands in this area are particularly dense, as neither self-thinning nor precommercial thinning has taken place. Many stands in these areas, especially on wetter soils and adjacent to small drainage systems, exhibit a significant deciduous component that typically decreases as slope and elevation increase. Understory shrub and herbaceous layer development is variable depending on specific canopy coverage, soil moisture, and extent of deciduous species coverage as in other similar areas discussed above.

Recent Harvest in the Upper Watershed

With the exception of areas adjacent to the upper mainstem and North and South Forks of the Cedar River, the majority of commercial timber harvest in old-growth forest within the upper watershed during the last four decades (especially during the last 20 years) has been concentrated above 2,500 ft elevation. Most forested land above 2,500 ft is located in the upper reaches of drainage basins (e.g., Rack, Boulder, and Lindsay creeks, and Rex River) or on the upper portions of steep slopes immediately adjacent to high-elevation ridgelines. These areas, most of which have been planted with conifer seedlings and augmented by natural seeding and post-harvest release, exist today in various stages of regeneration. The degree of development and present stand condition is dependent mainly on the soil types and climatic regimes present at specific sites.

Regeneration stands in these areas vary widely from open areas with few seedlings dominated by shrub and herbaceous vegetation (e.g., *Vaccinium* spp., *Xerophyllum tenax*) to over-stocked stands of conifer regeneration so dense that walking through them is challenging. Natural thinning in these dense regeneration stands has not taken place and, until recently, little precommercial thinning has occurred. Less than 2,000 acres of stands of this type in upper elevations have been precommercially thinned since this program began in 1995, but thinning will continue under this HCP (Section 4.2.2).

Riparian Corridors in the Upper Watershed

The most extensive riparian corridors in the upper municipal watershed exist within the broad, forested floodplains and lower gradient reaches of the Cedar and Rex rivers, east and south of Chester Morse Lake, respectively. The broad floodplain of the Cedar River immediately east of Chester Morse Lake is characterized by deciduous forest dominated by red alder, black cottonwood (*Populus trichocarpa*), and scattered Sitka spruce in the overstory. Sitka spruce is the most common conifer regenerating under the deciduous dominated canopy. Vine maple and salmonberry dominate the shrub layer (Raedeke Associates, Inc. 1997; Hanley 1980).

Most other stands within the Cedar floodplain corridor are mixed stands with Douglas-fir, western hemlock, and red alder all present in varying densities. Douglas-fir and western hemlock dominate drier sites, with red alder occupying wetter sites and many sections of the river bank. Where the floodplain narrows and the channel margins become steep, conifers tend to become more dominant in the forest and typically extend to the stream banks. The stream gradient increases gradually in this system. Red alder is dominant on almost all unstable sites where the river is actively meandering across the floodplain.

In contrast, the broad floodplain of the lower Rex River is characterized by mixed conifer forest composed of Douglas-fir and western hemlock dominating the canopy, with Sitka spruce and true firs (*Abies* spp.) scattered throughout. Below the closed canopy of conifers, understory is sparse or completely absent. On wetter sites where the canopy is more open, red alder, vine maple, and salmonberry occur. No extensive deciduous stands exist in the Rex River floodplain as they do in the Cedar River floodplain, but they do occur in patchy distribution on wetter sites and along some portion of stream banks.

As in the floodplain of the lower Cedar River, conifers tend to become more dominant and typically extend to the stream banks where the floodplain narrows and the channel margins become steep. The channel narrows and adjacent slopes become steep within a much shorter length of stream in the Rex drainage than in the Cedar drainage. Red alder is also dominant on almost all such unstable sites (meanders and gravel bars) in the lower Rex system as in the Cedar. However, this type of unstable channel is less common in the Rex system than in the Cedar system because the stream gradient increases more sharply moving upstream of the main floodplain, and the channel becomes confined in lower reaches.

Riparian corridors are generally relatively narrow in upper reaches of both the Cedar and Rex river drainages. Where old-growth conifer forest still exists, it extends to the channel edge and in most reaches the canopy completely spans the channel. Deciduous species are typically absent or infrequent in these stands. However, the old-growth forest has been harvested in most of these upper reaches of both the Cedar and Rex rivers. Typically, forest cover was completely removed and is currently in some state of regeneration. Young, linear stands of red alder border the channel in most of these reaches, except where dense conifer regeneration extends to the channel margins. The forest canopy does not span the channel in many of these areas, with the exception of uppermost stream reaches where the channel is of high gradient and is relatively narrow.

Other streams in the upper watershed are substantially smaller in physical dimensions and flow volume than either the Cedar or Rex rivers and are typically of substantially higher gradient. Forest cover has been completely harvested from most of these streams except for the uppermost reaches where patches of old growth may still remain. Many of these stream corridors, especially in higher-gradient and more deeply incised reaches, are dominated by second-growth conifer stands. However, in sections where channel substrates are unstable or a narrow floodplain exists, red alder may colonize and persist for a variable period of time. Site-specific conditions typically vary widely in these smaller stream channels, and adjacent forest habitat varies accordingly (Cupp and Metzler 1995).

Ecological Considerations

Major Habitat Distribution

The timing and methods of logging within the municipal watershed, and the differences among areas, have been the most influential factors directly determining the types, stages of succession, and pattern of forested habitats present today across the landscape. Logging activity began in the low-elevation western portion of the watershed, was concentrated there until native old-growth forest was extirpated, and then steadily progressed eastward and upward to the highest elevations along ridge lines. As a result, there are two distinct patterns in the predominant seral stages present in major sections of the lower and upper watersheds, one with respect to elevation and one with respect to east-west location.

First, most mature second-growth forest occurs in the lower elevation of the lower municipal watershed, whereas the majority of recent harvest, and therefore early-successional forest, is predominant in the higher elevations of the upper watershed. This effect is especially evident in the subbasins north and south of Chester Morse Lake and in some subbasins draining to the eastern reaches of the Cedar River. Secondly, the lower watershed has only 734 acres of unharvested native forest remaining, while the upper watershed has 13,155 acres remaining, most at high elevation in eastern subbasins.

Also, specifically within the upper watershed, substantial differences exist between the distribution of both old-growth and second-growth forest over the elevation gradients. First, the oldest second-growth forest predominates at lower elevation, and early successional stands are generally more common at high elevations in upper subbasins. Secondly, old-growth forest is concentrated in the eastern sections of the upper watershed; the western section of the upper watershed is predominantly second growth, much of which is in younger seral stages.

NON-FORESTED HABITAT IN THE UPPER WATERSHED

Open Water in the Upper Watershed

In addition to Chester Morse Lake and the Masonry Pool, which are of significant size, approximately 25-30 small lakes (e.g., Findley Lake, Twilight Lake, Sutton Lake), ponds, and unnamed bodies of open water are scattered over the higher elevation landscape within the upper watershed (Map 6). Although the total number of small areas of open water is not great, it is substantially greater than the number present in the lower municipal watershed. Also, the density of small lakes and ponds within the watershed is noticeably lower on a regional basis than within drainages immediately to the north and south of the watershed boundaries. Thus, these open water habitats contribute significantly to habitat diversity, not only within the upper watershed, but across the entire area of the Cedar River Watershed. Fish are not known to occur in most of these open waters. However, these lakes and ponds represent a unique habitat type and an aquatic community that is especially important to amphibian fauna present in these higher elevations.

Wetlands in the Upper Watershed

Several wetland habitat types are found throughout the upper municipal watershed. These wetland habitats vary widely in size and are distributed over the entire elevation range of the many, interconnected subbasins. Although frequently unrecognized, recharge areas supplying groundwater to each wetland are integral components of these aquatic habitats and need similar protection. Each of these components is critical to maintaining the natural ecological function of the aquatic ecosystem network within the municipal watershed.

Beginning within the Chester Morse Lake subbasin (Map 1), the most obvious wetland communities are represented by the large expanses of sedge (*Carex* spp.) and willow (*Salix* spp.) present on the deltas formed at the confluences of the Cedar and Rex Rivers with Chester Morse Lake (Paige 1988; Raedeke Associates 1997). One other small delta plant community exists at the mouth of Bridge Creek on the north side of Chester Morse Lake. Also unique are the sphagnum bogs south of Little Mountain that support a wide variety of sedge, grass, and unique wetland species (Paige 1988).

Several wetland types are found associated with higher elevations. These include sphagnum bogs, sedge-dominated wetlands associated with small lakes and ponds (e.g., Findley Lake, Sutton Lake), streams, and upland wet meadows supporting sedge and forb communities (e.g., headwater basins of Boulder and Lindsay creeks). Of particular interest is the wet meadow complex comprised of interrelated wet meadows in the upper Rex River basin, which represents the largest concentration of this habitat type within the watershed.

Upland Shrub-Forb Meadows in the Upper Watershed

Another type of vegetation that adds a component of habitat diversity to the upper watershed is the area of upland shrub-forb meadow, which is located on the south-facing slopes of Mt. Baldy and Tinkham Peak on the northeast boundary of the watershed. This habitat is unique within the municipal watershed and has not been identified in any other area within the watershed.

Rock, Talus, and Felsenmeer Features in the Upper Watershed

In contrast to the lower watershed, the higher elevations of the upper municipal watershed contain several areas where different types of rock formations are conspicuously prevalent, other areas where these types are represented in small, scattered patches, and still others where they are exposed as specific isolated features of the landscape. As examples, talus and felsenmeer rock formations are prevalent on the steep slopes north of Findley Lake and on the south-facing slopes of Tinkham Peak at the northeast boundary. Rock outcrops and cliffs are evident in Seattle Creek, in the upper reaches of Rack Creek, and above Rattlesnake Lake. A third type of rock formation is represented by the sheer rock walls in the U-shaped glacial cirques of upper Goat Creek, Troublesome Creek, and Findley Lake basins (maps 1 and 6).

Rights-of-way in the Upper Watershed

Right-of-way habitat is very limited within the upper watershed. Existing transmission rights-of-way are relatively small, both in terms of the width of open habitat created and the total cumulative length, especially compared to those located in the lower watershed (see above). All of these corridors are concentrated in the vicinity of Cedar Falls and from Masonry Dam to Cedar Falls. As such, they provide relatively little habitat for wildlife species.

Roads in the Upper Watershed

The upper municipal watershed has an extensive transportation system (Map 13; Appendix 17) consisting of 339 miles of forest roads that extend to all subbasins and to the eastern boundary of the watershed at the Cascade Crest. As indicated in Table 17-1 in Appendix 17, road densities in the upper watershed vary among subbasins from 1.6 to 6.6 miles per square mile.

The only areas that are not densely roaded are substantial portions of the large contiguous blocks of old growth in the spotted owl CHU. As in the lower watershed, forest roads in the upper watershed act as travel corridors and foraging areas (edges) for many larger wildlife species and provide edge habitat for many smaller species. In addition, roads, especially in the upper watershed during winter, may also attract predators, because elk and deer are concentrated and consistently use forest roads as routes of travel. The transportation plan is discussed in detail in Appendix 17.

Ecological Considerations in the Upper Watershed

Until the 1990s, minimal buffers were left during logging operations near streams, wetlands, and small lakes and ponds. Historically, all trees were harvested to the banks of both large and small streams, including many reaches of the Cedar River, especially in the upper watershed. Archival photographs document the clearcut harvest of native forest to the banks of the lower reaches of the Rex and Cedar rivers in the upper watershed (Figure 3.2-1). Similar harvest practices were employed on the upper reaches of the mainstem and North and South Forks of the Cedar River east of Chester Morse Lake. For example, all forest cover was removed from the wetland area and shoreline of the pond that forms the headwaters of the Rex River, and partially removed from the shoreline of Sutton Lake. Although vegetation has at least partially recovered along many of the stream reaches, it currently has not recovered sufficiently to shade or provide mature forest habitat adjacent to these unique aquatic habitats. Complete recovery may not occur for many years in these areas. Also, even in the case of partially recovered riparian vegetation, structure and species composition may not be ecologically capable of moderating temperature fluctuations and extremes or to provide functional large woody debris to the stream system.

Figure 3.2-1. An early photograph depicting logging up to the shores of Chester Morse Lake.

3.2.3 Life Cycle of Salmon, Trout, Char, and Whitefish

A variety of species of fish are present in the Cedar River Basin (King County 1993), including species from the family Salmonidae. The status of many of the salmonids - which include salmon, trout, char, and whitefish - is of particular concern in the region (WDFW 1997a, b; Washington Fish and Wildlife Commission 1997). Eight species of salmonids are known to occur in the basin, including chinook salmon *(Oncorhynchus tshawytscha*), sockeye salmon (*O. nerka),* coho salmon (*O. kisutch*), steelhead/rainbow trout (*O. mykiss*), cutthroat trout (*O. clarki*), bull trout (*Salvelinus confluentus*), pygmy whitefish (*Prosopium coulteri*), and mountain whitefish (*P. williamsoni*).

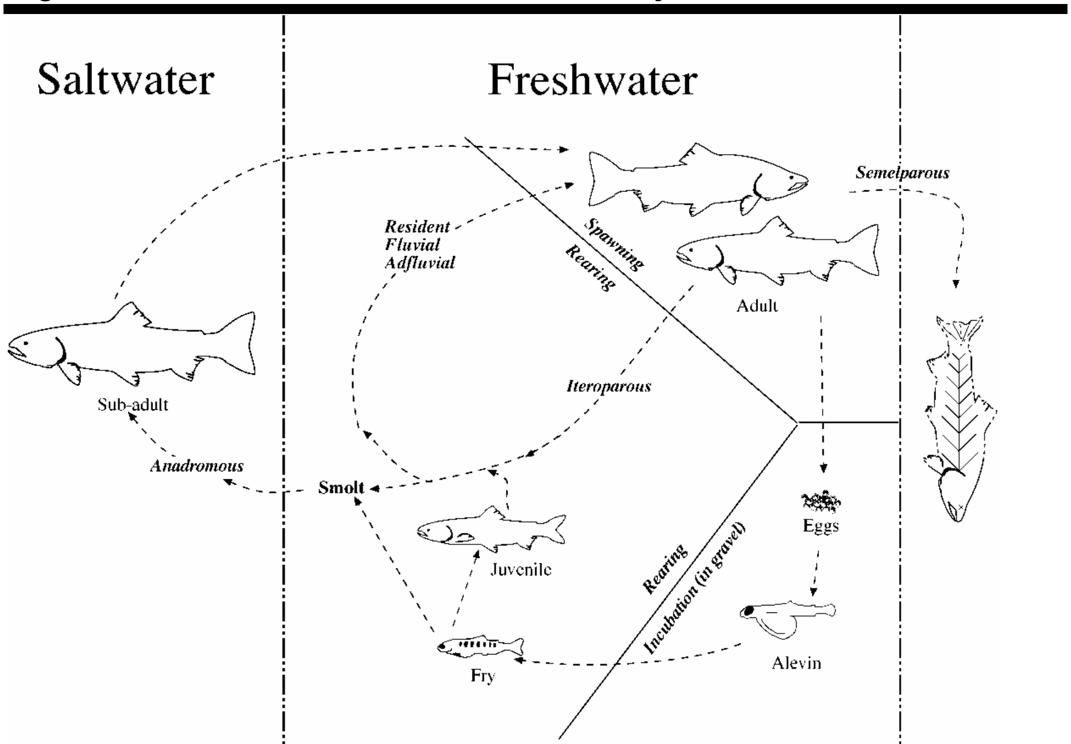
Although pink salmon (*O. gorbuscha*) and chum salmon (*O. keta*) are believed to have been historically present in large numbers in the Cedar River Basin, these species have been extinct since the Cedar River was rerouted into Lake Washington and the Lake Washington Ship Canal was constructed as the new outlet to the lake. This major engineering project was completed in 1916, and was the “most important human factor to ever affect the lake and its shorelands, [and] inflowing and outflowing streams . . . .” (Chrzastowski 1983).

Because salmonids spend all or a portion of their lives in freshwater streams or lakes, they are subject to the impact of both land management and water resource management in the basin. Information is given below to provide background on the different life history stages of salmonids and their potential susceptibility to anthropogenic impacts, which is important to understanding the mitigation and conservation strategies included in this HCP. The basic life cycle of salmonids, with many of the variations that occur among species, is shown in Figure 3.2-2, below.

THE REDD

Most members of the family Salmonidae begin their life cycle in streams, and sometimes lakes, when eggs and sperm are released into clean gravel (Wydoski and Whitney 1979). Over the course of several days, female salmon, char, and trout typically dig several egg pockets, each a little upstream of the last. Shortly after digging each egg pocket, the female will release a portion of her eggs as the male releases sperm. The eggs settle onto the gravel and after a short interval, the female will move upstream to repeat the process. As she digs the next egg pocket, the excavated gravel covers the previously deposited eggs. The combined group of egg pockets is called a redd. The pygmy whitefish presumably does not build a redd, but instead broadcasts its eggs over clean gravels (Wydoski and Whitney 1979).

Figure 3.2-2. Salmon, trout, and char life cycle.



EGGS, ALEVINS, AND FRY

The eggs develop for variable lengths of time, depending on species, subspecies, individual variability, water temperature, and general incubation conditions. After 1-3 months, the eggs hatch into larval fish called alevins. Newly hatched alevins are negatively phototactic (i.e., they avoid light) and within 48 hours migrate downward further into the redd (Fast 1987). Here they remain in the gravel and gradually continue to develop using the energy stored in their attached yolk sacs. After 1- 3 months, depending primarily on the species and water temperature, the yolk sacs are absorbed. At this time, they become positively phototactic (i.e., they swim towards light) and positively rheotactic (i.e., they swim towards current) and move up through the gravel to emerge as free-swimming fry. As fry, most salmonids have rather large oval to circular dark markings on their sides called parr marks.

JUVENILE SALMONIDS

There is considerable variation in life history strategies among species and populations of salmonids during the juvenile stage (Groot and Margolis 1991). Variability occurs with respect to time spent in fresh water and where young fish grow (rear) to maturity. Sockeye salmon fry, like pink and chum salmon fry, leave their natal streams almost immediately after emerging from the gravel and migrate to rearing areas with significant plankton food resources. In the case of sockeye salmon, these rearing areas are freshwater lakes, whereas pink and chum salmon migrate to near-shore saltwater areas. Juveniles of these three salmon species do not grow up and compete for food and territories in their relatively less productive natal streams, but instead migrate to and rear in more productive lake or salt-water environments. This life history strategy can result in large runs of returning adults that spawn at very high densities in their home streams.

Sockeye, pink, and chum are often called mass spawners for this reason, and it is known that this mass spawning results in a net gain of nutrients from the marine environment into the freshwater environment (Bilby et al. 1996). The exception to this is the landlocked form of sockeye called kokanee, in which the fish remain in fresh water for their entire lives.

Juvenile chinook, coho, and steelheads typically remain in their natal streams for extended periods and produce relatively smaller runs of adults. The time spent by juvenile salmonids in natal streams or associated lakes and wetlands varies by species.

LIFE HISTORIES

Salmonids that spend their entire lives within a fairly limited stream range are said to exhibit a *resident* life history. A second freshwater life history variation is *fluvial*, in which fish spawn and perhaps rear for a period in a smaller tributary but move into larger rivers later in their life. A third life history variation is *adfluvial*, in which fish spawn and sometimes rear in a stream then move into a lake where they mature.

Fish that leave fresh water to grow and mature in the sea before returning to spawn are said to be *anadromous*. This life history strategy is exhibited by chinook, coho, chum, pink, and sockeye salmon, as well as by sea-run cutthroat trout, steelhead trout, and some populations of bull trout. As the individual fish physiologically prepare to leave fresh water and enter salt water, they lose their parr marks. At this stage they are called *smolts*. Salmon and steelhead spend from one to several years at sea, depending on species, sub-species, and individual variability. Sea-run cutthroat may only spend a few days at a time foraging in salt water.

SPAWNING

As salmon, trout, and char approach sexual maturity they begin a spawning migration, homing to their natal stream, although a small percentage do stray to other streams (Hasler 1966; Groot and Margolis 1991). The maturing adults exhibit changes in body form and color. Females choose the site of the redd and defend it from other females. Males fight over the females, aggressively chasing off other males after being accepted by a female. In some species, a few males (and occasionally females) in a population will return to spawn a full year earlier than the great majority of the population. These precocious males (jacks) can successfully fertilize some of the eggs during the act of spawning by the full size pair. The five species of Pacific salmon in Washington State waters are *semelparous*, meaning that individuals breed only once and die after spawning. One important consequence of semelparity in anadromous fish is the net flow of nutrients in their bodies from the sea to the natal streams. This has been shown to contribute to aquatic and riparian productivity (Bilby et al. 1996). The trout species are *iteroparous*, which means that individuals breed more than once and may live to spawn in several years.

SENSITIVITIES TO IMPACTS

In the Cedar River Basin, stream habitat for salmonids can be impacted in a variety of ways from urbanization, water resource management, and forestland management (King County 1993). Urbanization can seriously damage streams. The amount of impervious surface is typically increased in a basin, which results in increased peak flows (Booth 1991), and streamside vegetation is often removed, leading to bank instability, erosion, water temperature increases, and loss of coarse woody debris in the stream (Booth and Reinelt 1993; Booth and Jackson 1994). In addition, the loading of chemical pollutants into water bodies is increased (King County 1993).

Management of water resources by dams and diversions can have impacts of several kinds. Adequate stream flows are needed by salmonids for migration, spawning, incubation, rearing, and holding of adults. Dams can impede fish migrations, and flood control by dams can reduce peak flows during flood events. Flood control over the long term can result in decreased connectivity of a river with its floodplain. In the short term, however, flood control can reduce flood scour of gravels with redds and, thus, egg mortality. Channelization, development, and diking along a river, such as is the case along most of the Cedar River below Landsburg, exacerbates peak flow damage in the channel and further reduces the connectivity of a river with its floodplain (King County 1993).

Forestland management activities, including timber harvest and associated roads, can impact stream habitat in several ways (Meehan 1991; Section 4.2.3). Timber harvest activities have often resulted in removal of streamside vegetation, and large-scale clearcutting and poorly designed forest roads have resulted in high levels of sediment delivery into many stream channels from increased erosion and landslides (Franklin 1992).

Because eggs and alevins need oxygen during incubation, they can be impacted by deposition of sediment, which can fill the interstitial spaces between the pieces of rock and reduce the flow of oxygen-bearing water. Sedimentation can also hinder the movement of alevins in the gravel. Juveniles that rear in streams are sensitive to a variety of impacts on their habitat that can result from forest management activities. Increased sediment inputs can fill pools, and the loss of streamside forests can result in loss of coarse woody debris. This can result in a loss of habitat complexity and a change in sediment dynamics in the stream.

3.2.4 Fish Habitat and Distribution in the Cedar River Watershed

The Cedar River and its tributary network provide abundant and varied habitat for a number of species of fish. The Cedar River Municipal Watershed, which encompasses all waters upstream of the Landsburg Dam and the Walsh Lake system, contains approximately 90 miles of fish-bearing streams; associated floodplain channels and wetlands; a large high-elevation reservoir (Chester Morse Lake); and a productive lowland lake (Walsh Lake).

A separate discussion of fish habitat in the mainstem Cedar River downstream of the Landsburg Diversion Dam is provided in Section 3.2.5, and sections 3.5.8 - 3.5.11 contain descriptions of the fish species. For the purpose of discussion in this section, the terms upper, middle, and lower are applied only to the Cedar River within the *municipal* watershed.

FISH DISTRIBUTION

Geographic Regions

There are four main geographic regions within the municipal watershed, each with a unique fish assemblage. The upper region above the Masonry Dam contains all of the streams that drain to the Chester Morse Lake and Masonry Pool reservoir system. These include the subbasins of the North and South Fork Cedar rivers, the Upper Cedar River (between the reservoir and the forks), the Rex River, and the smaller tributaries to Chester Morse Lake (Map 1). This region is primarily mountainous, high-relief land, and is geographically separated from the lower region along the front range of the Cascade Mountains. Two waterfalls in the Cedar River located downstream of Masonry Dam are natural barriers to upstream fish migration into this upper region (Map 8).

The lower watershed region drains to the Cedar River between Masonry Dam and Landsburg Diversion Dam. This area includes the Lower Cedar River subbasin and the Taylor Creek subbasin (Map 1). The landscape in this region is characterized by rolling foothills with low to moderate relief in the western portion, but moderate to high relief terrain as it merges on its eastern boundary with the mountainous upper watershed.

The third region is the Walsh Lake subbasin, which contains Walsh Lake (Figure 3.2-3), Webster and Hotel creeks, and the Walsh Lake Diversion Ditch, which is the outlet for the lake. The waters from this low-relief basin drain to a point in the Cedar River downstream of the Landsburg diversion and outside the administrative boundaries of the watershed (Map 1).

The fourth region is the smallest and contains only Taylor Ditch and a portion of Carey Creek. Waters in this region do not flow to the Cedar River. Carey Creek eventually connects to Issaquah Creek, which empties into Lake Sammamish. Taylor Ditch receives surface drainage from the old Taylor town site, passes under Webster Creek in a siphon, and empties into Carey Creek (Map 1).

Fish Studies

Information on fish distribution was gathered from several studies of fish in the watershed (see Appendix 23 ; R2 Resource Consultants, in preparation; Congleton et al. 1977; Wyman 1975). The variety of sampling techniques used in these studies included spawning surveys, angling, electrofishing, gill netting, and snorkeling. Additional data on fish distribution was gathered during minnow trapping, road-crossing construction activities, bull trout spawning surveys, and from recent observations of pygmy whitefish in the watershed by City biologists. Most field efforts were focused on collecting data on fish in the family Salmonidae. These results are summarized on Map 8 and in Table 3.2-2.

The fish family Salmonidae is represented within the municipal watershed by bull trout, pygmy whitefish, rainbow trout, cutthroat trout, kokanee (landlocked sockeye salmon), and coho salmon. The greatest uncertainty regarding the distribution of salmonid fish in the municipal watershed is associated with a lack of information on fish distribution in the smaller tributaries. Additional surveys of the upper portions of these tributary streams are needed to fully describe the fish habitat and fish distribution within the watershed.

The Upper Watershed Subbasins

The fish in the upper watershed region are separated from the populations in the lower watershed by the two impassable falls in the Cedar River downstream of Masonry Dam (Map 8). The fish assemblage in this upper region is distinct from the lower basins by the presence of bull trout and pygmy whitefish and the absence of cutthroat trout. Both bull trout and pygmy whitefish are found in Chester Morse Lake and Masonry Pool. Rainbow trout are also widely distributed in the upper watershed.

Bull trout occur in the Cedar River upstream of Chester Morse Lake; the lower sections of the North Fork and South Fork Cedar rivers; the streams of the broad Cedar River floodplain above Camp 18; Eagle Ridge Creek; the lower half of the Rex River; lower Lindsay, Boulder, and Rack creeks; and Morse and Cabin creeks (Map 7 and Table 3.2-2). There was one observation of a bull trout redd in Damburat Creek.

Pygmy whitefish have been observed during their spawning migration in the lower reaches of the Cedar and Rex rivers, as well as in Boulder Creek.

Rainbow trout are found throughout the range of bull trout in the watershed, as well as further upstream in the North Fork and South Fork Cedar rivers, Rex River, and Boulder Creek. Rainbow trout are also found in the lower reaches of the following Chester Morse Lake tributaries: McClellan, Green Point, Bridge, Otter, Damburat, and Lost (historic) creeks. Cutthroat trout have not been observed in the upper watershed region.

The only other fish species found in this region of the watershed are sculpin (*Cottus* spp.) in the family Cottidae. Sculpin have been found in all of the waters mentioned above, in lower Pine Creek, and also in the Rex River below Pine Creek.

Lower Cedar River and Taylor Creek Subbasins

The Lower Cedar River and Taylor Creek subbasins in the lower watershed contain two salmonid species: rainbow and cutthroat trout (Map 8 and Table 3.2-2). Rainbow trout have been found in the Cedar River, Rock Creek, and Taylor Creek. Cutthroat trout have been found in the Cedar River, and in Rock, Steele, Williams, and Taylor creeks. Rainbow trout are predominant in the Cedar River, while cutthroat trout are predominant in Rock Creek. Some hybridization between the two species has likely occurred in the Taylor Creek drainage. These subbasins also contain sculpin.

Walsh Lake Subbasin

The Walsh Lake subbasin contains the largest diversity of fish in the watershed (Table 3.2-2). Because the Walsh Lake Diversion Ditch joins the Cedar River downstream of the Landsburg Dam, this subbasin is accessible to some anadromous fish. The lower reach of this channel is reported to support anadromous coho, sockeye, and chinook salmon, and steelhead trout (King County 1993). A partial fish barrier in the Walsh Lake Diversion Ditch downstream of the Cedar River Municipal Watershed's western administrative border is a barrier to migrating sockeye salmon, although coho salmon are able to pass and have been observed in the Walsh Lake Diversion Ditch and Webster Creek (see Appendix 23).

Figure 3.2-3. Walsh Lake.

A recent study has also confirmed the presence of kokanee, a form of landlocked sockeye salmon, in Walsh Lake (see Appendix 23 and sections 3.5.8 and 3.6). The kokanee population spawns in lower Webster Creek and matures in Walsh Lake. Cutthroat trout are found throughout the waters of the Walsh Lake subbasin, and rainbow trout have been observed in the upper Walsh Lake Diversion Ditch (Map 8).

Other fish species in this subbasin include speckled dace (*Rhinichthys osculus*), redside shiner (*Richardsonius balteatus*), and western brook lamprey (*Lampetra richardsoni*), which have all been observed in the Walsh Lake Diversion Ditch. Walsh Lake also supports northern squawfish (*Ptychocheilus oregonensis*), a native fish, and largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*), both non-native species.

Issaquah Creek Subbasin

The portion of Carey Creek within the municipal watershed and the waters of the Taylor Ditch have not been sampled for fish. The lower reaches of Carey Creek, outside of the watershed, is a known salmon-bearing stream. The portion of the stream within the watershed may support trout and coho salmon. This reach of Carey Creek may also support common fish such as speckled dace and western brook lamprey.

FISH HABITAT

Chester Morse Lake and Masonry Pool

Chester Morse Lake is an approximately 1,500-acre reservoir with a maximum depth of approximately 125 ft. Current management of Chester Morse Lake can result in a maximum elevation change of 38 ft between full pool and the gravity-flow drawdown limit. Normal annual fluctuations are between 28 and 30 ft (sections 2.2.4 and 3.2.5). Masonry Pool, approximately 190 acres, is located downstream of Chester Morse Lake, and can fluctuate 70 ft in elevation, although the normal annual fluctuation is about 30 ft. At the higher lake levels, Masonry Pool and Chester Morse Lake join to form a single water body. At its lowest level, Masonry Pool is essentially a flowing channel.

The potential impacts of fluctuating lake levels in Chester Morse Lake on fish habitat include seasonal changes in the quantity and availability of lake volume and associated lake habitats, diminished productivity in the littoral zone (see Lindstrom 1973), inundation of tributary habitats used by spawning and incubating fish, and possible creation of physical obstructions to the upstream migration of spawning fish in the fall, when reservoir level is at its lowest, during dry years. Inundation is caused by high lake levels that cover areas with still water that are otherwise usually dry or covered by flowing water. Inundation of the lower reaches of streams during spring reservoir refill can cause diminished flow velocities, which could cause suffocation of some developing bull trout embryos, unless upwelling occurs in the spawning gravels (Section 3.5.6). Physical obstructions by exposed deltas can delay or prevent spawning migrations. These changes in lake habitat can affect the availability of food resources and influence competition and predation (sections 3.5.6 and 3.5.7).

A more detailed description of the results of reservoir operations on lake habitat is provided in sections 3.4.1 and 4.4.3 of the Revised NEPA EA/ final SEPA EIS for the Cedar River Watershed HCP, and the potential impacts of the changes in reservoir operations associated with the proposed instream flow regime are discussed in Section 4.5.6 of this HCP.

Stream Habitat

Fish-bearing Streams

Of the almost 400 miles of stream within the watershed, approximately one-fourth (90 miles) are classified by the state as fish-bearing waters (fish-bearing streams). These 90 miles include streams classified as Type I, II, and III waters (based on WDNR's water typing system) (Table 3.2-3; Map 8). Additional fish habitat in the municipal watershed includes Chester Morse Lake, Masonry Pool, Walsh Lake, and a number of smaller lakes and ponds.

Table 3.2-2. Fish distribution within the Cedar River Watershed.

Upper Watershed	Chester Morse Lake	Cedar River	North Fork Cedar River	South Fork Cedar Rive	Rex River	Camp 18 floodplain	Eagle Ridge Creek	Pine Creek	Lindsay Creek	Morse Creek	Cabin Creek	Boulder Creek	Rack Creek	Lost Creek (historic)	Damburat Creek	Otter Creek	Bridge Creek	Green Point Creek	McClellan Creek
Pygmy Whitefish	x	x			x							x							
Bull Trout	x	x	x	x	x	x	x		x	x	x	x	x		x				
Rainbow Trout	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x
Sculpin	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Lower Watershed	Cedar River	Rock Creek	Williams Creek	Steele Creek	Taylor Creek
Rainbow Trout	x	x			x
Cutthroat Trout	x	x	x	x	x
Sculpin	x	x	x	x	x

Walsh Lake System	Walsh Lk Diversior	Walsh Lake	Webster Creek	Hotel Creek
Coho Salmon	x		x	
Kokanee		x	x	
Rainbow Trout	x			
Cutthroat Trout		x	x	x
Sculpin	x		x	
Speckled Dace	x			
Northern Squawfish		x		
Redside Shiner	x			
Western Brook Lamprey	x			
Largemouth Bass		x		
Yellow Perch		x		

Table 3.2-3. Summary of Cedar River Watershed stream miles by stream type, based on 1994-1997 WDNR data. Note that miles do not reflect the new Emergency Water Type Rule (WAC 222-16-030).

BASIN Subbasin	**Stream Miles**					
	Type I	**Type II**	**Type III**	**Type IV**	**Type V**	**Total**
NORTH FORK CEDAR RIVER North Fork Cedar River	1.5	1.4	3.7	7.2	20.0	33.9

BASIN Subbasin	Stream Miles					
	Type I	Type II	Type III	Type IV	Type V	Total
SOUTH FORK CEDAR RIVER						
South Fork Cedar River	2.6	0.1	1.5	5.5	13.0	22.7
UPPER CEDAR RIVER [a]						
Bear Creek	NA	0.1	2.8	1.3	5.5	9.8
Goat Creek	NA	0.2	1.2	2.4	3.7	7.4
Seattle Creek	NA	NA	2.7	2.6	10.8	16.1
Findley Creek	0.3	0.1	2.3	0.3	4.5	7.5
Roaring Creek	NA	NA	0.7	0.8	3.0	4.5
Upper Cedar River	7.1	1.7	3.4	6.7	16.4	35.2
TOTAL	7.4	2.1	13.2	14.1	43.8	80.4
REX RIVER						
Pine Creek	NA	NA	0.6	1.9	3.2	5.7
Lindsay Creek	NA	NA	2.6	3.8	8.0	14.4
Boulder Creek	NA	1.1	1.6	5.5	13.2	21.4
Rex River	7.0	NA	2.2	6.9	26.2	42.3
TOTAL	7.0	1.1	7.1	18.0	50.6	83.81
CHESTER MORSE LAKE						
McClellan Creek	NA	NA	0.2	2.0	4.0	6.1
Rack Creek	NA	NA	0.2	2.1	7.5	9.8
Damburat Creek	NA	NA	0.1	0.8	0.9	1.8
Otter Creek	NA	NA	NA	0.5	2.1	2.6
Green Point Creek	NA	NA	NA	1.7	2.5	4.1
Chester Morse Lake	8.1	NA	NA	6.0	15.0	29.1
TOTAL	8.1	0.0	0.4	13.1	31.9	53.5
TAYLOR CREEK						
North Fork Taylor Creek	NA	1.3	NA	7.0	12.5	20.8
Middle Fork Taylor Creek	0.8	0.7	0.8	5.9	16.1	24.3
South Fork Taylor Creek	NA	1.7	1.0	1.2	5.7	9.7
Taylor Creek	4.0	NA	1.1	2.3	4.5	11.9
TOTAL	4.7	3.8	3.0	16.4	38.8	66.7
LOWER CEDAR RIVER [b]						
Steele Creek	NA	NA	1.7	0.6	1.0	3.3
Williams Creek	NA	2.9	NA	0.9	1.8	5.5
Rock Creek	1.6	2.2	3.3	2.8	4.0	13.9
Lower Cedar River	13.9	NA	NA	7.7	12.3	33.9
TOTAL	15.6	5.0	5.0	12.0	19.1	56.6
WALSH LAKE						
Webster Creek	NA	NA	2.5	2.0	5.0	9.5
Hotel Creek	NA	NA	0.3	0.7	1.2	2.2
Walsh Lake Diversion Ditch[c]	NA	NA	3.0	NA	NA	3.0
TOTAL	0.0	0.0	5.8	2.7	6.2	14.7
ISSAQUAH CREEK						
Carey Creek	NA	NA	0.8	0.3	NA	1.1
TOTALS	46.8	13.6	40.4	89.3	223.4	**413.5**

[a] Upstream of Chester Morse Lake to confluence of the North and South Fork Cedar rivers.
[b] Downstream of Masonry Dam to Landsburg Diversion Dam.
[c] Miles are for only the area within the municipal watershed property boundaries.
NA Not applicable.

Surveys of fish-bearing streams in other Washington State watersheds have indicated that many streams classified as Type IV (non-fish bearing) should actually be classified as Type II or III (fish-bearing) (Forest Practices Board 1997; Conroy 1997). Although this may be true for streams in the Cedar River Municipal Watershed, a systematic fish-habitat survey has not been conducted. Therefore, the full extent of streams in the watershed that can support fish is unknown.

In comparison to the quality and extent of fish habitat in the Cedar River Basin downstream of the Landsburg Dam, the municipal watershed contains some of the best fish habitat in the Lake Washington Basin (Seattle Water Department 1995; King County 1993; Williams et al. 1975). The lack of land development combined with an unharvested and naturally reproducing fishery has preserved a system that has relatively high quality habitat and is generally free of non-native species interactions. Nonetheless, as a result of past logging practices, some of the stream channels have been negatively affected by reduced volumes of large woody debris, and by increased sediment inputs, bedload movement, and segmentation from anthropogenic barriers.

Stream-crossing Structures and Effect on Fish Distribution

A survey of stream-crossing structures in the Cedar River Watershed was conducted by City biologists during the period 1994-1997 (Seattle Public Utilities 1998). Locations where forest roads cross streams were initially identified with the GIS system by overlaying the roads with the drainage network. Crossing locations were also identified in the field and marked with a comprehensive numbering system. The condition of each structure located on potential fish-bearing streams was assessed with visual observations and measurements of attributes affecting fish passage, such as structural gradient, structural alignment and size, water depth, and channel features.

Stream reaches were defined as potentially fish-bearing if they were designated as Type I, II, or III waters on WDNR maps, and also if the stream met the new Emergency Water Type Rule (WAC 222-16-030). The Emergency Water Type Rule, absent evidence that fish are not present, classifies as Type III any Type IV or higher type streams that are 2 ft wide or wider, and less than or equal to 20 percent gradient.

Many stream crossings (103 out of the total of 168 stream-crossing structures) were included for fish-passage evaluation because of the Emergency Water Type Rule. These stream locations will eventually need to be surveyed for fish habitat to assess if they can support fish life. Many of these reaches are located in headwater areas where fish habitat is minimal or likely absent, or in lower elevation streams that flow only for short periods during spring snow melt. Additionally, some of the reaches included as potentially fish-bearing are not expected to contain fish, because they are located above natural fish barriers, such as impassable waterfalls or chutes. A comprehensive inventory of fish habitat above and below each structure will be needed to finalize these survey results.

A separate survey of crossing structures on Type V and Type IX streams is on-going. Several stream locations from this survey that meet the new Type III stream criteria have already been identified and have been included in this summary. However, the survey is not yet complete. It is estimated that this survey may result in the reclassification of reaches associated with up to 60 additional crossings as Type III (fish-bearing) stream reaches. As these additional stream-crossing structures are identified, they will be assessed for fish passage and the stream reaches surveyed for fish habitat.

Of the 168 stream-crossing structures currently identified on potential fish-bearing streams, 39 are bridges, 120 are culverts, and 9 are wood puncheons. None of the bridges obstruct fish passage, and all of the stream-crossing puncheons are scheduled for replacement or removal. Of the 120 culverts, 82 percent of them create water velocities or hydraulic drops that would be partial or total obstructions to migrating trout and salmon based on state criteria for installation of new culverts in fish-bearing streams (WAC 220-110-070).

The actual effect of the impassable culverts on fish distribution is uncertain, as many of the streams with these obstructions have not yet been surveyed for natural barriers, fish presence, or fish habitat. It is likely that many of these stream reaches were not used by fish prior to the culvert installations, and therefore many of these crossings probably do not influence fish migration. However, all of the impassable culverts will be assessed in the field for their influence on fish migration.

Surveys for fish presence or absence, fish habitat, and natural barriers will have to be conducted at each obstacle to accurately determine its impact on fish. Structures that limit fish distribution will be upgraded, replaced, or removed. This scheduled work will follow a prioritization that involves the consideration of the species of fish affected; the area, type, and quality of habitat available; and the immediacy of the problem and other integrated watershed restoration and maintenance activities. The surveys will be used to update fish distribution maps and other databases.

3.2.5 Fish Habitat in the Cedar River Downstream of the Landsburg Diversion Dam

There are 21.8 mainstem river miles in the Cedar River downstream of the Landsburg Diversion Dam. This section of the river, below the boundaries of the Cedar River Municipal Watershed, flows from the Landsburg Diversion Dam to the river’s outlet at Lake Washington (Map 2). The basin area of the Cedar River downstream of the watershed boundary is approximately 35 percent of the total Cedar River drainage basin (King County 1993). This area is predominantly within unincorporated King County, with only a small percent in the City of Renton and the newly incorporated City of Maple Valley. The remaining 65 percent of the total basin area is within the municipal watershed.

The following discussion on fish habitat in the Cedar River downstream of the Landsburg Diversion Dam is summarized primarily from a King County basin planning report, the Cedar River Current and Future Conditions Report (King County 1993). This document provides a comprehensive assessment of the condition of the river and the basin downstream of the Landsburg Dam. Included in this report are descriptions of current land use in the basin, hydrology, flooding, erosion and deposition, aquatic habitat, and water quality.

CHANNEL CONDITIONS

Prior to the early 1900s, the Cedar River flowed into the Black River, the original outlet of Lake Washington, and then into the Duwamish River before emptying into Puget Sound at Elliot Bay (Map 2). Only during flood events did water from the Cedar River flow north through the Black River and into Lake Washington (Chrzastowski 1983). In 1916, the Lake Washington ship canal was completed under the direction of the ACOE. As part of this project, the outlet of Lake Washington was rerouted through Lake Union, down to the Ballard Locks and into Salmon Bay (Chrzastowski 1983). The principle objective of this project was to aid the navigation of logs, coal, and farm produce. Flood control for the Renton area was an additional benefit. As a result of this project, the elevation of Lake Washington was lowered approximately 9 ft, and the 3.3-mile long Black River became a dry channel. Additionally, the Cedar River was extended 1 mile north to flow into the south end of Lake Washington. At the same time the lower 1 mile of the existing Cedar River channel was straightened and the banks stabilized with large rock (King County 1993).

In addition to rerouting and channelizing the mouth of the Cedar River, other influences have shaped the channel morphology since the mid-1850s. Since this time, the channel has been hardened to prevent lateral migration, diked to prevent flooding, and straightened to facilitate railroad construction. The City's water management in the upper reaches has also contributed to changes in channel morphology. Flood management practices have to some degree decreased the magnitude and frequency of flood events (King County 1993). Water management has not eliminated all flood flow, however, as the water storage facilities at Masonry Dam have a limited storage capacity and only capture runoff from the uppermost 43 percent of the basin. The Cedar River still overtops the banks at some places, and creates potentially serious problems for almost 200 homes, downtown Renton, and Boeing Company aircraft assembly facilities situated within the 100-year floodplain (King County 1993).

Between 1865 and 1989, the active river channel and channel width between Renton and Landsburg decreased significantly (King County 1993). The channel narrowing was predominately the result of reduced flood flows, the confinement of the channel within rock-hardened banks (revetments), and floodplain development (King County 1993). The Cedar River has been transformed from a braided river with multiple channels, to a sinuous, generally single-channel river, with 64 percent of the length of the river hardened with revetments on at least one bank.

In the Cedar River, two important ecological interactions have been dramatically altered. The natural upstream-downstream connection between salt water and fresh water has been permanently changed, and the connection between the channel and its floodplain has been reduced. These connections represent the longitudinal and lateral interactions that are two primary components of a river ecosystem (Ward 1989). These ecological interactions have been altered in the Cedar River by rerouting the outlet of the Cedar River, narrowing and simplifying the channel shape, and reducing flood flows and frequencies. The rerouted upstream-downstream connection between the river and the ocean has altered the ability of the Cedar River to support fish, such as pink and chum salmon (Section 3.5.8), and the reduced connection between the channel and its floodplain has altered the supply and stability of spawning habitat for many fish, as discussed below.

SEDIMENT

The substrate composition in the Cedar River downstream of the Landsburg Diversion Dam generally provides good spawning habitat for anadromous salmonids (sections 3.5.8 - 3.5.11). The river contains abundant cobble and gravel that provide habitat for developing salmonid embryos and larvae. However, the supply and stability of the substrate has changed as a result of channel realignments and reduced flood flows. Extensive hardening of the banks has reduced localized inputs of gravel and cobble. Movement of sediments within the channel during high flows has also changed because the river is mostly contained within its banks. As a result, floodwaters do not spread onto the floodplain where sediments would naturally drop out as the flood energy is dissipated. High flows are consequently contained predominantly within the banks of the river, which causes greater velocity and increased scour of the substrate habitat. Sediment transported by the river tends to aggrade near the mouth of the river in Renton instead of its natural pattern of incorporation into and storage in the floodplain further upstream (King County 1993). Maintenance dredging of this reach was discontinued around 1980, although in 1998 the ACOE completed a renewed dredging project in this reach.

WATER QUALITY

Because the upper basin is managed by the City for high quality drinking water, contaminant concentrations in the lower Cedar River are typically low as a result of dilution with the upper waters. Water quality is reported as excellent just below the Landsburg Dam, where the intake for the City’s water supply is located However, at points further downstream heavy rainfall causes runoff of contaminants from animal pastures, roads, and commercial lots into the Cedar River, and contaminant concentrations periodically exceed established criteria to protect water quality (King County 1993). Water quality criteria exceedances occur most often near the river outlet (King County 1993).

FISH HABITAT

The mainstem Cedar River downstream of the Landsburg Dam supports a variety of fish populations, although habitat quality for many fishes has been negatively affected by the conditions described above. Much of the channel exhibits a low structural complexity, and a reduction in the supply and stability of spawning gravel. The revetments constructed along the majority of the channel length preclude the establishment of mature riparian trees that normally provide shade, cover, and inputs of large wood and nutrients. Approximately 45-67 percent of the riparian area along the river is devoid of large trees (King County 1993).

Because of the simplified channel shape, habitat in the river is dominated by riffles along much of its 21.8 miles. It is estimated that the river has approximately 70 percent fewer large pools than would be expected under unmanaged conditions (King County 1993). Most of the extant large pools are located at the bases of large bluffs. Smaller lateral-scour pools are typically located along banks artificially hardened with rock. The majority of these pools lack large woody debris and the structural complexity preferred by many fish species. The simplified channel configuration and lack of instream structure reduces the Cedar River’s ability to diffuse the energy of flood flows, which makes the channel more susceptible to substrate scour. This is especially destructive to fish eggs and larvae, which develop in the substrate.

Fish habitat in the Cedar River downstream of the Landsburg Dam can be divided into three distinct reaches. The Renton reach, from river mile (RM) 0.0 to 1.6, is entirely artificial and is essentially one long riffle with relatively little habitat complexity (King County 1993). This depositional area for coarse sediments is used extensively by spawning sockeye salmon, although it provides poor rearing habitat for stream-dwelling salmonids.

The second reach, from RM 1.6 to 16.2, is also dominated by riffle habitat, and is confined and stabilized throughout most of its length. A 1-mile section between RM 9.6 and 10.7 retains a more natural channel pattern with braids and side channels. A habitat concern in this reach is the lack of gravel recruitment and pool formation resulting from efforts to stabilize steep banks to prevent catastrophic landslides (King County 1993).

The third reach, from RM 16.2 to the Landsburg Diversion Dam, contains 5.5 miles of mainstem habitat. The river valley in this area is more confined by high bluffs than in the lower reach, but the channel itself is less constrained by revetments and there is less development in this portion of the basin. The majority of large pools in the lower Cedar River occur in this reach, generally along the bases of high bluffs.

Section 3.3 Contents

3.3 Studies, Analyses, and Workshops

3.3.1 Introduction

In preparing this HCP, the City conducted or sponsored a variety of specific studies, analyses, and workshops. Some of these efforts were initiated before preparation of this HCP began in 1993, and some were completed specifically for the HCP. These efforts include:

- Studies of the relationship of instream flows and fish habitats, conducted cooperatively with state and federal agencies and the Muckleshoot Indian Tribe;
- A watershed assessment patterned after the state watershed analysis process to determine the condition of the watershed, identify factors causing problems, and identify opportunities for restoration;
- A series of workshops with regional scientists to discuss conservation strategies for restoring old-growth forest habitat; designing an Ecological Reserve and developing approaches to timber harvest in the municipal watershed that would sustain the forest ecosystem; and developing mitigation and conservation strategies for bull trout that use the reservoir complex and for anadromous salmonids blocked from passage into the municipal watershed by the Landsburg Diversion Dam;
- A risk assessment performed to determine what species and numbers of fish could be passed above the Landsburg water intake without jeopardizing drinking water quality;
- A pilot aquatic monitoring project, designed to develop and evaluate methods for using benthic organisms in streams to monitor stream habitat health; and
- Forest inventory and modeling used to project future forested habitat and potential revenues from timber harvest.

3.3.2 Instream Flow Studies

GENERAL BACKGROUND

Over the past 30 years, there have been many studies of Cedar River fisheries, basin hydrology, and instream flows. The studies were funded or conducted by the City, the WDF, ACOE, WDOE, USGS, Muckleshoot Indian Tribe, and the University of Washington FRI. In addition, several M.S. theses and Ph.D. dissertations have been written on many aspects of Cedar River fisheries.

Of particular importance to the management of Cedar River water resources have been studies related to instream flows. Instream flow is the volume of water flowing through the stream channel per unit time, generally measured in cubic feet per second (cfs). Instream flow variations affect a number of aspects of the river, including fish and wildlife, recreation and aesthetics, and the maintenance of water quality, channel morphology, and riparian vegetation. If managed properly, instream flows can provide beneficial uses and functions for these varied aspects.

Factors influencing or controlling instream flows in natural rivers differ in some distinct ways from those in regulated systems. Instream flows in natural rivers are determined directly by precipitation levels, watershed characteristics, and other hydrologic variables. Instream flows of regulated rivers respond not only to precipitation and watershed characteristics but also to water storage, diversion, and release operations to meet particular water project management objectives, such as flood control, power generation, and water supply.

Instream flow and related studies attempt to provide natural resource and water project managers the scientific information necessary to appropriately allocate stream flow in regulated or diverted rivers to protect or enhance beneficial uses and functions. The earliest instream flow studies of the Cedar River that related salmon production to stream flow were conducted by the USGS and the WDF between 1967 and 1969 (Collings et al. 1970). The purpose of the study was to determine the appropriate spawning discharges for coho, chinook, and sockeye salmon in the fall. Results of these early studies indicated that peak spawning discharges measured at Renton for sockeye ranged from 240 cfs to 510 cfs and averaged 422 cfs. Studies of rearing habitat indicated a flow of between 50 and 100 cfs was appropriate (Collings et al. 1970). Based on study results of the USGS and the WDFW, instream flows (measured at the Renton USGS gage) were first set for the Cedar River in 1971 by WDOE at the request of the WDF (RCW 90.54).

Soon after 1971, the City and the ACOE determined that standard operations could not be sustained under the established minimum instream flow levels. The City then contracted the FRI to study the relationship between discharge and sockeye production in the Cedar River. Concurrently, studies by the ACOE indicated an increasing demand for lockage, a demand that would not be met with summer minimum flows of 75 cfs from the Cedar River.

Between 1972 and 1980, the FRI conducted numerous studies on the in-river biology and stream flow requirements of Cedar River sockeye. One finding was that maximum available spawning habitat for 11 Cedar River study reaches was achieved at a discharge 250 cfs measured at the Renton gage (Stober and Greybill 1974).

In addition, Stober et al. (1974, 1979, 1980) studied several factors that affect reproductive success of Cedar River sockeye. These included instream flows, effects of flood flows, and egg-to-fry survival. According to Stober, these studies indicated that the number of redds could hypothetically be increased by ramping the flow up iteratively. It was argued that this procedure would provide center channel habitat at lower flows and recruit additional habitat as the stream flow was increased over time, thus reducing density-dependent mortality of eggs as a result of redd superimposition by several spawning females. These studies also indicated that major flood events are a primary factor in limiting egg-to-fry survival in the Cedar River.

Miller (1976) studied the relationship between sockeye production and discharge in the Cedar River. Data used in his calculations were primarily from the literature. According to Miller, flows during spawning have a relatively small effect on fish production unless they are reduced to very low levels, which would be expected to occur very rarely. Miller also postulated that flood flows in the Cedar River have a very significant effect on fish production. In later studies, Ames (1983) and Thorne and Ames (1987) found a strong negative correlation between short-term, high river flows and survival to pre-smolt of sockeye from the Cedar River.

Differences in results between the USGS-WDF studies and the FRI studies led to controversy over which of the two study programs should be used as a basis for setting instream flows. In October 1976, the Cedar River Ad Hoc Water Resources Management Committee (Ad Hoc Committee) was formed to seek solutions for the problems surrounding the use of Cedar River waters (WDOE 1979). Between 1976 and 1979 there were numerous meetings and negotiations between the City, FRI, WDF, WDOE, ACOE, and the Ad Hoc Committee to resolve the instream flow issue. These exchanges did not resolve the instream flow issue for the Cedar River (WDOE 1979). By 1979, WDOE had decided that there would never be an agreement between the two study programs because each had different underlying purposes and different methodologies.

In early 1979, WDOE initiated the Western Washington Instream Resources Protection Program (WWIRPP) to establish instream flows in sufficient quantities to support food and game fish populations in western Washington streams. As a result of the WWIRPP, WDOE repealed Cedar River minimum flows established in 1971 and adopted adjusted normal year and critical year flow regimes (WAC 174-30-020; WDOE 1979). However, as acknowledged by WDOE, these new flows were not binding on the City (see Section 2.2.5).

In 1986, the City initiated the formation of the Cedar River Instream Flow Committee (the Committee) to develop an instream flow study program for the Cedar River that was based on current scientific methods and was conducted in full collaboration with state, federal, and Tribal scientists. The Committee benefited from the advances in instream flow science and computer technology since the WWIRPP and earlier instream flow studies. Committee members included the City, WDFW, WDOE, ACOE, USFWS, NMFS, and the Tribe. The Committee recommended that the widely used USFWS Instream Flow Incremental Method (IFIM) and supporting analyses be conducted.

The difference between previous methods and the IFIM was the IFIM's greater requirements for detailed site specific geomorphological, hydraulic, and habitat utilization data. The IFIM is discussed briefly in the subsection entitled "Overview of Study Methods" below.

The primary objectives of the instream flow and habitat utilization studies set by the Committee were to:

(1) Develop Weighted Useable Area for selected species and life stages for specified reaches of the Cedar River;

(2) Develop site-specific habitat utilization criteria for selected species and life stages;

(3) Conduct effective spawning habitat analyses for sockeye and steelhead;

(4) Conduct cumulative spawning habitat analyses in order to evaluate the feasibility of maximizing sockeye spawning potential; and

(5) Investigate flood scour impacts on sockeye redds.

Through an interview process conducted by the Committee in November 1986, Cascades Environmental Services, Inc. of Bellingham, Washington was selected to conduct the required studies. Instream flow and related studies were conducted in full collaboration and coordination with the Committee between 1986 and 1991. During this time, the Committee and various subcommittees met more than 20 times, including several field visits, to jointly develop and implement the study program. The Committee met at least an additional 27 times in the analysis phase of the program between 1991 and January 31, 1996. Much of this analytical work related to the development and evaluation of instream flow proposals during multiparty negotiations, which began in 1993. The contribution and frequency of attendance of each representative was high throughout the duration of the Committee's existence.

Draft and final reports titled *Cedar River Instream Flow and Salmonid Habitat Utilization Study* were submitted to the Committee in March 1990 and October 1991, respectively. With revisions to the draft, the final report was received by the Committee as an accurate representation of study program methods and results. Complete documentation of consultation with the Committee regarding study design, implementation, and analyses between 1986 and 1991 is included as an appendix to the final report. Documentation of consultation for these meetings is available upon request.

STUDY AREA BOUNDARIES

All studies were conducted between RM 1.7, which is the lower-most extent of the natural river, upstream 32.5 miles to the upper-most range of historic anadromous fish use at RM 34.2, at the base of Lower Cedar Falls. Within these boundaries, the Cedar River was segmented into four study areas. The major distinctions between each study area include existing and potential species utilization, flow control by diversion or storage, and hydrology. The study areas and their distinguishing characteristics are described below. *Note that the terms "lower" and "upper" used in this subsection for reaches of the Cedar River refer specifically to this study, and their use here does not reflect divisions of the river system for this HCP.*

- *Lower Cedar River Study Area*: This reach extends from RM 1.7 to the City's Landsburg Diversion Dam at RM 21.8. It is distinct from the three areas upstream in that it is accessible to all anadromous fish and it is the reach affected by water withdrawal at Landsburg. This study area is further divided into 3 study reaches.

- *Upper Cedar River Study Area*: This reach extends from RM 22.1 (the upper end of the Landsburg Diversion Dam forebay) upstream to a point immediately above Taylor Creek at RM 29.5. The primary reason for segmenting the river at this location is the large volume of ground water inflow originating from Masonry Pool and significant surface water inflow entering in the vicinity of Taylor Creek.

- *Cedar Falls Study Area*: This reach extends from RM 29.5 upstream to the Cedar Falls powerhouse tailrace at RM 33.7. The primary reason for this segment break is the immediate influence of powerhouse operations on river flow and the absence of significant inflows in this reach.

- *Canyon Study Area*: This reach extends from RM 33.7 upstream approximately 0.5 miles to RM 34.2, which is the location of the first natural barrier impassable to anadromous fish. The primary differences between the Canyon Reach and the Cedar Falls reach are channel morphology and the effect of Seattle City Light's bypass diversion on stream flows through the Canyon Reach.

TARGET SPECIES

Target species and life stages were selected in consultation with the Instream Flow Committee and are shown in Table 3.3-1 (Cascades Environmental Services 1991).

Table 3.3-1. Target species and life stages per study area.

Species	Life Stage	Study Area: Lower Cedar	Upper Cedar	Cedar Falls	Canyon
Winter and Summer Run Steelhead	Spawning	x	x	x	x
	Effective Spawning	x	x	x	
	Juvenile	x	x	x	x
	Adult Holding	x	x	x	x
Sockeye	Spawning	x	x	x	
	Effective Spawning	x			
	Cumulative Spawning	x			
Fall and Spring Chinook	Spawning	x	x	x	x
	Juvenile	x	x	x	x
	Passage	x			
Coho	Spawning	x	x	x	
	Juvenile	x	x	x	

OVERVIEW OF STUDY METHODS

The overall purpose of the study was to evaluate the instream flow and associated habitat requirements of salmon and steelhead in the Cedar River. Studies and analyses conducted between 1986 and 1996 include instream flow using the IFIM, sockeye and steelhead habitat preferences, effective spawning analyses, cumulative spawning analyses for sockeye and steelhead, redd scour studies, flow accretion studies (inflows to the mainstem), and sockeye and chinook run timing analyses and ramping rate (rate of flow decrease) analyses. Every aspect and detail of these study methods and associated analyses required the review and consent of the Committee before and during execution.

The study program was intensive. Over 15,000 individual measurements of river depth, velocity, substrate composition, cover, channel morphology, fish habitat preferences, and other variables were collected during 50 days of field work for crews of between two and five biologists. Methods for each of these studies are briefly described below.

IFIM Studies

The IFIM is the prescribed method of state and federal agencies for determining instream flow requirements in Washington State. The IFIM developed by the USFWS (Bovee 1982, 1986) is based on the premise that stream-dwelling fishes prefer a certain range of depths, velocities, substrates, and cover types, depending on the species and life stage, and that the availability of these preferred habitat conditions varies with stream flow. With input of stream flow, substrate, and cover type measurements, the IFIM uses a set of computer programs developed by the USFWS to quantify habitat availability over a range of flows. It is important to recognize that the result of the IFIM is not an absolute value but a range of values to be used as a tool for determining the appropriate stream flow or set of stream flows.

Application of the Cedar River IFIM followed a collaborative and thorough study scoping and design process in accordance with WDF IFIM study guidelines. Important fish habitat was mapped and incorporated into the study design using habitat maps and analysis of color aerial photographs, a low level aerial videotape, and topographic maps. With maps and photos in hand, Cascades Environmental Services met individually with WDF regional biologists who had first-hand knowledge of Cedar River fish life history, habitat use, and distribution. Final study designs were approved by the Committee.

Physical habitat parameters were measured using standard techniques according to Trihey and Wegner (1981), Bovee (1982), WDFW (1989), and the Cedar River IFIM scoping reports. Cedar River IFIM measurements extended over 32 miles of the river from just upstream of the City of Renton to the anadromous barrier falls, 0.5 miles above the Cedar Falls Powerhouse. A total of 63 study transects were selected to represent the mix of fish habitat and stream channel types in four study areas.

Flow Accretion

Flow accretion is the gain in river discharge between two points as a result of surface or subsurface inflows from tributaries, seeps, or upwellings. Understanding and quantifying the pattern and magnitude of surface flow accretion (and loss) is an important component of the instream flow study. In order to integrate hydrology with habitat and to provide a useful tool for water and natural resource managers, it was necessary to mathematically combine habitat from all IFIM locations along the river. Also, in order to correctly quantify the amount of habitat relative to the optional Renton or Landsburg control points, it was necessary to determine the cumulative discharge at IFIM study locations and Renton relative to any given bypass (discharge) below the Landsburg Diversion Dam.

Inflow is the primary hydrologic factor needed to integrate habitat between the study locations. Final accretion methods and analyses included Cedar River Inflow III analysis (Sun 1986), USGS records, Cascades Environmental Services flow measurements, and basin area calculations. The Committee agreed to use the 1929-1988 period of record as the basis for accretion analyses.

Fish Passage

Shallow depths across a riffle or gravel bar can limit a fish's ability to swim upstream. This type of barrier is called a *low-flow blockage*. If the shallow depth condition occurs just prior to the spawning period, upstream spawning migration can be blocked. Low-flow blockage conditions in a stream are a function of channel morphology, depth of flow, and flow timing.

The occurrence of low-flow blockages in a stream increases as the discharge drops during low-flow conditions. Under these conditions there are usually one or two critical riffles that are most sensitive to reductions in discharge and first become limiting as flows drop. If sufficient flows are maintained over these critical sections of the river then passage is assumed possible in all sections of the affected river reach. The critical passage section on the Cedar River was found at the shallowest and widest riffle in the river, approximately 0.5 miles upstream of Rock Creek (note that this is the Rock Creek below Landsburg).

Low flow passage criteria for salmon and steelhead were developed by Thompson (1972). According to Thompson, the minimum depth criteria are used only to ensure that fish have physical freedom to move throughout the stream. The minimum depth criteria do not account for the effect of short-term high flows on inducement of migration. Because of its large size relative to other salmonids, chinook salmon was chosen as an indicator for successful passage of all species. According to Thompson, chinook passage is not impeded if a depth of 0.8 ft is met over 25 percent of the total stream width *or* over a continuous 10 percent of the total stream width. Using IFIM cross-section measurement methods and the hydraulic model, the selected cross section was analyzed to determine the effect of the different discharges on stream depth relative to the passage criteria of Thompson.

Habitat Suitability Studies

The basic components of riverine fish habitat are space, water quality, flow, and cover. IFIM habitat suitability studies are designed to determine the suitable range of the flow and cover habitat components preferred by each species and life stage being studied. Although the USFWS maintains a large database on the habitat suitability of many species and life stages of fish, fisheries biologists recognize that a species' preferences may vary somewhat from stream to stream. For this reason the Committee directed that habitat suitability studies be conducted on sockeye and steelhead in the Cedar River. Habitat suitability for coho and chinook were obtained from the WDF.

Habitat suitability curves for sockeye spawning, as well as steelhead spawning and rearing, were developed from site-specific observations, existing curves from other rivers, data analysis, interpretation, and negotiation. The forum through which suitability curves were developed was the Cedar River Instream Flow Preference Curve Subcommittee. Members of the subcommittee included individuals from the City, Cascades Environmental Services, WDF, WDOE, the Muckleshoot Indian Tribe, USFWS, and the ACOE. Curves developed were used in the IFIM.

Effective Spawning Analysis

The purpose of the effective spawning analysis is to determine how best to protect against suffocation or dehydration of incubating eggs that may result from controlled stream flow reductions during or following the spawning period. The effective spawning model uses the hydraulic output from the IFIM to predict the discharge at which spawning areas in the stream could become dewatered. The effective spawning habitat model used in this study was adapted from an FRI model developed for similar evaluations of Seattle City Light's Skagit River Hydroelectric Project. The model was modified by the Committee for use on the Cedar River for sockeye. Of particular concern to the Committee was selection of the appropriate criteria for the minimum water depth required over a redd that would prevent egg suffocation. Considering the lack of reliable scientific data on depth criteria and the danger of setting the criteria too low, the Committee recommended that a conservative depth criteria of 0.3 ft be used in the model.

Ramping Rates

Fry and juvenile salmonids and other fishes are vulnerable to sudden flow reductions in the Cedar River. Fish can be killed by becoming stranded on open gravel bars or by isolation in potholes or side channels that subsequently dry up. To prevent such occurrences, the WDF has established ramping rate guidelines that limit the rate of flow reduction. The ramping rate guidelines are most effective when they are coupled with site-specific information such as river channel morphology, hydraulics, and species presence, and water project operational constraints and flexibilities. The primary source of information for the Cedar River on the relationship between reductions in discharge and streambed exposure was output from the IFIM.

Cumulative Spawning Analysis

The purpose of the cumulative spawning analysis as envisioned by the Committee was to determine if sockeye spawning potential in the Cedar River below Landsburg Dam could be maximized through regulated incremental increases in discharge during the spawning period. This "stepped flow" approach would theoretically provide maximum spawning potential by progressively adding habitat from the middle of the channel toward the edge of the channel through the duration of the sockeye spawning period. The cumulative spawning model was developed in a collaborative process with the Committee. The primary data source for the cumulative spawning model is spawning habitat output from the IFIM.

Redd Scour Studies

Flood flows in the Cedar River have been determined to have an adverse impact on sockeye egg survival. Because of this potential impact, the Committee was concerned that a negotiated lower flow during the sockeye spawning period could increase egg mortality by concentrating spawners in the mid-channel zone where bed scour is presumably more likely to occur. Related to this concern was the Committee's desire to provide safe areas for spawning, presumably along the margins of the river, where bed scour would not occur or would be less severe.

Three different methods were investigated to understand and quantify the relationship between spawning flow, flood flow, and the potential for sockeye redd scour. The three methods are outlined below.

(1) A radiotelemetry method was developed by Cascades Environmental Services, in consultation with the Committee, in which small radio transmitters were buried in sockeye redds and then monitored for displacement during subsequent flood events. During the 1990 sockeye spawning period, 30 transmitters were buried

in active sockeye redds at locations along the margins (presumed safe zone) of the channel and in the center (risk zone) of the channel at depths ranging from 0.25 to 0.75 ft. The transmitters were then monitored in real time with a multiple channel receiver for displacement during one minor and one major flood event of November 1990. The exact time of transmitter displacement was later cross-referenced to the USGS gage record at Renton to obtain river discharge at the moment the redd was scoured to the depth of the transmitter.

(2) A preliminary Incipient Motion Model was developed by Cascades Environmental Services and West Consultants, Inc., in consultation with the Committee, that used particle grain size data and output from the IFIM, results of the radio telemetry study, and bed movement equations to correlate site-specific bed movement to a specific flood discharge.

(3) An Edge Spawning Habitat Analysis method was also developed in consultation with the Committee. The basic purpose of the Edge Spawning Habitat Analysis was to examine the range of flows necessary to provide suitable sockeye spawning habitat in specified edge areas along the margins of the river. Output from the IFIM was the primary source of data for this method.

Three possible widths of safe zones were selected for the analysis: (1) the outer 10 percent of the wetted perimeter of each transect; (2) the outer 20 percent of the wetted perimeter of each transect; and (3) the outer 30 percent of the wetted perimeter of each transect. Percentages were equally split between the left and right banks. Wetted edges used to calculate the specific width of each safe zone for each transect were obtained from the IFIM model at flows of 400 and 600 cfs, as measured at the Renton gage. The IFIM data set was then modified to calculate WUA inside the safe zones only, excluding all habitat in the channel between the safe zones.

DATA ANALYSIS AND STUDY PRODUCT

IFIM Studies

IFIM data analysis required the use of a group of computer programs developed by the USFWS, called the Physical Habitat Simulation System. There are two main programs in this model: the hydraulic model, called IFG-4, and the habitat model, called HABTAT. IFIM data analysis involved close interaction with the Cedar River Instream Flow Committee. The Committee met on several occasions to review, discuss, and approve model calibration procedures.

The IFG-4 hydraulic simulation model predicts water depth and mean column velocity across the stream as a function of discharge. A log-log regression analysis was used to develop stage-discharge relationships at each transect and to predict velocity/discharge relationships at each habitat cell. Interpolation and extrapolation with the regression equations allowed modeling of flows between and outside the measured discharges. The resulting simulated hydraulic information was then input to the HABTAT program.

The HABTAT program integrates the simulated hydraulic information from IFG-4 with habitat suitability criteria and quantifies habitat availability over a range of flows for the specified target species and life stage. Habitat quantification is expressed as WUA, or square ft of habitat per 1,000 linear ft of stream.

The products of the IFIM and hydrologic studies were a series of tables and graphs representing the relationship between discharge (measured at either Landsburg or Renton) and total WUA (habitat) in the Lower Cedar Study Area (Cascades Environmental Services 1991). A similar series of tables and graphs was produced for study areas above Landsburg representing the relationship between habitat and accretion, flow regulation at Masonry Dam, and flow regulation at the Cedar Falls powerhouse.

An interactive computer model was developed and made available to the Committee that would allow the user to calculate the effects of various accretion and water management and demand scenarios on WUA for all species and life stages through all the Cedar River study areas. This model was used extensively by the City in evaluating instream flow proposals.

Flow Accretion

The product of the accretion study was a series of tables and graphs showing cumulative accretion on a weekly basis at each IFIM study location and the Renton USGS gage. These data were integrated into all flow-related analyses and models.

Fish Passage

Although the absolute minimum flow that would allow passage was not determined, studies indicated that upstream passage of adult chinook would not be impeded at flows of 94 cfs or more. The Committee decided that studies of less than 94 cfs would not be necessary as long as negotiated instream flows (at the passage transect) were equal to or greater than 94 cfs (Cascades Environmental Services 1991).

Habitat Suitability Studies

Habitat suitability criteria (preference curves) were developed from field observations using the methods described by Bovee (1986) and from negotiations with the Cedar River Instream Flow Preference Curve Subcommittee (Cascades Environmental Services 1991). A full report on preference curve development is presented in Appendix E of the Final Instream Flow Report (Cascades Environmental Services 1991).

Effective Spawning Analyses

Effective spawning analyses were conducted as agreed upon by the Committee. The product is a series of matrices and figures that specify the post-spawning flow required to protect incubating sockeye and steelhead eggs from dehydration.

Cumulative Spawning Analysis

Cumulative spawning analyses were conducted as agreed upon by the Committee. The Committee's primary purpose for the cumulative spawning analyses was to determine the feasibility of the incremental approach to flow regulation and sockeye spawning habitat maximization. Assuming that incremental flow regulation was determined to be feasible, the second purpose of the spawning analysis was to determine what flow steps would maximize sockeye spawning potential.

The analysis showed that, theoretically, incrementally increasing flow through the sockeye spawning period results in an increase in WUA over a constant flow held through the spawning period. Optional flow steps for maximizing WUA were presented in the Final Report.

Redd Scour Studies

An overview of redd scour analyses and products is provided below.

(1) The Redd Scour Subcommittee found results of the Radio Telemetry Study inconclusive for the purposes of quantitatively defining risk zones and safe zones. However, the results did indicate trends and phenomena that may be useful in understanding bed scour and its potential impact on sockeye redds in the Cedar River. These indications are that: (a) scour of sockeye redds may be initiated at higher flows than previously suspected; (b) the results of the transmitter study strongly support the premise that short-term high river flows can significantly reduce egg-to-fry survival; and (c) safe and risk zones are not clearly delineated in terms of channel margin and mid-channel zones. A number of mid-channel telemetered redds incurred minimal scour at even the highest flood flows.

For a number of technical reasons the Incipient Motion method was discontinued by the Committee in December of 1994. At that time the Committee decided to further develop the Edge Habitat Analysis Method.

(2) The Edge Habitat Analysis Method proved the most useful of the three redd scour study methods for allocating sockeye spawning flows that would minimize redd scour resulting from flooding. The product of the edge habitat analysis is an interactive model that permits the user to calculate the effects of various accretion and water management and demand scenarios on availability of edge habitat in the Lower Cedar River Study Area.

3.3.3 Watershed Assessment

OVERVIEW

A Watershed Assessment was conducted during the summer of 1995 to develop and document a scientifically based understanding of the environmental processes and interactions occurring in the Cedar River Municipal Watershed that affect aquatic habitats. The Watershed Assessment followed procedures as described in the Washington State Watershed Analysis Manual, Version 2.0 (Washington Forest Practices Board 1993) or were slightly modified from the these procedures. Adjustments to procedures in the manual were employed to increase accuracy of the investigation. Procedures used in the Cedar River Watershed Assessment are detailed in Watershed Assessment Modules and Methodologies (Foster Wheeler Env. Corp. 1995b).

The State of Washington Watershed Analysis process is a structured resource specialist team approach for developing sound management decisions using the best available data. Watershed Analysis procedures were specifically designed to provide information for the development of management prescriptions (Appendix 16) that prevent, avoid, or minimize negative environmental impacts to natural resources and identify restoration opportunities. Watershed Assessment results were incorporated into a series of GIS maps depicting existing features, such as landslides, and areas of concern, such as high surface erosion potential areas (Appendix 15).

The Watershed Assessment was conducted by scientists employed by the City, Foster Wheeler Environmental Corporation, and Terrapin Environmental. Individual disciplines represented by the scientists included forest hydrology, forest engineering, geology, fisheries biology, and geomorphology. Modules within the Watershed Assessment included mass wasting (landslides), surface erosion, hydrology, riparian zones, stream channel, and fish habitat. The Watershed Assessment also incorporated information provided by regional experts in such forums as the Cedar River Watershed Bull Trout Workshop (Foster Wheeler Env. Corp. 1995d) and Watershed Conservation Biology Workshops (Foster Wheeler Env. Corp. 1995a) (Section 3.3.4).

At the time the Watershed Assessment was completed, the Water Supply/Public Works and Water Quality modules were not conducted, because the entire Cedar River Watershed is a drinking water supply basin and a specific Water Quality module did not formally exist. Even though no formal Water Quality module existed, the City has extensive water quality data for points throughout the watershed and these data were incorporated into the assessment.

The Watershed Assessment produced a number of reports documenting the assessments described above, such as the "Stream Channel and Fish Habitat Assessment" (Cupp and Metzler 1995) and the "Mass Wasting and Surface Erosion Assessment." (Foster Wheeler Env. Corp. 1995c). A major product of the Watershed Assessment is a document entitled "Basin Condition Reports, Prescriptions, and Restoration Opportunities for the Cedar River Watershed Habitat Conservation Plan" (Seattle Water Department 1995), which is summarized below. Resulting prescriptions presented in this report are included in Appendix 16.

SUMMARY OF BASIN CONDITIONS REPORT

The Basin Condition Report provided a summary of basin conditions for eight physiographic regions and 24 hydrologic subbasins within these regions. These eight regions included the Lower Cedar River (Masonry Dam to Landsburg Dam) and Secondary Tributaries, Lower Glacio-fluvial Terrace, Taylor Creek, North Shore of Chester Morse Lake Reservoir, South Shore of Chester Morse Lake Reservoir, Rex River, Boulder Creek, and the Upper Cedar River. Each physiographic region summary provided the following information by hydrologic subbasin: (1) region overview discussing geology, geomorphology, history of resource use, and historic channel trends; (2) description of the fisheries resources; (3) discussion of potential and delivered hazards, including mass wasting and surface erosion, peak flows, and riparian function; (4) identification of particularly important stream reaches and the response (low, medium, or high) of each channel segment to specific material (wood, sediment, etc.) or energy (water, temperature, etc.) inputs; and (5) restoration considerations.

The Watershed Assessment identified six principal elements that contribute to resource degradation within the Cedar River Watershed above Landsburg Diversion Dam. The six elements summarized below include past land management activities within inner gorges and on unstable hillslopes, hillslope surface erosion and runoff from road surfaces, past road construction methods, riparian zone degradation, and adverse impacts to the hydrologic regime.

Inner Gorges

Land management activities such as timber felling, ground-lead yarding, and road construction within inner gorges have destabilized over-steepened hillslopes producing a number of landslides that have delivered coarse and fine sediment directly to streams.

Hillslope Landslides

Similar to the situation with inner gorges, past land management activities such as timber harvest, yarding, and road construction using inappropriate methods on unstable or landslide-prone hillslopes have directly or indirectly led to a number of landslides that have delivered both coarse and fine sediment to downslope streams.

Hillslope Surface Erosion

Creation of impervious areas as a result of soil compaction and vegetation removal from inappropriate yarding methods and road construction has resulted in overland water flow that carries fine sediment to downslope streams. Additionally, removal of vegetation from highly erodible soils has resulted in fine sediment entering streams from soils exposed to water and wind.

Roads

Fish habitat has been degraded as a result of fine sediment entering streams from unprotected native soil road surfaces, drainage facilities, and road prism cut and fill slopes. Additionally, mass-wasting events from road embankment slopes have contributed coarse sediment to downslope channels.

Riparian Zones

The degradation of aquatic resources within the watershed has in part been a consequence of timber harvesting and road building within riparian areas and wetlands. Improper typing of streams (see Section 3.2.4) has also led to the degradation of riparian vegetation resulting in increased sediment, nutrient, and solar energy inputs.

Hydrology

Impacts to the aquatic resources as a result of timber harvesting and road construction over a large percentage of a subbasin can alter the hydrologic regime, potentially increasing the magnitude and changing the timing of peak flows. Peak flow increases can affect both channel stability and available fish habitat in heavily harvested watersheds.

POTENTIAL RESTORATION OPPORTUNITIES

Besides describing the current conditions of the aquatic resources, the Watershed Assessment also provided prescriptions to prevent, avoid, or minimize adverse impacts, and restoration opportunities for each physiographic region and specific recommendations for some of the 24 subbasins. Many of the restoration opportunities are not region- or subbasin-specific, but apply to the entire Cedar River Watershed. The seven primary restoration opportunities included in-channel placement of large woody debris, abandonment of roads, stabilization and revegetation of road cut and fill slopes, creation of off-channel rearing habitat in floodplains, restoration of riparian vegetation, replacement of structures (culverts and bridges) that block fish passage, and road resurfacing.

3.3.4 Summary of Workshops Sponsored by the City

Since 1991, the City has hosted a number of workshops on subjects related to the HCP or on specific parts of the HCP as it was being developed. These workshops provided an opportunity to solicit the perspectives of a variety of university, agency, and Tribal scientists in an interactive format with City staff. Many of the ideas developed in the workshops were incorporated into the HCP.

WATERSHED CONSERVATION BIOLOGY WORKSHOPS

Approaches to timber harvest in the context of landscape management were discussed at two conservation biology workshops the City held with scientists from the Pacific Northwest and agency biologists in 1995 (Appendix 14). The participants reviewed the following: work related to the HCP that the City had completed to date; the potential design and management of an ecological reserve; harvest of timber; species and habitats of concern; and proposed watershed restoration, mitigation, management guidelines, and monitoring.

The first workshop was held August 14, 1995. Along with City staff and consultants, participants included biologists from USFWS, NMFS, the U.S. Environmental Protection Agency, WDFW, and WDNR. A major point of discussion involved whether it was best to protect the entire northern spotted owl CHU (sections 3.2.2 and 3.5.2) in the reserve, or instead allow harvest of second-growth in the CHU and include additional mature, low-elevation, second-growth forest in the reserve to recruit more old-growth forest over time at lower elevation. A second major point of discussion involved the standards for tree retention when timber was harvested. The City proposed to generally follow the approach to retention recommended by Dr. Jerry Franklin in his New Forestry approach (Franklin 1989), but the City had not proposed specific standards at that time.

Following the first workshop, WDFW recommended specific tree retention standards in excess of state forest practices requirements (letter dated October 5, 1995). The recommended retention standards were incorporated into the City's mitigation strategy for the draft HCP.

The second workshop involved a number of prominent research scientists working in various aspects of conservation biology. In addition to City staff, consultants, and biologists from several federal and state agencies, participants included Dr. Gordon Orians, Dr. Jerry Franklin, and Dr. James Karr of the University of Washington; Dr. Dennis Paulson of the University of Puget Sound; Dr. Jan Henderson and Dr. Andrew Carey of the USFS; and Dr. Klaus Richter of King County. Participants agreed that the management of matrix lands (lands *not* in an ecological reserve) would ultimately determine the overall landscape connectivity.

The scientists at the workshop did not agree on any single overall approach to forest management, but four themes emerged:

(1) The importance of a core forest reserve system, particularly to protect aquatic habitats, with no timber harvest for commercial purposes;

(2) The importance of retaining biological legacies at harvest to carry over key processes that contribute to structural and biological complexity in the regenerating stands;

(3) The value of allowing harvested stands to mature and develop characteristics of mature forest habitat in the commercial harvest zone; and

(4) The importance of restoring degraded habitats, particularly the natural function of the riparian/stream complex.

Dr. Henderson, a plant ecologist, pointed out that having patches of mature forest distributed over the watershed would be the best strategy to create favorable conditions for such organisms as lichens, fungi, and mosses. There was a consensus that there should be no limit on harvest unit size, because such limits would produce more fragmentation. There was also consensus that tree retention standards should be applied on a landscape level, rather than a stand or harvest unit level, because site conditions would vary and strongly dictate the best retention strategy. For example, heavy retention would be unsuccessful in areas of high winds with blowdown potential.

Most of the scientists at the workshop, as well as the state agency biologists and environmental groups, have uniformly suggested that more of the mature, low-elevation second growth in the lower watershed should be included in the City's ecological reserve. Based on the workshop discussion, input from the environmental groups, and meetings with WDFW and USFWS staff, a large block of additional low-elevation forest was added to the proposed Ecological Reserve in the draft HCP.

The scientists and agency biologists at the workshop also recommended that the harvest program incorporate long rotations, and Dr. Franklin recommended a higher average standard for retention of green trees at harvest, equal to about 20 percent of the stand volume. These two recommendations were also incorporated into the City's mitigation strategy for the draft HCP.

OLD-GROWTH FOREST RESTORATION WORKSHOP

On October 2-3, 1991, the City hosted a workshop on old-growth forest restoration. The purpose of the 2-day workshop was to discuss whether silviculture could or should be used to accelerate development of old-growth conditions in older, previously harvested stands, and to develop approaches to restoration. Participants spent one day in the field visiting several stands in Cedar River Municipal Watershed, and discussing potential treatments to restore old-growth conditions. The second day was spent in a workshop setting at the University of Washington, during which objectives, silvicultural treatments, and issues were discussed.

In addition to City technical staff, participants included in the workshop were Dr. Keith Aubry, Dr. Andrew Carey, Dr. Dick Miller, and Dr. Lori Wunder of the USFS Pacific Northwest Research Station; Dr. Jerry Franklin, Dr. Gordon Orians, Dr. Chad Oliver, Dr. Dave Shaw, Dr. Steve West, Dr. Gordon Smith, and Mr. Dean Berg of the University of Washington; Dr. Gabe Tucker of Oregon State University; and Dr. Carol Perry of Corvallis, Oregon.

The workshop group agreed that some older stands could be silviculturally manipulated in a manner that would increase the rate of development of old-growth conditions. However, the group also concluded that, given the experimental nature of the silvicultural treatments involved, older stands that were beginning to develop internal structure naturally should be left to develop without intervention.

The group discussed forest habitat needs of species and species groups, including:

- Salamanders, which as a group need logs, healthy soils, streams, and ponds;
- Spotted owls, which need large, moderately decayed snags, live trees with cavities as habitat for prey, large live trees with platforms or cavities for nesting, diversity of fungi and lichens, and roosting and foraging perches in the mid-story;
- Open-nesting birds, which require a variety of types of nesting sites and foraging substrates;
- Winter seed-eating birds, which require seed crops from different tree species;
- Birds and mammals that use tree cavities;
- Bats, which need large trees with exfoliated bark for roost sites, as well as caves, rocks, and crevices; and
- Invertebrates, many of which need coarse woody debris and decadent canopies.

The group identified a number of desired features a forest manager might attempt to develop through manipulation of harvested stands to foster development of old-growth characteristics:

- A wide range of tree sizes, with large trees important;
- Both healthy and defective trees;
- A large accumulation of biomass;
- Large logs, ranging in diameter, length, and level of decay, with large logs important;
- Snags, varying in size and decay class, with large snags important;
- Forest floor conditions that support fungi and invertebrates, and soil structure typically present in older, naturally regenerated stands;
- A variety of vascular plants, epiphytes, and fungi;
- Spatial heterogeneity in forest structure and species composition; and
- Cold, clear streams, with low sediment levels and high levels of coarse woody debris.

Several silvicultural techniques were discussed that could produce the desired features of stands:

- Thinning to: (1) create variable spacing among trees, a diversity of tree diameters, and several canopy layers; (2) create forest openings to recruit desired plant species, and stimulate growth of large trees and understory shrubs and trees; (3) release intermediate-sized trees and advanced regeneration (small hemlocks); and (4) favor desired species or damaged trees, fostering structural and species diversity.

- Using equipment and other means to create desired tree conditions in the following ways: (1) create snags by topping, damaging, or burning trees; (2) create logs by felling trees; and (3) create cavities using chainsaws and fungi.
- Stimulating development of plant diversity by planting forbs, shrubs, and trees, spraying lichen fragments in the canopy, and damaging trees to create defects.
- Avoiding fertilization, because of possible impacts to soil systems.
- Leaving existing features that generate diversity, such as root rot centers.
- Enhancing hardwood development, recruiting species such as big leaf maple (*Acer macrophyllum*) to diversify stand structure and development of mycorrhizae.
- Uprooting trees to create logs, root masses, and holes.
- Using prescribed fire, only after a careful risk assessment, to control fuel loads.

The group identified some risks of thinning that would have to be addressed or controlled, including soil compaction, introduction of disease or insect infestations (by damage to live trees), reduction of natural tree mortality, creation of too much uniformity, and impact to shrubs and snags from heavy equipment. The group designed specific treatments for one stand, based on a field visit, inventory data, and growth modeling, and designed future experiments for restoration.

BULL TROUT WORKSHOP

On November 18, 1994, the City held a 1-day workshop at Cedar Falls on bull trout in the municipal watershed (Foster Wheeler Env. Corp. 1995d), in part because bull trout are present in the reservoir and because the species was under review for potential listing under the Endangered Species Act. The goals of the workshop were to identify relevant new or unpublished information about bull trout ecology; assess potential effects of reservoir operations and land management activities on bull trout; review and discuss the City’s proposed mitigation plans; and generate ideas for ways to identify, protect, restore, and monitor important habitats.

In addition to City staff and consultants, participants included biologists from USFWS, NMFS, the Muckleshoot Indian Tribe, WDFW, University of Washington, and King County, as well as other experts on bull trout from the Pacific Northwest. These experts included Scott Craig and Fred Goetz, biologists who did master’s degree research on bull trout; Dr. Karen Pratt, an independent consultant from Idaho; Dr. Dudley Reiser and Dr. Ed Connor of R2 Resource Consultants, who had been studying bull trout in the watershed for several years; and Don Ratliff of Portland General Electric Company, who had done research on bull trout in reservoir systems.

Agency and Tribal biologists who were participating in instream flow studies and negotiations for the HCP were also present for the workshop to foster a better discussion of reservoir operations that could affect bull trout and how those operations and their effects might be altered by water releases to maintain downstream river flows for anadromous salmonids.

The workshop format consisted of presentations followed by open roundtable discussions. Presentations included the potential impacts of water supply and watershed management practices on bull trout, and potential mitigation elements and benefits for bull trout. Information covered included the historic pattern of timber harvest, historic and current migration barriers in the mainstem Cedar River, and the biological significance of the Cedar and Rex river deltas.

The elements chosen to develop the protective stream buffer system of the HCP were explained. Preliminary results of the fisheries study by R2 Resource Consultants (in preparation) were presented, which summarized most of what is known about bull trout in the municipal watershed. Overviews were given of the factors affecting reservoir operations, the role of the temporary pumping plants for emergency supply, and instream flows in the lower Cedar River.

The potential impacts of water supply and watershed management practices on bull trout were presented and discussed. One issue discussed was that of timing and magnitude of reservoir levels with respect to the bull trout's annual life cycle. Bull trout are known to spawn during the fall in the lower reaches of the two major tributaries to the reservoir, the Rex and Cedar rivers (Section 3.5.6). Rising reservoir levels in the spring can cause inundation of some bull trout redds, with a potential for mortality of eggs and alevins because of sedimentation and reduced oxygen supply (Section 4.5.6)

Falling reservoir levels during the summer and fall, prior to the late fall rains, may restrict access by adult bull trout to tributary spawning areas, and fish passage between Masonry Pool and Chester Morse Lake is restricted at lower levels (Section 4.5.6). Other potential impacts that were discussed included: the possible effects of using temporary pumps to lower the reservoir below its gravity feed outlet; the possible effects of lowering Masonry Pool for maintenance at Masonry Dam; the significance of entrainment of bull trout into the hydroelectric plant intakes at Masonry Dam; the cumulative impacts on bull trout from past timber harvest; and the impact of poaching on the bull trout population.

Potential mitigation elements were discussed that addressed the effects of reservoir fluctuations; the cumulative damage to streams from prior timber harvest and road building; and proposed research and monitoring directed at protecting and restoring the bull trout and its environment in the municipal watershed. Participants felt that the most likely limiting stage in the life history of watershed bull trout is the period of juvenile rearing in streams. They thought that the City's proposed stream and riparian conservation strategy, with its emphasis on large buffer strips and protection and restoration of stream habitats for fish, was a key mitigation element.

There was a general acceptance by the group regarding the plans and direction the City was taking for the protection of the bull trout, but the group also recognized some importance uncertainties. Participants made the following recommendations to the City:

- Determine the significance of the potential problem of access to spawning tributaries during low water years;

- Design and carry out a study to determine the significance of the problem of bull trout redd inundation by the reservoir in the lower parts of the Rex and Cedar rivers;

- Obtain more complete information on bull trout distribution and specific spawning habitats in the watershed, using radio-tagging to survey smaller tributaries for bull trout spawning; and

- Attempt to quantify the number of fish entrained into the hydroelectric project through a comparative literature survey (Section 3.5.6).

The first three recommendations were incorporated into the HCP monitoring and research program (Section 4.5.4), and the literature survey was completed after the workshop (Appendix 19).

ANADROMOUS FISH MITIGATION WORKSHOP

The City conducted a 1-day workshop on December 18, 1995, to evaluate anadromous fish population restoration measures that were then under consideration for the HCP. These measures addressed sockeye, coho, and chinook salmon and steelhead trout in the context of mitigation for the fish passage barrier created by the Landsburg Diversion Dam.

In addition to City staff and consultants, workshop participants included biologists from NMFS, USFWS, the Muckleshoot Indian Tribe, WDFW, King County, and ACOE; a representative of the Puget Sound Anglers; and Dr. Tom Sibley and Dr. Chris Foote, fisheries scientists from the University of Washington. Representatives of several environmental groups were invited but did not attend. A report covering the workshop proceedings, including a list of attendees and materials distributed at the meeting, was prepared and submitted to the City (Montgomery Watson 1997).

The group discussed the status of sockeye, coho, and chinook salmon and steelhead trout in the Lake Washington Basin, as well as possible causes for recent population declines and the general lack of understanding of these causes. Issues that were discussed included:

- The need for continued studies to identify and fill key information gaps to support the development of effective restoration measures;

- The need to assess the feasibility of providing fish passage facilities at Landsburg and evaluate potential risks to drinking water quality and public health;

- The potential role of a supplementation facility (hatchery or spawning channel) in population support and restoration; and

- The need for careful monitoring of selected restoration measures, including the impact on drinking water from fish passage above the raw water intake, and potential impacts of artificially produced sockeye fry on wild salmonids.

Potential mitigation elements were discussed that included interim and long-term measures. Long-term measures could provide passage above Landsburg for steelhead, chinook, and coho; habitat protection and rehabilitation above Landsburg; artificial production facilities for sockeye as an alternative to passage above Landsburg; and habitat restoration below Landsburg. Interim measures would be implemented prior to passage of anadromous fish above Landsburg Dam and construction of sockeye production facilities. For chinook, coho, and steelhead, such measures could include emergency supplementation and/or critical studies needed to provide information for development of effective and biologically sound long-term restoration measures that could contribute to reversing the decline of the fish runs. For sockeye, such measures could include continued funding contributions to the Lake Washington ecological studies and continued operation of the interim hatchery at Landsburg.

Following the workshop, consultants to the City completed a risk assessment regarding the potential impacts of fish passage above the raw water intake on drinking water quality and safety (Section 3.3.5; Appendix 5). The purpose of the evaluation was to determine if passage of small numbers of salmonids (steelhead trout, coho, and chinook salmon) above the Landsburg diversion could be consistent with drinking water regulations and other drinking water constraints and objectives.

An open discussion was held on various issues related to restoration plans. Topics of discussion included: cost-effectiveness of different measures; the kinds of monitoring needed to determine the success of mitigation and detect problems; the nature of an appropriate balance between artificial production and habitat enhancement; and implementation timelines.

3.3.5 Water Quality Risk Assessment for Landsburg Diversion Dam Blockage

Public water systems are required to comply with the provisions of the federal Safe Drinking Water Act (SDWA) and its associated regulations, as developed and implemented by the United States Environmental Protection Agency (EPA) and the Washington State Department of Health (WDOH). The SDWA was originally enacted by Congress in 1974, and was reauthorized and amended in 1986 and 1996.

The purpose of these regulations is to ensure that drinking water delivered to customers is of high quality, and is protective of public health. The regulations look at source water quality and protection, primary treatment reliability and efficiency, and distribution system water quality protection and maintenance. Each of the elements mentioned above are considered to be part of the multiple barrier approach to water quality enhancement. They build upon one another. Maintenance of the highest possible quality of source water is the first barrier of water quality protection used by Seattle Public Utilities. The high quality source water has enabled Seattle to maintain a high quality of drinking water without complex treatment systems.

Activities associated with the implementation of this HCP, especially fish passage facilities, have the potential to change the chemical, physical, and microbiological nature of the source water. The primary concern has been the potential for increased nutrient loading as anadromous fish are allowed passage above Landsburg Diversion Dam. Included in the Appendices to this document is a report prepared by CH2M Hill (Appendix 5) that specifically evaluates the potential water quality impacts of allowing anadromous fish above Landsburg Dam.

This risk assessment indicated that passage of chinook, coho, and steelhead above the raw water intake would be unlikely to pose risks to drinking water quality, largely because of the relatively low numbers of these species expected to spawn above the Landsburg Diversion Dam. However, the CH2M Hill report also indicated that there was some uncertainty with changes in particular variables, particularly pathogens, and recommended that monitoring be done prior to and after passage is effected. This monitoring recommendation has been incorporated into the overall research and monitoring program (Section 4.5.3).

In contrast to the small number of chinook, coho, and steelhead that could spawn above Landsburg – perhaps 5,000 fish – the escapement goal for sockeye in this habitat is 262,000 adults. The biomass of sockeye carcasses after spawning would be about 30 times as great as the biomass of the other species combined. Thus, the report concluded that passing sockeye above the raw water intake would pose an unacceptable risk to water quality.

A concern associated with the implementation of the HCP relates to the potential degradation of water quality during the construction of facilities in or near the raw water intake at Landsburg. Both the scheduling of construction and construction procedures are being developed to address this risk (Section 4.3.2), and water quality protection plans will be developed and implemented for each phase of work.

3.3.6 Cedar River Watershed Aquatic System Monitoring Plan

In 1994, the City of Seattle was awarded a Centennial Clean Water Fund Grant from WDOE to develop and implement an Aquatic System Monitoring Plan for the Cedar River Municipal Watershed. The main purpose of this program has been to collect information on the chemical, physical, and biological components of the freshwater streams of the watershed. A Technical Advisory Committee (TAC) was assembled to assist the City in designing the program. Participants on this committee included a variety of Seattle Water Department employees from different disciplines, representatives from the USFWS and NMFS, and Dr. James Karr from the University of Washington, who is widely recognized for his development of methodologies for assessing the biological integrity of aquatic systems (e.g., see Karr 1991). The TAC was provided with consultant support for additional expertise in the fields of statistics, fisheries, and hydrology.

Over a period of approximately 6 months, the TAC developed a 2-year sampling program that involved a combination of water quality sampling, hydrologic monitoring and aquatic insect sampling for the development of a *Benthic Index of Biological Integrity* (BIBI) for the watershed. Field sampling activities began in the fall of 1995 and extended through the fall of 1997. Data for this program are currently being analyzed by the USGS as part of an interagency agreement with the City of Seattle. A final project report for the program is expected by early 1999.

The primary goal of the program as adopted by the TAC has been to collect, analyze, and synthesize information that can be used to determine the condition of the aquatic system of the Cedar River Watershed for evaluating alternative management strategies and ensuring a reliable safe supply of high quality drinking water. In support of this goal, the monitoring program was designed with three main components: (1) the collection of hydrologic information; (2) the collection of water quality data; and (3) the development of a BIBI for the watershed. Outlines of these three main components are presented below.

HYDROLOGIC MONITORING COMPONENT

Objectives established for the hydrologic monitoring component include:

(1) Determining flow contributions and peak flows from subbasins;

(2) Evaluating the condition of the state of recovery of critical stream reaches;

(3) Collecting quantitative information that can be used to detect trends and construct predictive models;

(4) Determining land management impacts to the hydrology of subbasins; and

(5) Coordinating data collection with hydrologic needs of other branches of Seattle Public Utilities (for example, use of water management modeling tools such as yield (CUE) and forecast (SEAFM) models).

Data that has been collected for the hydrologic monitoring component includes:

(1) Stream flow measurements via:

- installation of continuous flow recorders at 17 locations;
- installation of staff gages at 29 locations; and
- installation of crest gages at 19 locations.

(2) Channel stability measurements at 10 sites, including:

- cross-sectional profiles;
- longitudinal profiles;
- channel width/width-depth ratios;
- Wolman pebble counts (Wolman 1954);
- stream channel stability evaluation (Pfankuch 1978); and
- Riffle Armor Stability Index (Kappesser 1992).

(3) Culvert surveys on all Type I-IV streams, and many of the Type V and untyped streams.

WATER QUALITY MONITORING COMPONENT

The objectives established for the water quality monitoring component include determining:

(1) Current condition of water quality throughout the Cedar River Watershed;

(2) Seasonal differences in water quality among sampling sites;

(3) A sampling design scheme that over time could be used to determine long-term trends;

(4) Whether or not a correlation between turbidity and flow and total suspended solids exist in the mainstem of the Cedar River and selected subbasins;

(5) What loading of nutrients and disinfection byproduct precursors that the Cedar River contributes to Lake Youngs; and

(6) If violations of State Water Quality Standards for Surface Waters and the Surface Water Treatment Rule are occurring in the watershed.

Data that has been collected for the water quality component includes:

(1) Turbidity, total suspended solids, and particle counts, and total organic carbon samples using a stratified hydrograph approach for collection of data at 11 stations in the watershed. Flow and temperature are also continuously monitored at these sites.

(2) Samples for nutrients, turbidity, total organic carbon, total suspended solids, and other parameters at four locations in the lower watershed under runoff and low-flow events. Runoff events included the first full bank-channel-width storm event of the season, one additional storm event, and the first full-bank channel snow melt runoff event in the spring over the 2-year sampling period.

BIOLOGICAL MONITORING COMPONENT

The objectives established for the biological monitoring component, which included the Benthic Index of Biological Integrity (macro-invertebrate sampling), include:

(1) Evaluating the condition and state of recovery of critical stream reaches, including segments susceptible to disturbance and streams with a unique or significant resource value;

(2) Detecting impacts to the aquatic system from land management activities, including road construction, use, maintenance, and abandonment, timber harvesting, and watershed rehabilitation efforts; and

(3) Establishing sampling sites that can be used as points of reference for evaluating the cumulative impacts from water supply operations and land management activities in the Cedar River Watershed.

Data that have been collected in support of this component include:

(1) Three benthic macro-invertebrate samples each were collected from one riffle at 46 different locations throughout the watershed for each year of sampling. Sampling station locations were selected based on a statistical stratification that includes: elevation (above and below 3,000 ft); stream order (1-3 and 4-6) (Strahler 1957); and the degree of human influence characterized by road density, percent of acres harvested within the last 40 years, and the number of stream crossings and miles of road within 100 meters of a stream for all of the land area draining to each sampling site. Additional benthic macro-invertebrate samples were also collected from pools at 10 sites.

(2) Other field data, including measurements of conventional water quality parameters and stream characteristics, were recorded at each site where aquatic insect samples were collected.

The final report providing an analysis of the data collected for the Aquatic System Monitoring is expected to be available by early 1999. If this analysis determines that a viable BIBI index has been developed for the watershed, then the macro-invertebrate sampling techniques should prove useful in prioritizing proposed stream restoration projects and evaluating the effectiveness of these projects over time. If the BIBI approach proves useful, it will be part of the long-term monitoring program for the HCP (Section 4.5)

3.3.7 Resource Inventory, Database Development, and Timber Harvest Modeling

INVENTORY AND DATABASE DEVELOPMENT

In 1991, the City initiated a comprehensive multi-resource inventory project to replace its outdated 1974 timber inventory. Utilizing satellite imagery and a modified satellite imagery vegetation classification developed by Pacific Meridian Resources for the USFS, the municipal watershed and a 1-mile buffer surrounding the watershed were stratified into thousands of distinct forested and non-forested habitat units, or polygons. The forested polygons were then assigned classification labels based on physical attributes that included primary and secondary tree species, tree size, and tree stocking levels (density). To verify the accuracy of the satellite classification system, field inspections were conducted, and when necessary, changes were made to the classifications. Further refinement of the stratification was achieved by phototyping hundreds of additional non-forested polygons as small as 1/10 acre.

In addition to the satellite and aerial photo classification, the City conducted a systematic, multi-resource cruise to supplement the existing satellite data with ancillary data relative to wildlife habitat and commercial timber potential. Approximately 28 percent (23,000 acres) of the forested area of the watershed was field sampled at a stand level using a cruise intensity of one sample plot per 5 acres. Handheld data recorders were used to collect attributes such as tree species, diameter, and height, tree taper, defect, crown ratio, and age. Snags, stumps, and down logs were classified by decay class, and understory vegetation was recorded by species and percent cover. Sampled polygons were then extrapolated to unsampled polygons that had been assigned similar vegetation classes from the satellite classification. By integrating this stand-based inventory with the geographic information system (GIS), the City is now able to perform complex, spatial analysis.

Once the inventory and classification process was finalized, the watershed was then divided into 27 individual subbasins. This division process allows analysis on a much smaller scale, thereby allowing timber harvest simulations and habitat analysis on a subbasin level. For example, rain-on-snow harvest constraints can be modeled and outputs regulated accordingly to minimize any cumulative impacts on streams from harvesting within a subbasin.

Presently the watershed contains 4,117 polygons (90,546 acres total), of which 2,808 polygons (85,412 acres total) are forested and have a minimum size of 2 acres. Non-forested polygons are mapped to a minimum size of 1/10 acre. For each polygon there may be up to 140 different descriptive attributes. In order to store and analyze such a large amount of data, the City selected the Forest Projection System (FPS), a forest inventory software program developed and provided by Forest Biometrics, a consulting firm from Oregon.

FPS is a forest planning software program that links to external forest inventory databases for the purpose of long-range planning and analysis. FPS contains a set of utilities that process and extrapolate sample plot data, project future yields, and simulate various timber harvest regimes. FPS's embedded growth model utilizes over 40 years of ongoing growth and yield research in the Pacific Northwest. In 1997, comprehensive calibrations were made to the western Washington yield tables (Western Washington Growth and Yield Calibration, Arney 1997), which significantly improved the growth model's ability to account for natural tree mortality and inherent stand variability as a result of natural regeneration. Other growth models do not simulate this natural variability or a stand's *clumpiness*, which in FPS is estimated using a stand's clumpiness index.

The FPS harvest scheduler simulates various timber harvest regimes for up to 10 periods of variable length into the future. This is accomplished through the use of a search algorithm to schedule stands for harvest by user-defined periods. Harvest levels can be set to optimize yields or they can be regulated by various constraints such as rotation age, maximum number of acres, or rain-on-snow zone limitations. Polygons not available for harvest are passed to FPS from the GIS and coded so that they are not included in the schedule. Volume and economic reports provide the means to predict cash flow on a sustained-yield basis.

FPS's report functions allow for compiling individual stand data at any projected period in time, thereby providing a means to characterize and qualify future conditions. When linked to GIS, these FPS projections can be mapped and further analyzed. However spatially explicit mapping is only possible if each expected harvest unit is hand digitized, which the City did not do for the analysis of alternatives. Mapping by subbasin and stand is possible, but mapping of harvest units that are smaller than their parent stands cannot now be done.

Tree growth projections and harvest simulations for the HCP and various alternatives were carefully designed to ensure that each alternative's individual constraints and silvicultural regimes were met (see Revised NEPA EA/SEPA EIS). Volume outputs were then optimized. When the projections were completed, polygons were then compiled and classified so that wildlife habitat analysis could be performed. Data characterizing the forest cover for each polygon were generated for years 1997, 2020, and 2050. From this, a habitat rating system was applied. Volume and revenue outputs were reported by decade to the year 2050 so that cash flows could be evaluated.

3.4 Species Addressed by the HCP

The Cedar River Watershed's unique geologic history, topography, elevation range and past land management have resulted in the presence of a diversity of habitats including, but not limited to, freshwater lakes and streams, various kinds of wetlands, meadows, talus and felsenmeer slopes, late-successional and unharvested native old-growth forests, and second-growth forests in a range of seral stages (Section 3.2.2). This combination of habitats across the watershed landscape supports many species of fish and wildlife.

As part of this HCP, a preliminary list of vertebrate and invertebrate species potentially present in the municipal watershed and potentially at risk or otherwise of concern in the region was prepared from staff knowledge and supplemented with a literature review. The purpose of compiling this list was to identify species potentially to be addressed in this HCP, in particular species that are, or might become during the term of the HCP, listed under the Endangered Species Act as threatened or endangered. Copies of the preliminary species list were sent to approximately 30 experts (Appendix 18) in the fields of vertebrate and invertebrate biology for comment on its completeness, accuracy, and validity.

The experts' comments, which in some cases were in conflict, were used to modify the original species list to incorporate a wide range of professional views, to develop a list of species to be addressed by this HCP, and to categorize the species by relative level of concern. (The term species of concern as used in this HCP should not be confused with the federal "Species of Concern" designation, which applies to those species that appear to be in jeopardy but for which insufficient information exists to support listing.) Additional species were later added to and removed from the list of species of concern after consultation with the Services regarding species under consideration for listing reviews, and after further discussion of the population status of species under consideration. A total of 83 species of concern are addressed in this HCP.

The species of concern list was first broken down into three levels of concern. However, this division proved to be cumbersome and not useful, and was not consistent with the final No Surprises Rule, in which all species must be treated in HCPs as if they were listed (Section 2.3.2). After consultation with the Services, the City decided to use two levels of concern, as described below, so that the species of most concern could receive particular attention in the HCP. Species were assigned to these two levels of concern based upon current listing status, regional and local population status, likelihood of occurrence in the watershed, likelihood of listing under ESA, and potential for impacts from City activities.

- Species of Greatest Concern (14 total):

  Species for which current population status indicates that immediate measures need to be taken in order to halt or reverse serious regional population declines, all species currently listed as threatened or endangered under the ESA and potentially present in the watershed, species considered to be at greatest risk of listing in the near future, and at-risk species with the most uncertainty regarding effects of City operations.

- Other Species of Concern (69 total):

  Species for which current population status indicates that there is some decline, or a potential risk of future decline, and potential that the species could be listed at some time in the future.

The species of greatest concern are described in Section 3.5, and the other species of concern are described in Section 3.6. This HCP contains specific *species conservation strategies* for all 14 species of greatest concern (Section 4.2.2). Conservation strategies for all other species of concern are based largely on protection of their habitats (Section 4.2.2). Animal species designated as species of concern for this HCP are listed in Table 3.4-1. Additional information on species of concern, including their formal federal and state listing statuses, is given in sections 3.5 and 3.6.

Plant species are not addressed in this HCP, because no listed plant species are known to occur in or near the watershed. According to the Washington Natural Heritage Program (October 1997), the only federally listed species that may occur in King County, based on knowledge of its range and historic distribution, is swamp sandwort (*Arenaria paludicola*), which is listed as endangered, and golden Indian-paintbrush (*Castilleja levisecta*), which is listed as threatened. Swamp sandwort is usually found in sand (Hitchcock and Cronquist 1990), a habitat type lacking within the municipal watershed. Golden Indian-paintbrush typically occurs at low elevations of Puget Sound, which are also lacking in the municipal watershed. In addition to these 2 species, 22 other plant species that are listed by the state as threatened, endangered, sensitive, or review species may be present in King County (see Table 3.3-3 of the Environmental Assessment/Environmental Impact Statement). Of these 22 species, based on habitat requirements, 18 species could be found in the Cedar River Municipal Watershed. Although no formal surveys have been conducted, there is no evidence that any of these listed plant species are present in the municipal watershed.

As described in Section 1.4, during their review of the City's application for an incidental take permit, the Services determined that all of the 83 species addressed in the HCP can be included on the incidental take permit as Covered Species. These 83 species are listed in Exhibit A to the Implementation Agreement (Appendix 1).

Also as described in Section 1.4, during their review of the City's application for an incidental take permit, the Services identified any species for which the HCP cannot be shown to provide a continuous net conservation benefit. Species for which the HCP does provide a continuous net conservation benefit are termed "pay-as-you-go" species. If the incidental take permit is suspended or revoked, no post-termination mitigation can be required by the Services for such "pay-as-you-go" species (Appendix 1, Exhibit B). For species that do not qualify as "pay-as-you-go," post-termination mitigation may be required if the Services demonstrate that any take of such species at the time of termination has not been substantially mitigated according to permit conditions.

Table 3.4-1. Vertebrate and invertebrate species of concern potentially present in the Cedar River Municipal Watershed. Species of concern are grouped alphabetically by common name.

Common Name	***Latin Name***
SPECIES OF GREATEST CONCERN	
Birds	
Bald Eagle	*Haliaeetus leucocephalus*
Common Loon	*Gavia immer*
Marbled Murrelet	*Brachyramphus marmoratus*
Northern Goshawk	*Accipiter gentilis*
Northern Spotted Owl	*Strix occidentalis caurina*
Peregrine Falcon	*Falco peregrinus*
Fish	
Bull Trout	*Salvelinus confluentus*
Chinook Salmon	*Oncorhynchus tshawytscha*
Coho Salmon	*Oncorhynchus kisutch*
Pygmy Whitefish	*Prosopium coulteri*
Sockeye Salmon	*Oncorhynchus nerka*
Steelhead Trout	*Oncorhynchus mykiss*
Mammals	
Gray Wolf	*Canis lupus*
Grizzly Bear	*Ursus arctos*

OTHER SPECIES OF CONCERN

Common Name	***Latin Name***
Birds	
Band-tailed Pigeon	*Columba fasciata*
Black Swift	*Cypseloides niger*
Brown Creeper	*Certhia americana*
Golden Eagle	*Aquila chrysaetos*
Great Blue Heron	*Ardea herodias*
Harlequin Duck	*Histrionicus histrionicus*
Merlin	*Falco columbarius*
Olive-sided Flycatcher	*Contopus borealis*
Osprey	*Pandion haliaetus*
Pileated Woodpecker	*Dryocopus pileatus*
Rufous Hummingbird	*Selasphorus rufus*
Three-toed Woodpecker	*Picoides tridactylus*
Vaux's Swift	*Chaetura vauxi*
Western Bluebird	*Sialia mexicana*
Willow Flycatcher	*Empidonax traillii*
Fish	
Cutthroat Trout, sea run	*Oncorhynchus clarki*

Common Name	*Latin Name*
Kokanee	*Oncorhynchus nerka*
Pacific Lamprey	*Entosphenus tridentatus*
River Lamprey	*Lampetra ayresi*
Mammals	
Big Brown Bat	*Eptesicus fuscus*
California Myotis	*Myotis californicus*
Canada Lynx	*Lynx canadensis*
Fisher	*Martes pennanti*
Fringed Myotis	*Myotis thysanodes*
Hoary Bat	*Lasiurus cinereus*
Keen's Myotis	*Myotis keenii*
Little Brown Myotis	*Myotis lucifugus*
Long-eared Myotis	*Myotis evotis*
Long-legged Myotis	*Myotis volans*
Marten	*Martes americana*
Masked Shrew	*Sorex cinereus*
Northern Water Shrew	*Sorex palustris*
Silver-haired Bat	*Lasionycteris noctivagans*
Western (Townsend's) Big-eared Bat	*Plecotus townsendii*
Wolverine	*Gulo gulo*
Yuma Myotis	*Myotis yumanensis*
Amphibians and Reptiles	
Cascade Frog	*Rana cascadae*
Cascade Torrent Salamander	*Ryacotriton cascadae*
Larch Mountain Salamander	*Plethodon larselli*
Long-toed Salamander	*Ambystoma macrodactylum*
Northwestern Salamander	*Ambystoma gracile*
Pacific Giant Salamander	*Dicamptodon tenebrosus*
Red-legged Frog	*Rana aurora*
Roughskin Newt	*Taricha granulosa*
Spotted Frog	*Rana pretiosa*
Tailed Frog	*Ascaphus truei*
VanDyke's Salamander	*Plethodon vandykei*
Western Pond Turtle	*Clemmys marmorata*
Western Redback Salamander	*Plethodon vehiculum*
Western Toad	*Bufo boreas*
Invertebrates: Insects	
Beller's Ground Beetle	*Agonum belleri*
Carabid Beetle	*Bembidion gordoni*
Carabid Beetle	*Bembidion stillaquamish*
Carabid Beetle	*Bembidion viator*
Carabid Beetle	*Bradycellus fenderi*
Carabid Beetle	*Nebria gebleri cascadensis*
Carabid Beetle	*Nebria kincaidi balli*
Carabid Beetle	*Nebria paradisi*
Carabid Beetle	*Omus dejeanii*

Common Name	***Latin Name***
Carabid Beetle	*Pterostichus johnsoni*
Fender's Soliperlan Stonefly	*Soliperla fenderi*
Hatch's Click Beetle	*Eanus hatchii*
Johnson's (mistletoe) Hairstreak	*Mitoura johnsoni*
Long-horned Leaf Beetle	*Donacia idola*
Invertebrates: Mollusks	
Blue-gray Taildropper	*Prophysaon coeruleum*
Oregon Megomphix	*Megomphix hemphilla*
Papillose Taildropper	*Prophysaon dubium*
Puget Oregonian	*Cryptomastix devia*
Snail	*Valvata mergella*

Section 3.5 Contents

3.5 Species of Greatest Concern

3.5.1 Introduction to Species of Greatest Concern

Species of greatest concern are those species for which current population status indicates that immediate measures need to be taken in order to halt or reverse serious regional population declines, all species currently listed as threatened or endangered under the ESA and potentially present in the watershed, species considered to be at greatest risk of listing in the near future, and at-risk species with the most uncertainty regarding effects of City operations. The list not only includes all species currently listed under the ESA as threatened or endangered but also some state listed species, and unlisted species identified as being at high risk in the region by taxonomic experts. Some species that are listed as threatened or endangered or that are candidates for listing by the state or federal government occur commonly or abundantly in the watershed, while others are not known to occur at all in the watershed, although some have been reported in areas not far from the watershed.

Additional background information regarding the status of the species of greatest concern is presented below in Sections 3.5.2 - 3.5.15. The status within the municipal watershed and the state and federal status for each species of greatest concern is given in Table 3.5-1 below.

Table 3.5-1. Status of fish and wildlife species of greatest concern that are known to occur or that could potentially occur in the Cedar River Watershed. Species are listed in the order in which they are presented in the text.

Species	Status in the Cedar River Watershed		Designated Status	
	status	notes	State	Federal
Northern Spotted Owl *Strix occidentalis caurina*	present, breeding	one breeding pair in upper watershed in CHU, plus singles	Endangered	Threatened
Marbled Murrelet *Brachyramphus marmoratus*	unknown	aural detection in 1992	Threatened	Threatened
Northern Goshawk *Accipiter gentilis*	present, breeding	one pair in upper watershed in CHU in 1992	Candidate	Species of Concern

Species	Status in the Cedar River Watershed		Designated Status	
	status	notes	State	Federal
Common Loon *Gavia immer*	present, breeding	three nesting pairs; some use of artificial nest platforms	Candidate	
Bull Trout *Salvelinus confluentus*	present, breeding	present in reservoir, major and some minor tributaries		Threatened
Pygmy Whitefish *Prosopium coulteri*	present, breeding	present in reservoir and major tributaries	Sensitive	
Sockeye Salmon *Oncorhynchus nerka*	not currently present above Landsburg Dam	present in Cedar River below Landsburg Dam		
Coho Salmon *Oncorhynchus kisutch*	present, breeding	present in Walsh Lake system; present in Cedar River below Landsburg Dam		Candidate
Chinook Salmon *Oncorhynchus tshawytscha*	not currently present above Landsburg Dam	present in Cedar River below Landsburg Dam	Candidate	Threatened
Steelhead Trout *Oncorhynchus mykiss*	not currently present above Landsburg Dam	present in Cedar River below Landsburg Dam, previously released above Landsburg		
Bald Eagle *Haliaeetus leucocephalus*	present	present regularly as transients and migrants	Threatened	Threatened
Peregrine Falcon *Falco peregrinus*	unknown	closest verified nest 4.5 miles away	Endangered	
Grizzly Bear *Ursus arctos*	not known to be present	watershed at southern periphery of current range in Washington State	Endangered	Threatened
Gray Wolf *Canis lupus*	not known to be present	watershed at southern periphery of current range in Washington State	Endangered	Endangered

3.5.2 Northern Spotted Owl

INTRODUCTION

The spotted owl (*Strix occidentalis*) (Figure 3.5-1) is a forest-dwelling owl that occurs in three sub-species within its range in North America. The sub-species found in the Pacific Northwest and present in the municipal watershed is the northern spotted owl (*S. o. caurina*). Extensive reviews of the general ecology and literature pertaining to this sub-species are included in the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b) and Habitat Conservation Plans developed by the WDNR (WDNR 1997) and Plum Creek Timber Company, L.P. (Plum Creek 1996). Because both of these plans include lands contiguous with the Cedar River Municipal Watershed, the basic information contained in those plans also applies to this HCP. Much of the following discussion of the northern spotted owl in the Western Cascade Physiographic Province represents a summarization of information contained in those two HCP documents, supplemented with information specific to the Cedar River Watershed.

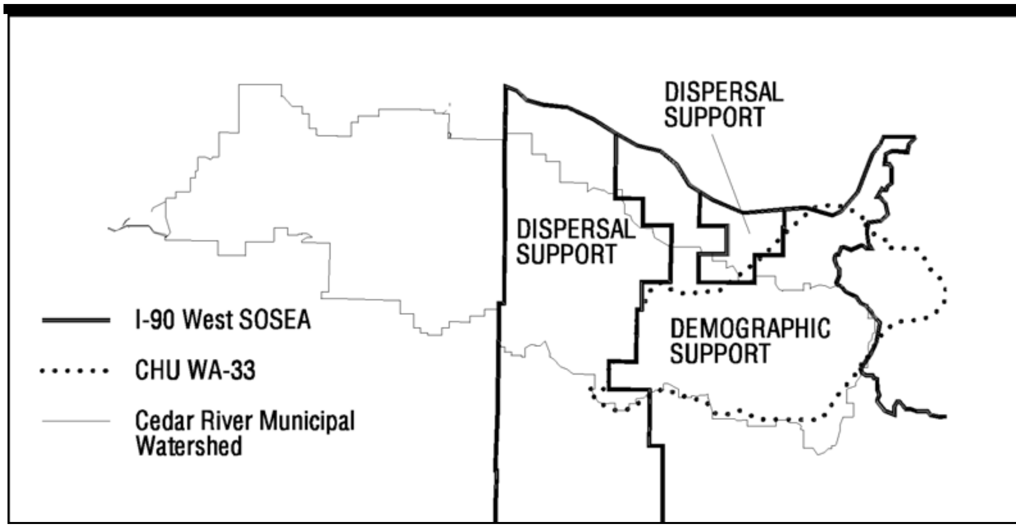
Figure 3.5-1. The northern spotted owl.

RANGE AND STATUS

Northern spotted owls presently occur from southern British Columbia, Canada, south to Marin County in central California. Although numbers vary substantially, they are most strongly associated with old-growth and late-successional coniferous forest habitats throughout their range. As a result of the progressive loss of preferred habitat throughout its range, the spotted owl was federally listed as a threatened species in 1990 (Fed. Reg. Vol. 55, Pp. 26114-26194). It is listed as an endangered species by Washington State (WAC 232-12-014).

In order to protect remaining critical late-successional and old-growth forest habitat for the northern spotted owl and to reduce fragmentation, the USFWS designated several Critical Habitat Units (CHUs) in 1991 (Fed. Reg. Vol. 57, Pp. 1796-1838). One of these, Northern Spotted Owl CHU WA-33, overlaps 22,845 acres of the municipal watershed (Figure 3.5-2). The Washington State Forest Practices Board developed a series of Spotted Owl Special Emphasis Areas (SOSEA) to complement the federal CHUs. One of these, the I-90 West SOSEA, incorporates 48,877 acres of the municipal watershed, and overlaps all of the CHU (Figure 3.5-2). SOSEA land in the municipal watershed is designated either for *demographic support* or *dispersal support*. Demographic support lands offer appropriate habitat for roosting, nesting, and foraging. Dispersal support lands offer minimum necessary habitat for young to cross from the natal stand to a new territory and for non-breeding adults to move across the landscape. There are 25,501 acres of demographic support lands in the municipal watershed, 22,167 acres of which overlap the CHU. An additional 23,367 acres of the municipal watershed within the SOSEA are designated dispersal support, 668 acres of which are in the CHU.

Figure 3.5-2. Relationship of Northern Spotted Owl Critical Habitat Unit WA-33 and I-90 West SOSEA to the Cedar River Municipal Watershed.



A northern spotted owl site center is defined as the location of status 1, 2, or 3 northern spotted owls, based upon the following definitions: (1) pair or reproductive status, (2) two birds, pair status unknown, and (3) resident territorial single status (WAC 222-16-010). Determination of the existence, location, and status of spotted owl site centers are documented in compliance with guidelines established by and available from WDFW. For management purposes, a median home range circle (called an owl circle) with a radius of 1.8 miles is established around each spotted owl site center (WAC 222-16-010). The owl circle incorporates the approximate median annual home range of northern spotted owls in the western Cascade Mountains of Washington. Within the municipal watershed there are two northern spotted owl reproductive site centers (one of which has not been active since 1981), two single resident centers (one of which has not been active since 1987), and one single owl with an unknown status (WDFW 1997d). In addition, there are two reproductive owl circles that partially overlap the municipal watershed (WDFW 1997d).

LIFE HISTORY

Spotted owls live an average of 8 years, and reach reproductive maturity during their third winter (Thomas et al. 1990). Pair bonds are usually formed at the end of winter and are typically of long-term duration. Commitment by a pair to nesting in any particular year depends on whether prey is available and in sufficient abundance, the male's hunting effectiveness, and the physiological condition of the female (sub-adults often breed). Forty to 60 percent of spotted owl pairs initiate nesting in a given year (Fed. Reg., Vol. 55) and nesting success can vary from 1 to 100 percent within a population (USDI 1992b). In March or April, successful pairs typically lay one or two eggs, and rarely three eggs. Owlets hatch in approximately 30 days, remain as nestlings for 3-5 weeks, and depend on their parents for food until they fledge and disperse in September or October. The adults then separate for the winter. Mean survival rates of juveniles, summarized from 11 study sites in California, Oregon, and Washington, have been estimated at 0.258 (range 0 to 0.418), and for adults at 0.844 (range 0.821 to 0.868) (Burnham et al. 1994).

Spotted owls typically hunt by perching on a relatively low branch, locating prey by sight or sound, and then pouncing on and capturing the prey with their talons. The diet of spotted owls is composed of predominately two or three species of small mammals (Solis 1983; Forsman et al. 1984), although it can include small birds and insects. The actual forage species that are preferred are consistent within a particular region, but vary across the sub-species range. Based on biomass and frequency of capture, significant prey species are flying squirrels (*Glaucomys sabrinus*), wood rats (*Neotoma fuscipies* and *N. cinerea*), deer mice (*Peromyscus* spp.), red tree voles (*Arborimus longicadus*), and rabbits (*Sylvilagus* spp.).

HABITAT REQUIREMENTS

Habitat Area

The median annual home range for individual spotted owls in the Western Washington Cascades Physiographic Province has been variously reported as 6,657 acres (USDI 1992b) and 8,205 acres (Hanson et al. 1993), with the smallest home range size reported being 2,969 acres (Hanson et al. 1993). Despite low sample sizes, it can be generalized that individual spotted owl home ranges are relatively large and generally increase as the amount of old-growth forest decreases (Carey 1985; Forsman et al. 1984; Thrailkill and Meslow 1990). It may also be generalized that there is a substantial degree of overlap of home range between members of a mated pair (Forsman et al. 1984; Solis and Gutierrez 1990) and less overlap among adjacent pairs (Forsman et al. 1984). Additionally, there is considerable variation in home range size across the geographic range of the species.

Habitat Structure

Old-growth forests occupied by spotted owls are typically characterized by moderate to high numbers of old trees with structural damage and decay (Brown 1985a). Such trees are important as nest sites for the owls. The distribution of old-growth forest especially, but mature coniferous stands as well, strongly correlates with the known range of the northern spotted owl in the Western Cascades. Suitable habitat for spotted owls consists mainly of older forest stands with large live trees having an average canopy cover greater than 70 percent and containing relatively high densities of logs and snags (Thomas et al. 1990; Buchanan 1991; Hanson et al. 1993; North 1993). Conifers dominate stands used by spotted owls.

Correlation studies indicate that spotted owls prefer old-growth forest for both nesting and roosting, with early-successional, pole, and young stands being consistently avoided. Multilayered, old-growth forests are the preferred nesting habitat of spotted owls in Oregon and Washington (Brown 1985a). Most nests found on public land have been in mature and old-growth forest (Forsman et al. 1984; LaHaye 1988). Nest site locations are typically associated with structures particularly characteristic of old-growth trees (broken tree-top cavities, lateral tree cavities, abandoned raptor stick nests, and debris platforms including mistletoe clumps). Most studies have shown that reproductive success is higher for pairs that have more old growth in their home ranges. Also, adult persistence, defined as adult occupation of the same stand over several years, and spotted owl density both correlate positively with increasing amounts of old-growth forest in contiguous stands.

Radiotelemetry studies in western Oregon have shown that spotted owls forage primarily in old-growth and mature forests, and avoid clearcuts and young second growth (Forsman 1980, 1981, both as cited in Brown 1985a). However, in relative contrast to preferred nesting and roosting habitat, foraging habitat may consist of a slightly wider range of structural conditions. Young stands and pole stands were consistently avoided during foraging in studies reviewed by Thomas et al. (1990), and forests less than 80 years old were avoided by 55 percent of spotted owls and selected by 3 percent. In contrast, Blakesley et al. (1992) found no tendency for owls to avoid stands in the 11-21 inch diameter breast height (dbh) size class, but these young stands did develop after natural disturbances and had diverse composition and complex structure. Stands used most often by foraging owls had relatively closed canopies and more complex understory structure (USDI 1992b).

Dispersal Habitat

Dispersal habitat is defined for the spotted owl because of the extent to which preferred, old-growth forest habitat has been depleted and fragmented throughout most of its original range. After leaving the relative security of their natal territory, dispersing juveniles must be able to forage and at the same time avoid the greater predation risk in typically less optimal habitat (e.g., clearcuts) if they are going to be successful in establishing a territory as an adult. It is also likely that dispersal habitat would be used by many adult owls moving among habitat patches suitable for foraging, roosting, or nesting.

When spotted owl juveniles cross open and fragmented landscapes, they are more vulnerable to their primary predator, the great horned owl (*Bubo virginianus*) (Miller 1989), which occurs more frequently in such landscapes than does the spotted owl (Anthony and Cummins 1989; Hamer et al 1989; Johnson 1993). Ideally, the distance between suitable habitat sites for spotted owls should not exceed the distance that most successfully dispersed juveniles are known to have traveled (Thomas et al. 1990). In Oregon and California these distances averaged 4 miles for males and 12 miles for females (USDI 1992b).

POPULATION STATUS

The federal Northern Spotted Owl Recovery Team identified 10 threats to existing populations of the spotted owl (USDI 1992a). Although the threats varied in severity between physiographic provinces, the single most significant factor contributing to the overall decline of the species was consistently identified as the loss of nesting, roosting, and foraging habitat to clear-cutting and other even-aged harvest methods (Thomas et al. 1990). The most severe future threat to the northern spotted owl was attributed to habitat loss (USDI 1992a).

Other conditions posing moderate threats to the northern spotted owl in the Western Washington Cascades Province, which includes the Cedar River Watershed, were:

(1) Limited habitat in which decreased productivity levels and occupancy occur; the province has between 20 and 60 percent suitable habitat coverage (Bart and Forsman 1992);

(2) Population decline (demographic rates exhibiting a downward trend);

(3) Small populations, which are at greater risk from environmental and demographic variations and loss of genetic diversity;

(4) Sparse populations with lack of habitat distribution (surrounded by over 12 miles of poor habitat), which are subject to the same risks as small populations; and

(5) Province isolation, which prevents immigration and leads to loss of genetic diversity.

Other factors were considered to be of lesser overall significance. Vulnerability to such natural disturbances as fire, insect or disease infestation, and windthrow was considered a low threat in the Western Washington Cascades (USDI 1992b). Predation as a threat was not ranked because information was lacking.

HABITAT AVAILABILITY IN THE CEDAR RIVER WATERSHED

The existing landscape within the Cedar River Municipal Watershed presents a wide array of coniferous forest habitat types over an elevation range of approximately 4,500 ft, extending from the lower-elevation foothills to the crest of the Cascades (Section 3.2.2). Over that span, a substantial portion of the habitat is potentially suitable for varied types and degrees of use by spotted owls. Presumably, the most significant of these habitat types, both on a local and regional scale, is the 13,889 acres of unharvested native conifer forest (old growth) older than 190 years that exists today the watershed, of which 13,155 acres is in the upper watershed. These old-growth forest stands, although varying widely in structural development and habitat quality, can potentially provide at least some high-quality reproductive, roosting, foraging, and dispersal habitat.

Additionally, of the 34,710 acres of second-growth forest within the upper watershed that are in varying stages of development from recent clearcuts (regeneration) to mature and late-successional forest, the oldest and most structurally developed stands are potentially suitable for use at least to some degree as foraging or dispersal habitat by owls. Finally, there is a substantial amount (approximately 26,902 acres) of second-growth forest in the lower watershed that is over 50 years old. This second-growth forest has already developed or will progressively develop vertical and horizontal structure considered to be characteristic of mature, and in some cases late-successional, ecological stages of forest development (sections 3.2.2 and 4.2.2, and Map 5).

Complicating the issue of spotted owl habitat requirements and availability is the fact that there is a substantial degree of variation in habitat structural development, and therefore in habitat quality, within stands essentially equal in chronological age in the watershed. Unharvested native forests are not always of equal habitat quality. Therefore, only a small portion of available habitat as it now exists within the watershed may be adequate to support individuals and be effectively utilized by the species. It is likely that only a small amount of the total habitat area available, even old-growth forests, receives use by spotted owls. No comprehensive studies have been conducted within the watershed to accurately document and compare the probable range of habitat preference and differential use patterns of the spotted owls, although there have been surveys of general habitat use throughout the forest of the upper and lower watershed (Egtvedt and Manuwal 1988).

STATUS IN THE CEDAR RIVER WATERSHED

Calling surveys were conducted throughout both upper and lower sections of the municipal watershed during 1986-87 by University of Washington graduate students and City personnel in order to detect the presence of spotted owls and determine their distribution within the watershed. Detection of other owl species and documentation of ecological interactions among the species present were also objectives of the project. Over the course of the study, six species of forest-dwelling owls, including northern spotted, barred (*Strix varia*), great horned, western screech (*Otus asio*), northern pygmy (*Glaucidium gnoma*), and saw-whet (*Cryptoglaux acadica*), were detected (Egtvedt and Manuwal 1988).

During the survey period, call responses from spotted owls were documented in three distinct areas of the watershed. All three of these areas lie within the upper watershed above 2,500 ft elevation. Two of the areas of detection also fall within the CHU, which was designated to protect spotted owl habitat on federal lands (Fed. Reg. Vol. 57, pp. 1796-1838). Both male and female owls responded within each of the two areas in the CHU, but only one mated, reproductive pair was documented. Responses in the other area were evaluated as coming from a single, transient, or unknown-status male individual. Significantly, no detections of spotted owls were documented in the lower watershed during this study (Egtvedt and Manuwal 1988) and none have been documented at these lower elevations to date.

No further surveys or monitoring studies were executed by City staff until 1990, when calling surveys were re-initiated in selected areas of the CHU. Results of these efforts included the confirmation of a transient male in one section of the CHU. In addition, the adult male that had previously been radio-tagged was relocated in 1990 (see section entitled "Habitat Selection within the Cedar River Watershed"), still within the original territory area. This male had not been observed or located since 1988. Subsequently, City staff worked with USFS personnel to locate, capture, and band both adults and one juvenile. The non-functional transmitter was removed from the radio-tagged male and not replaced. The juvenile that was caught represents one of only two spotted owl offspring known to have been found, up to that time, on the west side of the Washington Cascades between I-90 and Mt. Rainier.

The reproductive pair has been monitored periodically by a private timber company with land ownership immediately adjacent to the municipal watershed boundary that is within the potential territory of the pair. This reproductive site center has presumably been occupied each year to date since 1987, when it was originally discovered. Several specific nest trees appear to have been used. The female originally banded in 1990 was still present when they were last located, but a new male - replacing the male that had been radio-tagged - appeared and is still present. Offspring have been produced periodically throughout the term of monitoring. Only one other reproductive site center, located in a separate section of the CHU and not observed to have been active since 1981, has been verified within the municipal watershed boundaries to date.

Very few other spotted owl activity centers have been identified within the Cedar River Watershed boundaries. Only two single resident site centers and one single, status-unknown activity center have been confirmed. Both of these are located in the upper municipal watershed, and only one is in the CHU.

Several spotted owl activity centers also occur on lands in various ownerships that are adjacent to the municipal watershed. Several reproductive site centers have been documented on lands within 4 miles of the municipal watershed boundary, including four to the north, and two to the east. All of these reproductive site centers are within the designated boundaries of the CHU, which includes lands both inside and beyond the municipal watershed boundaries. The relative proximity of these reproductive site centers to the municipal watershed may either directly or indirectly influence both the number and distribution of calling survey detections within the watershed. Detections may be influenced directly if the municipal watershed is within a pair's territory. Detections may be influenced indirectly if juvenile dispersal patterns or territorial shifts include land within the watershed.

Habitat Selection within the Cedar River Watershed

A major objective of the 1988 spotted owl study (Egtvedt and Manuwal 1988) was to gather basic information regarding spotted owl habitat use and general behavior in the municipal watershed. As a means to collect data for this purpose, the adult male from the mated pair was fitted with a radio transmitter and subsequently located by the use of standard radiotelemetry techniques for a period of 10 months from July 1987 through April 1988, when the transmitter signal terminated. During that period the adult male was located 93 times. The total home range of the radio-tagged male was 8,868 acres, including 3,873 acres (43.7 percent) of old-growth forest within the CHU. A disproportionate 73 percent of radio locations were within these old-growth stands. The remaining locations were relatively evenly distributed among four immature and one other mature coniferous forest habitat type. It was assumed, based on subsequent detections, that the bird was in transition between old-growth stands at the time many of these observations were taken.

Significantly, three out of the four spotted owl activity centers documented within the municipal watershed to date are located in unharvested native forest stands greater than 189 years old, three out of the four are within the CHU, and both reproductive site centers (one not confirmed active) are in stands older than 250 years. Additionally, all verified site centers are located within the upper watershed; none have been found in the predominantly second-growth conifer forests of the lower watershed or below 2,500 ft elevation.

POTENTIAL HABITAT LIMITATIONS AND ECOLOGICAL CONSIDERATIONS

The total amount of suitable reproductive habitat (old-growth and late-successional forest) available within the upper watershed and concentrated within the CHU may be of either inadequate area or insufficient quality to support numerous reproductive spotted owl pairs. The relative amounts, quality, and spatial distribution of habitat types required to successfully support additional reproductive spotted owl pairs may be inadequate.

The relatively large amount and distribution of young successional forest types in the upper watershed tends to favor competitive species (barred owls, great horned owls) which may increase competition for nest sites and prey, and also increase the potential for predation, especially on dispersing juvenile spotted owls. Both barred and great horned owls are relatively numerous throughout the watershed.

The dramatic overall difference in major types of spotted owl habitat between the upper and lower watersheds creates a situation where more potential reproductive habitat is available in upper elevations. However, in the lower watershed to the west the lower elevations may actually provide better quality dispersal and foraging habitat than the upper watershed.

Spotted owls, especially dispersing juveniles, moving westward out of the watershed will encounter an ever-increasing amount of intensive commercial forestry activity and rural residential development. Because juveniles are known to disperse more or less in random directions (Guitierrez and Carey 1985), and because the lower watershed is surrounded on three sides by areas experiencing increasing residential development, recruiting breeding habitat in the lower watershed may result in poor reproductive performance of any pair nesting in that area.

3.5.3 Marbled Murrelet

INTRODUCTION

The marbled murrelet (*Brachyramphus marmoratus*) (Figure 3.5-3) is a Pacific seabird that occurs in two subspecies, the North American race (*B. m. marmoratus*) and the Asian race (*B. m. perdix*), which is commonly known as the long-billed murrelet. Only the North American race occurs in Washington State. Because of the species' unique behavior of selecting inland forest nesting sites (see below), the marbled murrelet was the only North American avian species whose nest remained undiscovered as recently as 1974 (Binford et al. 1975). Even today, relatively little information is known about the bird's distribution within the two distinctively different ecosystems that it inhabits (marine and inland coniferous forest) compared with Washington's other seabirds that primarily utilize marine environments (WDW 1993d).

Extensive literature reviews pertaining to the general ecology of the marbled murrelet have been included in recent Habitat Conservation Plans prepared by WDNR (WDNR 1997) and Plum Creek Timber Company, L.P. (Plum Creek 1996). Both of these plans include lands contiguous with the Cedar River Municipal Watershed. The following discussion of marbled murrelets in Washington State was generally derived from these two HCP documents and supplemented with specific information about potential marbled murrelet habitat in the Cedar River Watershed.

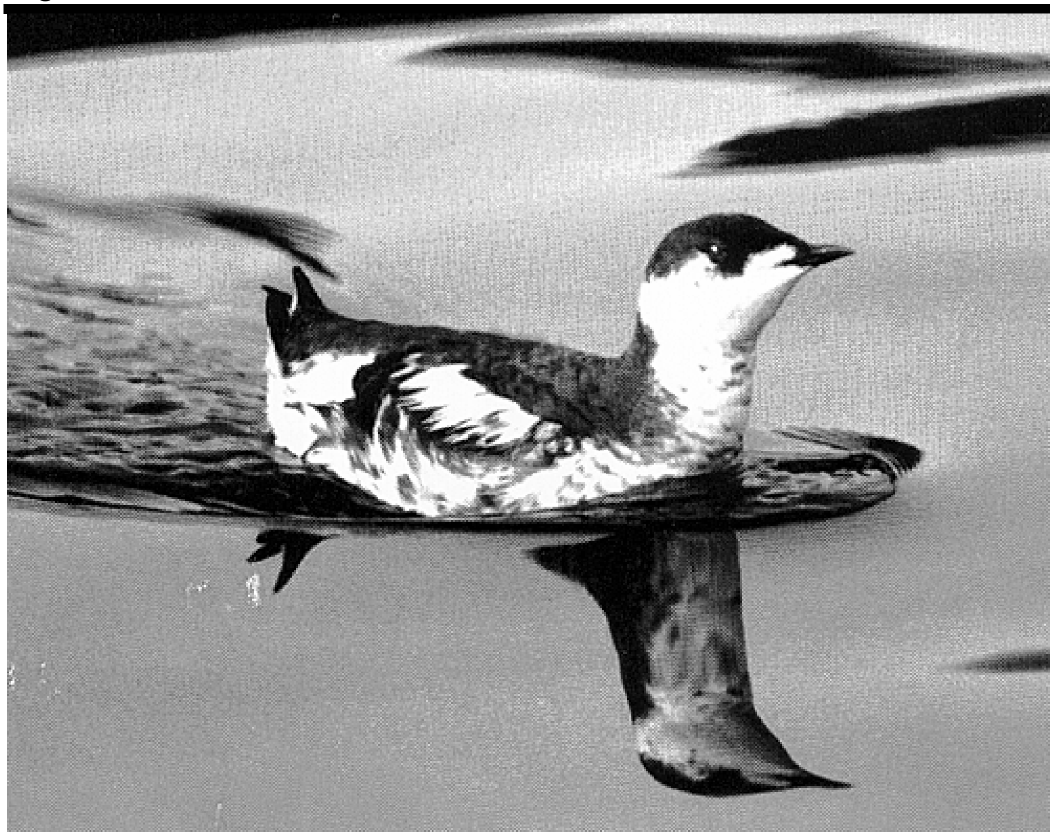
RANGE AND STATUS

The marbled murrelet occurs along the Pacific coastline from the Bering Sea, Alaska, southward to central California. Unlike the relatively continuous occurrence of the species exhibited across the northern extent of its range in Alaska, there are distinct gaps separating the breeding populations throughout Washington, Oregon, and California. The gaps between populations appear to correlate with loss of nesting habitat in late-successional and old-growth forests (Carter and Erickson 1992; Leschner and Cummins 1992; Nelson et al. 1992; Ralph et al. 1995). Observations made along the three states' coastlines document that the largest concentrations of marbled murrelets at sea during the breeding season were adjacent to areas with available inland nesting habitat (old-growth forest) (Sowls et al. 1980, Nelson et al. 1992). This fact supports the theory identifying habitat loss as the major causative agent for gaps in breeding range.

The marbled murrelet was federally listed as a threatened species in Washington, Oregon, and California September 28, 1992 (Fed. Reg. Vol. 57, No. 191), primarily because of loss of old-growth nesting habitat, and secondarily because of mortality caused by gill nets (USDI 1992a). The species is also listed as threatened by Washington State (WAC 232-12-011).

Washington Department of Natural Resources classifies a stand as an occupied marbled murrelets site (WAC 222-16-010; see Appendix 24 for WAC definition) if an active nest or recent nest site has been discovered, a chick or eggshell fragments have been found on the forest floor, or murrelets have been observed exhibiting subcanopy behaviors (WAC 222-16-010). Occupied marbled murrelet sites are restricted from harvest and road building. Harvesting is also restricted within an average 300-ft managed buffer zone adjacent to an occupied marbled murrelet site (WAC 222-16-080) (Appendix 24). Areas associated with a visual or audible detection of a marbled murrelet, that are not identified as occupied sites, are classed as marbled murrelet detection areas (WAC 222-16-010). Restrictions within marbled murrelet detection areas include timber harvesting, other than removal of down trees outside of the critical nesting season (April 1 to August 31), or road construction within suitable marbled murrelet habitat. The same restrictions apply within suitable marbled murrelet habitat containing seven platforms per acre outside a marbled murrelet detection area (WAC 222-16-080).

Figure 3.5-3. The marbled murrelet.



Distribution in Washington State

Most marbled murrelets found along the Washington coastline are in the northern regions of Puget Sound and the outer coast (Speich et al. 1992). Currently, insufficient information exists on abundance and regional distribution to definitively determine population trends in the western Cascade region. However, the estimate of 5,500 marbled murrelets in Washington (Speich and Wahl 1995; Varoujean and Williams 1995) probably reflects a region-wide decline in population. This regional decline is thought to be caused by a combination of many factors, including a reduction in old-growth forests, oil spills in marine waters, and entanglement in gill nets (Marshall 1988; Leschner and Cummins 1992).

LIFE HISTORY

Marbled murrelets are relatively unique among seabirds because they utilize both marine and coastal environs as well as inland forest habitats within their inclusive range. Most of their activity during fall, winter, and early spring is feeding in the open sea or in coastal habitats. In Washington, they forage mainly in Puget Sound or in near-shore ocean waters. Their predominant prey items in winter and spring are marine invertebrates, with small fish important during the breeding season (Burkett 1995). In addition, they have been observed on large lakes, but foraging behavior has not been documented in fresh water (Marshall 1989).

As stated above, one parameter that defines an occupied marbled murrelet site involves the observation of marbled murrelets exhibiting subcanopy behaviors (WAC 222-16-010). Flying into, through, and out of the tree canopy, and landing in trees are examples of subcanopy behaviors associated with nesting (Nelson and Hamer 1995a). However, marbled murrelet nests are difficult to detect and fairly inaccessible. Because of this, demographic information on the species is limited.

During late spring and summer, reproductive individuals fly substantial distances inland to establish nests and produce offspring. The maximum distance that a marbled murrelet has been found inland was in Oregon at a distance of 66 miles (52.25 miles in Washington), but the majority were located inland within 40 miles of marine waters (Hamer 1995; Miller and Ralph 1995; Ralph et al. 1995). The mated pairs typically nest in old-growth trees, specifically on large branches and usually more than 100 ft above ground. They do not actively build traditional nests, but instead seek out and use naturally formed platforms usually composed of large, wide limbs with thick moss or duff, mistletoe brooms, or other structural deformities that provide a surface of sufficient size to rear a chick. Adult marbled murrelets approach and leave the nest at high speed primarily at dusk and dawn, but also during the night, which makes nest detection difficult for observers (WDW 1993d).

The duration of the breeding period in Washington State has been estimated to be 124 days, from April 26 to August 27, based on 13 breeding records (Hamer and Nelson 1995a). An individual pair produces and incubates a single egg per nesting attempt. Hatching occurs within 27-28 days (Sealy 1974, 1975; Simons 1980; Hirsch et al. 1981; Carter 1984). Each member of a mated pair alternates incubation shifts, one brooding while the other forages, for up to 24 hours per shift. Incubation exchanges typically occur near dawn (Nelson and Hamer 1995a). Chicks fledge at 30-40 days and presumably fly to the ocean during their first flight (Sealy 1975; Quinlan and Hughes 1990; Hamer and Cummins 1991).

REPRODUCTIVE HABITAT REQUIREMENTS

The first marbled murrelet nest was discovered in California in 1974 (Binford et al. 1975), and, as of 1993, only six nests had been verified in Washington State out of the 65 nest trees known in all of North America (Nelson and Hamer 1995b). Of these 65 nest trees, adequate data were compiled for 32 of them to determine nest success, which is defined as a nest that has fledged a chick. Only nine (28 percent) of the nests were successful (Nelson and Hamer 1995b). Predation of an egg or chick resulted in 10 failures (43 percent of the failures). The relatively high rate of nest predation on those nests located near the edge of old-growth forest may be a result of a higher susceptibility to predators relying on visual stimuli. However, there is not enough historical demographic data on marbled murrelets in the western Cascades to distinguish effects of habitat loss from effects of other population-limiting factors (Ralph et al. 1995).

Hamer and Nelson (1995b) conducted an extensive study on marbled murrelet nest stands and individual nest trees from sites in California, Oregon, Washington, and British Columbia. Attributes recorded at Washington nest sites are summarized in Table 3.5-2 below. Of the six nest trees in examined in Washington, all were conifers, including three Douglas-firs, two western hemlocks, and one western red cedar. Nest branches were within the canopy, and an average of 90 percent of the nests were under canopy cover.

Table 3.5-2. Marbled murrelet nest tree and nest stand[1] data from Washington State (after Hamer and Nelson 1995b).

Attribute	Sample Size	Mean	Range
Tree height	5 trees	187 ft	148-213 ft
Tree dbh	5 trees	60 inches	35-87 inches
Branch thickness at nest	4 trees	11 inches	4-18 inches
Nest height	5 trees	121 ft	75-174 ft
Stand size	5 stands	877 acres	12-2,452 acres
Elevation	6 stands	1,142 ft	49-2,001 ft
Slope	6 stands	21%	0-39%
Tree density	5 stands	55 trees/acre	34-65 trees/acre
Canopy height	5 stands	177 ft	144-194 ft
Canopy layers	4 stands	3.4 layers	3-4 layers
Canopy closure	5 stands	69%	36-88%
Stand age	3 stands	879 years	450-1,736 years
Distance from the coast	6 stands	10 miles	3-21 miles

[1] Nest stand as defined by Hamer and Nelson (1995b) as a contiguous group of trees including the nest tree with gaps in the canopy no larger than 330 ft.

POPULATION THREATS

The principal threat to marbled murrelet populations from land-based activities is loss of nesting habitat as a result of old-growth harvest. Loss of nesting habitat negatively affects reproduction rates in the following four ways:

(1) It reduces the availability of nest sites, thereby reducing the proportion of the population able to reproduce;

(2) It inhibits the ability of displaced adults to find new nest sites after destruction of old ones;

(3) It increases the concentration of nests, thereby increasing use of lower quality nest sites and stand edge nest sites that incur increased predation; and

(4) It results in fragmentation of existing habitat, which increases the number of nests near stand edges and isolates populations, which increases vulnerability to environmental changes and to the loss of genetic vigor (Divoky and Horton 1995; Ralph et al. 1995; Washington Forest Practices Board 1995).

HABITAT AVAILABILITY IN THE CEDAR RIVER WATERSHED

In the Pacific Northwest, Marbled murrelets are believed to use forest stands within about 50 miles of marine waters and are reported to nest in forest stands up to 3,600 ft elevation (USDI 1997a). All forested habitat within the municipal watershed is less than about 35 miles from marine waters, but some is above 3,600 feet elevation.

Given the current state of knowledge of the nesting ecology of marbled murrelets on the west slope of the Cascades in central Washington, the greatest potential for suitable habitat to be available within the Cedar River Watershed exists primarily within the 13,889 acres of old-growth forest (greater than 190 years old), some of which is above 3,600 ft elevation. These unharvested native conifer forest stands are the most significant forest type potentially available for use by marbled murrelets within the municipal watershed. These stands (13,155 acres) are almost exclusively located in the upper watershed, in higher elevation subbasins, and most (10,093 acres) are within the spotted owl CHU in the eastern portion of the watershed. The stands range in age from 190 to approximately 850 years, with most of the stands presumed to be in the 200-350 year range and only a few stands as old as 850 years. The oldest stands are essentially remnant islands in the heavily harvested upper Rex River drainage (Map 5).

Most of the remaining old-growth forest is contained in several large, contiguous blocks located in the CHU in the areas of Abiel and Tinkham Peaks, Meadow Mountain, Goat Peak, and Findley Lake. In some cases, these blocks are contiguous with old growth outside the municipal watershed in other land ownership. Other remaining old-growth stands within the watershed are relatively small in comparative size and either widely scattered, isolated, or substantially fragmented (e.g., near Echo Creek), but all are greater than the minimum 7-acre size reportedly used by murrelets (USDI 1997a). Most of these stands are essentially old-growth islands separated from the larger contiguous blocks and either surrounded by stands in early stages of successional development or fragmented by recent harvest units. Most stands of this type are located outside the CHU along the northern border or in the upper reaches of subbasins south of Chester Morse Lake.

Although the chronological age of much of this habitat type is within a similar range, 200-350 years, there is substantial variation in stand structural development (Section 3.2.2). Because climatic conditions, soil conditions, elevation, and chronological age vary widely among this range of old-growth forest stands, the extent of development of both vertical and horizontal structure characteristic of ecologically functional old-growth forest, including structural development required by breeding murrelets, also varies substantially. Therefore, habitat quality may not be assumed to be of equal potential or realized use by murrelets.

The second forest type that represents potential marbled murrelet reproductive habitat is the substantial amount of advanced young and mature stands of second-growth forest in the lower watershed. Ninety-six percent (22,542 acres) of the stands within this total age range are concentrated from 61-80 years old, and very few stands (1,050 acres) fall in the 81-190 year range. Many of these stands, located within the lower Taylor Creek and Walsh Lake subbasins, have already or will soon develop vertical and horizontal structure considered to be characteristic of mature, and in some cases, late-successional stages of forest development (Section 3.2.2). A few stands of this type also exist within the Chester Morse Lake Basin within the upper watershed. Although no comprehensive studies of habitat quality have been made to date, a few preliminary evaluations have indicated that a limited amount of nest platform development is already present or could develop within the next few decades in some of these stands.

STATUS IN THE CEDAR RIVER WATERSHED

In 1991, City staff consulted with WDNR personnel who were actively studying marbled murrelet ecology in other areas of the western slope of the Cascades. Existing habitat conditions within the municipal watershed were reviewed based on topography, relative forest age, and existing cumulative knowledge of forest stand structural development. One area was identified as having the greatest potential for providing nesting habitat for murrelets. The area was surveyed late in the nesting season, and no murrelets were detected. However, in 1992 WDFW surveyed the same area during the nesting season and detected murrelet calls on two occasions (WDFW 1994b). No nest site was located and no additional surveys have been conducted to date.

Several potential habitat limitations for the marbled murrelet exist within the Cedar River Municipal Watershed. These potential limitations are outlined below.

(1) A majority of old-growth forest stands within the municipal watershed have not reached the chronological age, nor presumably the required structural development, of stands preferred by nesting murrelets in regional studies (USDI 1997a). Very few stands within the municipal watershed are over 350 years old or have developed the size or structure of forests commonly utilized by murrelets in Washington.

(2) Much of the available old-growth forest exists at high elevations in the eastern one-third of the municipal watershed, while mature second-growth is mostly in the lower municipal watershed. Suitable nesting habitat is unevenly distributed within and among these stands, and some old growth is above the reported 3,600 ft elevation limit for murrelet nests (USDI 1997a).

3.5.4 Northern Goshawk

INTRODUCTION

The northern goshawk (*Accipiter gentilis*) is a federal species of concern and a state candidate for listing as a threatened species (WAC 232-12-297). The principal reason for decline of goshawk populations is considered to be loss of habitat resulting from intensive timber harvest. A review of the general ecology and literature on the northern goshawk has been included in Habitat Conservation Plans for WDNR (WDNR 1997) and Plum Creek Timber Company, L.P. (Plum Creek 1996). Because both of these plans include lands contiguous with the Cedar River Municipal Watershed, the same general life history and ecology that they detail pertaining to the northern goshawk also applies to the municipal watershed. A portion of the following discussion is based on these two HCP documents.

RANGE

Northern goshawks are found across North America and Eurasia in boreal, temperate, and highland subtropical regions. Goshawks of the Pacific Northwest are associated with late successional coniferous forests, and are most abundant in old-growth forest (Thomas et al. 1993). They occur as permanent residents, and less commonly as migrants, primarily in old-growth conifer forest habitats. They range widely in the winter, presumably in response to variable climatic conditions and availability of food resources. In Washington State, northern goshawks are less numerous on the west side of the Cascades than on the east side.

LIFE HISTORY

Nesting

Northern goshawks build large, stick platform nests, and lay three to five eggs (Peterson 1990). Aerial radio telemetry work in southeast Alaska found adults to be nonmigratory (Titus et al. 1995). Males maintained year-round areas loosely associated with the nest area, while some females vacated the nest area for fall and winter. The same study reported that two out of seven females renested near the previous year's nest, while five selected new mates and nested from 2.4 miles to 26.7 miles away. Reynolds et al. (1991) reported that in the Southwest the northern goshawk typically has two to four alternate nest areas within the home range, using alternate ones in different years. From the time of fledgling until the young disperse in the fall, the northern goshawk family occupies what is called the post fledging-family area. This area includes the nest area and the habitat necessary for the fledglings to learn to hunt while evading predation.

Northern goshawks may be highly sensitive to human disturbance. In Idaho it was found that nest site occupancy was reduced by 75 to 80 percent when timber harvest occurred within 0.25 miles (Patla 1990).

Forage Selection

Remains of prey items collected from 38 northern goshawk territories in western Washington (22 in the western Cascades) have been analyzed (Watson et al. 1996). Douglas squirrels (*Tamiasciurus douglasii*), blue grouse (*Dendragus obscurus*), and ruffed grouse (*Bonasa umbellus*) were the prey species selected with the highest frequency. Prey representing the greatest biomass were snowshoe hare (*Lepus americanus*) (67 percent of the mammalian prey biomass) and grouse (81 percent of the avian prey biomass). The different prey species live in a variety of forest habitats and seral stages, and along forest edges.

HABITAT REQUIREMENTS

Home Range

The home range of the northern goshawk is highly variable, depending primarily on prey density when nest sites are readily available (Reynolds et al. 1992). Based on radiotelemetry data from 51 goshawks (including 24 juveniles) in southeast Alaska, total areas used varied from 1,900 acres to 349,023 acres (Titus et al. 1995). Mean home range size was not considered a usable concept in light of the extreme degree of variability. However, Austin (1994) used minimum convex polygon methods with radio telemetry data to compute a mean home range of 7,657 acres for adults (n = 10) in the southern Cascades.

Habitat Structure

Northern goshawk nests are most often located in old-growth and mature coniferous forest stands that have a closed canopy. Of particular significance is the fact that there is great similarity between the nesting habitats selected by northern goshawks and those selected by northern spotted owls. Their nests have been found less than 100 yards apart (Marshall 1992), and 47 of 85 spotted owl nests on the east slope of the Cascades were on stick nests built by goshawks (Buchanan 1991). Approximately 80 nest sites are known in Washington (Washington Environment 2010 1992). Nest trees on the Olympic Peninsula averaged 28.2 inches dbh for breeding territories (n = 7, range 8.1 to 57.5 inches dbh). These findings also suggest that younger forest stands may not contain enough trees of sufficient size to accommodate the large nests of goshawks, and therefore are not typically selected as nesting habitat.

Goshawk foraging habitat is more varied than that typically selected for nesting and includes deciduous and mixed forests in addition to coniferous forest in all seral stages. However, the usefulness of younger forest stands is limited, because there is insufficient space both within and below the canopy to accommodate the relatively large body size and wingspan of goshawks during hunting flight. Use of such widely varied habitat suggests the northern goshawk may choose foraging habitat based on prey availability, rather than existing habitat structure or composition (Kenward and Widen 1989; Reynolds 1989). Recent observations indicate that goshawks may nest in second-growth forest, at least in some areas (Bogaczyk, B., USFWS, personal communication, April 17, 1998).

HABITAT AVAILABILITY IN THE CEDAR RIVER WATERSHED

No specific studies have been conducted within the Cedar River Watershed to determine habitat preferences of northern goshawks or specifically to evaluate the existing habitat potential. However, because there is a substantial correspondence between goshawk and northern spotted owl habitat preference, especially for nesting habitat, several parallels can be established, and habitat availability and potential can be generally evaluated.

Currently, the municipal watershed landscape exhibits a broad diversity of coniferous forest habitat types in all stages of succession from recently harvested stands to old-growth forest, extending over an elevation range of approximately 5,000 feet (Section 3.2.2). Deciduous stands, although relatively few in number, and mixed species stands are also interspersed throughout the terrain. Over that elevation span and range of diverse forest types, a substantial portion of the habitat is potentially suitable for northern goshawk nesting and foraging activity. However, these habitat types are not distributed evenly over the landscape, nor are they all of equal potential to support use by goshawks.

For northern goshawks, as is the case for spotted owls, the most significant of these habitat types is the 13,889 acres of unharvested, native conifer forest (old growth) that still remains within the municipal watershed. Ninety-five percent of these stands (13,155 acres) are almost exclusively located in the upper watershed, at higher elevations, and along ridge tops, and 10,072 acres is predominately within the spotted owl CHU in the eastern portion of the watershed. The stands range in age from 190 to approximately 850 years, with most of the stands presumed to be in the 200-350 year range, but only a few stands as old as 850 years. The oldest stands are essentially remnant islands in the heavily harvested upper Rex River drainage (Map 5).

The majority of old-growth habitat exists in large contiguous forest blocks located in the CHU in the areas of Abiel and Tinkham Peaks, Meadow Mountain, Goat Peak, and Findley Lake. These areas represent the largest contiguous blocks of old-growth forest still remaining within the watershed. In some cases, these blocks are contiguous with old growth outside the watershed in other land ownerships. Presumably, these large, contiguous blocks of old-growth forest have the greatest potential as both nesting and foraging habitat for goshawks. This type of old-growth habitat includes habitat presently utilized by northern spotted owls (Section 3.5.2).

Other remaining old-growth stands within the municipal watershed are relatively small and either are widely scattered and isolated, or are substantially fragmented (e.g., near Echo Creek). Most of these stands are essentially old-growth islands separated from the larger contiguous blocks and either surrounded by stands in early stages of successional development or fragmented by recent harvest units. Most stands of this fragmented type are located outside the CHU along the northern border or in the upper reaches of subbasins south of Chester Morse Lake.

In contrast to spotted owls, northern goshawks are highly mobile and can utilize both old growth and younger forest types as foraging habitat, and as such may be able to use a broader range of old-growth forest stand types and sizes within the Cedar River Watershed, even fragmented and isolated stands. Such use may entail both nesting and foraging activities.

Significantly, because climatic conditions, soil conditions, elevation, and chronological age vary widely among these old-growth forest stands, the extent of canopy formation (or breakup), tree height and diameter development, as well as the extent of internal structural development characteristic of ecologically functional old-growth forest also varies substantially. As a result, the relative degree of variation in stand development exhibited throughout the old-growth forest available in the upper watershed also presents a similar variation in relative habitat quality for northern goshawks. It is probable that minimum habitat requirements, but not necessarily optimum requirements, can be met for goshawks within the Cedar River Watershed under current habitat conditions, but the number of pairs or individuals that could be supported cannot be determined (see below).

In addition to old-growth forest, a substantial portion (71,525 acres, 79 percent) of the watershed landscape is occupied by second-growth forest that is in varying stages of successional development, from recent clearcuts to mature coniferous forest. These areas represent potential suitable nesting and foraging habitat, but differentially favor one or the other type of activity depending on which particular section of the municipal watershed is examined. As discussed above, the broader age range, growth conditions, and resultant structural development of these second-growth stands exhibits an even greater range of relative habitat quality than within old-growth forest habitat.

Although old-growth forest is conspicuously lacking in the lower watershed, the nearly unbroken canopy of second-growth forest may provide habitat for goshawks. This habitats is perhaps most suitable as foraging, but the oldest young and mature stands may also provide structural development sufficient to support at least some level of nesting activity as well. In particular, there are 26,902 acres of young and mature second-growth forest 50 - 119 years old in the lower watershed, stretching between the lower Taylor and Walsh subbasins (maps 1 and 5). This forest habitat presently has or will soon develop vertical and horizontal structure considered to be characteristic of mature, and in some cases late-successional, ecological stages of forest development. These older and more developed second-growth forests also represent the most substantial area of the municipal watershed in which high quality reproductive and foraging habitat for northern goshawks could be recruited in the near future by protection from harvest.

In addition, the upper watershed also contains a substantial quantity (34,710 acres) of second-growth forest. However, 54 percent of this area is in younger stages (0 - 39 years), with only 10,470 acres in the age classes between 50 and 90 years old. This distribution of younger forest represents a marked contrast both to the lower watershed and to the eastern portion of the upper watershed. In the upper watershed, younger second-growth forests predominate in subbasins both north and south of Chester Morse Lake and throughout low and mid-elevation portions of subbasins within the eastern extent of the watershed and CHU.

These relatively young stands present an especially wide range of habitat structure, and correspondingly, a wide range of foraging habitat quality for goshawks. While these areas are essentially of lower relative reproductive habitat quality than either the old-growth forests of the upper watershed or the older second-growth forests predominating in the lower watershed, they do represent a substantial area of foraging habitat. The considerable extent of young seral stands and associated edge habitat also support substantial populations of preferred prey species (e.g., hare and grouse).

STATUS IN THE CEDAR RIVER WATERSHED

No comprehensive studies of northern goshawk numbers or distribution have been conducted within the Cedar River Watershed to date. Specific knowledge concerning use of existing habitat is very limited.

Presently, only one northern goshawk nesting territory has been documented within the Cedar River Municipal Watershed. Identified in the summer of 1992 in unharvested native forest included within the northern spotted owl CHU during surveys by WDW personnel, the site was occupied, and two offspring were observed. The site was also occupied during 1996, but no offspring were observed (Spencer, R., WDFW, 1997, personal communication). This goshawk nesting territory is within a 1.8 mile spotted owl circle near the reproductive site center. No other information is known to be available on habitat use or activity in this territory.

Several potential habitat limitations for the northern goshawk exist within the Cedar River Municipal Watershed. These potential limitations are outlined below.

(1) The evaluation of northern goshawk habitat requirements and availability is complicated by the fact that there is a substantial degree of variation in habitat structural development, therefore in habitat quality, not only across successional stages but also within stands essentially equal in chronological age. Even unharvested native old-growth forest within the watershed is not of equal habitat quality, and only some of the available old-growth habitat may be adequate to support reproductive individuals.

(2) No studies on the west side of the Cascades have documented thresholds of timber harvest levels, stand age distribution, or extent of disturbance that determine the demographic attributes or limits of goshawk populations in these coniferous forest ecosystems.

3.5.5 Common Loon

INTRODUCTION

The common loon (*Gavia immer*) is one of five species of loons, very specialized diving birds that belong to the small, closely related taxonomic family Gaviidae. The geographic distribution of loons is Holarctic (without tropical species) (McIntyre 1988).

RANGE

The range of the common loon, a migratory species, extends throughout Canada, Alaska and the northern United States, and a much smaller population winters along the European Coast and breeds in Iceland and Greenland (McIntyre 1988). The North American populations breed on freshwater lakes throughout Canada, most of Alaska (except the high Arctic), and the northern tier of the lower 48 United States (Roderick and Milner 1991; McIntyre 1988). The North American populations winter along the Pacific coast from Alaska to northern Mexico, and along the Atlantic coast from Newfoundland to northern Mexico.

Substantial numbers of birds, including an unknown number of nonreproductive adults and subadults, are present temporarily on many lakes throughout sections of western Washington and the Puget Sound region during both spring and fall migrations. However, few of these wintering and migrating loons remain in the region during the summer breeding season (Roderick and Milner 1991). As a result, breeding populations in Washington State are low.

Figure 3.5-4. Common loons on Rattlesnake Lake.

STATUS

Several nest sites have been confirmed on at least five different lakes in King County during the last decade. Nest sites have also been confirmed in five other counties in the state, including several counties in eastern Washington (Roderick and Milner 1991). However, a majority of common loon nest sites in Washington are located west of the Cascade Mountains. In addition, not all of the sites identified have been confirmed active or have been reproductively successful in all years during the decade. Significantly, only 10 or 12 common loon breeding sites are currently known to have been active at any time during the 10-year period in Washington State.

The Pacific Northwest, and particularly the Puget Sound region of Washington, is located at the western and southern edges of the documented breeding range of the common loon. Historic densities of breeding loons in this region may never have been as high as the densities currently found in more central areas of the species' breeding range, particularly in Canada, Alaska, north-central United States, or in some northeastern states. However, because of the impact that human disturbance has on loons (discussed below), it is quite possible that the breeding population of this region was higher than it is today and that it has declined in recent decades.

Several types of human activity may have contributed, either directly or indirectly, to the suspected decline in the common loon breeding population in Washington State. The rising popularity of recreational boating activities on lakes that have or might have supported nesting loons may have been a major influencing factor. These activities are thought to be responsible for a dramatic increase in egg predation, which occurs after incubating loons are frightened off the nest by boats (Titus and Vandruff 1981, as cited in Roderick and Milner 1991). The species is also vulnerable to other human activities such as logging, road construction and traffic, development of shoreline (Vermeer 1973), camping (Ream 1976), removal of large wood from lakes, and fluctuation of water levels such as occurs in reservoir systems (see below). Finally, another human-related environmental factor that has contributed to the decline of loon population numbers in other areas is acid rain (Ream 1976). In areas where acid rain is a problem, loons successfully hatch eggs, but the chicks or young loons starve to death because of a lack of forage fish caused by acidification of lakes.

As a result of a suspected decline resulting from human activities, the common loon has been designated as a state candidate species, under consideration for listing as either a threatened or an endangered species.

LIFE HISTORY

Life Span, Migration, and Pair-bonding

Common loons are relatively long-lived birds that may live 25-30 years. They appear to return to the same breeding areas in successive years throughout their lives (McIntyre 1988). The annual reproductive cycle usually begins in early spring when adult males leave marine wintering areas and migrate inland to breeding territories on freshwater lakes. Pair bonding occurs soon after both members are present and territories are established quickly. Pair-bonding, mating, and egg laying in the Pacific Northwest region typically occurs between April 1 and May 15.

Breeding Territories

Individual loons have been observed to exhibit strong fidelity to nest sites and territories (McIntyre 1974), occupying the same nest sites and utilizing the same territories for many years. Until recently it had been assumed that pairs were monogamous within the breeding season and over their full life span. However, recent evidence suggest that although pair-bonds are maintained within a breeding season, pair membership may change in successive seasons, and then, in some cases, be reestablished.

Mated pairs typically occupy their established breeding territory throughout the summer until just prior to fall migration. However, individual pair members may leave territories periodically during the summer on a temporary basis, move to other lakes, and then return, even if chicks are present. This type of shift in habitat use may be related to available food supply within breeding territories and nursery areas (McIntyre 1988).

Nest Site Characteristics

Loons prefer to nest on small islands within lakes and ponds rather than on perimeter shoreline (Roderick and Milner 1991; McIntyre 1988; Titus and Van Druff 1981; Ream 1976; Vermeer 1973). Because loons' walking ability is very poor, nests are usually located at the water's edge or within 4.5 ft of shore (Vermeer 1973). Nests are constructed from a wide range of terrestrial and aquatic plant materials (McIntyre 1988), but may also include other types of materials such as sticks, and in some cases, stones. If nest material is not available, eggs may be placed on bare substrate. Ideally, the nest floats or is adjacent to water deep enough to permit underwater approach and departure by the adults (Ehrlich et al. 1988). Common loons also nest on emergent aquatic vegetation at the edge of shallow water, and are known to successfully use artificial nesting platforms in some areas (McIntyre 1988; McIntyre and Mathisen 1977, including the Chester Morse Lake reservoir complex.

Effects of Water Level Fluctuations on Nest Sites and Behavior

As mentioned above, common loons typically establish nest sites at the waterline to provide both easy and covert access to the nest from the water and immediate escape from the nest to water when threatened (McIntyre 1988). Nests may consist of a minimal amount of material deposited on a relatively flat surface or be of more substantial size, constructed of materials such as sticks, vegetation, and aquatic plants, and attached to a shoreline structure or emergent vegetation (McIntyre 1988). Nests established in either of these ways are relatively secure under most conditions in natural systems, but because of their waterline locations, are always susceptible to any changes in water levels. Relatively small increases in water levels can inundate nests, tilt them, or break them free and cause the nests to float away, resulting in loss of eggs or nest abandonment. Conversely, decreasing water levels may prevent adults from accessing established nest sites in certain situations because of the awkwardness of loons on land (McIntyre 1988; Leahy 1982). Decreasing water levels may also prevent newly hatched chicks from reaching water and thus expose them to abandonment or excessive threat from predators.

During the nesting season, loons are capable of behaviorally compensating for small changes in water levels by adding material to nests to keep eggs above water, or in rare cases traversing dewatered substrates to access nests. On most natural bodies of water, changes in water levels tend to be gradual and of relatively small magnitude. However, in many regulated systems such as reservoirs, operational constraints imposed by water supply, flood control demands, and unpredictable environmental conditions produce both rapid and dramatic fluctuations in surface elevations. Such fluctuations can create adverse conditions for nesting loons.

Clutch Size and Incubation

Common loon females typically lay from one to three large, brown eggs per season, but four-egg clutches have been observed on rare occasions (McIntyre 1988). A clutch size of two eggs is the most common. Pairs do renest and deposit additional eggs, especially if initial nest sites are disturbed or eggs are lost early in incubation, but subsequent clutches may not contain more than a single egg. Both pair members alternately incubate eggs over a period of time that is approximately 26-31 days in duration. Nests are normally occupied by an adult more than 99 percent of the time (McIntyre 1988).

Chick Behavior

Chicks are usually coaxed from the nest onto open water by offers of small food items and communication calls within a few hours of hatching, but may return and leave the nest several times if hatching of a second egg is delayed. If hatching is synchronized, the chance of more than one chick surviving is significantly increased. Mated pairs are not known to raise more than one brood in a single breeding season (Ehrlich et al. 1988). Once all viable chicks have been taken from the nest, they move to an open water nursery pool where the chicks are alternately carried on the backs of adults (up to 65 percent of their first week) or encouraged to swim on their own. In the nursery area, both adults feed the chicks small aquatic invertebrates at first, but gradually shift the diet to small fish as the chicks develop.

A suitable nest site is important during the egg-laying and incubation period, but a suitable nursery pool is also necessary to ensure chick survival (Ehrlich et al. 1988). The water in the nursery should be clear enough for the birds to spot their prey, shallow enough to limit the size of predatory fishes and turtles, and reasonably free of predatory eagles and gulls, and it should be rich enough to furnish an 11-week supply of food for two chicks. The nursery pool should also provide a good view of neighboring territories and should be protected from wind and wave action that could separate the adults from the chicks as they swim from nest to nursery. An adequate food supply of larger fish and aquatic invertebrates must also be available for adults either in the nursery area or within accessible distance during the remainder of the summer season prior to fall migration.

STATUS IN THE CEDAR RIVER WATERSHED

Historic Perspective

Relatively little is known about the historic presence or reproductive success of common loons within the Cedar River Watershed prior to the last 20-25 years. Despite the lack of information before that period, a general knowledge does exist of (1) the historic uses of the watershed, (2) the major habitat changes through time, and (3) the degree of protection that has been afforded Chester Morse Lake over the last 100 years. The City assumes that loons have nested on the shores of Chester Morse Lake (reservoir) for many decades, and possibly on the original natural lake (Cedar Lake) for hundreds of years. In the period of the mid-1970s to late-1980s, loons were frequently sighted on Chester Morse Lake, and young chicks were observed by City staff on the Masonry Pool at least once in each of the years 1979, 1982, and 1988.

Common Loon Ecology Project in the Cedar River Watershed

Beginning in 1989, City biologists have been conducting an ongoing research project investigating the ecology of common loons in the Cedar River Watershed, focusing primarily on the Chester Morse Lake/Masonry Pool reservoir complex. In addition to annual surveys of the extent of loon utilization on watershed lakes, the reproductive success of nesting pairs has also been monitored. Since 1990, a third component of the project has been the construction and experimental deployment of floating nest platforms to enable nesting pairs to deal more effectively and consistently with fluctuating reservoir levels (Section 4.5.5). Loons have consistently utilized several bodies of water within the watershed, and individual pairs have been reproductively successful on the reservoir complex in each of the years that the research and monitoring project has been conducted (see below).

Lakes and Ponds Used by Common Loons in the Cedar River Municipal Watershed

Several bodies of open water are present in the Cedar River Watershed below 2,000 ft elevation that are of sufficient size (greater than 30 acres) and provide a food supply of mostly salmonid fishes to adequately support common loons (Map 8). Both Chester Morse Lake (1,537 acres) and Masonry Pool (187 acres) are frequented by loons during spring and fall migrations and are also utilized on a regular basis during the nesting season. The use of these nesting areas is likely increased by the minimal human activity adjacent to the lake, the absence of artificial structures from almost all of the shoreline, and very limited boat traffic. Boat traffic is limited to essential operational activities.

Such activities are minimized whenever possible, especially during the nesting season, to avoid adverse impacts on loons.

Only supervised public access to these two areas is allowed, providing substantial protection form disturbance. However, both Chester Morse Lake and Masonry Pool are subject to substantial water level fluctuations of 10-20 ft during the spring to fall period, when nesting loons are present on the reservoir complex. Such fluctuations may produce habitat conditions that can negatively impact loon reproductive success in the reservoir system.

Walsh Lake – 69 acres in size and at elevation of 725 ft – is protected and of adequate size to support loons, yet receives a relatively low level of foraging use and has had no documented nesting activity. The lack of use may be a result of an inadequate food supply, insufficient water quality or shoreline habitat, or high levels of predation. Rattlesnake Lake (111 acres), near the boundary of the watershed and on a major vehicle access route, is open for public recreation (boating, fishing, swimming) and supports heavy human recreational use, especially during summer months. Despite the high level of human activity, common loons use Rattlesnake Lake during migration periods, especially for foraging. However, loons do not presently nest there, presumably because of the consistently high level of intrusive human disturbance.

Only one other water body over 25 acres exists within the municipal watershed: Findley Lake, at 3,701 ft elevation. However, Findley Lake, a high-elevation lake of relatively low productivity, probably does not contain a food supply adequate to sustain use by loons on a regular basis. No known observations of loons have been documented at Findley Lake. Several small bodies of water (less than 5 acres) are scattered throughout the watershed, mostly at elevations above 3,000 ft, that may receive occasional limited use by loons, but there have been no observations of loons on these water bodies.

Migration

Annual field surveys from 1990 to 1997 have confirmed that common loons consistently use the reservoir complex during spring and fall migrations. In smaller numbers, loons also use the reservoir as foraging and nesting habitat during summer months. Loons typically begin arriving in the watershed by mid-March, but individuals may arrive or travel through the watershed as soon as late February. At the peak of migratory activity from mid-March to mid-April as many as 25 birds may be using bodies of water within the watershed system. The greatest numbers of loons have been observed on the Chester Morse Lake/Masonry Pool complex (up to 18 individuals), followed by Rattlesnake Lake (up to 7), and Walsh Lake (up to 2). It is not unusual to observe birds moving back and forth between Chester Morse Lake and Masonry Pool or Rattlesnake Lake, especially during periods of peak migration.

Although many loons are present on the reservoir complex during the peak of spring migration, numbers decline by late April to three nesting pairs and one or two additional birds that may remain for some portion of the summer. Several loons are present on Rattlesnake Lake during the migration period and prior to the seasonal increase in human activity coinciding with the opening of fishing season. One or two birds may be sighted occasionally during the summer months, but typically not on a sustained basis, suggesting only sporadic or transient use. Substantially less use of Walsh Lake occurs both during late spring migration and during the summer period. Use of this lake appears to be far less consistent than use of other bodies of water in the watershed.

Fall migration, including possibly inter-regional movement, is less well defined with varying periods of activity extending from late August through September and sometimes into early October. Adults, and occasionally juveniles reared on other lakes, move through the watershed system during this time. Most adults, including birds that nested on Chester Morse Lake and Masonry Pool, have typically left the reservoir complex by mid-October, but individual juveniles may remain as late as mid-November. Fewer loons are in the watershed system at any one time during the fall season.

Nest Site Availability

Because a steep, rocky slope dominates most of the perimeter of Chester Morse Lake, only a small percentage of its shoreline appears to constitute suitable loon nesting habitat. These areas are concentrated in the delta regions of the Cedar and Rex rivers described by Raedeke Associates, Inc. (1997). Additional nesting habitat exists adjacent to the Masonry Pool, but habitat along most of its shoreline presents is poor. Loons nesting in this system typically select nest sites that are protected by both adjacent and overhead deciduous cover, usually willow (*Salix* spp.) shrub, alder (*Alnus rubra*), or black cottonwood (*Populus trichocarpa*). Natural nests on Chester Morse Lake and Masonry Pool are rarely located completely in the open. Although loons are capable of constructing nests attached to the shoreline, the loons nesting in this system tend to select floating logs as nest sites. Both of these types of nests are susceptible to adverse impacts resulting from widely fluctuating water levels. Nests can be trapped or tilted by overhanging vegetation as water rises, or tilted or left far from water as levels drop.

Experimental Nest Platforms

Artificial nest platforms have been made available within each of the three loon nesting territories each year since 1990. The floating platform nests ideally provide nesting loons with an alternative, more stable nest site that can more effectively adjust for most rising water conditions, but only some degree of falling water level conditions. Platforms have been used in at least one, and typically in two, of the three nesting territories in each of the 8 project years during which platforms have been deployed. Nesting platforms have been used exclusively whenever birds have nested in two of the three territories since the first year platforms were utilized in those territories, including 7 consecutive years in one territory and 6 of 8 years in the second territory. A platform has been used in only 2 of 8 years in the third territory; different natural nest sites were selected instead.

Nesting Activity on Chester Morse Lake and Masonry Pool

Three mated pairs of common loons have been present on Chester Morse Lake and Masonry Pool during each pair-bonding and nesting season for the last 9 years (1989-1997). These pairs have consistently occupied very similar, widely separated territories at the two opposite ends and on the south side of the reservoir system. All three areas are partially isolated both visually and audibly from each other. Each territory encompasses approximately 25-30 percent of the reservoir complex area. Two of the nesting territories have been occupied by reproductive pairs in each of the 9 years of the study. However, although a pair of loons has been present in a third territory in each of the 9 years of the study, the pair has failed to establish a nest during 3 of those years. Low water levels, pair member changes, or other factors may have prevented reproductive efforts during these 3 years.

Nests are typically established in mid-April, but may be delayed until early to mid-May by individual pairs in some years. Clutch size is consistently two. Hatching usually occurs in mid-May after an approximate 28-30 day period of incubation, but may not occur until mid-June if egg-laying is delayed. Hatching success varies widely between pairs from year to year, as some eggs are lost during the incubation period to predation, mainly by river otters and birds, or are addled and abandoned, which results in a single chick or no chicks being hatched. Survival to fledging is high for chicks, which live 3-5 days after hatching. Between one and four chicks have fledged on the reservoir system each year since 1989.

Common loons have established a total of 21 nests on Chester Morse Lake and the Masonry Pool during the period 1990-1997, since experimental nest platforms were first deployed in 1990. Of the 21 nests established during that 8-year period, 7 have been on natural nest sites and 14 have been on experimental platforms. A total of 24 chicks have hatched: 6 on natural nests (5 of which survived to fledging) and 18 on platforms (16 of which survived to fledging). Four chicks hatched and survived to fledging from 3 natural nests in 1989, before any experimental platforms were deployed.

POTENTIAL HABITAT LIMITATIONS AND ECOLOGICAL CONSIDERATIONS

Effects of Fluctuating Water Levels on Reproductive Success

Water levels are one of the major environmental elements determining reproductive success of common loons in the Cedar River Watershed. Cumulative observations of loon nesting behavior during the 9 years of study strongly indicate that water level fluctuations in the Chester Morse Lake/Masonry Pool reservoir complex during the nest establishment and incubation periods are the most significant factor that determines (1) the timing of loon nest establishment, (2) the general areas of nest locations, and (3) the ultimate stability of natural nest sites once established. While water levels are of importance in all natural bodies of water, their potential impact on loon nesting success is magnified within reservoir systems that present widely fluctuating water levels on a day-to-day or week-to-week basis.

Experimental nest platforms in the watershed have proven adequate in stabilizing the environment of active nests by compensating for relatively large increases (5-8 ft) in water levels. Nest platforms have also compensated for some decreases in water levels, but are limited in this capacity, just as natural nests are, when water depths adjacent to and under floating nest structures (logs, platforms) reach very low levels (less than 2 ft depth) or critical levels (less than 1 ft depth to being stranded). Observations of common loons' sensitivity to disturbance of nest sites, especially early in the nesting period, strongly indicate that attempts to physically move platforms with nests already established, possibly depending on the stage of incubation, would probably cause abandonment.

The timing of nest platform deployment would be inconsequential in natural systems that have relatively stable water levels, because platforms can remain in place year round without substantial change in the nest site environment or unusual risk to nesting birds. However, in reservoir systems where water levels fluctuate irregularly, the timing of nest platform deployment and exact placement are both critical factors directly affecting nest success. Unless placement and timing of platform deployment is handled carefully, birds may establish nests on platforms that will eventually expose the nests to risk. This risk may occur where early-season high water allows access to higher elevation sites, including platforms, that will later become stranded as water level drops. Risks may also result from the opposite situation in which early-season low water levels cause the birds to use initially exposed, marginal sites and platforms, which will become progressively more precarious as water levels rise.

Although nest platforms have been used with some success to compensate for extremely low reservoir levels, such as those created by drought conditions when all known traditional habitat was inaccessible, the nesting environment created for the incubating birds subjects them to risk. When positioned in open water on either Chester Morse Lake or Masonry Pool, as is necessary under existing low reservoir conditions, nests on platforms are exposed to the severe winds and wave action and are constantly exposed to an increased risk of egg predation. Incubation is much less consistent because birds leave the nest platforms more often under such severe conditions, which ultimately may adversely affect nest success.

These observations indicate that loon nesting platforms in the Chester Morse Lake/Masonry Pool reservoir complex work very effectively within a certain range in the level and timing of reservoir conditions to provide more stable nesting environments than presented at many natural sites affected by water level fluctuations. However, these same observations strongly indicate that nest platforms should not be considered as capable of offsetting the effects of *widely fluctuating* reservoir levels, especially in the case of prolonged, early-season low surface elevations characteristic of a drought.

Water Level Effects on Nest Site Habitat Structure

Common loons nesting in the Cedar River Watershed on Chester Morse Lake and the Masonry Pool during the past 9 years have consistently selected nest sites that are located within the willow scrub-shrub vegetation communities of the Cedar and Rex river deltas or under a deciduous canopy of red alders and black cottonwoods at the shoreline perimeter of the lake. Both of these habitat types exist within an elevation zone that is directly influenced by reservoir levels during some period of time during the annual fill and drawdown cycle of the lake. These vegetation communities are typically exposed for much of the annual cycle and not appreciably affected during periods of drawdown and low lake levels. However, each habitat is impacted during the late winter and early spring period of reservoir refill when the elevation zones occupied by these deciduous species are inundated by varying depths of water. Duration of inundation also varies from year to year.

The direct effect of inundation is to reduce oxygen and light reaching roots and other growth tissues of the willow, red alder, and scattered coniferous species present in the flooded zone. The duration of inundation is also critical, because most of the shrub and tree species in these areas can withstand some level of inundation for relatively short periods of time but are progressively impacted as periods of inundation are extended. Conifer species are most sensitive, alder is moderately sensitive, and willow is the most resistant to such inundation.

Reservoir levels and the duration of periods of inundation during the critical spring season have increased in recent years. Raedeke Associates, Inc. (1997) have identified a trend in lake level increases and correlated the observed die back of conifer, red alder, and willow in mid-delta zones and lake perimeter areas with decreases in growing season length over the last 3-4 years. These findings suggest that if current reservoir fill regimes are continued, die back of deciduous vegetation may continue to some extent, with a potential for additional loss of nesting habitat. The extent to which these same habitats would recover and regenerate if reservoir levels were lower and periods of spring inundation were shorter is unknown.

3.5.6 Bull Trout

INTRODUCTION

Bull trout (*Salvelinus confluentus*) (Figure 3.5-5) is a western North American char in the family Salmonidae. The USFWS listed the Puget Sound Distinct Population Segment as threatened on November 1, 1999 (Fed. Reg. Vol. 64, No. 210). Currently, Washington State classifies bull trout as a priority species because it is considered to be vulnerable to significant population declines (WDFW 1996a).

The bull trout is declining in numbers throughout its range, especially along its southern limits (McPhail and Baxter 1996). Over-fishing, human-made migration barriers, increased siltation, changes in temperature and flow regimes, and competition and hybridization with introduced salmonids are the predominant causes of population declines (McPhail and Baxter 1996). The factors affecting Puget Sound bull trout include (Fed. Reg. Vol. 63, No. 111):

- Habitat degradation, with a variety of causes, including reservoir operations, dams, agricultural practices, urbanization, forest management, and human-constructed barriers in streams;
- Over-fishing and poaching;
- Inadequacy of existing regulatory mechanisms; and
- Impacts from introductions of non-native species.

Bull trout in the Cedar River Watershed have been insulated from some of these pressures. Three factors have contributed to maintaining the viability of the native bull trout population in this system: (1) Since 1908, the municipal watershed has been closed to public access, and the Chester Morse Lake population has not been harvested; (2) habitat modifications from land use have been reduced because the municipal watershed is relatively undeveloped; and (3) non-native fish species detrimental to the health of stocks in other systems are not present in the Chester Morse Lake system.

STATUS OF STOCK

In a 1998 study, WDFW assessed the status of individual populations of bull trout and Dolly Varden (*Salvelinus malma*) in Washington State, and found that of the 80 identified stocks placed into five rating categories (healthy, depressed, critical, unknown, or extinct), the status of 72.5 percent are unknown and 17.5 percent are categorized as healthy. The Chester Morse Lake stock status is classified as unknown. However, the assessment states "there are no data suggesting a chronically low condition, or short-term severe decline" in the population. (WDFW 1998a). One of the reasons for this unknown status is the discrepancy between the number of redds expected and the number counted. By applying information from bull trout spawning studies in the Flathead Lake system to the Cedar River Municipal Watershed, an estimate can be derived for the number of redds that may be expected. R2 Resource Consultants (in preparation) predict over half of the estimated 3,100 or more bull trout in Chester Morse Lake are adults. An average of 57 percent (38-69 percent) of adult-size bull trout are believed to leave Flathead Lake to spawn, and there were an estimated 3.2 spawners per redd in the spawning tributaries (Fraley and Shepard 1989). Using these data as a basis for estimation, of the approximately 1,550 mature fish in Chester Morse Lake, 884 (589-1070) could be expected to leave to spawn, potentially creating 276 (184-334) redds. However the annual number of bull trout redds counted from 1992-1997 in the municipal watershed has averaged 38 (6-109).

Figure 3.5-5. Bull trout.

Most of the information regarding the status of bull trout in the Cedar River Watershed discussed in this section was collected during a resident fisheries study that was conducted between 1992 and 1995 by R2 Resource Consultants with assistance by Fisheries Consultants, Herrera Environmental Consultants, and Taylor and Associates. This study was initiated in response to concerns about the possible effects of current and future water management operations on resident fish in the reservoir complex. The purpose of the study was to obtain baseline information regarding bull trout, rainbow trout, and pygmy whitefish in Chester Morse Lake, Masonry Pool, and their primary tributaries, the upper Cedar and Rex Rivers. Hydroacoustic surveys, gill net sampling, and stream surveys were combined to determine fish abundance distribution; spawning locations; habitat; fry emergence and migration; feeding habits and food availability; age and growth of basin bull trout; and basin conditions that influence this stock (R2 Resource Consultants, in preparation). Additional information on the bull trout population was gathered from other fisheries studies in the Cedar River Watershed (Wyman 1975; EVS Consultants 1984), published literature, and studies and field observations conducted by City biologists.

No substantive evidence to date indicates that either a self-sustaining population of bull trout or any significant number of individuals exists in the approximate 14 miles of the mainstem Cedar River, or its tributaries, between the Masonry Dam and the Landsburg Diversion Dam. Although passage over the Masonry Dam, and subsequent downstream movement, of a limited number of bull trout is expected to occasionally occur during seasonal spillway releases of water from the Masonry Pool, it apparently has not been sufficient to support establishment of bull trout populations under the ecological conditions existing in downstream reaches. Only recently has an observation been documented from this reach, an incidental sighting of a single adult bull trout near the powerhouse at Cedar Falls during September, 1997 (Binkley, K., Seattle City Light, Personal communication, 1997).

Until recently, only limited sampling of the Cedar River and its tributaries between the Masonry Dam and the Landsburg Diversion Dam had been conducted. Casne (1975) reported that rainbow trout were predominant in the river, and did not report capturing bull trout. Similarly, no bull trout have been documented by Water Department, Seattle Public Utilities, or other state agency personnel during subsequent, periodic sampling efforts.

Most recently (1994), City personnel, with Taylor Associates, conducted systematic snorkel surveys of four, 1-mile reaches and two, 100-meter reaches of the 12.5-mile section of the mainstem Cedar River between Landsburg Diversion Dam and the natural passage barrier approximately 0.75 mile upstream of Cedar Falls. All sample reaches were sampled during daylight hours and two, 1-mile reaches were sampled at night. Of the total 5,250 salmonids observed, none were identified as bull trout.

LIFE HISTORY

In 1978, bull trout were differentiated from Dolly Varden as a separate species (Cavender 1978). This original work was supported by the further investigations of Haas and McPhail (1991). In 1995, detailed physical analyses (meristics) were performed on the char population in Chester Morse Lake. The analyses determined that these fish are bull trout and not Dolly Varden (R2 Resource Consultants, in preparation). The bull trout in the Cedar River Watershed are considered to be native.

Bull trout are known to exhibit four types of life history strategies. The three freshwater forms include adfluvial forms, which migrate between lakes and streams; fluvial forms, which migrate within river systems; and resident forms, which are non-migratory. The fourth strategy, anadromy, occurs when the fish spawn in fresh water after rearing for some portion of their life in the ocean. Data indicate that the bull trout in the Chester Morse Lake system are adfluvial. Adfluvial forms rear as juveniles in tributaries, migrate to lakes where most growth occurs, then return to the tributaries as adults to spawn.

Although it is possible that bull trout with a resident life strategy exist in the watershed, ongoing studies have not provided clear evidence that confirms this scenario. In the municipal watershed, bull trout are found only within the Chester Morse Lake/Masonry Pool system and their major tributaries, above the natural migration barrier of Lower Cedar Falls (Map 8).

Age and Size

Survey results indicate that most of the bull trout in Chester Morse Lake are 3 years of age or older, although survey techniques used in Chester Morse Lake did not target fish smaller than 200 mm. Bull trout in Chester Morse Lake become mature at approximately 5 years of age and may live to at least 12 years (R2 Resource Consultants, in preparation). This life span and age at maturity is consistent with observations of bull trout in other systems (McPhail and Baxter 1996).

The bull trout captured in Chester Morse Lake and Masonry Pool ranged in size from 250 to 581 mm and were 2-12 years of age (R2 Resource Consultants, in preparation). Although the sampling gear of gill nets and rod and reel limited the size range of fish captured, the lower size limit of bull trout in other lakes is usually around 200 mm (McPhail and Baxter 1996). The growth rate of bull trout in Chester Morse Lake appears to be typical of the species in other lakes in the Pacific Northwest, although as the bull trout become larger, their growth rate in Chester Morse Lake becomes somewhat slower than in other systems. This slower growth rate of the larger fish may be a consequence of lower lake productivity or a reduced prey base relative to other systems.

In the Cedar and Rex rivers, bull trout sizes were all less than 200 mm in the age classes 0+ to 2+ (R2 Resource Consultants, in preparation). The average size of age 1+ fish caught in the rivers was approximately 140 mm. This size was similar to those reported for other northwestern char and trout, but less than the theoretical size in the river back-calculated from larger fish caught in Chester Morse Lake (R2 Resource Consultants, in preparation). Back calculations of fish size at earlier ages from analysis of scale annuli showed two peaks in distribution for years 2-5 (R2 Resource Consultants, in preparation). These were 180 and 220 mm for age 2, 270 and 325 mm for age 3, 340 and 380 mm for age 4, and 440 and 520 mm for age 5.

The two size groups (called a bimodal distribution) probably represent fish that follow different life history strategies. Those in the larger group likely enter the lake before reaching age 1+, or rear in particularly favorable stream or off-channel habitat. Populations with a similar bimodal size distribution were found in coho fry that overwintered in off-channel ponds and the mainstem Coldwater River, B.C. (Swales and Levings 1989), and between two off-channel ponds with different characteristics on the Clearwater River, Olympic Peninsula (Peterson 1982). Cedar River bull trout juveniles have been found residing in wall-base channels, a type of stream noted for low velocity flows and moderate temperatures (Peterson and Reid 1984). The absence of bull trout older than 2+ in the streams indicates that the stock is adfluvial.

ABUNDANCE

The population of Chester Morse Lake bull trout was estimated to be approximately 3,100 fish in 1995 (R2 Resource Consultants, in preparation). This is probably an underestimate, as it was based on hydroacoustic analysis. As a method of censusing fish populations, hydroacoustic analysis is generally incapable of providing data that can clearly distinguish between the reflected acoustic signals of fish near a lake bottom and background noise. Bull trout were most abundant between 75 and 125 ft, and they typically remained within 10 ft of the bottom. Although bull trout appear to prefer deeper waters, they use a wide range of lake habitat as discussed below in the subsection entitled “Rearing Distribution and Habitat Use.”

The density of bull trout in Masonry Pool is much less than, and possibly half, the density observed in Chester Morse Lake. The overall bull trout population in Masonry Pool is estimated to be less than 5 percent of the total Chester Morse Lake bull trout population, or approximately 150 fish.

In the upper Cedar River, bull trout density ranged from 69 to 543 fish per acre. Bull trout density in the Rex River ranged from 89 to 348 fish per acre. These densities are within the range of bull trout densities reported for other Pacific Northwest rivers. The highest densities found at certain sites in the Cedar and Rex rivers are characteristic of high densities found in critical rearing habitat in other systems. However, the variety of methods used to estimate abundance that are reported in the literature makes comparisons among systems difficult (McPhail and Baxter 1996).

REARING DISTRIBUTION AND HABITAT USE

Chester Morse Lake

As mentioned above, hydroacoustic analysis in Chester Morse Lake revealed that bull trout typically distribute themselves in deep water within 10 ft of the bottom. However, angling surveys indicated that the fish are also abundant in the littoral areas at certain times of year, particularly near the river deltas (Wyman 1975). Because bull trout are cold-water fish and prefer temperatures between 7.8º and 13.9º C (46º and 57º F) (Shepard 1985), their distribution in the lake is probably influenced by temperature. In the summer, as surface water temperatures increase, bull trout move out of shallow, littoral areas and into deeper water (Shepard 1985).

Bull trout that are rearing in the lake depend for food on benthic insects and fish, and rely less on food that is carried in from the rivers. As bull trout grow, their diet shifts from predominantly benthic insects to fish. An examination of bull trout stomachs revealed that 29 percent of all stomachs contained dipterans (primarily chironomids), 25 percent contained sculpins, and 25 percent contained pygmy whitefish (R2 Resource Consultants, in preparation). These food items indicate that bull trout rely on all major regions of the lake, including the near-shore (littoral), deep (profundal), and mid-column (pelagic) waters. In the spring, bull trout rely more heavily on benthic insects and pygmy whitefish. In the fall, bull trout rely more on sculpins. Crayfish were also a commonly consumed prey item in the spring and fall. Research in other systems similarly has shown that sculpins and whitefish are important food items for bull trout (McPhail and Baxter 1996).

Streams

In streams, bull trout are primarily bottom dwellers, occupying positions in contact with, and often within, the substrate. Although rearing bull trout use a wide range of habitats, they are most commonly associated with a large cobble and boulder substrate, woody debris, and deep scour and plunge pools (Shepard et al. 1984; Fraley and Shepard 1989; Heifetz et al. 1986; Goetz 1991; R2 Resource Consultants, in preparation). Newly emerged fry are often found in shallow, low-velocity side-channels or alcove pools, often in association with woody debris and fine substrates (Goetz 1991).

In the Rex and Cedar rivers, the highest densities of juvenile bull trout were found in pools with high hydraulic complexity and large woody debris or boulders (R2 Resource Consultants, in preparation). Additional data on bull trout distribution in smaller tributaries to Chester Morse Lake and Masonry Pool were collected during continuing field investigations by City biologists. In 1995 and 1996, minnow traps were deployed in several streams not included in the R2 Resource Consultants study. The 1995-1996 effort was conducted as part of a larger fish distribution study throughout the municipal watershed. Results confirmed that bull trout juveniles were present in seven additional streams: four small groundwater-fed channels (wall-base channels) to the Cedar River near Camp 18, and in Eagle Ridge Creek, Morse Creek, and Cabin Creek (Map 7).

In 1997, a preliminary study in the municipal watershed was initiated in which visual observations of juvenile bull trout were made from streambanks during daylight hours. Although during the day juvenile bull trout may react to observers by seeking cover more readily than at night (Bonneau et al. 1995), daylight observations in the municipal watershed seemed an efficient method of spotting recently emerged bull trout. Results from this preliminary study reaffirmed the reliance of newly emerged bull trout on low velocity, shallow side-channels, alcove pools, and woody debris. These foot surveys also confirmed the presence of juvenile bull trout in an eighth stream, Rack Creek.

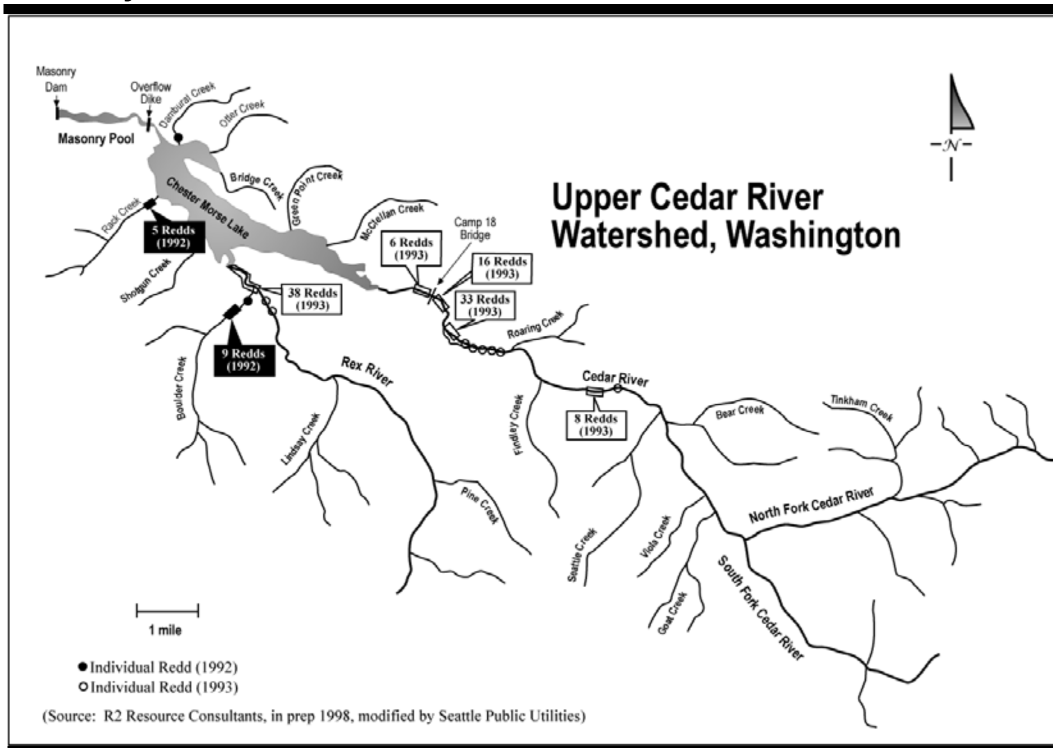
In addition to hydraulic conditions, water temperature and food supply may be important factors to juvenile fish distribution. Juvenile bull trout were observed actively feeding in the daytime at temperatures above 9º C (48.2º F), but were not observed feeding in the water column of streams below this temperature (R2 Resource Consultants, in preparation). The diet of juveniles in the Rex and Cedar rivers was not examined directly, but newly emerged fry are believed to feed predominantly on benthic insects. As they grow larger their diet shifts to drifting insects and small fish such as sculpins and juvenile trout (McPhail and Baxter 1996).

SPAWNING DISTRIBUTION AND HABITAT USE

Bull trout spawn in the Cedar and Rex rivers, as well as in some of the smaller tributaries of Chester Morse Lake. Spawning surveys of Chester Morse Lake bull trout were conducted over 3 years (1992-1994) as part of the R2 Resource Consultants study (in preparation). Fourteen tributaries to Chester Morse Lake were surveyed during this study, and redds were observed in five tributaries. A total count from all streams yielded 38, 109, and 27 redds during the years 1992, 1993, and 1994, respectively (Figure 3.5-6). While it is unknown if lake spawning occurs along the shores of Chester Morse Lake, lake spawning is known to sustain the populations of at least one bull trout stock in Washington State (Middle Hidden Lake, Okanogan County) and possibly one other (Lower Hidden Lake, Okanogan County) (WDFW 1997a).

City biologists have continued spawning surveys in the Cedar and Rex rivers since 1995. The total number of redds observed in 1995, 1996, and 1997 were 6, 8, and 41 redds, respectively. Redd surveys in 1995 and 1996 were seriously hampered by repeated high flows throughout the spawning period, and may not reflect the actual number of redds constructed. In 1997, some surveys were extended to upstream reaches in the Cedar and Rex rivers and Boulder and Rack creeks in order to gain further insight into spawning habitat distribution.

Figure 3.5-6. Distribution of bull trout redds, showing year of highest count by stream, 1993-1997.



Chester Morse Lake bull trout spawn later in the year than any other known bull trout population. Some other bull trout stocks spawn as early as mid-July, and all populations complete their spawning by mid-November (WDFW 1997a; McPhail and Baxter 1996). The start and finish dates of the bull trout spawning period in the municipal watershed varied among the study years, but generally ranged from early October to early December. Peak spawning varied from mid-October to mid-November, and seemed to be somewhat correlated with flow conditions.

Table 3.5-3. Bull trout fry trapping summary in the Cedar and Rex rivers, 1994–1997.

Trap Site Location	Year	Distance From Lake	Trapping Period	Trap Hours	Days Set	Fry Captured
Cedar River Camp 18	1994	0.96 mi	3/24 - 6/12	811	46	193
Cedar River Camp 18	1995	0.96 mi	3/16 - 6/06	1364	68	163
Cedar River Camp 18	1996	0.96 mi	3/23 - 6/21	963	54	0
Cedar River Camp 18	1997	0.96 mi	3/11 - 6/13	743	38	15
Cedar River down-stream of Bear Ck.	1995	7.06 mi	3/23 - 6/23	1051	60	2
Rex River	1994	0.58 mi	3/24 - 6/10	454	25	4
Rex River	1995	0.58 mi	4/23 - 6/07	657	33	17

It is unknown why the Chester Morse Lake population exhibits such a unique spawning period, but it is probably because the stock is adapted to the specific flow conditions and species assemblage present in the watershed. The fish apparently migrate into the streams and rivers to spawn following high flows. Water temperatures may also be a stimulus for bull trout spawning. Spawning surveys conducted in the Wenatchee National Forest over an 8-year period indicate that redd construction begins as temperatures drop below 9-11º C (Brown 1992a). These observations are consistent with the water temperatures recorded in the Cedar River near Camp 18 at the beginning of the spawning period (Figure 3.5-4). Unlike with the direct observations of bull trout on redds in the nearby Skykomish River (Pfeiffer, B., WDFW, 1997, personal communication), bull trout in the municipal watershed have not been seen on their redds during daylight hours.

In the municipal watershed, the highest spawning densities occurred in the lower reaches of the rivers where gravels were most concentrated, and in areas with low gradients. Spawning densities decreased as the gradient increased up each river. In the Cedar River, the preferred habitat was between the Camp 18 bridge and 1 mile upstream, and in the Rex River the preferred spawning habitat was downstream of Boulder Creek (Figure 3.5-6). In other watersheds, spawning sites are commonly associated with upwelling groundwater and nearby cover (Goetz 1989; Shepard 1985; McPhail and Baxter 1996). In the municipal watershed, temperature differentials indicative of upwelling were not found at redd sites during the 1992-1994 spawning seasons, and nearby cover did not appear to influence redd site selection (R2 Resource Consultants, in preparation).

In some years access to spawning habitat in the smaller tributaries was limited during fall low-flow conditions by subsurface flows near the outlets. Additionally, some Cedar River redds below the Camp 18 bridge and redds in lower Rex River were inundated by rising reservoir levels during late winter and early spring (see subsection entitled "Redd Inundation" below, and sections 3.2.4 and 4.5.5).

FRY EMERGENCE AND DOWNSTREAM MIGRATION

Trapping of newly emerged fry in the Rex and Cedar rivers was initiated during 1994 and 1995 (R2 Resource Consultants, in preparation), and was continued by City biologists during 1996 and 1997. The purpose of this study was to determine the timing of fry emergence and movement in the river system, and to contribute to the development of an index of reproductive success and population condition. A fyke net (8 ft long by 30 inches square), placed mid-stream, was used to collect downstream-moving fry at three sampling locations. One sampling location was in the Cedar River at Camp 18 and has been used in each of the sampling years. This site is located downstream of the majority of bull trout redds in the river. A second site in the Cedar River was just downstream of Bear Creek and was used only in 1995. It was located upstream of all observed bull trout redds. The third sampling site was used in 1994 and 1995 and was located in the mainstem of the Rex River. This site was located upstream of some observed redds and downstream of other observed redds, but it was above the area of the river subject to inundation from rising reservoir levels in the spring (Section 3.2.4).

The number of fry trapped in the nets varied among locations and years (Table 3.5-3). The greatest catch variability was between different years at a single location. In 1994, 193 fish were trapped at the Camp 18 sampling site on the Cedar River, but no fish were trapped there in 1996. Based on daily catch of bull trout fry per unit effort (the number of fry captured per hour of fishing multiplied by the average proportion of trap submerged), the period of most substantial fry emergence and movement in the Cedar River extends from late March through mid-May, with peak activity during April and early May (Figure 3.5-7). These observations are similar to those of fry movement in other systems (McPhail and Baxter 1996). Limited data from the Rex River indicates that the timing is somewhat later in the Rex River than in the Cedar, as fry emergence occurred from late April through early June, with peak activity during early May (Figure 3.5-8). However, results from the Rex River are less reliable than data from the Cedar River, because the trap was placed upstream of many redds inundated by spring reservoir levels.

The trap in the Cedar River located just downstream of Bear Creek was established to help clarify the upstream extent of spawning in the Cedar River (Figure 3.5-6). Only two newly emerged fry were captured at this location. This confirmed that bull trout spawning occurs upstream of this area, but suggests that the level of spawning activity may be relatively low compared to that the lower reaches of the river.

The numbers of fry trapped near Camp 18 in 1994 -1997 during the spring shows a roughly positive relationship to the numbers of redds counted the previous fall. The greatest number of fry were captured in 1994 (Table 3.5-3), and this was preceded in the fall by the largest redd count (see Spawning Distribution and Habitat Use above). In contrast, the lowest redd count was made in 1995, and this was followed in 1996 by the complete absence of captured fry. In addition, scouring flood flows occurred during both the 1995 spawning and 1995-96 incubation periods. These results suggest a highly variable reproductive success from year to year, depending on both the number of spawning fish and the flow conditions during incubation.

Fry size and development were fairly uniform during the fry-sampling period. All fry ranged in size from 24 to 40 mm, with most about 27-28 mm long. All fish had completely absorbed yolks, except for a few captured during March.

Figure 3.5-7. Bull trout fry catch per unit effort (CPUE) in the Cedar River near Camp 18 from 1994 through 1997.

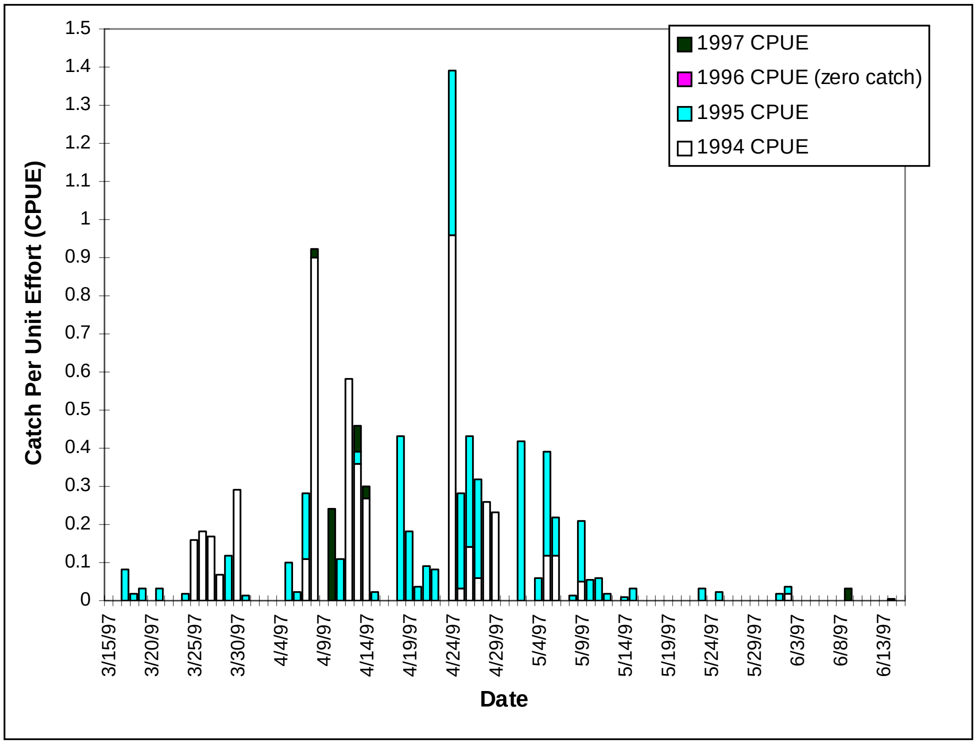
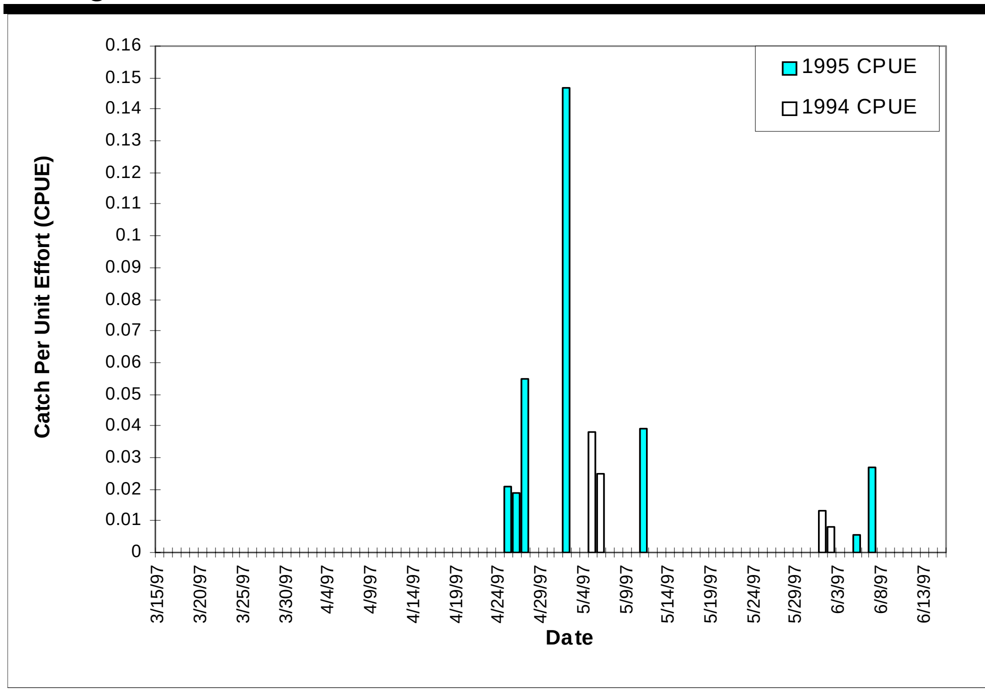


Figure 3.5-8. Bull trout fry CPUE in the Rex River below Cabin Creek during 1994 and 1995.



REDD INUNDATION

Inundation of bull trout redds by rising winter and spring reservoir levels occurs in the lower reaches of the tributaries of Chester Morse Lake. The probable result of this phenomenon is diminished water flow over and through the redds and death of some developing eggs or alevins. R2 Resource Consultants calculated that 22 out of 63 Cedar River bull trout redds (35 percent) in 1993 were at elevations that would be inundated at a reservoir level of 1,565 ft above sea level, the highest reservoir elevation that year (normal high pool elevation is generally 1,563 ft). However, 6 of the 22 bull trout redds were between thalweg elevations 1,554.57 ft and 1,560.96 ft and the other 16 were between thalweg elevations 1,560.96 ft and 1,565.06 ft. The R2 Resource Consultants report (in preparation) states that the 6 bull trout redds in the lower elevation range were all located downstream of the Camp 18 bridge. Independent field observations by City biologists indicate that the most upstream extent of reservoir inundation caused by a high pool reservoir level of about 1,563 ft is still several hundred feet below the Camp 18 Bridge. Thus, a high pool elevation of about 1,563 ft would have flooded 6 of the 63 redds (9.5 percent) in 1993. In the Rex River, at least 38 out of 40 (95 percent) of the observed bull trout redds in 1993 were located below the confluence of Boulder Creek at thalweg elevations less than 1,556.69 ft. Redds below this elevation would be inundated almost every year. The remaining two redds in the Rex River were located above elevation 1,563 ft (R2 Resource Consultants, in preparation).

The extent to which bull trout spawning habitat is inundated varies by different years depending on precipitation and operationally related fluctuations in the reservoir level (Section 2.2.4; Appendix 22, Figure 22-1). Bull trout redds in the Rex River are at greater risk from inundation than those in the Cedar River because many redds in the Rex River are located at lower elevations. Eggs or alevins in the Rex River also may be more at risk from inundation because they appear to emerge later in the spring when reservoir levels are historically highest.

The actual level of mortality caused by inundation of redds in the lower Rex and Cedar rivers is not known. It is particularly puzzling to biologists that such a high percentage of Rex River bull trout redds are built at elevations that have been annually inundated by Chester Morse Lake for almost 85 years. Severe mortality to eggs and alevins usually would be expected to exert a strong selective pressure against those bull trout spawning in the regularly inundated stream reaches. Inundation of salmonid redds is known to cause mortality in some reservoirs (Seattle City Light 1989). In Chester Morse Lake, one hypothesis is that the degree of impact is somewhat reduced by water upwelling through the spawning gravels in the inundated stream reaches. Upwelling in spawning gravels serves to aerate eggs and alevins and remove metabolic wastes. It is not known whether upwelling actually occurs in bull trout spawning areas in the lower Cedar or Rex rivers. However, the fact that regular inundation has been occurring for decades in much of the area in which bull trout spawn, suggests that there has been relatively little selection exerted on bull trout to avoid these areas. Furthermore, even if a high degree of mortality from inundation does occur, it is possible, even likely, that the limiting life stage for bull trout in the watershed is not spawning but juvenile rearing (Section 3.3.4; Foster Wheeler Env. Corp. 1995d).

In short, while the degree of impact from redd inundation is unknown, it is of concern. As a part of the Bull Trout Monitoring and Research Program (Section 4.5.4) a comprehensive research study will be conducted on potential mortality in inundated bull trout redds.

POTENTIAL BLOCKAGE OR IMPEDANCE OF SPAWNING MIGRATIONS

Bull trout spawning migrations may be blocked or impeded at the mouths of the rivers during exceptionally dry years with their concomitant extraordinarily low reservoir water levels (sections 3.2.4 and 4.5.6). Detailed bathymetry conducted at the edge of the Cedar and Rex river deltas determined that the slope of these areas is 14 and 17 percent, respectively. Exposure of several feet of these steeply sloped delta fans may present a barrier to migrating bull trout. These steeply sloped delta areas first begin to be exposed as reservoir levels drop below 1,540 ft in elevation. The degree of potential impact is smallest immediately below 1,540 ft, as only a short distance of steep gradient stream channel is exposed. However as the reservoir level drops below 1,535 ft, the steep channel gradients are believed to extend for sufficient length to potentially impede or block migration (R2 Resource Consultants, in preparation). Actual field observations of this phenomenon with low reservoir levels have never been made. Chester Morse Lake's minimum drawdown level is 1,532 ft, and under emergency conditions it can be lowered to 1,502 ft using the existing pumps (Section 2.2.3). An extended period of 60 consecutive days of lake levels below 1,540 ft occurred in 1987. The lowest level reached during the 1987 spawning period was 1,533 ft, when a portion of the steeply sloped delta fans was theoretically exposed. Chester Morse Lake water levels have not dropped below 1,540 ft since 1991. The potential for blockage or impedance of bull trout spawning migrations during infrequent periods of low reservoir levels will be thoroughly examined under the HCP Monitoring and Research Program as part of the Environmental Evaluation of the Cedar Permanent Dead Storage Project contained in Section 4.5.6.

ENTRAINMENT

There may be some loss to the bull trout population in the Chester Morse Lake/Masonry Pool system resulting from entrainment through the intakes of the Cedar Falls Hydroelectric Project at Masonry Dam and through the Overflow Dike into Masonry Pool. The issue of possible entrainment was raised at a City-sponsored Bull Trout Workshop on November 18, 1994 (Section 3.3.4) (Foster Wheeler Env. Corp. 1995d). To address this question, the City contracted Foster Wheeler Environmental Consultants to develop an estimate of entrainment based on a comparative literature search (Appendix 19). Foster Wheeler's study concluded that any potential loss of fish from the Chester Morse Lake/Masonry Pool system is likely having little effect on the reservoir's population. The study estimated that about 200 bull trout per year may be lost to entrainment through Masonry Dam, with a possible range of 10 fish to several hundred fish (Knutzen 1997).

Foster Wheeler considered the estimated 200 fish lost, or 6.4 percent of the estimated 3,100 bull trout in Chester Morse Lake, to be a sustainable loss, because any such entrainment has been ongoing for most of the twentieth century, and because only about 5 percent of the reservoir's bull trout population occurs in the Masonry Pool. In other systems, trout have been able to maintain stable population levels despite annual exploitation rates greater than 20 percent (Nehring and Anderson 1982). The health and long-term sustainability of the Chester Morse Lake bull trout population, in spite of entrainment, is further supported by the fact that losses to the population above Cedar Falls have always occurred, even before Masonry Dam was constructed. Historically, any trout or char in the upper Cedar River watershed that migrated downstream on its own volition or during storm events would have passed over Cedar Falls.

Entrainment losses from the Overflow Dike between Chester Morse Lake and Masonry Pool can occur whenever the reservoir level drops near or below 1,550 ft (the top of the Overflow Dike spillway), which occurs about 36 percent of the year (Section 2.2.4). At these lake levels the flow from Chester Morse Lake to Masonry Pool is primarily through a 6.5 ft diameter discharge pipe and onto a concrete energy dissipation block. It appears that some fish are likely injured or killed from passing through this Overflow Dike pipe, but solid conclusions cannot be drawn from available information (Knutzen 1997). Knutzen postulated that the fish population probably incurs much less damage from passing through the Overflow Dike than from entrainment at the Masonry Dam.

3.5.7 Pygmy Whitefish

BACKGROUND AND STATUS

The pygmy whitefish (*Prosopium coulteri*) (Figure 3.5-9) is a glacial relict species in the family Salmonidae. During the last ice age it was widely distributed across North America, but currently the species is found in small, isolated populations in deep, high-elevation lakes from the Columbia River basin in Washington, Montana, and British Columbia north to Alaska (Wydoski and Whitney 1979). Pygmy whitefish also occur in northern Asia in rivers flowing to the Arctic Ocean (Chereshnev and Skopets 1992), and a population outside of its typical distribution also exists in Lake Superior (Eschmeyer and Bailey 1955). The number of lakes that support pygmy whitefish is relatively uncertain, however, because the common sampling methods of gillnetting and angling are not efficient at capturing these small, deep-water fish.

The pygmy whitefish is not a federal listed or candidate species, but it is a Washington State Sensitive species (WDFW 1998b). In Washington State, pygmy whitefish are known to have previously occupied 15 lakes, although currently they are found in only 9 (Hallock, M., WDFW Freshwater Fish Division, January 21, 1998, personal communication). The species disappeared from 3 of the 15 lakes as a result of interactions with introduced fish species. Pygmy whitefish were extirpated from the other 3 lakes through fish removal efforts conducted prior to restocking these lakes with game fish. Pygmy whitefish populations are especially vulnerable to local extinction because recruitment of new fish is usually impossible among isolated lake systems.

Figure 3.5-9. A school of pygmy whitefish in the Cedar River upstream from Chester Morse Lake.

The pygmy whitefish population in the Chester Morse Lake/Masonry Pool system has benefited from the lack of development in the drainage basin, the absence of non-native fish species, and the preservation of high quality water. Pygmy whitefish are the most abundant salmonid in the lake, and they are one of the major prey items for the bull trout population (R2 Resource Consultants, in preparation).

Much of the information in this section regarding the status of pygmy whitefish in Chester Morse Lake was obtained from a recent study on resident fish habitat and populations in the upper Watershed (R2 Resource Consultants, in preparation). This study combined hydroacoustic surveys, gill net sampling, and stream surveys to estimate the pygmy whitefish population, to determine their distribution, and to gain an understanding of their life history. Additional information on the pygmy whitefish population was gathered from other fisheries studies in the Cedar River Watershed (Wyman 1975; EVS 1984), published literature, and field observations by City biologists.

LIFE HISTORY, AGE, AND GROWTH

In the Cedar River Watershed, pygmy whitefish are found in Chester Morse Lake and Masonry Pool. They are also found in some tributaries to Chester Morse Lake, although their use of the rivers and tributaries of the system appears to be limited to spawning. City biologists observed spawning migrations of pygmy whitefish in the Cedar River, Rex River, and Boulder Creek during early December. Pygmy whitefish are a relatively short-lived species. In Chester Morse Lake, the population is comprised mostly of fish in the age class 2+ and 3+ and a few fish in age class 4+ (R2 Resource Consultants, in preparation). In the Flathead Lake system in Montana, researchers observed that male pygmy whitefish generally live only to age 3, whereas some females reached age 5 (Weisel et al. 1973). They also noted that males generally mature at age 2 while females first mature at age 3, and likely spawn in consecutive years. The earlier maturation and shorter life spans of the males may be an evolutionary strategy that reduces the use of limited food resources and helps sustain pygmy whitefish stocks (Weisel et al. 1973).

Pygmy whitefish in Chester Morse Lake are the largest known pygmy whitefish in the world. They are larger than fish from other lakes in Washington State (Hallock, M., WDFW Freshwater Fish Division, January 21, 1998, personal communication), and they are larger than fish from Montana, Alaska, and northern Asia (Weisel et al. 1973; Chereshnev and Skopets 1992; Eschmeyer and Bailey 1954). The total length of fish in Chester Morse Lake ranged from 195 to 220 mm for age class 2+ fish (n=23), 208 to 216 mm for age class 3+ fish (n=10), and 210 to 246 mm for age class 4+ fish (n=2) (R2 Resource Consultants, in preparation). Known sizes of fish from other populations contain only one report of a fish larger than 200 mm. The greater body size of the Chester Morse Lake fish suggests that this is a relatively productive and unique stock.

ABUNDANCE

The population of pygmy whitefish in Chester Morse Lake was estimated to be approximately 51,000 fish, based on the results of hydroacoustic surveys (R2 Resource Consultants, in preparation). However, hydroacoustic techniques underestimate bottom-oriented fish populations, such as the pygmy whitefish. When fish are near the lake bottom the hydroacoustic signal is compromised by bottom noise.

Masonry Pool likely supports a lower density of pygmy whitefish than Chester Morse Lake, because Masonry Pool does not have deep-water habitat comparable to the deep areas of Chester Morse Lake. The population of pygmy whitefish in Masonry Pool is estimated to be less than 1 percent of the population in Chester Morse Lake, or approximately 300 fish (R2 Resource Consultants, in preparation).

REARING DISTRIBUTION AND HABITAT USE

In Chester Morse Lake all of the pygmy whitefish collected in gill nets were within approximately 1-10 ft from the bottom, and most were in water deeper than 100 ft (R2 Resource Consultants, in preparation). The fish appeared to remain near the bottom during the day and were more active at night.

Feeding habits of pygmy whitefish in Chester Morse Lake were determined by stomach content analysis (R2 Resource Consultants, in preparation). Their diet was found to be fairly consistent among spring, summer, and fall sampling events. In each season, the fish predominantly consumed benthic organisms that live in the deeper parts of the lake. The dipteran families Chironomidae and Ceratopogonidae were the most common food organisms and were present in more than 65 percent of all stomachs. Various small clams were the second most commonly consumed prey, and, depending on the season, appeared in 22-48 percent of all stomachs. Other less commonly consumed groups include zooplankton, benthic amphipods, and other insect taxa. Fish and terrestrial organisms were absent from the diet of pygmy whitefish, indicating their food source is primarily from the lake bottom, especially the deeper profundal zone.

Observations that Chester Morse Lake pygmy whitefish feed at or near the bottom are corroborated by research at Flathead Lake in Montana (Weisel et al. 1973). This same study also examined stomach contents in December during the pygmy whitefish spawning period. Results indicated that spawning fish in the creek actively fed on fish eggs and on chironomids and other insects.

SPAWNING DISTRIBUTION AND HABITAT USE

Little is known about pygmy whitefish spawning behavior, incubation, and early life history. In the Chester Morse Lake system, large aggregations of sexually mature fish move into the Cedar River, Rex River, and Boulder Creek during early December. Observations during these spawning migrations are limited, but City biologists observed pygmy whitefish in the Cedar River above Camp 18 as individuals or in groups ranging in size from 2 to approximately 1,000 fish during the first 2 weeks of December in 1996 and 1997. The fish were observed in pools, over pool tailouts, and in shallow riffles. Many of the groups of fish were actively swimming upstream while other groups appeared to be maintaining their position in the channel. In 1997, during the same period, fish were also observed in the lower Rex River and in lower Boulder Creek. No fish were observed in Cabin, Otter, McClellan, Green Point, Shotgun, or Lost (historic) creeks nor along the beach area of Lost (historic), Shotgun, or McClellan creeks.

It is presumed pygmy whitefish spawn by broadcasting their eggs on clean gravel (Wydoski and Whitney 1979). This is supported by observations by City biologists of pygmy whitefish eggs within the gravel of a shallow riffle upstream of Camp 18 in 1996. It is unknown if pygmy whitefish also spawn along the shoreline of the lake, but it is probable that this strategy is used by other populations that occur in lakes without surface water inlets (Hallock, M., WDFW Freshwater Fish Division, January 21, 1998, personal communication).

POTENTIAL EFFECTS OF RESERVOIR OPERATIONS ON PYGMY WHITEFISH

It is unknown if seasonal changes in lake levels from reservoir operations (sections 2.2.4, 3.2.4, and 4.5.6) significantly affect the pygmy whitefish population. Management of Chester Morse Lake can result in a maximum elevation change of 38 ft between maximum full pool and the gravity flow drawdown limit. The lake level of Masonry Pool can fluctuate 70 ft. At the higher lake levels, Masonry Pool and Chester Morse Lake join to form a single water body. At the lowest level, Masonry Pool is essentially a flowing channel. Because Masonry Pool supports such a low density of pygmy whitefish relative to Chester Morse Lake, the effect of such a drastic change in Masonry Pool is not expected to significantly affect the total pygmy whitefish population.

3.5.8 Sockeye Salmon

GENERAL DESCRIPTION

The sockeye salmon (*Oncorhynchus nerka*) (Figure 3.5-10) is a common and relatively well-studied species of the family Salmonidae. The sockeye is the third most abundant of the seven species of Pacific salmon and has been targeted in major commercial fisheries for most of the twentieth century[2]. Spawning populations of sockeye have been reported from the Sacramento River in the south to the rivers of Kotzebue Sound in the north, and east to basins that drain into the Sea of Okhotsk (Burgner 1991). Size at maturity varies considerably between and within populations of sockeye, with larger fish typically spending additional time at sea. The average weight of sockeye returning to the Cedar River is approximately 5.25 pounds (James M. Montgomery Inc. 1990).

The Washington Department of Fisheries et al. (1993) identified four populations of anadromous sockeye salmon in Puget Sound: one population in the Baker River and three populations that occur in the Lake Washington watershed (Cedar River, Issaquah/Bear Creek, and Lake Washington beach spawners). Hendry et al. (1996) used analysis of variation in allelic frequencies to suggest a slightly different population structure in Lake Washington. Their work suggests two subgroups in the Lake Washington watershed: a potentially native stock that spawns in Bear and Cottage Creeks at the north end of the system and a second stock derived from transplants of Baker River sockeye in the 1930s and 1940s that spawns in the Cedar River, Issaquah Creek, and on the beaches of Lake Washington. Within the Baker River sub-group, Issaquah Creek fish could be distinguished from Cedar River and lake spawning fish. However, allelic frequency was not sufficient to distinguish between Cedar River and lake-spawning fish. In a companion study, Hendry and Quinn (1996) were able to use morphological differences in spawning fish to distinguish between Cedar River and lake-spawning fish. The results of these studies could be used to support the hypothesis that the fish introduced from the Baker River are beginning to diverge into distinct sub-populations.

Although considered by the state as a wild stock (naturally reproducing), the Cedar River stock is not presently considered by NMFS to constitute an Evolutionarily Significant Unit (ESU) under the Endangered Species Act. However, the stock present in Bear Creek, a tributary to the Sammamish River, is potentially of native origin (Fed. Reg., Vol. 63, No. 46, pp. 11749-11771; Waples, 1998). The Bear Creek stock is considered by NMFS to be a provisional ESU, although it is not believed to be presently in danger of extinction nor likely to become endangered in the foreseeable future if present conditions continue (Fed. Reg., Vol. 63, No. 46, pp. 11749-11771).

The majority of sockeye returning to Lake Washington spawn in the Cedar River. The north Lake Washington sub-group also exhibits significant returns in most years. Returns to Issaquah Creek are typically lower than returns to the north-end tributaries. Lake spawners typically account for the smallest portion of the run, usually three orders of magnitude less than returns to the Cedar River (Hendry et al. 1996).

IMPORTANCE IN THE LAKE WASHINGTON WATERSHED

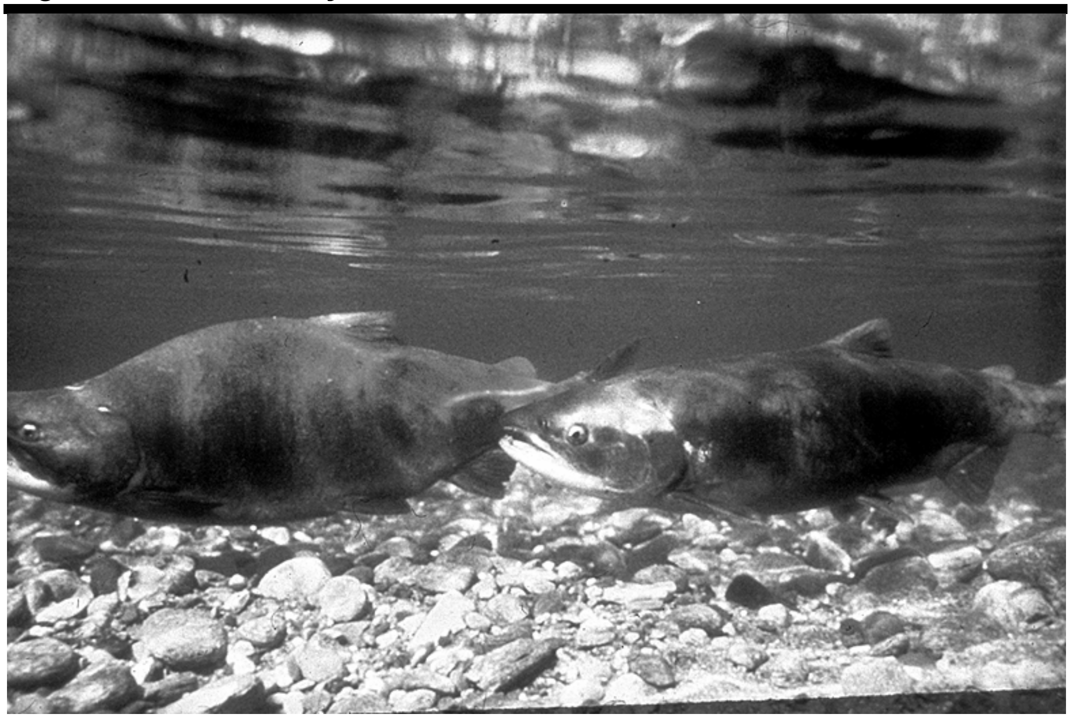
Sockeye are an important component of the Lake Washington ecosystem. Post-spawning salmon carcasses contribute nutrients to the biotic communities in streams and lakes (Kline et al. 1994; Bilby et al. 1996). Returning spawners excavate and, to some degree, redistribute significant amounts of gravel in spawning areas each year (Burgner 1991). A number of fish species in the system feed upon sockeye eggs and juveniles (Foerster

[2] Rainbow and cutthroat trout are now included in the genus *Oncorhynchus*. For convenience, we follow the convention of Groot and Margolis (1991) to maintain the common distinction between salmon and trout and do not include these two species when referring to the seven species of salmon in the Pacific basin.

1968; Stober and Hamalainen 1980; Beauchamp 1993; Tabor and Chan 1996). Birds and mammals scavenge on carcasses (Cederholm et al. 1989), and a number of bird species, such as dippers, kingfishers, and mergansers, feed on eggs and juvenile fish (Burgner 1991). During their extended rearing period in the lake, juvenile sockeye are important predators that consume significant amounts of zooplankton (Foerster 1968; Woodey 1972; Chigbu and Sibley 1994).

Sockeye salmon are the most numerous naturally reproducing salmonids in the basin and, in years of high abundance, the population has supported a significant Tribal treaty harvest and one of the largest sport fisheries in the state (Fresh 1994). The migration of sockeye through the fish ladder at the Ballard Locks attracts thousands of visitors each year. The observation of spawning sockeye in the Cedar River, Bear Creek, and Issaquah Creek has become a popular fall outdoor recreation activity for many people in the region.

Figure 3.5-10. Sockeye salmon.



LIFE HISTORY OVERVIEW

Sockeye salmon exhibit a typical salmon life history pattern that integrates anadromy (juveniles migrate to the ocean where they mature and return as adults to spawn in fresh water), homing (adults generally return to their natal streams to spawn), and semelparity (adults die after spawning once) (Section 3.2.3). Sockeye can also exhibit a resident life history that is similar to the typical pattern, but lacks the feature of anadromy (Burgner 1991). These resident sockeye are called kokanee. Although small numbers of sockeye in the Lake Washington Basin exhibit the resident life history pattern, including a population in Walsh Lake in the Cedar River Watershed (sections 3.6 and 3.2.4), the vast majority of the population is anadromous. Unlike any of the other species of Pacific salmon, juvenile sockeye rear primarily in freshwater lakes.

Adult sockeye salmon begin returning to the Lake Washington watershed through the Ballard Locks in late May with a peak migration in early July. By mid- to late August, essentially all fish have entered the lake (Warner, E., Muckleshoot Indian Tribe, 1998, personal communication). Once in the lake, the fish move into deep, cold areas below the thermocline. Adults will spend from 1 to 4 months in this region of the lake, where they undergo final sexual maturation (Parametrix, Inc. 1991). During this time, gametes mature and the outward appearance of the fish is dramatically transformed by the onset of secondary sexual characteristics. Most fish will move into tributary streams to spawn during the fall, but a relatively small proportion of the population will spawn in selected beach areas along the eastern shores of the lake and along the northern shoreline of Mercer Island (Map 2). The Cedar River supports the largest population of sockeye salmon in the Lake Washington Basin with significant numbers of fish also spawning in the Bear Creek subbasin, and in North Creek, Swamp Creek, and Issaquah Creek. Although there have been exceptions in some years, approximately 90 percent of the returning fish typically spawn in the Cedar River (James M. Montgomery, Inc. 1990).

Cedar River sockeye exhibit relatively protracted periods of spawning and incubation. Mature adults begin to enter the Cedar River in early September. Spawning activity begins to increase in mid-September and continues into January with a peak in mid- to late October (Cascades Environmental Services 1995). Each female selects a site for spawning, digs a redd, and deposits an average of 3,200 eggs. Males compete to court females and fertilize the eggs. After fertilization, the eggs are buried by the female, who guards the site until she dies several days to 2 weeks later. Alevins hatch from the eggs after 2 or 3 months and remain in the gravel for an additional 2-4 months, during which time they are sustained by their yolk sacs as they complete their development into free-swimming fry (Foerster 1968; James M. Montgomery, Inc. 1990).

Fry begin to emerge from the gravel in late January and continue through May, with a peak in late March and early April. Upon emergence, fry immediately begin migrating downstream. Most fry arrive at Lake Washington within 48 hours of emergence (Seiler and Kishimoto 1996). Most juvenile sockeye reside in the lake for approximately 12-14 months, then undergo the process of smoltification as they migrate out of the lake into salt water via the Lake Washington Ship Canal and the Ballard Locks. These migrating smolts move out of the lake and into Puget Sound between April and June (James M. Montgomery, Inc. 1990).

Once in the marine environment, Cedar River sockeye are thought to display distribution and migration patterns similar to those of other northeastern Pacific sockeye stocks as summarized by Burgner (1991). After leaving Puget Sound, subadult sockeye move north along the continental shelf, into the Gulf of Alaska, and then migrate south into the open ocean. Once they reach maturity, the adult fish return to near-shore waters and migrate south along the coastline to Puget Sound and back to Lake Washington. The majority of Lake Washington sockeye return after 2 years at sea, however, a significant proportion from any give year class may return after 3 years at sea. Typically, a very small portion of the population (<1 percent) returns after only 1 year at sea (WDFW 1997e).

HABITAT CHARACTERISTICS AND KEY FACTORS AFFECTING SURVIVAL

A number of factors can potentially affect the survival of Lake Washington sockeye salmon at various stages of their life history, including habitat loss and degradation resulting from a variety of land and water management practices (King County 1993); scour of incubating eggs and alevins during floods (Seiler and Kishimoto 1997); predation by native and non-native fish in the Cedar River and Lake Washington (Beauchamp 1993; Tabor and Chan 1996); food supplies in the lake (Beauchamp 1996); injury to smolts leaving the Lake via the Ballard Locks (Goetz et al. 1997); droughts; and unfavorable ocean conditions. As a result of the population's early run timing, harvest rates for Lake Washington sockeye are typically very low in the marine environment. Occasionally, early season harvests targeting up-river stocks of Fraser River Sockeye are permitted in north Puget Sound. This fishery must be carefully controlled to prevent unintentional over-harvest of Lake Washington sockeye (Warner, E., Muckleshoot Indian Tribe, 1998, personal communication). Although sport and Tribal harvests in Lake Washington are typically well controlled to ensure that adequate numbers of fish return to streams to spawn, Cedar River sockeye can be vulnerable to over-harvest, as demonstrated during the 1996 season when insufficient numbers of fish returned to meet escapement goals after substantial sport and Tribal harvests in the lake.

Clearly, there are a number of ways in which human activities have had impacts on sockeye in the Lake Washington Basin. But perhaps the most profound human impact on the aquatic ecosystem, the alteration of the basin's hydrologic pattern (Chrzastowski 1983), has been beneficial for anadromous sockeye salmon.

Hydrologic Reconfiguration of the Cedar River Basin

In its original configuration, Lake Washington drained south via the Black River near the present day site of the City of Renton (Section 3.2.5). The Black River continued south for a short distance and joined the Duwamish River en route to Puget Sound. The Cedar River flowed into the Black River approximately 0.4 miles downstream of the lake outlet, rather than directly into the lake as it does today. Large numbers of fish reportedly spawned in the Cedar River between its confluence with the Black River and the natural barrier formed by Lower Cedar Falls 34.2 miles upstream. The large numbers of spawning carcasses present in the river were considered a detriment to water quality by early settlers (Bagley 1929). This reference to large numbers of carcasses suggests the presence of mass spawning pink and chum salmon in addition to coho, chinook, and steelhead trout. There have been no reports of significant returns of pink and chum salmon to the Cedar River since that time. Juvenile pink and chum salmon migrate to salt water very shortly after emergence as very small fish. The likelihood that these small fish can successfully navigate through a large natural lake such as Lake Washington and arrive in the near-shore marine environment during the appropriate period in the spring is quite small. If populations of these species were present, they were apparently unable to adapt to the rapid hydrologic changes in the early twentieth century and are now extinct in the Lake Washington Basin. In contrast, sockeye salmon have established themselves in the Cedar River and flourished since the hydrologic changes.

Kokanee (resident sockeye) were thought to have been present in Lake Washington prior to the turn of the twentieth century, and, as mentioned above, are still present in isolated populations. Although it is possible that anadromous sockeye may also have been present in small numbers, their presence was not conclusively determined prior to the introduction of Baker River fish in the 1930s (U.S. Fish Commission 1897; Cobb 1916; Burgner 1991).

This apparent lack of substantial numbers of anadromous sockeye is perhaps not surprising when one considers the hydrology and ecology of Lake Washington and the Cedar River subbasin prior to the early twentieth century. The largest potential spawning area for sockeye in the Lake Washington watershed was located in the Cedar River. However, the Cedar River emptied into the Black River downstream of Lake Washington and therefore did not provide direct access for juvenile sockeye into Lake Washington for rearing. In addition, any adult sockeye that might have returned to the system would likely have been competing with large numbers of pink and chum salmon for spawning habitat.

When stream flows in the Cedar River were very high, the direction of flow in the Black River would apparently reverse and some Cedar River water would flow into the lake. During protracted periods of high run-off, the water level of Lake Washington would rise by as much as 7 ft (Chrzastowski 1983). While it is possible that some sockeye fry might have arrived at the lake when high water conditions occurred during the spring, these same conditions would have made it very difficult for outmigrating smolts to find their way out of the lake and into salt water. Also, conditions in Lake Washington were likely conducive to a kokanee life history pattern. On an annual basis, the water in the lake was replaced at approximately one-half the rate at which it is replaced today. The lake was likely very rich in nutrients and food for juvenile and adult kokanee. The highly favorable conditions for salmonid growth and survival in the lake, and the potential lack of a clear pathway for outmigrating smolts prior to the hydrologic changes completed early in1917, may have resulted in conditions that favored a resident life history strategy over an anadromous pattern.

By 1917, the hydrologic pattern of the Lake Washington Basin had been dramatically altered with the rerouting of the Cedar River directly into Lake Washington, the creation of a new outlet via the Ballard Locks, and the lowering of the mean water level in the lake by nearly 9 ft (Chrzastowski 1983). While this alteration likely had significant negative effects on some salmonid species, it created conditions under which anadromous sockeye salmon could flourish in the Cedar River. In contrast to the other anadromous salmonids in the watershed that rear as juveniles for extended periods in stream habitats (steelhead trout, coho salmon, and chinook salmon), sockeye move downstream immediately after emergence from the gravel and begin to take advantage of the comparatively vast rearing areas and abundant food resources offered by the lake.

In this new hydrologic configuration, sockeye fry produced in the Cedar River were provided with a very direct pathway to the lake and outmigrating smolts were provided with direct access to salt water. In only 30 years, the transplanted Baker River sockeye grew into a robust, naturally reproducing population from relatively small initial plantings. This rapid population growth over a limited number of years and the presence of substantial numbers of potentially native sockeye in the north Lake Washington tributaries are perhaps good indicators of the generally favorable environment for anadromous sockeye salmon provided by Lake Washington. However, many other effects of human settlement and development on this generally benign environment have also reduced the system's resilience and capacity to support anadromous fish, including sockeye.

Landsburg Diversion Dam

Since the early 1900s, the Landsburg Diversion Dam has blocked the migration of anadromous fish into approximately 17 stream miles of formerly accessible habitat between Landsburg and the natural barrier formed by Lower Cedar Falls. As previously mentioned, anadromous sockeye were not reported in the Cedar River prior to the alterations of the basin's hydrology and subsequent introduction of Baker River fish. However, large numbers of other species of salmon were present in this reach prior to the construction of the Landsburg Diversion Dam. Today, naturally reproducing sockeye are established in the lower river and every year significant numbers of adult fish migrate upstream as far as the migration barrier at Landsburg. Exclusion from the habitat upstream of the diversion limits the productive capacity and resiliency of the Cedar River sockeye population.

Stream Flow

Sockeye begin spawning in the early fall when stream flows often recede to their lowest levels of the year. During the last half of September and early October, the amount of spawning habitat available to sockeye can be limited by low stream flow. By mid- to late October, stream flow typically exceeds the levels that provide the maximum amount of spawning habitat for sockeye (Cascades Environmental Services 1991).

In the Cedar River, redd scour during flood events is thought to be a dominant factor controlling the survival of incubating eggs and alevins (Thorne and Ames 1987). Floodplain development, diking, bank armoring, and flood management practices have reduced the width of the functional stream channel and reduced the river's ability to spread into the floodplain and dissipate energy during high water events (Section 3.2.5). High flows are now confined within a relatively narrow corridor that has had the effects of increasing water velocity, transporting sediment, and subsequently increasing the frequency and degree of redd scour. Redd scour starts to occur when streamflow, as measured near the mouth of the river in Renton, exceeds approximately1800-2000 cfs. Scour rates increase quite rapidly as flows increase beyond this level (Cascades Environmental Services 1991; Seiler and Kishimoto 1997b). Redds located near the stream margins appear to be somewhat less vulnerable to scour than redds located in the center of the channel. However, the amount of spawning habitat available along the stream margins is relatively limited and generally available to spawning fish only at relatively high flow levels that exclude fish from much of the spawning habitat in mid-channel areas (Cascades Environmental Services 1991).

Recent information suggests that newly emerged sockeye fry can experience significant mortality during their 1-2-day migration downstream to Lake Washington. The survival of outmigrating fry appears to be higher during periods of elevated flows, and survival at similar flow levels can vary significantly from year to year (Seiler 1994, 1995; Seiler and Kishimoto 1996, 1997a). Other factors that may affect outmigrant survival include water clarity, temperature, and light intensity. One of the key mechanisms causing mortality during outmigration to the lake is hypothesized to be predation by sculpin (Tabor and Chan 1996). Sculpin population size may in turn be partially controlled by peak winter flood events.

Disease

Fish disease is not thought to be a major factor affecting the survival of Cedar River sockeye. However, a virus present in the population could potentially be of concern. Cedar River sockeye, like most sockeye, carry infectious hematopoietic necrosis virus (IHNV), the causative agent of the potentially fatal fish disease, infectious hematopoietic necrosis (IHN). This disease most often afflicts developing alevins and fry near and shortly after the time of emergence. Although disease outbreaks are rarely observed in natural conditions, the prevalence of IHNV in spawning adult Cedar River sockeye can be quite high (Amos et al. 1989) and has been detected in outmigrating wild sockeye fry from the Cedar River, indicating some mortality does occur as a result of IHN (Thomas, J., WDFW, 1998, personal communication). Since 1991, the WDFW Fish Health Division has been monitoring the incidence of IHNV in adult and juvenile fish in the Lake Washington Basin. This information will help improve our understanding of IHNV and its potential impacts on sockeye in Lake Washington and elsewhere in the region.

Juvenile Sockeye Survival in Lake Washington

In recent years, the survival of juvenile sockeye during their residence in Lake Washington has been significantly lower than in the past and is now quite low compared to other lakes that support sockeye. The factors causing this poor survival are unclear, and a number of hypotheses are being tested as part of the Lake Washington Ecological Studies (Section 2.3.8). The hypotheses may be grouped into two categories: (1) those that consider the effects of predators on juvenile salmon, and (2) those that consider trophic relationships and the carrying capacity of Lake Washington. There are a number of native and non-native predators that prey on juvenile salmon. However, attempts to understand the magnitude of predation, especially in offshore areas where young sockeye spend most of their lives, have not yet been successful. Sockeye smolts leaving Lake Washington are consistently among the largest in the world (Burgner 1991), which suggests that food may be quite abundant. However, recent bioenergetic modeling exercises indicate that, in years when planktivorous fish are abundant and zooplankton populations are relatively sparse, newly emerged sockeye fry that enter the lake during the early period of their migration could experience difficulty in securing an adequate food supply (Beauchamp 1996).

All sockeye smolts must migrate through the facilities at the Ballard Locks to reach Puget Sound. There are approximately five pathways for juvenile sockeye through the Ballard Locks. Under certain operating regimes, some of these pathways can injure or kill a portion of the fish migrating through the system. The ACOE, in cooperation with Lake Washington Ecological Studies program, is currently investigating the factors affecting the survival of outmigrating salmonids as they pass through the locks and testing methods to provide better downstream passage conditions (Goetz et al. 1997).

PRESENT STATUS IN THE LAKE WASHINGTON WATERSHED

After building to relatively robust levels in the 1960s and 1970s, the Lake Washington sockeye population has experienced a period of significant decline. The mean spawner return ratio during the last 11 brood years for which full return data is available is 0.79. This means that, on average, for each 100 fish that successfully spawns in the basin, only 79 fish have returned to spawn in the subsequent generation. Since record keeping began in 1967, the escapement goal for the system of 350,000 adult fish has been met or has been exceeded four times. Since the escapement goal was last achieved in 1988, the mean run size has been approximately 135,000 fish (WDFW 1997e). Washington Department of Fisheries et al. (1993) classify the Lake Washington sockeye population as depressed in the Cedar River and elsewhere in the basin.

Sockeye harvest opportunities have recently declined in frequency. In 8 of the 22 years between 1967 and 1988, Tribal and sport fishers harvested substantial numbers of sockeye in Lake Washington. Since 1988, Tribal and sport harvests have been conducted in Lake Washington only in 1996 (WDFW 1997e). Although the 1996 return of approximately 450,000 adult fish indicates that the system has retained some potential to produce significant numbers of fish, the general trend in the sockeye population remains one of relatively steep decline.

3.5.9 Coho Salmon

GENERAL DESCRIPTION

The coho salmon (*Oncorhynchus kisutch*) is one of the most popular sport fishes in the family Salmonidae. For most of the twentieth century it has been the mainstay of the average west coast salmon fishing trip. Coho salmon occur along the Pacific coast from Monterey Bay, California, northward to Point Hope, Alaska (Wydoski and Whitney 1979). The typical size of adult coho salmon in the Lake Washington Basin is between 4 and 7 pounds, although fish as large as 10 pounds have been observed. The largest coho in the state weighed 21 pounds, but in recent years large coho have been rare.

The average size of Puget Sound coho weighed at terminal landings has declined from an average of 8.8 pounds to 4.4 pounds from 1972 through 1993 (Bledsoe et al. 1989). It is not clear whether the reductions in size of Puget Sound coho salmon are a result of harvest practices, effects of fish culture, declining ocean productivity, density-dependent effects in the marine environment, or a combination of these factors. Wild spawners on the Cedar River range from 6 to 7 pounds and tend to be somewhat larger than Issaquah Creek Hatchery spawners, which range from 4 to 5 pounds (Antipa, B., WDFW, 1998, personal communication).

The coho population in the Lake Washington watershed is composed of both natural and hatchery subpopulations. Significant releases of hatchery yearlings were made from the early 1950s to the early 1970s, and regular fingerling and fry plants were made from the mid-1970s to the present. These releases have included coho salmon from the Minter, Green, and Skykomish rivers. There are also annual yearling releases from the Issaquah Creek Hatchery and the University of Washington.

Natural spawning populations of coho salmon are common in tributaries to Lake Washington and the Cedar River, including the Lake Walsh subbasin. The extent of historical and current mixing between hatchery coho and wild spawning populations, both spatially and temporally, is unknown. It is also unknown what straying rates occur from the on-station programs. As a result of this uncertainty, the two stocks in the Lake Washington Basin are designated as mixtures of native and non-native stocks (WDF et al. 1993).

The population of coho salmon in the Cedar River is somewhat unique and is defined by the timing of their spawning (late October to late February) as well as by their geographic separation from other significant coho streams in the drainage (WDF et al. 1993). It is unknown how spawner interchange or differences in off-station planting has influenced the Cedar River subpopulation. Until a genetic evaluation is made of the various subpopulations in the basin, designations between Cedar River spawners and other geographical groups are tentative.

IMPORTANCE IN THE LAKE WASHINGTON WATERSHED

Coho salmon are the second most abundant anadromous salmonid in the Lake Washington Basin next to sockeye salmon and contribute significantly to recreational catch in the Puget Sound region. Historically, coho have been harvested in sport, Tribal, and non-Indian commercial fisheries at relatively high rates in mixed stock fisheries in south Puget Sound. Once the fish enter the Shilshole Bay area, they are harvested at considerably lower rates (King County 1993). In years of high abundance, coho are also harvested by sport and Tribal fishers in Lake Washington.

As a result of the recreational popularity of coho, significant efforts have been made to supplement natural spawning populations. Coho fish culture practices are relatively well developed and provide an effective research and teaching tool for fisheries students at the University of Washington. Coho returns to the University of Washington hatchery average about 300 fish per year. Coho salmon are also widely used in elementary school classrooms to help teach students about aquatic organisms and their habitats in the Lake Washington Watershed.

Coho salmon are an important component of the Lake Washington ecosystem. Post-spawning carcasses contribute nutrients to the biotic communities in streams (Bilby et al. 1997). Because adult coho salmon generally spawn in small streams and tributaries, they are particularly important as a nutrient source for areas away from the mainstem of rivers. Carcasses are also important food for some species of mammals and birds (Cederholm et al. 1989). A number of fish species in the system feed upon coho eggs and young fish (Sanderock 1991). While rearing in the river, juvenile coho can consume significant amounts of aquatic insects and affect the distribution of other juvenile salmonids (Allee 1974).

LIFE HISTORY OVERVIEW

General Patterns

Like all eastern Pacific salmon, coho are anadromous (Section 3.2.3) and return to their natal streams to spawn. Coho salmon have one of the more predictable life histories of the Pacific salmon. Juveniles spend approximately 18 months in freshwater and go to sea after their second spring. After growing to maturity in the ocean, they return to their natal streams after 18 months. Coho salmon exhibit two alternative and less common life histories that vary from this pattern. In many populations, a small percentage of coho (typically males) return to spawn after only one summer in salt water. And in some populations, a significant percentage of juveniles spend an extra year rearing in fresh water (Sandercock 1991).

Upstream Migration and Spawning

Adult coho typically begin returning to Lake Washington through the Ballard Locks in late August and continue through early to mid-November (Warner, E., Muckleshoot Indian Tribe, 1998, personal communication). Historically, a group of late-spawning coho entered the locks in January, but the current status of this late returning subpopulation is not known (Antipa, B., WDFW, 1998, personal communication). After entering Lake Washington, most coho will remain in the lake for several weeks if river flows are low.

When river flows rise with fall rain, coho begin to stage at the mouth of the Cedar River. If flows continue to stay high, coho will move upstream and locate preferred spawning habitat in small tributaries with adequate gravel. Cedar River coho are thought to begin spawning in mid-October and continue into February (Cascades Environmental Services 1991). Females select a site to spawn and dig the redd, typically about three square meters in size (Bell 1991). Fecundity depends on size, but the average Cedar River female coho lays approximately 3,200 eggs (Antipa, B., WDFW, 1998, personal communication). Males will compete with one another to court females and fertilize the eggs. After fertilization, the eggs are buried by the female, who will then guard the site until she dies 3-15 days later (Sandercock 1991).

Incubation and Early Rearing

The specific development rate and emergence timing of Cedar River coho has not been well documented. In most coho populations in this region, eggs hatch in about 2-3 months. Alevins remain in the gravel for an additional 2-3 months sustained by their yolk sac (Sandercock 1991). Coho fry probably begin to emerge from the gravel in early March and continue through late May with peak emergence in mid-April.

Juvenile coho rear in freshwater for at least 1 year. After a short period of schooling behavior immediately after emergence, Coho fry become very territorial and typically maintain distinct feeding territories during daylight hours (Sandercock 1991). Some coho may remain in the same tributary for a full year before they migrate downstream. Others may migrate downstream to larger streams or possibly to the lake to continue rearing prior to smoltification the following spring. However, the role of Lake Washington in juvenile coho rearing and migration is not well understood.

After rearing for approximately 1 year in fresh water, most juvenile coho undergo the process of smoltification and migrate to salt water. Specific size data on Cedar River coho smolts is not presently available. An extensive review by Sandercock (1991) suggests that coho smolt size at the time of migration does not vary greatly across the range of the species in North America and averages between 9 and 12 cm. Coho smolt outmigration has not been extensively documented, but typically occurs from late April through early July, with peak migration occurring in mid- to late May (Goetz et al. 1997).

Distribution in the Marine Environment

Once in the marine environment, coho from the Cedar River are assumed to undergo migrations similar to other coho from the Puget Sound region. This migration takes coho primarily northward into the coastal waters of British Columbia. Coho salmon released from Puget Sound are recovered in Washington (23 - 72 percent of the fish), British Columbia (27 - 74 percent of the fish), and Oregon (0 - 3 percent of the fish), with essentially no recoveries from Alaska or California (NMFS 1995).

HABITAT CHARACTERISTICS AND KEY FACTORS AFFECTING SURVIVAL

Coho salmon are native to the Cedar River and may have been present in Lake Washington tributaries prior to the turn of the twentieth century. However, it is unclear to what extent anadromy existed in Lake Washington and its tributaries as a result of the Lake's outlet connection to the Black River (Section 3.2.5). The response of the original population of coho salmon in the Cedar River to the rather dramatic changes in the hydrology of the Lake Watershed in the early twentieth century is not known. It is not clear to what degree the present Cedar River coho population is derived from the original population that eventually found their way back to the river. Nor is it known if strays from other nearby systems or from past plantings of hatchery fish have contributed significantly to the present day population. Regardless of the source, a naturally reproducing population of coho salmon has evidently persisted in this altered environment.

There are a number of factors that can potentially affect the survival of Lake Washington coho salmon at various stages of their life history. These factors occur in both the fresh water and marine environment. Factors in fresh water include habitat loss and degradation (Scott et al. 1986), predation, droughts, floods (NMFS 1995), and injury or mortality at the Ballard Locks (Goetz et al. 1997). Factors in the marine environment include predation, unfavorable ocean conditions, and harvest (NMFS 1995). Although sport and Tribal harvests in Lake Washington are typically well controlled to ensure an adequate escapement, there is little control over harvest of coho in Puget Sound and Canada.

Since 1916, the Landsburg Diversion Dam has blocked the migration of coho to approximately 17 miles of formerly accessible mainstem and associated tributary habitat within the Cedar River Municipal Watershed. Historical reports indicate that large numbers of salmon spawned in the river between Landsburg Dam and the historical barrier at Cedar Falls (Bagley 1929). In its original configuration, the Cedar River and its tributaries likely formed ideal habitat for coho salmon. It is likely that coho salmon were present in quite significant numbers. Coho salmon currently spawn in the Cedar River downstream of Landsburg Dam every year. If provided with passage over the diversion dam, these fish would likely colonize the habitat above Landsburg Dam quite rapidly, provided that other factors outside the watershed do not adversely affect their survival.

It is believed that redd scour during flood events is a dominant factor controlling the survival of species such as sockeye that spawn in the mainstem Cedar River (Thorne and Ames 1987). Because coho salmon spawn principally in smaller streams and tributaries to the Cedar, mainstem redd scour does not significantly affect coho production. However, urbanization below Landsburg Dam has had significant impacts in smaller tributaries entering the Cedar River. These impacts include sedimentation resulting from urban development in upstream plateau areas and reduction in the complexity of stream channels, riparian areas, and wetlands (King County 1993). Other areas have been modified to pass higher peak flows during storm run-off and have resulted in significant bed and bank scour and channel shifting (WDFW 1993; NMFS 1995). These factors have significantly altered spawning gravel quality and stability and calm water areas used by juveniles for refuge during flood events.

Low summer base-flow conditions can have significant effects on species like coho that rear in the river for an extended period. During low flow periods, juvenile fish can be stressed by factors such as high water temperatures and crowding, which in turn can increase rates of disease, competition, and predation (Zillges 1977; Baranski 1989). According to an extensive, collaborative instream flow study conducted by Cascades Environmental Services (1991), flows in the Cedar River typically exceed levels required to produce maximum coho rearing habitat except from mid-July to mid-September. During this period, flows typically provide approximately 95 percent of the maximum rearing habitat for juvenile coho (Cascades Environmental Services 1991). Although these summer base flows provide substantial levels of habitat, they are typically lower than pre-diversion flows (King County 1993). These reduced flows, in addition to extensive riparian clearing, increased impervious surfaces, reduced amounts of large woody debris, increased sedimentation, and channel confinement, have reduced channel complexity and pool habitat and caused a decline in the quality of coho summer rearing habitat in the Cedar River basin downstream of Landsburg Diversion Dam. Urban development in the Lake Washington Basin has also changed the structure of fish communities. The typical native Puget Sound fish community, with a diverse assemblage of salmonids and non-salmonids, is replaced with a less diverse species assemblage in which cutthroat trout predominate (Scott et al. 1986).

Similar to other salmonids in the Lake Washington watershed, coho must migrate through the facilities at the Ballard Locks to reach Puget Sound. Some of the pathways through the locks can injure or kill a portion of the juvenile fish migrating through the facility. The degree to which migrants are injured has not been well quantified (Goetz, F., ACOE, 1998, personal communication). In an effort to determine the extent of the problem and identify improvements, the ACOE is currently analyzing the factors affecting the survival of outmigrating salmonids and is beginning to develop measures to improve downstream migrant survival (Goetz et al. 1997).

PRESENT STATUS IN THE LAKE WASHINGTON WATERSHED

With some exceptions, coho populations in the Lake Washington Basin have undergone a significant decline. Coho escapement peaked at over 30,000 fish in 1970, but declined to less than 2,000 fish in 1992 (Fresh 1994; King County 1993). The escapement goal for Lake Washington coho is 15,000 fish. Based on available habitat, coho returns to the Cedar River are estimated to be usually 12-15 percent of the total return to the Lake Washington Basin (King County 1993). Therefore, recent returns of approximately 2,000 coho represent a run of only 270 fish to the Cedar River. Although the status of Cedar River coho salmon was determined to be healthy in 1992 (WDFW et al. 1993), this assessment acknowledged that the stock would fall into the depressed classification if future returns similar to those in 1991 were observed. As a result of the continuation of the downward population trend (Fresh 1994; King County 1993), coho salmon are now considered depressed in the Cedar River and elsewhere in the Lake Washington Basin.

With continued low returns of coho salmon over the past 7 years, harvests in the Lake Washington Basin and the Cedar River have declined to almost nil. Recreational fishing on the Cedar River is currently closed and is not expected to fully reopen until significant improvements in returns of all anadromous salmonids are reported. The current outlook for the population is one of continued decline.

In response to a petition to list coho salmon under the Endangered Species Act, NMFS (1995) completed a comprehensive status review of coho salmon along the west coast of the United States. Within this range, the status review identified six Evolutionarily Significant Units (ESUs) of coho salmon, each of which contains numerous spawning populations. Because coho from Puget Sound and the Strait of Georgia formed a coherent genetic cluster, it was determined that this population was unique. This population includes coho from Lake Washington and the Cedar River. In comparison to other populations along the California and Oregon coasts, NMFS determined that coho salmon in Puget Sound and the Strait of Georgia were generally stable and a listing was not warranted. However, because of limited information regarding the health of this population and definitive information on the risks to naturally reproducing fish, NMFS decided to add the Puget Sound/Strait of Georgia population to the federal list of candidates for threatened and endangered species. Upon reevaluation at any time, NMFS may reconsider the present candidate listing and propose to list the Puget Sound/Strait of Georgia population as threatened or endangered.

3.5.10 Chinook Salmon

GENERAL DESCRIPTION

The chinook salmon (*Oncorhynchus tshawytscha*) (Figure 3.5-11) is the largest of the seven species of Pacific salmon. Mature adults can reach weights in excess of 40 kg. Chinook are the least numerous of the five Pacific salmon species that occur in North America. In the eastern Pacific, spawning populations range from the central coast of California, north to the drainages of Kotzebue Sound. In the western Pacific, the species is somewhat less numerous and ranges from the Anadyr River, which drains into the northern Bering Sea, south to the island of Hokkaido.

Chinook salmon have been commercially harvested since the mid-nineteenth century. They have been highly valued by indigenous peoples for thousands of years. Today, they are also a highly prized sport fish throughout their range in North America. Chinook is the only species of salmon that has been successfully introduced in the southern hemisphere. Naturally reproducing populations have become established in New Zealand from introductions of North American chinook in the early part of the twentieth century (Healey 1991).

Individual spawning populations of chinook salmon tend to be relatively small, typically not more than a few tens of thousands. Healey (1982) reports that 80 percent of the chinook populations in British Columbia average fewer than 1,000 spawners. Larger river systems tend to support the largest populations (Healey 1991).

According to WDF et al. (1993), there are 26 stocks of chinook salmon in Puget Sound. At the time of their report, the authors classified the population status of approximately half of the stocks as depressed. However, since that time, there has been a sharp decline in the abundance of Puget Sound chinook, and nearly all naturally reproducing populations in the area are now considered depressed (Johnson et al. 1997; Smith, C., WDFW, 1998, personal communication).

Three stocks of chinook are present in the Lake Washington Watershed: (1) the Issaquah Creek stock, a composite population that is at least partially sustained by production from the Issaquah Hatchery; (2) the Cedar River stock, classified as native/wild; and (3) the north Lake Washington tributary stock also classified as native/wild. Annual counts of spawners for the period from 1989 to 1996 averaged approximately 1,600 fish in Issaquah Creek, 420 fish in the Cedar River, and 285 fish in the north Lake Washington tributaries (Smith, C., WDFW, 1998, personal communication). Recent genetic analyses indicate that Cedar River chinook are clearly members of the South Puget Sound, Hood Canal & Snohomish Summer/Fall chinook Genetic Diversity Unit described by Marshall et al. (1995). They are closely associated with the Green River Hatchery population but are distinct from this population and all other populations within the Genetic Diversity Unit. The degree to which the present Cedar River population has been affected by past interbreeding with hatchery fish is not known (WDF et al. 1993; Marshall, A., WDFW, 1998, personal communication).

Figure 3.5-11. Chinook salmon.

The Lake Washington watershed has a long history of being stocked with hatchery-reared salmonids (Ajwani 1956). Today, the majority of chinook salmon returning to the basin originate from the Issaquah and University of Washington hatcheries. Hatchery-reared chinook were planted in the Lake Washington Basin as early as 1914 (Darwin 1916). Ajwani (1956) reported extensive plantings of Issaquah and Green River hatchery chinook into Cedar River during the period from 1943 to 1954. According to a 1948 WDF report, salmon returns to the Cedar River were at one time negligible, but were significantly enhanced by plantings from the Issaquah and Green River hatcheries (WDF 1948). Like many early artificial production programs, the effectiveness of this planting program was not rigorously monitored. Therefore, it is difficult to confirm the former status of salmon in the Cedar River. Currently, there are no releases of hatchery chinook into the Cedar River.

Puget Sound chinook salmon, including the populations in the Lake Washington Basin, were recommended for listing as threatened under the federal Endangered Species Act on February 26, 1998 (Fed. Reg. Vol. 63, No. 45, March 9, 1998).

IMPORTANCE IN THE LAKE WASHINGTON WATERSHED

Of the three species of salmon returning to Lake Washington, chinook salmon are the least numerous. However, because of their large size and high quality flesh, they are highly prized by tribal, sport, and commercial fishers. Anecdotal information suggests indigenous people may have harvested spring-run chinook, which are not present in the river today. Precise chinook harvest information is not available for Cedar River chinook. However, harvest data is available for the nearby Green River Hatchery chinook and is likely representative of harvest patterns for Cedar River chinook. From 1985 to 1994, approximately 44.9 percent of the harvest of Green River Hatchery chinook occurred off the coast of Canada, 42.5 percent occurred in Puget Sound sport and net fisheries, 11.7 percent in commercial troll fisheries off the coast of Washington and Oregon, and 0.3 percent of the harvest was taken in Alaskan waters (Pacific Salmon Commission 1996). Wild chinook are not typically targeted for harvest in Lake Washington.

Although the population of Lake Washington chinook salmon is typically two orders of magnitude smaller than the sockeye salmon population, it is an important component of the ecosystem. Post-spawning carcasses contribute nutrients to the biotic communities in streams (Bilby et al. 1997). A number of fish species in the system feed upon chinook eggs and juveniles (Healey 1991). Birds and mammals scavenge on carcasses and some species also feed on chinook eggs and juveniles (Cederholm 1989). Additionally, while rearing in the river, juvenile chinook can consume significant amounts of aquatic insects and affect the distribution of other juvenile salmonids (Chapman and Bjornn 1969).

Chinook salmon are viewed by visitors to the Ballard Locks fish ladder. Chinook salmon returning to Issaquah Creek downstream of the Issaquah hatchery offer an unusual and exceptional opportunity to view large fish spawning in a very small stream. The annual return of these fish is the centerpiece of the Issaquah Salmon Days Festival, which attracts thousands of visitors each year.

LIFE HISTORY

General Patterns

Like all eastern Pacific salmon, chinook are anadromous (Section 3.2.3), they return to their natal streams to spawn, and they are semelparous (die after spawning). In an extensive review of the literature, Healey (1991) used differences in life history patterns to divide eastern Pacific chinook salmon into two broad races: stream-type populations and ocean-type populations. While there is significant variation in specific life history patterns between and within stocks in each race, it is possible to discern broad, general patterns unique to each race. In North America, spawning populations of stream-type chinook are predominant north of latitude 56°N and in headwater areas of large river systems throughout the species' range. Ocean-type populations predominate south of latitude 56°N, except in headwater areas of large river systems. Table 3.5-4 summarizes the key life history attributes of each race. Note that stocks in the extreme south and north of the chinook's range may depart somewhat from this general model (Kjelson et al. 1982; Hallock and Fry 1967; Yancey and Thorsteinson 1963).

Table 3.5-4. Comparison of the life history characteristics of stream-type and ocean-type races of eastern Pacific chinook salmon (summarized from Healey 1991).

Life History Stage	Stream-type	Ocean-type
Spawning migration	Enter rivers in spring and early summer and may hold in fresh water for up to several months before spawning.	Enter fresh water in summer and fall and spawn shortly after entry into fresh water.
Spawning	Spawn in summer and fall.	Spawn in fall and early winter.
Juvenile rearing	Rear in fresh water for at least one full year. Move through the estuary fairly quickly as yearling smolts and into near-shore areas of the marine environment.	May move directly downstream to estuary immediately after emergence in the spring; or may rear in streams for up to three months. Rear in estuary for up to several months before dispersing into near-shore areas of marine environment.
Adults at sea	Move rather quickly through the near-shore areas and into the open ocean where they tend to exhibit extensive migrations in the North Pacific Ocean.	Tend to remain in continental shelf waters and typically range less than 1,000 km from natal stream.

Cedar River chinook appear to be relatively well-matched with the description for ocean-type chinook. Their natal stream is located well south of 56° N, but is still within the central portion of the range of eastern Pacific chinook populations. Adult chinook enter Lake Washington through the Ballard Locks from late June through September with a peak in late August (Warner 1998). They spawn from early to mid-September through mid- to late November with a peak in early to mid-October (Cascades Environmental Services 1995; WDF et al. 1993). Although extensive surveys have not been conducted, juvenile chinook have not typically been found in the Cedar River after mid-summer.

Spawning populations of ocean-type chinook are not commonly found above large natural lakes. Although there are a few examples of chinook spawning upstream of natural lakes in this region (e.g. Nanaimo River, Vancouver Island), most of these populations are thought to exhibit the stream-type life history and use the lakes primarily as over-wintering habitat (Carl and Healey 1984; Healey 1980, 1982). The position of Lake Washington between the Cedar River and the marine environment raises some interesting questions regarding the ocean-type life history pattern and is discussed later.

Spawning

Chinook spawning behavior is similar to that of other salmonids (Section 3.2.3). The female selects an appropriate spawning location over gravel and small cobble substrate where she excavates the redd. After spawning, females have been reported to remain on the redd from 4 to 26 days until they die or become too weak to hold in the current (Neilson and Green 1981; Neilson and Banford 1983). During this period, females will vigorously defend the redd against the spawning activity of newly arriving fish.

Fecundity is quite variable within and between populations of chinook salmon. Fecundity increases with fish size and generally increases from south to north across the range of the species. Reported fecundity values range from approximately 4,000 eggs per female for small fish from southern populations, to over 14,000 eggs per female for large fish in northwest Alaska (Healey 1991). Fecundity data is not available for the Cedar River stock, however, fecundity for chinook returning to the nearby Issaquah Hatchery in 1996 and 1997 averaged approximately 4,400 eggs per female (Antipa, B., WDFW, 1998, personal communication).

Incubation and Early Rearing

Chinook eggs in this region typically hatch 2 or 3 months after fertilization. The larval fish, or alevins, remain in the gravel for an additional 2 or 3 months, then emerge into the stream as free-swimming fry. There is little data on the precise development rate and emergence timing of Cedar River chinook. In the Cedar River, fry probably begin to emerge in February and continue through March and perhaps April.

Chinook fry typically emerge at night and tend to exhibit an immediate downstream dispersal (Reimers 1971; Healey 1980; Kjelson et al. 1982). Within the ocean-type race, Healey (1991) distinguishes two life history variations: (1) fry that emerge from the gravel, disperse downstream to the estuary in a matter of hours or days where they then rear for an extended period; and (2) fry that emerge, disperse a shorter distance downstream, then stop and rear in the river for up to 3 months before migrating downstream to the estuary for another period of extended rearing. In several well-studied rivers in southern British Columbia, the movement of newly emerged fry to the estuary typically occurs from early March through early May. A second migration of fry that have reared in the river and are approximately twice the size of the early migrants occurs from mid-May to mid-June (Healey 1991). The degree to which Cedar River chinook exhibit these two alternative behaviors at emergence is not known. In addition, the distribution and behavior of chinook fry in Lake Washington and the role that the lake plays as a rearing area and migration corridor are not well understood.

Distribution in the Marine Environment

Healey (1991) cites a large number of studies that have reported the importance of estuaries as rearing habitat for ocean-type chinook. The behavior and distribution of juvenile Cedar River chinook, after they have migrated through the Ballard Locks and into salt water, has not been studied.

No data are available on the specific distribution of Cedar River chinook in Puget Sound or the North Pacific. However, harvest data for the Green Hatchery stock indicate that nearly all fish that are taken in sport and commercial fisheries are harvested off British Columbia, the coast of Washington, and in Puget Sound. Less than 1 percent of the fish are harvested off the coast of Alaska (Pacific Salmon Commission 1996). This information suggests that the ocean distribution of Cedar River chinook is likely similar to that described by Healey (1991) for ocean-type populations in this region.

There is little information on the specific age structure of returning adult Cedar River chinook. However, age at return is thought to be similar to the Green River population. While age at return can vary considerably between brood years, the average age at return for the 1990, 1991, and 1992 brood years at the Green River Hatchery counting from fertilization to subsequent spawning is: 4 percent 2-year old fish, 18 percent 3-year old fish, 65 percent 4-year old fish, and 13 percent 5-year old fish (Kimble, M., WDFW, 1998, personal communication).

HABITAT CHARACTERISTICS AND KEY FACTORS AFFECTING SURVIVAL

Stouder et al. (1997) discuss the complexity of identifying the factors contributing to the decline of Pacific salmon in the Northwest. They point out the need to consider the cumulative effects of small incremental changes in habitat and population structure, the potential synergistic effects of seemingly unrelated factors, the far-ranging nature of individuals in the populations, and potentially profound and uncontrollable cyclic changes in the marine environment. Further, all of these issues must be considered in the context of very complicated governance and regulatory structures. Faced with such a complex system, it is helpful to view the factors that affect salmon survival in a relatively broad context.

There are a number of factors that have affected the survival of Cedar River chinook salmon, including loss and degradation of stream habitat resulting from a variety of land and water management practices; predation by native and introduced species in the river and lake; injury to juvenile fish exiting the lake via the Ballard Locks; droughts; floods; over-harvest; and unfavorable ocean conditions. All of these effects should be viewed in the context of what may have been the most significant single anthropogenic effect on the ecosystem, the alteration of the basin's hydrologic configuration.

Hydrologic Reconfiguration of the Cedar River Basin

At about the turn of the twentieth century, early settlers reported the presence of large numbers of spawning salmon and carcasses throughout the Cedar River from near its confluence with the Black River, upstream to Cedar Falls (Bagley 1929). At this time, the Cedar joined the Black River just downstream from the outlet of Lake Washington. The Black flowed a short distance into the Duwamish River and the Duwamish then flowed another short distance into an extensive estuary (Map 2; Section 3.2.5). In this configuration, the Cedar River likely formed ideal habitat for ocean-type chinook salmon. Although reports of early observations of salmon in the river did not differentiate between species, significant numbers of chinook salmon were undoubtedly present in the Cedar River in its original configuration.

Between 1912 and 1917, the hydrology of the Cedar River and Lake Washington was dramatically altered when the Cedar was rerouted into the lake and the outlet of the lake was rerouted through the Ballard Locks to Salmon Bay. The response of the original population of chinook salmon in the Cedar River to these changes is not known. It is not clear to what degree the present chinook population is derived from members of the original population that eventually found their way back to the river. Nor is it known if strays from other nearby systems, or past plantings of hatchery fish, have contributed significantly to the present day population. Regardless of the source, a naturally reproducing population of chinook salmon has persisted in this highly altered environment. Between 1967 and 1991 annual counts of adult chinook salmon in the Cedar River ranged from a low of 488 to a high of 1,745 fish (WDF et al. 1993).

The effects on Cedar River chinook of rerouting the river into Lake Washington are difficult to ascertain but potentially quite profound. The lake provides a much different migration environment for recently emerged fry than the original river environment. Although the lake could potentially provide rearing habitat for newly emerged chinook fry, it is not clear to what degree ocean-type chinook possess the adaptive capacity to make use of a lake-rearing environment. It is also difficult to quantify the quality of this environment, which has been subjected to extensive shoreline development and is home to a host of introduced species that can prey on young chinook. The requirement for young ocean-type chinook to migrate through Lake Washington could limit the productive capacity of the population.

The highly modified environment at the marine-freshwater interface downstream of the Ballard Locks creates an additional puzzle. This environment is much different than the natural estuary that was present at the mouth of the Duwamish River. Numerous sources as cited by Healey (1991) have reported on the importance of estuarine rearing for juvenile ocean-type chinook salmon. The behavior, growth, and survival of juvenile ocean-type juvenile chinook in the ship canal downstream of the Ballard Locks has not been well studied. However, it seems clear that this environment provides much less favorable conditions than the original estuary at the mouth of the Duwamish River.

The effects of the alterations in the lake and estuary on adult chinook are also unclear. For example, the relatively warm surface waters of the lake might, in some years, have an effect on upstream migration at the locks and perhaps in the lake itself. However, because adult chinook primarily use these environments for migration and are generally more resilient and much less vulnerable to predation than juvenile fish, the effects of these habitat alterations are perhaps less significant for adult fish than for juvenile fish.

Landsburg Diversion Dam

The Landsburg Diversion Dam is a run-of-the-river dam that was built near the turn of the century to serve as the intake point for the City's municipal water supply system. The dam is located on the Cedar River 21.8 miles upstream from Lake Washington and has excluded chinook salmon and other anadromous fish from 17 stream miles of formerly accessible habitat between Landsburg and the natural migration barrier formed by Lower Cedar Falls. This loss of spawning, incubation, and rearing habitat has limited the productive capacity of the chinook salmon. However, ascertaining the actual magnitude of the lost productive capacity for the population is complicated by effects of the hydrological reconfigurations discussed above.

Although the aquatic habitat in the area between Lower Cedar Falls and Landsburg Dam was degraded by extensive timber harvest and other land use practices early in the twentieth century, much of the area has recovered to a substantial degree. Consequently, this portion of the watershed offers some of the best fish habitat in the Lake Washington Basin. With provisions for sufficient releases of water from upstream storage facilities to meet instream flows requirements, this part of the watershed has the potential to provide excellent habitat for salmonids. A robust population of rainbow trout, thought to be derived from the original stock of steelhead present before the construction of the diversion dam, currently occupies this habitat (Section 3.5.11). There are relatively large inputs of high quality ground water throughout this reach. Erosion and sedimentation are largely in balance with other natural processes. Riparian zones are largely intact, and much of the stream channel is shaded by mature conifers. Chinook salmon currently spawn and, to an unknown degree, rear throughout the 21.8 miles of river below the Landsburg Diversion Dam. Provided that downstream factors do not seriously impair the productive capacity of the population, these fish would likely colonize the habitat upstream of Landsburg quite rapidly if allowed to pass above the dam.

Stream Flow

Streamflow represents a very important factor in the quality of habitat for aquatic life in the Cedar River, and particularly for the four anadromous fish species found there. The City's water supply and hydroelectric power generating operations on the river (Section 2.2.3) can affect the total flow volume and the rate of change in those volumes. Although juvenile chinook do not rear for extended periods in the river like steelhead or coho, flows in the mainstem are likely an important consideration for newly emerged fry and are certainly important for chinook spawning and incubation.

Most chinook salmon typically spawn in medium to large size rivers. They have been reported to spawn in habitats from small tributaries 3 meters wide, to the mainstem of the largest rivers emptying into the eastern Pacific Ocean. There does not appear to be a distinction between the physical spawning habitat preferences of stream- and ocean-type races of fish. Data from a number of different studies suggest that chinook salmon will spawn at depths of 10-700 cm and in water velocities of 10-189 centimeters per second (cm/s). However, these same studies report much narrower ranges of 30-56 cm for mean spawning depth and 40-61 cm/s mean water velocity (Healey 1991). As part of the IFIM study discussed in Section 3.3.2, Cascades Environmental Services (1991) established a preferred depth range of 30-104 cm and a preferred water velocity range of 30-107 cm/s for spawning chinook salmon in the Cedar River. Egg deposition has been reported at depths from 10 to 80 cm under the surface of the gravel, with deeper redds typically associated with slower water velocities (Briggs, 1953; Neilson and Banford 1983; Chapman et al. 1986).

Chinook begin spawning in the early fall, when stream flows in the Cedar are often at their lowest levels of the year. During the last half of September and early October, the amount of spawning habitat available to chinook can be limited by low stream flow. By mid- to late October, stream flows typically exceed the levels that provide the maximum amount of spawning habitat for chinook (Cascades Environmental Services 1991). In the Cedar, like many systems that support both sockeye and chinook salmon, spawning sockeye are present in large numbers during the entire time that chinook spawn. Chinook tend to spawn in deeper, swifter water, in larger substrate, and typically bury their eggs deeper than sockeye. While it is not presently considered a major controlling factor, the effects of the overlap between these two species on chinook spawning and incubation success in the Cedar River is not known.

Because chinook tend to spawn in deeper areas of the river, their redds are perhaps somewhat less vulnerable to dewatering than those of other salmonids spawning in the Cedar. However, chinook redds can become vulnerable to dewatering if periods of very low flow occur during incubation. Alevins are much more vulnerable to damage during dewatering than eggs (Becker et al. 1982, 1983).

There is little quantitative data on the effects of floods on chinook incubation survival in the Cedar River. Because chinook redds tend to be constructed in larger substrate and with deeper egg pockets than the redds of other species of salmon, they are perhaps somewhat less sensitive to scour during high flow events. However, major flood events on the Cedar likely cause significant mortality of incubating chinook. In the lower river, human development in the floodplain, diking, bank armoring, and flood management practices have reduced the width of the functional stream channel and reduced the river's ability to spread into the floodplain and dissipate energy during high water events (King County 1993; Section 3.2.5). High flows are now confined within a relatively narrow corridor, which increases water velocity, sediment transport, and subsequently increases the frequency and degree of redd scour. This situation has been further aggravated by the removal of forest cover and by increases in impervious surfaces in the lower watershed, which can increase the amplitude of high run-off events.

Thoughtful water management practices can help to reduce flood peaks and frequency. However, in the Cedar River, water storage facilities only capture water from the upper 43 percent of the basin, leaving flows in the lower 57 percent unregulated. In addition, storage facilities in the upper basin have a relatively limited storage capacity. Although water management activities can help to reduce the magnitude of flood events and, to a limited degree, decrease the frequency of such events, the facilities are not adequate to eliminate the occurrence of major channel forming events.

During the period in which ocean-type chinook fry would be rearing in the Cedar River, stream flows are typically well above the levels that provide the maximum amount of rearing habitat (Cascades Environmental Services 1991). Newly emerged chinook fry tend to occupy the areas near the margins of the stream and are quite sensitive to stranding during rapid reductions in stream flow, especially at night (R.W. Beck and Associates 1989; Hunter 1992). However, because little is known about the precise juvenile life history of chinook in the Cedar River, the magnitude of this problem is uncertain. Fish that stay in the river prior to migrating downstream will be more vulnerable to stranding than fish that move directly downstream to the estuary.

The gap in our understanding of juvenile Cedar River chinook makes it difficult to predict the effects of flow on juvenile rearing and migration. If most juvenile chinook migrate to the lake immediately after emergence, successfully rear, and migrate to salt water, then higher stream flows in the spring would be beneficial. However, if the dominant life history pattern is one in which the fish rear in the stream for longer periods prior to migrating to the lake and estuary, then high flows in the spring may force fry out of their preferred habitat too early.

Disease

Fish disease is not thought to be a major factor affecting the survival of Cedar River chinook. However, a virus carried by sockeye salmon could potentially be of concern. Cedar River sockeye, like most sockeye, carry infectious IHNV (see Section 3.5.8), the causative agent of the potentially fatal fish disease, infectious hematopoietic necrosis (IHN) virus. Chinook salmon are susceptible to IHN. However, the degree to which Cedar River chinook might be affected by the particular strain of IHNV present in Cedar River sockeye is uncertain (Wolf 1988; Hsu et al. 1986).

PRESENT STATUS IN THE LAKE WASHINGTON WATERSHED

Washington Department of Fisheries et al. (1993) classified the status of Lake Washington chinook salmon as unresolved because of differing viewpoints of state and Muckleshoot Indian Tribe and Suquamish Indian Tribe resource managers. Johnson et al. (1997) describe wild Puget Sound chinook as relatively stable from 1968 to 1990 with a sharp drop in abundance beginning in 1991 because of poor ocean survivals, habitat alterations, and harvest pressures. Recent trend analyses confirm the continuation of this decline and the State of Washington now classifies the demographic status of Lake Washington chinook as depressed (Smith, C., WDFW, 1998, personal communication).

Puget Sound chinook salmon, including the populations in the Lake Washington Basin, were listed as threatened under the federal Endangered Species Act on March 24, 1999 (Fed. Reg. Vol. 64, No. 56, March 24, 1999).

3.5.11 Steelhead Trout

GENERAL DESCRIPTION

Steelhead trout (*Oncorhynchus mykiss*) (Figure 3.5-12) are rainbow trout that display an anadromous life history pattern. Originally, this species was included in the genus *Salmo* but further scientific study suggested that the morphometric, genetic, and physiologic traits of this species more accurately reflect those of the genus *Oncorhynchus*. Officially, the species is now considered to be a Pacific salmon but, considering the present vernacular and the purposes of this document, anadromous and resident forms will be referred to as steelhead trout (steelhead) and rainbow trout, respectively. The primary focus of this section is to relate information on steelhead trout, but references to resident rainbow populations will be included in discussions related to local stocks in the Cedar River Basin.

Steelhead life history characteristics are quite diverse, exemplifying their extensive ability to adapt to a wide variety of environmental conditions. Cumulatively, these characteristics make the steelhead life history the most complex and variable of all the species in the genus *Oncorhynchus*. In Washington State, wild steelhead trout are the least numerous anadromous member of their genus with the possible exception of anadromous cutthroat trout, which have not been studied extensively enough to provide an accurate statewide population estimate.

Steelhead trout inhabit Pacific coast streams of North America and northern Asia. The original native range of North American steelhead extends southward from the northern side of the Alaska Peninsula to northern Mexico. The present range is somewhat smaller because human activities have virtually eliminated steelhead populations south of San Francisco. In western Washington, steelhead are present in most Puget Sound drainages, coastal streams, and tributaries of the lower Columbia River. East of the Cascade Mountains they are found in tributaries of the Columbia drainage such as the Entiat, Okanogan, and Yakima rivers, and tributaries of the Snake River such as the Grand Ronde, Clearwater, and Willawa rivers. Asian stocks are most abundant in streams along the west coast of the Kamchatka Peninsula although they also occur, to a lesser extent, in eastern Kamchatka streams and in scattered areas along the northern coast of the Okhotsk Sea.

The total annual abundance of all North American steelhead stocks (including hatchery fish) was estimated to be 1.6 million fish in 1987 (Light 1987). The center of abundance occurs in the Columbia River Basin, which produces 28 percent of the total coast-wide population, followed by Oregon (21 percent), California (17 percent), British Columbia (16 percent), coastal Washington and Puget Sound (13 percent), and Alaska (5 percent). Fifty percent of total coast-wide estimated abundance was attributed to hatchery production, which ranged from 3 percent of Alaska production to 73 percent of production in the Columbia River Basin.

There are 60 wild steelhead stocks inhabiting the Puget Sound drainage (WDF et al. 1993). Of these stocks, 16 are considered healthy, 14 are classified as depressed and 1 stock is considered to be in critical condition. The remaining 29 stocks in the Puget Sound drainage are designated "status unknown." The Lake Washington Basin is considered to have only 1 stock of native/wild steelhead trout. Historically, natural production has occurred in the Cedar River, Issaquah Creek, and north Lake Washington tributaries such as Bear Creek and the Sammamish River (WDF et al. 1993). The Lake Washington steelhead stock is considered to be depressed, and there is no longer significant natural production from any stream in the basin other than the Cedar River (Foley, S., WDFW, 1997, personal communication).

Hatchery steelhead have been planted extensively throughout the Lake Washington and Lake Sammamish basins with the first recorded plant occurring in 1915 (Ajwani 1956). Between 1915 and 1954, over 1,073,000 steelhead fry were planted in the Lake Washington watershed (Ajwani 1956). Additional hatchery plantings were made in the Cedar River and other Lake Washington and Lake Sammamish tributaries between 1954 and 1993, and the last steelhead planting to occur in the Cedar River was in 1993 (WDF et al. 1993). Like many early artificial production programs, the effectiveness of the early steelhead plantings was not rigorously monitored. Available data indicate that estimated levels of hatchery introgression among wild Cedar River steelhead is low as compared to other wild steelhead stocks in the region (Phelps et al. 1994). In 1997, WDFW, in cooperation with Trout Unlimited, started a wild broodstock program designed to incubate and rear Cedar River steelhead for out-planting in Issaquah and Bear Creeks, with the intent of re-establishing the species in these streams.

IMPORTANCE IN THE LAKE WASHINGTON WATERSHED

Steelhead stocks are not typically exposed to the heavy commercial fishing pressure that is associated with Pacific salmon fisheries. This is, in part, a result of relatively low production levels, a highly dispersed ocean life history pattern, and protracted timing for river return and spawning migrations. Historically, returning Lake Washington steelhead have been harvested by the Muckleshoot and Suquamish tribes in the lower reaches of the Lake Washington ship canal (both tribes) and in Lake Washington (Muckleshoot Indian Tribe only). These fisheries were intended to target hatchery fish between December and January, prior to the arrival of significant numbers of wild fish. The last Tribal fishery for Lake Washington steelhead occurred in December 1989 and January 1990 (WDF et al. 1993). Native American tribes have also historically harvested Lake Washington and Cedar River steelhead in hook and line subsistence fisheries in Puget Sound.

Figure 3.5-12. Steelhead trout.

Steelhead are considered to be one of the most sought-after salmonid species by recreational fishers throughout the Pacific Northwest, Canada, and Alaska. The relative importance of the steelhead is exemplified by the Washington State Legislature's designation of steelhead as the State Fish. Cedar River steelhead were once an important component of the Puget Sound steelhead fishery, but recent declines in escapement levels have required that the river be closed to all recreational fishing until the population recovers. Steelhead are not typically targeted for harvest in Lake Washington and any captured rainbow trout measuring over 20 inches (standard length) must be released.

Although the Lake Washington steelhead population is small compared to the other anadromous fish populations found in the basin, it remains an important component of the ecosystem. Steelhead fry are subject to predation by adult cutthroat trout and coho salmon smolts. Diving birds such as mergansers and kingfishers also feed upon steelhead juveniles during the stream rearing period. In general, juvenile steelhead feed on various invertebrates including zooplankton, larger crustaceans, insects, snails and earthworms. As they reach smolt size they also feed on the fry of other fishes, including salmonids. In addition to the competition for food between juvenile steelhead and other juvenile salmonids, the territoriality of juvenile steelhead can affect the behavior and distribution of other salmonids such as cutthroat trout (Meehan and Bjornn 1991).

LIFE HISTORY OVERVIEW

General Patterns

Steelhead are anadromous fish that home to their natal rivers to spawn. They exhibit an iteroparous life history, unlike the semelparous Pacific salmons. Steelhead populations are typically divided into two seasonal races of fish that are primarily defined by the timing of adult returns to spawning streams and by the state of sexual maturity upon entry into fresh water (Neave 1944; Shapovalov and Taft 1954; Bali 1959; Withler 1966; Smith 1968). *Summer steelhead* is the term given to fish that return to fresh water between May and October, and *winter steelhead* is the term given to fish that return to fresh water between November and April (Withler 1966; Smith 1968).

The major differences between the seasonal races are the sexual maturity of the fish upon freshwater entry and the time between freshwater entry and actual spawning. When summer steelhead enter fresh water their gonads are only slightly developed. The gonads of winter steelhead are well developed upon freshwater entry. Summer steelhead usually reside in the freshwater environment for several months before spawning while their winter counterparts spend much less time between freshwater entry and spawning (Shapovalov and Taft 1954; Withler 1966). Summer steelhead also tend to have a higher percentage of body fat than winter steelhead when returning to fresh water (Smith 1968). Despite their significant behavioral and physiological differences, both summer and winter steelhead typically spawn between January and May.

Summer and winter steelhead can exist in the same stream but many steelhead streams are only inhabited by one of the races. Summer steelhead tend to be more prevalent in larger drainages whereas winter steelhead typically inhabit smaller streams (Murphy and Shapovalov 1950; Bali 1959; Withler 1966). It is important to note that this is only a general trend that includes many exceptions.

Two major genetic groups of North American steelhead have been established through extensive genetic studies (Allendorf 1975). These genetic groups are termed *inland* and *coastal* and they tend to be separated by a geographic line that coincides with the Cascade Mountains. The inland group exists in drainages east of the Cascade Mountains and is exclusively comprised of summer steelhead from the Fraser River and Columbia River drainages. The coastal group inhabits rivers west of the Cascades and includes both the summer and winter races (Allendorf 1975; Parkinson 1984; Okazaki 1984).

The Cedar River steelhead population is a coastal population of winter-race fish. Historically, adult steelhead enter Lake Washington through the Ballard Locks between December and early May (WDF et al. 1993). They spawn primarily in the mainstem from March through early June (Burton and Little 1997), although there are historic records of steelhead spawning in Cedar River tributaries such as Rock Creek (below Landsburg Diversion Dam) (Pfeifer, R., WDFW, 1998, personal communication).

Although ocean residence can range from one to several years of age, steelhead typically reside and mature in the ocean for 2-3 years. After maturation, steelhead leave their open ocean feeding areas and migrate to their natal streams to spawn. Most steelhead populations have a period of freshwater entry that lasts several months and is comprised of many minor peaks in abundance of immigrants. Entry into fresh water can be influenced by tides and stream discharge. However, steelhead do not typically linger in the estuary if stream conditions are favorable for their spawning migration (Shapovalov and Taft 1954; Withler 1966; Everest 1973; Oguss and Evans 1978). After freshwater entry, steelhead appear to have the ability to delay spawning for short periods to avoid high instream flow events (Burton and Little 1997). The average size of adult steelhead returning to fresh water to spawn is between 625 and 750 mm, and rare individuals can reach lengths that exceed 1 meter (Ball and Petit 1974; Whately 1977). The majority of the fish returning to Washington streams weigh between 5 and 10 pounds, but fish in excess of 30 pounds have been caught in Washington’s recreational steelhead fisheries.

Spawning

Steelhead spawning behavior is similar to that of other salmonids (Section 3.2.3). Cedar River steelhead spawn between March and early June, with peak spawning activity occurring in mid-May (Burton and Little 1997). After spawning, the female will leave the redd site to migrate back to the ocean or die. In small streams, up to 30 percent of the adult steelhead may survive to spawn a second or third time but fish that spawn in larger streams that require long freshwater migrations to reach the spawning grounds are prone to much higher rates of mortality after their initial spawning period. In the Columbia River Basin, summer steelhead rarely ever survive spawning and are essentially semelparous (Long and Griffin 1937).

Before steelhead undertake their first spawning migration they are termed *maiden fish*. If these maiden fish survive their first spawning and manage to return to the sea they are referred to as *kelts*. Kelts that return to spawn in the season immediately following their prior spawning period are termed *consecutive spawners*, whereas kelts that remain in the saltwater environment for an additional year before a subsequent spawning migration are referred to as *alternate spawners*. Studies in Alaska and Canada suggest that approximately 80 percent of repeat spawners are females (Hooton et al. 1987; Didier 1990).

Steelhead trout take advantage of a wide range of spawning habitats including large mainstem habitats such as the Skagit River, and small perennial streams such as Rock Creek below Landsburg Diversion Dam. Steelhead usually spawn in medium- to high-gradient sections of streams at the tails of pools or at the heads of riffles, where hydrologic conditions maintain adequate inter-gravel flows that provide an oxygenated environment for egg incubation (Greeley 1932; Orcutt et al. 1968). Depths during spawning are typically in excess of 24 cm and water velocities for spawning range between 40 and 91 cm/s (Smith 1973).

Steelhead fecundity varies with the size of the female and the strain or stock of fish (Bulkley 1967). Small fish can have as few as 1,000 eggs but large fish can produce in excess of 10,000 eggs. In 1996, 22 Cedar River steelhead were captured and spawned as part of a hatchery broodstock program. The average fecundity of the females captured was 5,172 eggs, with a range of 1,378 to 9,597 eggs per female (Antipa, B., WDFW, 1998, personal communication).

Incubation and Rearing

Steelhead egg development typically occurs in the spring and early summer when water temperatures are increasing. Steelhead require a significantly lower number of degree days for embryonic development and emergence than Pacific salmon.

Steelhead typically hatch between 4 and 8 weeks after fertilization and the larval fish (alevins) remain in the redd for an additional 3 - 5 weeks, absorbing nutrients from a yolk sac connected to their abdomen. Emergence studies occurring in the Cedar River during 1996 and 1997 indicate that fry emergence for an individual redd begins approximately 54 days after fertilization and is complete approximately 63 days after fertilization (Burton and Little 1997). The emergence period for Cedar River steelhead lasts from late May to early August with peak emergence occurring in mid- to late July (Burton and Little 1997). The survival rate of steelhead embryos depends on the amount of fine sediments in the redd, predation and disease rates, the frequency and intensity of scour events during spring freshets, and the maintenance of adequate flows (Bley and Moring 1988).

Steelhead alevins emerge at night and begin feeding within days of becoming free-swimming fry. Less than 20 percent of these fry will survive their first year in the stream environment, because they are highly vulnerable to predation and extreme winter and spring flow conditions that can cause significant scour and premature outmigration (Seelbach 1987). Steelhead typically reside in the stream for 2-3 years, although a small number of fish may outmigrate after 1 year. In some northern rivers, juvenile steelhead can rear 4 or 5 years before migrating to the ocean. Freshwater residence time generally increases from south to north for steelhead populations along the coast of North America (Burgner et al. 1992).

Cedar River steelhead rear in the mainstem and tributaries below Landsburg Diversion Dam. The majority of Cedar River fish are believed to outmigrate as smolts after 2 years of freshwater residence. Size, not age, is the main determinant in smolt outmigration. Fish from less productive systems take longer to reach smolt size and, therefore, are older when they begin to migrate to the ocean. Cedar River steelhead smolts tend to attain large sizes compared to other local and regional stocks (Foley, S., WDFW, 1997, personal communication).

Distribution in the Marine Environment

Generally, steelhead outmigration from fresh water occurs in the spring between mid-March and early June. The peak of the smolt migration usually coincides with peak spring runoff in mid-April to mid-May. The majority of steelhead smolts appear to migrate directly to the open ocean and do not spend significant amounts of time in the estuarine or coastal environments around their birth stream (Burgner et al. 1992). Timing of Cedar River steelhead smolt outmigration is not well understood, although there are ongoing studies being conducted at the Ballard Locks.

After spending 2-3 years in the ocean, the majority of steelhead become mature and leave their feeding grounds to migrate back to their birth stream. Very few fish return after only 1 year in the marine environment, and some fish remain in the ocean for up to 6 years. Steelhead in specific rivers of southern Oregon and northern California are unusual in that a large proportion of the population returns to fresh water only a few months after entry into the marine environment (Kesner and Barnhart 1972; Everest 1973). During their initial ocean residence, these fish grow to an average weight of one-half pound, hence the common name half-pounders. Half-pounders are typically sexually immature and tend to return to the ocean without spawning. Fish displaying this life history pattern usually return to spawn in their natal streams after their second summer in the ocean. Most of the fish returning to Washington streams have been at sea for 2 years and weigh between 5 and 10 pounds. In the Green River (the system directly south of the Cedar; see Map 2), 73 percent of returning steelhead migrate to sea as age-2 smolts, and most of those fish spend 2-3 years in the ocean (Pautzke and Meigs 1941).

HABITAT CHARACTERISTICS AND KEY FACTORS AFFECTING SURVIVAL

Hydrologic Reconfiguration of the Cedar River Basin

In 1917, the Lake Washington ship canal was completed and the outlet of Lake Washington was rerouted through Lake Union, down to the Ballard Locks and into Salmon Bay (see Section 3.2.3 for full discussion). As a result of this project, the elevation of Lake Washington dropped approximately 8.8 ft and the Black River was dewatered. After the change in lake elevation, the Cedar River was re-routed into the south end of Lake Washington, cutting off the normal migration corridor for Cedar River anadromous fish populations. The response of the original population of steelhead trout to these alterations is not known, and information concerning the role of the lake in juvenile and adult life history phases is lacking.

In the early 1900s, construction of Landsburg Diversion Dam was completed without fish passage facilities, blocking access to approximately 17 miles of previously productive anadromous fish habitat. By the beginning of the twentieth century the stream habitat between Cedar Falls and Landsburg Dam had been impacted by extensive timber harvesting. Today this habitat has largely recovered from the effects of logging, and its potential to provide excellent habitat for salmonids is indicated by the presence of a robust population of resident rainbow trout. There are relatively large inputs of high quality ground water throughout the Landsburg Dam-Cedar Falls reach. Erosion and sedimentation is largely in balance with the other natural processes, and riparian zones are largely intact, with much of the stream channel shaded by mature stands of coniferous trees.

Steelhead trout currently spawn and rear in the 21.8 miles of mainstem river habitat downstream of the Landsburg Diversion Dam and can be expected to colonize the habitat above Landsburg Dam if fish passage facilities are provided. Access to the upstream habitat would contribute significant benefits to the population if other factors outside the watershed do not adversely affect their survival. Although the habitat in the Cedar River below Landsburg Dam has been modified by channel confinement structures, increased impervious surfaces, commercial and agricultural development, and a general lack of riparian forest cover and large woody debris, it is still considered to provide the best steelhead habitat in the basin (Foley, S., WDFW, 1997, personal communication).

Stream Flow

Streamflow represents a very important factor in the quality of habitat for aquatic life in the Cedar River, particularly for the four anadromous fish species found there. The City’s water supply and hydroelectric operations on the river can affect the total flow volume and the rate of change in those volumes. Flows in the mainstem of the Cedar River are an important consideration for protecting steelhead during spawning, incubation, and rearing.

Steelhead typically spawn at a time when the hydrograph is on a decreasing trend (river water levels are decreasing), which can potentially make their redds vulnerable to dewatering. Particularly during years with high spring stream flows, steelhead are able to access spawning habitat that may later become dewatered as instream flows decrease with the declining snow melt and rainfall in June and July. To address this potential problem, a cooperative effort between WDFW and the City was established in 1995 to monitor steelhead redds to determine the relationship between instream flows and impacts to incubating and emerging steelhead. The initial results of the ongoing monitoring program indicate that significant redd dewatering can occur in years with unusually high spring freshet flows if measures are not taken to adaptively manage instream flows to protect shallow, vulnerable redds. The probability of redd dewatering increases significantly in July when the majority of steelhead remaining in their redds have hatched to become alevins. Alevins are much more vulnerable to damage by dewatering than eggs (Becker et al. 1982).

Instream flow levels in the Cedar River can also impact incubating and emerging steelhead by scouring redds during spring freshet events in March and April. There is very little quantitative data on the effects of floods on steelhead incubation survival in the Cedar River. Because steelhead spawn on a descending hydrograph, they are generally less vulnerable to redd scour than their Pacific salmon relatives that spawn and incubate during fall and winter when the hydrograph is increasing and the probability of major flood events is much higher. Nevertheless, significant Cedar River flood events have occurred in March and April, causing potential mortality to incubating and emerging steelhead. In addition, floodplain development, levees, bank armoring, and flood management practices have reduced the width of the functional stream channel and reduced the river's ability to interact with the natural floodplain to dissipate energy during flood events (King County 1993). High flows are now confined within a relatively narrow corridor, which increases water velocity and sediment transport, and subsequently increases the frequency and intensity of flood scour. This situation has been further aggravated by the removal of forest cover and large woody debris, and increases in the impervious surface area in the lower watershed.

Thoughtful water management practices can help to reduce flood peaks and frequency. However, water storage facilities only capture water from the upper 43 percent of the Cedar River Basin, leaving inputs from the lower 57 percent of the watershed unregulated. In addition, storage facilities in the upper basin have a relatively limited storage capacity. Although water management activities can help to reduce the magnitude of flood events and, to a limited degree, decrease the frequency of such events, the facilities are not adequate to eliminate the occurrence of major channel forming events. Studies have shown that significant impacts to sockeye redds from redd scour occur at approximately 2,000 cfs in the Cedar River (Cascades Environmental Services 1991). Water management practices protect incubating sockeye salmon and steelhead trout from scour events by attempting to reduce the frequency of events that exceed this scour threshold.

Disease

Fish disease is not thought to be a major factor affecting the survival of Cedar River steelhead. However, a virus (IHN) carried by sockeye could potentially be of concern. Steelhead trout are susceptible to IHN (McDaniel et al. 1994; Section 3.5.8), but the degree to which Cedar River steelhead might be affected by the particular strain of IHNV present in Cedar River sockeye is uncertain (Hsu et al. 1986; Wolf 1988).

Other Factors Affecting Survival

In addition to the hydrological alterations associated with rerouting the Cedar River into Lake Washington, there are a number of other factors that potentially influence the survival of Cedar River steelhead trout. These factors include predation by sea lions at the Ballard Locks; degradation of stream habitat from land and water management practices; predation by native and non-native species in the basin; injury to juvenile fish exiting the lake via the Ballard Locks; excessive recreational harvest; illegal fishing practices (poaching); droughts; floods; and unfavorable ocean conditions.

One of the major factors contributing to the decline of steelhead in the Cedar River is predation from sea lions at the Ballard Locks. The precipitous decline experienced during the 1990s coincides with the arrival of feeding sea lions at the locks in the 1980s. Recent studies have shown that sea lions once consumed an annual average of 60 percent of the adult steelhead migrating through the locks (Fraker 1993). As a result of this impact, there has been an exemption from the Marine Mammals Act that allows problem sea lions at the Ballard Locks to be removed or euthanized. In 1996, three problem sea lions were captured and moved to Sea World in an attempt to reduce the associated predation mortality at the locks.

PRESENT STATUS IN THE LAKE WASHINGTON WATERSHED

On February 16, 1994, a comprehensive petition to list west coast steelhead was submitted by Oregon Natural Resources Council and 15 co-petitioners. In response to this petition, NMFS assessed the best available scientific and commercial data, including technical information from Pacific Salmon Biological Technical Committees and interested parties in Washington, Oregon, Idaho, and California. NMFS also established a Biological Review Team, composed of staff from NMFS's Northwest and Southwest Fisheries Science Centers and Southwest Regional Office, as well as a representative of the National Biological Service, which conducted a coast-wide status review for west coast steelhead (Busby et al.1996).

Based on the results of the Biological Review Team's report, and after considering other information and existing conservation measures, NMFS published a proposed listing determination that identified 15 Ecologically Significant Units (ESUs) of steelhead in the states of Washington, Oregon, Idaho, and California. Ten of these ESUs were proposed for listing as threatened or endangered, 4 were found not warranted for listing, and 1 was identified as a candidate for listing. The Lake Washington steelhead population is included in the Puget Sound ESU, which did not warrant listing.

As previously mentioned, the status of Lake Washington Basin steelhead, of which the Cedar River run is the largest component, was deemed depressed in the WDF Salmon and Steelhead Stock Inventory (1993), a report developed prior to the lowest recorded return (70 fish) in 1994. Between 1983 and 1997, escapement estimates for the Lake Washington Basin ranged from 2,575 fish in 1983 to 70 fish in 1994 (all of which were in the Cedar River). The average escapement for this time period was 800 fish. Very low returns in the early 1990s resulted in the closing of all recreational fisheries in the Cedar River until steelhead numbers return to healthy levels. Since the record low return in 1994, steelhead escapement estimates have increased each year from 126 fish in 1995 to 616 fish in 1997.

Genetic analyses has shown that Cedar River steelhead belong to the Puget Sound Genetic Conservation Management Unit (GCMU) (Leider et al. 1994). Stocks comprising the Puget Sound GCMU are presumed to have differentiated from Columbia River stocks of the coastal lineage because of the substantial geographical isolation of their respective migration corridors. Stocks within the Puget Sound GCMU that might merit their own GCMU status in the future were identified in four areas, including Deer

Creek, Hood Canal, South Puget Sound, and North Puget Sound subunits. There are some distinguishing characteristics among some stocks of the South Puget Sound subunit, most notably the presence of alleles that do not appear to have been reported in any other genetic assessments of steelhead or rainbow trout (Phelps et al. 1994). Recent investigations seem to indicate that there is sufficient evidence to create a Central Puget Sound GCMU that is comprised of the Pilchuck, White, Puyallup, Green, and Cedar rivers (Phelps, S., WDFW, 1998, personal communication).

Rainbow Trout in the Municipal Watershed

In addition to the wild population of winter steelhead found below Landsburg Diversion Dam, there are also two populations of resident rainbow trout above the diversion. The first population occurs between Landsburg and Cedar Falls, the historic natural barrier to anadromous fishes. The second population occurs in Chester Morse Lake and its tributaries. Genetic analysis of these populations suggests that rainbow trout in Chester Morse Lake were derived from a hatchery planting, however not necessarily from one of the strains currently maintained at the WDFW hatcheries. In contrast, the rainbow trout population between Landsburg and Cedar Falls are more similar to Cedar River and Puget Sound steelhead than to Chester Morse rainbow trout. However, the rainbow trout population above Landsburg Dam also contains alleles from hatchery rainbow trout. Because these alleles are spread throughout the population, the hypothesis that there has been interbreeding between hatchery-originated and wild fish in this reach is supported.

Because of the introgression with non-native, hatchery-originated rainbow trout, neither of the resident rainbow populations in the municipal watershed are considered suitable for artificial supplementation of steelhead in the Lake Washington Basin (Phelps, S., WDFW, 1998, personal communication).

3.5.12 Bald Eagle

STATUS

Legal Status. The bald eagle (*Haliaeetus leucocephalus*) is a federally listed threatened species and a threatened species at the state level in Washington

The bald eagle was listed as endangered throughout the lower 48 states in 1978, except for Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was listed as threatened. In 1995, bald eagle populations in other states were down-listed from endangered to threatened by the U.S. Fish and Wildlife Service. On July 4, 1999, the USFWS proposed to remove the bald eagle from the List of Threatened and Endangered Wildlife in the lower 48 United States, citing population recovery due in part to habitat protection, and to reduced levels of organochlorine pesticide residue in the environment (Fed. Reg. Vol. 64, No. 128, July 6, 1999).

Population Status. Biologists estimate that there may have been 25,000 to 75,000 nesting bald eagles in the lower 48 states prior to extensive settlement by Europeans (USDI 1995c). Since then, bald eagle populations have declined precipitously as a result of habitat disturbance and loss, direct killing, lead poisoning, power line electrocutions, and reproductive failures caused by the pesticide DDT (USDI 1995c). By the early 1960s, there were fewer than 450 bald eagle nesting pairs in the lower 48 states (USDI 1995c). Today, through aggressive recovery programs, there are more than 4,500 breeding pairs of bald eagles in the lower 48 states (USDI 1995c).

In Washington State, the number of active bald eagle nests has increased steadily since 1980, and now numbers over 550 (WDFW 1997f). However, for unknown reasons, reproductive rates in the Hood Canal and Lower Columbia River areas remain below the target level of one young per nest per year.

RANGE

The bald eagle historically ranged throughout North America, except extreme northern Alaska and Canada, and central and southern Mexico (USDI 1995c).

Bald eagles are present year-round throughout Washington. Most nesting in the state occurs on the San Juan Islands and along the Olympic Peninsula coastline. Bald eagles have been documented to nest in the vicinity of the Cedar River Municipal Watershed along Lake Washington and Lake Sammamish (Smith et al. 1997). Several nests of bald eagles occur within the city limits of Seattle (Smith et al. 1997). Nesting territories are also found along Hood Canal, on Kitsap Peninsula, along the Columbia River in southwestern Washington, in the Cascade Mountains, and in eastern Washington (USFWS 1986). Primary wintering areas include the Olympic Peninsula, the San Juan Islands, Puget Sound and its tributaries, Hood Canal, the Cowlitz and Columbia Rivers (Taylor 1989), and rivers of the western Cascade slopes (e.g., Skagit River).

LIFE HISTORY

Bald eagles usually reach sexual maturity when they attain adult plumage, in the fifth year after hatching; this species is thought to have a reproductive life of 20 - 30 years (Stalmaster 1987). Bald eagles are monogamous, with pair bonds assumed to last for life (Stalmaster 1987; Ehrlich et al. 1988). Both birds in a pair share the duty of caring for the clutch of 2 or 3 eggs during the incubation period of 34 - 36 days; in addition, both sexes care for the young during the 10- to 12-week period before fledging (Ehrlich et al. 1988). During the winter, bald eagle populations in the Pacific states are primarily associated with open water or major river systems (USDI 1986). Radio tracking studies indicate that wintering populations in Washington state come from nesting territories in coastal and interior British Columbia, Alaska, and the San Juan Islands (USDI 1986).

Diet is highly variable, both seasonally and geographically; when a choice is available, however, bald eagles invariably select fish over other prey (Stalmaster 1987). Carcasses of spawned-out salmon provide a key winter food source in the Pacific Northwest (USDI 1986; Stalmaster 1987); eagles will also catch live fish, or steal prey from ospreys (Terres 1980). Other major prey items include birds (most commonly seabirds and waterfowl) and mammals (usually carrion, but rabbits and smaller mammals are also taken occasionally) (USDI 1986; Stalmaster 1987).

HABITAT

Suitable habitat for bald eagles includes the presence of accessible prey and trees for nesting and roosting (Stalmaster 1987). The availability of adequate, non-contaminated food resources is an important determinant of bald eagle nest and territory distribution, and wintering habitat (Stalmaster 1987; Keister et al. 1987). Important food items during the breeding season include fish, small mammals, waterfowl, seabirds, and carrion (Anderson et al. 1986; USFWS 1986). Carrion, such as “spawned out” salmon, also comprises an important part of the fall and winter diet for bald eagles (Stalmaster et al. 1985). Foraging habitat is usually within a short distance of nesting and perching sites during the breeding season, but may be a longer and more-variable distance from winter roosting sites (Stalmaster 1987). The most common foraging habitats for bald eagles are lakes, rivers, and ocean shorelines (Stalmaster 1987).

Nesting habitat for the bald eagle typically includes mature and old-growth forest within 1 mile of water bodies that support an adequate food supply (USFWS 1986). Nests are most commonly found in large Douglas-fir and Sitka spruce trees, averaging 125 - 186 ft in height (Anthony et al. 1982; Anthony and Isaacs 1989). Mature, tall trees tend to provide an unobstructed view and are sturdy enough to support the eagles' large stick nest (which can be 5-6 ft in diameter) (Stalmaster 1987). Perch trees, used by adults and fledged young for resting and searching for prey, are important components of bald eagle habitat (Stalmaster 1987). Perch trees are usually large and located close to open water or the nest tree (Stalmaster 1987). Snags are often used for perching.

Wintering habitat typically includes daytime perches in close proximity to an abundant food source (e.g., anadromous fish runs, waterfowl concentration areas) and communal night roosting areas (USFWS 1986). Communal roosting habitat provides thermal and wind protection for wintering birds. Communal roosts typically occur in uneven-aged forest stands with some old-growth characteristics, and are frequently in areas sheltered by landforms and close to a rich food source (Anthony et al. 1982). Roost trees are typically the most dominant trees of the site (Anthony et al. 1982).

Destruction or degradation of habitat and human disturbance are the main threats to bald eagle populations. Habitat alteration can limit suitable nesting and roosting habitat, and human disturbance can cause birds to leave their nests and can affect prey availability (Roderick and Milner 1991). Bald eagles are particularly intolerant of human disturbance during the breeding season (USFWS 1986). Human activity has been documented to cause nest abandonment and reproductive failure (Bogener 1980; Lehman 1983).

OCCURRENCE IN THE CEDAR RIVER WATERSHED

Bald eagles are present in the Cedar River Watershed regularly as transients and migrants. They are most often associated with habitats adjacent to major streams and larger lakes, especially Chester Morse Lake. No comprehensive surveys have been conducted and no nests or breeding activity have been documented within the Cedar River Municipal Watershed to date.

Nesting habitat for the bald eagle in the municipal watershed may be found in late-successional and old-growth forest within approximately 1 mile of larger water bodies (such as the Cedar River and Chester Morse Lake). Foraging habitat includes rivers, lakes, and other aquatic habitats. Communal winter roost sites may exist wherever the favorable juxtaposition of protective landforms and mature coniferous forest occurs near anadromous fish spawning areas.

3.5.13 Peregrine Falcon

STATUS

<u>Legal Status</u>. The peregrine falcon (*Falco peregrinus*) was recently removed from the federal endangered species list, but remains a state endangered species in Washington.

Population Status. Peregrine falcon populations in the United States were suffering a gradual decline prior to World War II, the result of habitat loss and disturbance from a growing human population (Peregrine Falcon Recovery Team 1982). Their decline accelerated rapidly following World War II as a result of the widespread use of organochlorine pesticides, primarily DDT (Peregrine Falcon Recovery Team 1982). Pesticide use resulted in further reproductive decline and failure in many populations because of eggshell thinning and disruption of normal reproductive behaviors (Peregrine Falcon Recovery Team 1982).

The historical population level of peregrine falcons in Washington State is not well known, because available information is sketchy and non-systematic (Allen 1991). In 1980, one researcher documented at least 12 historical nest sites on the outer coast, San Juan Islands, Columbia River Gorge, and Snake River canyons of Washington (Allen 1991). Washington's peregrine falcon population increased from one known pair in 1978 to 15 pairs in 1990 (Allen 1991), and is considered to be undergoing a slow, steady recovery (Allen 1991).

RANGE

The peregrine falcon is one of the most widely distributed birds in the world, occurring on all continents except Antarctica. Peregrine falcons occur year-round in Washington, as either nesting or migratory individuals. Breeding evidence was confirmed on Mt. Si, approximately 4.5 linear miles from the municipal watershed in 1996 and 1997(Spencer, R., Wildlife Biologist, WDFW, North Bend, Washington, Sept. 21, 1998, personal communication). In 1990, breeding pairs were found on the outer coast, in the San Juan Islands, and in the Columbia River Gorge (Allen 1991). Peregrines have exhibited an increasing use of urban areas, such as Seattle and Tacoma (Smith et al. 1997).

LIFE HISTORY

Peregrine falcons normally reach reproductive maturity in their third year after hatching, and have been known to live up to 20 years (Terres 1980). Pairs are usually monogamous, with the female assuming primary responsibility for incubation of the clutch of 2 to 6 (usually 3 or 4) eggs (Ehrlich et al. 1988). Young hatch in about 29 to 32 days, and remain as nestlings for 5 to 6 weeks before fledging (Ehrlich et al. 1988). A second clutch may be initiated if the first fails early in the incubation period (Terres 1980). Northern populations usually retreat from their nesting areas in fall, and spend the winter south of their breeding range; populations along the Pacific coast may winter within their breeding range, however (Terres 1980).

Peregrine falcons are noted for their hunting prowess, and admired as the swiftest birds of prey (Bent 1938). Diet consists almost entirely of birds, usually obtained on the wing by attacking from above or chasing from behind (Peregrine Falcon Recovery Team 1982; Ehrlich et al. 1988). Doves and pigeons are the most preferred prey; shorebirds, waterfowl, and passerines are commonly eaten in areas where preferred prey are not available (Peregrine Falcon Recovery Team 1982).

HABITAT

Potential nesting and roosting habitat for the peregrine falcon usually includes cliffs or high escarpments that dominate the nearby landscape, although office buildings, bridges, and river cutbanks have been used for nesting as well (Peregrine Falcon Recovery Team

1982; Craig 1986). Most preferred nesting cliffs are at least 150 ft high, can occur from sea level to 11,100 ft elevation, and are usually near water (Peregrine Falcon Recovery Team 1982). The preferred cliff usually has a small cave or overhung ledge large enough to accommodate three or four large nestlings (Peregrine Falcon Recovery Team 1982). Availability of nest sites may be a limiting factor in some areas (Peregrine Falcon Recovery Team 1982).

Peregrines do not build nests (Terres 1980). Instead, they scrape out a shallow depression in which to lay their eggs. Peregrines are sensitive to disturbance during all phases of the nesting season (Hoover and Wills 1987), particularly disturbances that occur directly above the nest (WDW 1993). Disturbance near the nest site may cause the peregrines to desert their eggs or young, and may cause older young to fledge prematurely (WDW 1993).

Foraging habitat for peregrines includes open areas such as wetlands, lakes, river bottoms, estuaries, intertidal mudflats, coastal marshes, croplands, and meadows (Porter and White 1973). They feed on a variety of songbirds, shorebirds, seabirds, and waterfowl (Johnsgard 1990). Their hunting territory may extend up to 12 to 15 miles from nest sites (Hoover and Wills 1987; WDW 1993).

OCCURRENCE IN THE CEDAR RIVER WATERSHED

No comprehensive surveys to determine the presence or absence of peregrine falcons have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Peregrine falcons have been sighted in the vicinity of Mt. Si since 1993. They were observed copulating in 1996, but no nest site was found. A nest was located in 1997 and 3 young were fledged that year; 2 were fledged in 1998 (Spencer, R., Wildlife Biologist, WDFW, North Bend, Washington, Sept. 21, 1998, personal communication). Falcons have been spotted flying from the Mt. Si site toward the general direction of Rattlesnake Lake, but foraging hasn’t been confirmed in the Rattlesnake Viewshed (Spencer, R., Wildlife Biologist, WDFW, North Bend, Washington, Sept. 21, 1998, personal communication). Because an active nest site is located within approximately 4.5 linear miles of the watershed boundary on Mt. Si, and because presumably suitable nesting and foraging habitat are both present within the watershed, it is possible that peregrine falcons are currently nesting or will eventually nest within the Cedar River Municipal Watershed.

Potential nesting habitat for the peregrine falcon in the watershed includes cliffs and rock outcrops. Foraging habitat may be provided by naturally open habitats (grass-forb meadows and persistent shrub communities) and open wetlands (palustrine emergent wetlands and palustrine scrub-shrub wetlands).

3.5.14 Grizzly Bear

STATUS

Legal Status. The grizzly bear (*Ursus arctos*) is federally listed as a threatened species in the lower 48 States, and it is listed by Washington State as endangered. The Grizzly Bear Recovery Plan (USDI 1993) identified the North Cascades ecosystem as one of six potential recovery areas for the grizzly bear. The North Cascades Ecosystem Grizzly Bear Recovery Zone extends from the Canadian border south to Interstate 90 to include both east and west slopes of the Cascade Mountains (USDI 1993a).

Population Status. Historical records (Sullivan 1983; Almack et al. 1993) indicate that grizzly bears once occurred throughout much of Washington State. Early explorers in Washington mentioned observations and killings of several grizzly bears from the Okanogan and Columbia rivers (Thompson 1970; Sullivan 1983). Grizzly bear observations occurred more frequently along the crest and east slopes of the North Cascades (Thompson 1970).

The decline of Washington's grizzly bear population, dating from the mid-1800s, was likely a result of intensive killing (first for the fur trade, then by indiscriminate killing of grizzlies as "vermin" and government predator control programs) followed by rapid human encroachment into their habitat (Sullivan 1983; Almack et al. 1993). Today, the grizzly bear has been extirpated from much of its range in Washington. Only the North Cascades ecosystem is considered to have a small resident population, while occasional individuals are sighted further south in the Cascades. In 1997, approximately 5-10 grizzly bears were believed to be resident in the North Cascades, with most of these sightings occurring north of the Skykomish Ranger District of Mt. Baker-Snoqualmie National Forest (Almack, J., WDFW, Sedro Woolley, Washington, November 18, 1997, personal communication).

RANGE

Grizzly bears occurred historically throughout most of central and western North America (USDI 1982) including most of Washington State. Their current distribution within Washington is not well known, but a resident population appears to be confined to remote areas of the North Cascades. The North Cascades Grizzly Bear Evaluation Project (1986-1991) verified 15 observations of grizzly bears in the Cascades of Washington between 1964 and 1991, including 3 on the Cle Elum Ranger District of Wenatchee NF (Almack et al. 1993). An additional 75 observations were considered highly reliable (Almack et al. 1993), including several on the Cle Elum Ranger District, one on the St. Helens Ranger District of Gifford Pinchot National Forest, and one on the Packwood Ranger District of Gifford Pinchot National Forest (Almack et al. 1993). Sightings south of the Skykomish Ranger District appear to be primarily transient individuals.

LIFE HISTORY

Female grizzly bears attain sexual maturity at 3.5 years of age, but successful production of litters doesn't appear to occur until at least 5.5 years (Craighead and Mitchell 1982). Young females may breed in alternate years or every third year; individual bears often show greater intervals between breeding as they grow older (Craighead and Mitchell 1982). Cub production has been observed in females up to 25.5 years of age; litter size ranges from 1 to 4, with 2 cubs most common (Craighead and Mitchell 1982). Cubs usually remain with their mother for one or two years before establishing a separate home range as a subadult (Interagency Grizzly Bear Council 1987). Young males disperse greater distances, while subadult females often establish a home range encompassing some portion of the maternal range (Interagency Grizzly Bear Council 1987). Adult male grizzly bear home ranges are generally much larger than those of adult females; there is generally little overlap in individual home ranges, except in the vicinity of rich food sources (Craighead and Mitchell 1982; Interagency Grizzly Bear Council 1987).

HABITAT

Food, cover, denning habitat, extensive space, and solitude are all important constituents of effective habitat (see glossary) for grizzly bears (Craighead et al. 1982; USDI 1993). Vegetative and topographic diversity and extensive areas with low human activity characterize prime grizzly bear habitat (USDI 1993; Interagency Grizzly Bear Committee 1994). The relative importance of forest cover to grizzly bears, especially for bed sites, has been documented in several studies (e.g., Blanchard 1978; Servheen and Lee 1979; Schallenberger and Jonkel 1980). It is not known whether grizzly bears use forest cover because of an innate preference or to avoid humans (Blanchard 1978). Interspersion of open habitats (e.g., shrub lands, riparian areas, meadows, emergent wetlands, avalanches chutes, talus slopes) with forest cover is also important, as documented by Blanchard (1978). These open habitats are extremely important foraging areas for bears.

Diverse vegetation types provide the abundance and diversity of plant and animal foods used by grizzly bears on a seasonal basis. When they emerge from dens in the spring, grizzlies seek lower elevation areas, valley bottoms, avalanche chutes, and ungulate winter ranges where their food requirements can be met (USDI 1993). Through spring and early summer they tend to move to higher elevations, tracking the emergence of herbaceous plants that are higher in crude protein levels (USDI 1993). In late summer and fall, there is typically a transition to roots, tubers, nuts and berries (USDI 1993). Animals (e.g., ground squirrels, pocket gophers, deer and elk) are preyed upon or scavenged opportunistically throughout the active period of the year.

Grizzly bears sleep during the winter (approximately 5 months, from late November to late April) in dens they excavate. Dens are usually dug on steep slopes where wind and topography cause deep snows to accumulate and where that snow is unlikely to melt during warm periods (USDI 1993). Elevations of dens vary geographically, but they generally occur at higher elevations well away from development or human activity (USDI 1993). Several instances of den abandonment resulting from human disturbance have been reported (USDI 1993).

Individual grizzly bears can have extensive home ranges, sometimes encompassing 1,000 - 1,500 square miles. Thus, large amounts of space are essential to the maintenance of viable grizzly bear populations (USDI 1993). Because grizzly bears can conflict with humans and their land uses, grizzly populations require some protection from human depredation and competitive uses of habitat (including road construction, traffic, logging, mining, grazing, recreation, and human settlement) (USDI 1993). Effective grizzly bear habitat must include some areas isolated from human development and high levels of human activity.

Roads probably pose the most imminent threat to grizzly bear habitat today with mortality being the most serious consequence (USDI 1993). Several studies have documented that grizzlies are more vulnerable to legal harvest and poaching as a consequence of greater road access by humans (e.g., Aune and Kasworm 1989). Bears are also killed by collisions with vehicles (Palmisciano 1986). In addition, numerous studies have documented that grizzly bears, especially females with cubs, avoid using areas near roads, even roads officially closed to public use (e.g., Smith 1978; Zager 1980; Archibald et al. 1987; Mattson et al. 1987; McClellan and Shackleton 1988; Aune and Kasworm 1989; Kasworm and Manley 1990). The Interagency Grizzly Bear Committee (1994) concluded that "core areas, areas free of motorized access during the non-denning period, are an important component of the habitat of adult females grizzlies that have successfully reared and weaned offspring." The Committee defined core areas as those areas greater than 0.3 miles from any open road or motorized trail (Interagency Grizzly Bear Committee 1994). Management consideration should be given to ensure that core areas meet seasonal grizzly bear habitat needs (Interagency Grizzly Bear Committee 1994).

OCCURRENCE IN THE CEDAR RIVER WATERSHED

No comprehensive surveys to determine the presence or absence of grizzly bears have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Additionally, recent sighting information suggests that the watershed is at the southern periphery of the current range of grizzly bears in Washington State (Interstate 90 forms the southern boundary of the North Cascades Ecosystem Recovery Zone; this is approximately 3 linear miles north of the Cedar River Watershed administrative boundary).

The occurrence of highly reliable grizzly bear sightings south of the watershed within the past 10 years suggests that an occasional bear may travel through the watershed (e.g., while dispersing).

3.5.15 Gray Wolf

STATUS

Legal Status. The gray wolf (*Canis lupus*) is federally listed as an endangered species and is listed as endangered by Washington State.

Population Status. Once considered common throughout forested areas of Washington (Johnson and Cassidy 1997), the gray wolf was essentially extirpated from the state by the 1930s as a result of trapping for pelts and predator control (Roderick and Milner 1991). However, gray wolves appear to be in the early stages of becoming re-established in Washington State. Since 1984, wolves have been observed in the vicinity of Ross Lake on both sides of the U.S.-Canada border (North Cascades National Park no date). In the past 10 years, wolf family groups have been confirmed in two areas in Washington – North Cascades National Park and the Okanogan area; three other sightings appear to be reliable, but are unconfirmed (Almack, J., WDFW, Sedro Woolley, Washington, November 18, 1997).

RANGE

Gray wolves occurred historically throughout most of the United States, including most of the forested areas in Washington. The species was virtually extirpated from the lower 48 states in the 1800s through large-scale predator control programs and severe reduction of natural prey populations. The species' current distribution in Washington is not well known, but a resident population appears to be confined to remote areas of the North Cascades. Other sightings have been made as far south as the Taneum Creek, Big Creek, and Bald Mountain areas of Wenatchee National Forest, and the Randle area of Gifford Pinchot National Forest (WDFW database 1996). There is one Class 2 sighting (reliable but unconfirmed) of a gray wolf within the Green River Watershed analysis area (USDA 1996). These sightings appear to be primarily transient individuals.

LIFE HISTORY

Wolves gain sexual maturity in their second year, but often do not breed until their third year. It is commonly thought that wolves mate for life, with breeding occurring annually (Mech 1970; Paradiso and Nowak 1982). Breeding occurs from late January through April, depending on latitude; gestation lasts about 9 weeks (Mech 1970). The average litter contains 4 to 7 pups, although as many as 14 pups have been reported (Mech 1970). Pups are born blind and helpless, and remain with their mother for several months after birth (Paradiso and Nowak 1982). The life expectancy of wolves is 16 years, although a 10-year-old wolf can be regarded as a very old animal (Paradiso and Nowak 1982).

HABITAT

The gray wolf is a very wide-ranging species that uses almost any natural habitat (Laufer and Jenkins 1989), including forestlands and natural openings (e.g., alpine meadows, shrublands, marshes), as long as the level of human activity is low and an adequate ungulate prey base is available (Laufer and Jenkins 1989). Suitable denning and rendezvous habitat for the gray wolf is defined as broad valley bottoms away from human disturbance, usually at high elevations (Mech et al. 1988). Wolves avoid areas with greater than approximately one mile of open roads per square mile of land area (Mladenoff et al. 1995). Primary threats to transient and re-introduced gray wolf populations include human disturbance, habitat loss, and lack of ungulate prey (USDI 1987).

Because large ungulates (black-tailed deer, mule deer, elk, caribou, moose) are the principal prey of gray wolves, habitat conditions that favor ungulate species (i.e., interspersion of forest cover with open areas for feeding) would also favor wolves. Ungulate winter ranges and calving areas are especially important habitats for wolves.

Wolves are highly social, living in family groups (packs) with 2 - 25 individuals (Mech 1970). Wolf packs consist of one dominant pair (alpha pair), their offspring from one or more generations, and other non-breeding adults. Den sites are usually underground although abandoned beaver lodges or hollow logs are also used (Mech 1970). Typically, dens are located on south or southwest aspects of moderately steep slopes in well-drained soils, and are usually within 600 ft of surface water (Mech 1970). Wolf packs have territories ranging in size from 50 square miles to over 1,000 square miles, depending on pack size and prey density (Mech 1970). Thus, a viable wolf population requires an extensive geographic area.

OCCURRENCE IN THE CEDAR RIVER WATERSHED

No comprehensive surveys to determine the presence or absence of gray wolves have been conducted in the Cedar River Municipal Watershed. Recent sighting information suggests that the watershed is at the southern periphery of the current range of gray wolves in Washington State. The occurrence of reliable gray wolf sightings east and south of the watershed within the past 10 years suggests that an occasional wolf may travel through the watershed (e.g., while dispersing).

Section 3.6 Contents

3.6 Other Species of Concern

3.6.1 Introduction

Other species of concern in the Cedar River Watershed are those species for which current population status indicates that there is some decline or a potential risk of future decline, and the potential that the species could be listed at some time in the future (Section 3.4). Most of this group of 69 species are declining or at risk of declining in population numbers because their key habitats are regionally declining, although many are currently believed to be relatively stable within the municipal watershed.

Some of these species, such as the Larch Mountain salamander (*Plethodon larselli*), are highly vulnerable to disturbance. Other species, such as the ground beetles (family Carabidae), have narrow habitat requirements. Some species are both highly vulnerable to disturbance and have narrow habitat requirements, such as the Western Townsend's big-eared bat (*Plecotus townsendii*).

All bat species potentially present in the Cedar River Watershed are considered species of concern. Some invertebrate species that are considered to be at-risk and are potentially present on the Cedar River Watershed are also considered species of concern. Bat and invertebrate species are included in this list partly because information regarding their presence and status in the state is very limited.

Although individual species conservation strategies have not been developed for any of the species of concern other than the 14 species of greatest concern (Section 3.5), the community-based strategies presented in Section 4.2.5 were developed to address these species. If, in the future, any of these other species are listed by the USFWS or NMFS, individual conservation strategies may be developed. A species-by-species discussion follows for each of the other species of concern addressed in this HCP. The status in the municipal watershed and the state and federal status for each species is given in Table 3.6-1.

Table 3.6-1. Status of other fish and wildlife species of concern that are known to occur or potentially could occur in the Cedar River Watershed.

Species	Status in the Cedar River Watershed		Designated Status	
	Status	Notes	State	Federal
Birds				
Band-tailed Pigeon *Columba fasciata*	present	sightings on occasion		
Black Swift *Cypseloides niger*	present		Monitor	
Brown Creeper *Certhia americana*	present, breeding			
Golden Eagle *Aquila chrysaetos*	unknown	historic sighting on adjacent ownership	Candidate	
Great Blue Heron *Ardea herodias*	present	common	Monitor	
Harlequin Duck *Histrionicus histrionicus*	present	Cedar River and major tributaries		Species of Concern
Merlin *Falco columbarius*	present		Candidate	
Olive-sided Flycatcher *Contopus borealis*	present			Species of Concern
Osprey *Pandion haliaetus*	present, breeding	several pairs	Monitor	
Pileated Woodpecker *Dryocopus pileatus*	present, breeding	common	Candidate	
Rufous Hummingbird *Selasphorus rufus*	present	common		
Three-toed Woodpecker *Picoides tridactylus*	unknown		Monitor	
Vaux's Swift *Chaetura vauxi*	present, breeding		Candidate	
Western Bluebird *Sialia mexicana*	incidental	sightings on occasion	Monitor	
Willow Flycatcher *Empidonax traillii*	present, breeding			Species of Concern
Fish				
Kokanee *Oncorhynchus nerka*	present, breeding	present in Walsh Lake and Webster Creek		
Pacific Lamprey *Entosphenus tridentatus*	unknown	below Landsburg (if present)		Species of Concern
River Lamprey *Lampetra ayresi*	unknown	below Landsburg (if present)	Candidate	Species of Concern

Species	Status in the Cedar River Watershed		Designated Status	
	Status	Notes	State	Federal
Sea-run Cutthroat Trout *Oncorhynchus clarki clarki*	unknown	below Landsburg (if present)		
Mammals				
Big Brown Bat *Eptesicus fuscus*	unknown			
California Myotis *Myotis californicus*	unknown			
Canada Lynx *Lynx canadensis*	unknown		Threatened	Proposed Threatened
Fisher *Martes pennanti*	unknown		Endangered	Species of Concern
Fringed Myotis *Myotis thysanodes*	unknown		Monitor	
Hoary Bat *Lasiurus cinereus*	unknown			
Keen's Myotis *Myotis keenii*	unknown		Monitor	
Little Brown Myotis *Myotis lucifugus*	unknown			
Long-eared Myotis *Myotis evotis*	unknown		Monitor	
Long-legged Myotis *Myotis volans*	unknown		Monitor	
Marten *Martes americana*	unknown			
Masked Shrew *Sorex cinereus*	unknown			
Northern Water Shrew *Sorex palustris*	present			
Silver-haired Bat *Lasionycteris noctivagans*	unknown			
Townsend’s Western Big-eared Bat *Plecotus townsendii*	unknown		Candidate	Species of Concern
Wolverine *Gulo gulo*	unknown		Candidate	Species of Concern
Yuma Myotis *Myotis yumanensis*	unknown			Species of Concern
Amphibians and Reptiles				
Cascades Frog *Rana cascadae*	present, breeding		Monitor	Species of Concern
Cascade torrent salamander *Rhyacotriton cascadae*	unknown	known range to south	Candidate	

Species	Status in the Cedar River Watershed		Designated Status	
	Status	Notes	State	Federal
Larch Mountain Salamander *Plethodon larselli*	unknown	known range to south	Sensitive	Species of Concern
Long-toed Salamander *Ambystoma macrodactylum*	present, breeding			
Northwestern Salamander *Abystoma gracile*	present, breeding	widely distributed		
Pacific Giant Salamander *Dicamptodon tenebrosus*	present, breeding	widely distributed		
Red-legged Frog *Rana aurora*	present, breeding	widely distributed	Monitor	Species of Concern
Roughskin Newt *Taricha granulosa*	present, breeding	common		
Oregon Spotted Frog *Rana pretiosa*	unknown		Endangered	Candidate
Tailed Frog *Ascaphus truei*	present, breeding	widely distributed in streams and rivers of municipal watershed	Monitor	
Van Dyke's Salamander *Plethodon vandykei*	unknown	known range to south	Candidate	Species of Concern
Western Pond Turtle *Clemmys marmorata*	unknown	no habitat within delineated elevation range	Endangered	Species of Concern
Western Redback Salamander *Plethodon vehiculum*	present			
Western Toad *Bufo boreas*	present, breeding	common	Candidate	
Invertebrates: Insects				
Beller's Ground Beetle *Agonum belleri*	present	found in bogs	Candidate	Species of Concern
Carabid beetle: *Bembidion gordoni*	unknown			
Carabid beetle: *Bembidion stillaquamish*	unknown			
Carabid beetle: *Bembidion viator*	unknown			
Carabid beetle: *Bradycellus fenderi*	unknown			

Species	Status in the Cedar River Watershed		Designated Status	
	Status	Notes	State	Federal
Carabid beetle: *Nebria gebleri cascadensis*	unknown			
Carabid beetle: *Nebria kincaidi balli*	unknown			
Carabid beetle: *Nebria paradisi*	unknown			
Carabid beetle: *Omus dejeanii*	unknown			
Carabid beetle: *Pterostichus johnsoni*	unknown			
Fender's Soliperlan Stonefly *Soliperla fenderi*	unknown			Species of Concern
Hatch's Click Beetle *Eanus hatchi*	unknown		Candidate	Species of Concern
Johnson's (mistletoe) Hairstreak (butterfly) *Mitoura johnsoni*	unknown		Candidate	
Long-horned Leaf Beetle *Donacia idola*	unknown		Candidate	
Invertebrates: Mollusks				
Blue-gray Taildropper (slug) *Prophysaon coeruleum*	unknown		Monitor	
Oregon Megomphix (snail) *Megomphix hemphilla*	unknown		Monitor	
Papillose Taildropper (slug) *Prophysaon dubium*	unknown		Monitor	
Puget Oregonian (snail) *Cryptomastix devia*	unknown		Monitor	
Valvata mergella (snail)	unknown			

3.6.2 Species Accounts

BIRDS

Band-tailed Pigeon

Status

Legal Status. The band-tailed pigeon (*Columba fasciata*) is not a listed species, candidate species, or species of concern at the federal level in Washington. It is considered an upland game species by Washington State (WDNR 1996).

Population Status. Concern for the band-tailed pigeon has been prompted by the population decline reflected in breeding bird surveys (WDNR 1996). Populations in Washington have exhibited the greatest decline (Braun 1994).

Range

The band-tailed pigeon occurs along the west coast of North America, from southwestern British Columbia to southern California, in the southern Rocky Mountain states of Utah, Colorado, New Mexico, and Arizona, and in Mexico and Central America.

In Washington, the band-tailed pigeon occurs west of the Cascade crest (Roderick and Milner 1991; Smith et al. 1997).

Habitat

Band-tailed pigeons are found within the coniferous forest zone and are associated with mixed conifer-hardwood habitats (Larsen et al., in prep., as cited in WDNR 1996). This species typically uses a stick platform in a conifer tree as a nest (Ehrlich et al. 1988; Braun 1994). During the nesting season, band-tails are more common in low-elevation forests (less than 1,000 ft elevation) with various seral stages and openings that are well interspersed (Roderick and Milner 1991). Nesting band-tailed pigeons appear to be negatively associated with old-growth forest, possibly because accipiters and other predators can maneuver more readily through the open understory of old-growth forest (Jarvis, R., Oregon State University, September, 1999, personal communication). The species is also known to occur in west-side residential areas or city parks with suitable large coniferous trees (Smith et al. 1997). Band-tailed pigeons use a variety of open habitats for foraging, including natural meadows, and small patches of early seral forest (Jarvis, R., Oregon State University, September, 1999, personal communication).

Band-tailed pigeons feed on various plant foods, including the buds, flowers, and fruits of hardwood trees and shrubs, such as cascara, elderberry, wild cherry, and huckleberry (Braun 1994). This species depends on the availability of mineral resources (e.g., from mineral springs, intertidal flats) for producing crop milk for juveniles (Braun 1994). Band-tailed pigeons will travel considerable distances to meet their mineral requirements, using mineral springs 15 to 20 miles from their nest sites (Jarvis, R., Oregon State University, September, 1999, personal communication).

Occurrence in the Cedar River Municipal Watershed

Band-tailed pigeons are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date.

Nesting habitat for the band-tailed pigeon in the Watershed includes low-elevation coniferous or mixed hardwood-conifer forest. Other important habitat elements include red elderberries and huckleberries for foraging, and mineral springs for crop milk. No mineral springs have been identified in the Cedar River Municipal Watershed.

Black Swift

Status

Legal Status. The black swift (*Cypseloides niger*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The black swift is a state monitor species in Washington.

Population Status. Smith et al. (1997) consider the black swift an uncommon breeder in Washington.

Range

In Washington, the black swift occurs in the Cascades north of Mt. Adams and along the rocky coastline from Grays Harbor County to Clallam County (Smith et al. 1997).

Habitat

Smith et al. (1997) described good habitat for the black swift as "mid- to late-seral mixed and conifer forests and rivers/riparian areas in forested zones above the ponderosa pine zone in eastern Washington, and above the Puget Sound Douglas-fir zone in western Washington; and similar habitats, plus rocky shoreline, of the coastal strip in the Sitka spruce zone."

Few black swift nests have been documented in Washington, but they have been found on steep cliffs and behind waterfalls (Smith et al. 1997). Foerster and Collins (1990) described five features that are generally associated with black swift nest sites: (1) water (flowing water is present at every nesting site, ranging in degree from a trickle to a torrent); (2) high relief (the nesting site must have a commanding position above the surrounding terrain so that swifts flying out from the nest are automatically above that terrain); (3) inaccessibility (the site is inaccessible to potential terrestrial predators); (4) darkness (the nest is in a position that the sun will not shine on an occupied nest); and (5) unobstructed flyways (the flyway in front of the nest must be free of obstructions).

Occurrence in the Cedar River Municipal Watershed

Black swifts are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date.

Potential habitats for the black swift in the municipal watershed include cliffs, rock outcrops, headwalls and inner gorges, waterfalls on streams, and mature to old-growth forests, especially in riparian areas.

Brown Creeper

Status

Legal Status. The brown creeper (*Certhia americana*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The brown creeper is considered to be common throughout its range in Washington (Smith et al. 1997). However, brown creeper populations in Oregon and California have been steadily declining (Sauer et al. 1997).

Range

The brown creeper is widely distributed in the Northern Hemisphere. In North America it occurs from southeastern Alaska east to Newfoundland and south through the western mountain ranges and through Mexico to Nicaragua; in the eastern United States to southern Wisconsin and Massachusetts, and in the Appalachian Mountains to eastern Tennessee and western North Carolina.

In Washington, two subspecies of brown creeper are known to breed: *C. a. montana* of eastern Washington and *C. a. occidentalis* of western Washington (Smith et al. 1997). The brown creeper occurs throughout the forested regions of western Washington, northeastern Washington, and extreme southeastern Washington (Blue Mountains). The species is absent from the hot, dry Columbia Basin.

Habitat

The brown creeper is found in many types of forested areas, but its primary habitat is considered to be mature, moist coniferous forests (Smith et al. 1997). Mariani (1987) demonstrated that brown creepers in southern Washington had a high preference for mature conifer forest.

Usually the nest is under a piece of loose tree bark, typically a hardwood (Mariani 1987), but is reported occasionally in a natural cavity or old woodpecker hole. When built under loose bark, the nest is a crescent-shaped structure of twigs, bark shreds, moss, spider webs, and feathers. Douglas-fir is considered to be a preferred tree for foraging in western Washington, presumably because the highly contoured bark provides a high density of prey, such as insects and spiders (Mariani 1987). The preferred combination of nesting and foraging habitat typically occurs at the transition between riparian hardwood vegetation and forest conifer vegetation. The nest is placed in a hardwood located near the water, while foraging occurs in the nearby conifers (Smith et al. 1997).

Occurrence in the Cedar River Municipal Watershed

Brown creepers are present and known to breed in the Cedar River Municipal Watershed.

Potential habitats for the brown creeper in the watershed include mixed and coniferous forest, and late-successional conifer wetland forest. Because mature coniferous forest habitat is declining throughout Washington, and exists as fragmented patches, key habitat for brown creepers is assumed to be limited.

Golden Eagle

Status

Legal Status. The golden eagle (*Aquila chrysaetos*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The golden eagle is a Washington State candidate species.

Population Status. The 1990 population estimate for Washington was 80 breeding pairs (Roderick and Milner 1991).

Range

Golden eagles occur across the western United States from the western Dakotas, eastern Colorado, and extreme eastern Texas to central Oregon and Washington and the coast of California (Sauer et al. 1997). Golden eagles are most common in the open dry forests of the east Cascades, northeastern Washington, and southeastern Washington (Smith et al. 1997). They are absent from the Columbia Basin. West of the Cascade crest, golden eagles are found in the rain shadow area of major volcanoes, at high elevations in alpine parkland, and at clearcuts at mid elevations (Smith et al. 1997).

Habitat

Golden eagles nest on large, rocky cliffs or in large trees in areas where suitable small mammal prey, such as rabbits and marmots, is abundant (Smith et al. 1997). East of the Cascades, golden eagles are associated with open ponderosa pine and steppe habitats near cliff and plateau topography (Roderick and Milner 1991). In western Washington, nests are primarily in large trees in mature to old-growth forests near the edges of clearcuts (Anderson and Bruce 1980). Bruce et al. (1982) found that golden eagle tree nests were placed at or below canopy height and were less than 500 m from large clearcuts (less than 10 years old) or open fields.

Hares, rabbits, ground squirrels, and marmots are the golden eagle’s principal prey (Snow 1973; McGahan 1967). Mountain beaver are important prey on the west side of the Cascades (Bruce et al. 1982).

Occurrence in the Cedar River Municipal Watershed

Golden eagles are present in the Cedar River Municipal Watershed only intermittently as transients and migrants, and are most often observed above high-elevation ridges. At least one historic (late 1970s) nest site has been documented on lands adjacent to the watershed (City of Seattle, unpublished observations). No comprehensive surveys have been conducted and no nests have been documented within the Cedar River Municipal Watershed to date.

Potential nesting habitat for golden eagles in the municipal watershed includes cliffs and rock outcrops; naturally open habitats (grass-forb meadows and persistent shrub communities) provide potential foraging habitat.

Great Blue Heron

Status

Legal Status. The great blue heron (*Ardea herodias*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The great blue heron is a monitor species at the state level in Washington.

Population Status. The great blue heron is considered common in Washington, especially in the Puget Sound area (Smith et al. 1997).

Range

The great blue heron occurs throughout southern Canada, the United States, and Mexico. It occurs year-round along the west coast, from southern Alaska to the tip of Baja California.

The great blue heron is common in wetlands, mud flats, and agricultural areas at low to mid-elevations on both sides of the Cascade crest (Smith et al. 1997). West of the Cascade crest, great blue herons occur in all vegetation zones below the silver fir zone. Along river valleys they may be found up to fairly high elevations (e.g., along the Skagit River near Ross Lake in Whatcom County). They also occur at Cle Elum, Kachess, and Keechelus lakes in Kittitas County, but these birds may not be breeding (Smith et al. 1997).

Habitat

Great blue herons nest colonially in tall deciduous or coniferous trees near wetlands (Roderick and Milner 1991). Nests are usually constructed in the largest trees available, although smaller trees, bushes, and artificial structures have been used (Bruce 1986; Blus et al. 1980). A study in British Columbia found that most heron colonies were in trees over 46 ft tall, and no nests were found in trees under 33 ft. tall (Mark 1976).

Great blue heron feeding areas can include irrigated agricultural fields, irrigation canals, and the marshy edges of ponds, lakes, and estuarine areas (Smith et al. 1997). Documented distances from an active nesting colony to a foraging area range from 13 to 18 miles, but most feeding areas are located within 2.5 to 3 miles of the colony (Short and Cooper 1985).

Human disturbance has been documented to be a major cause of nest abandonment by great blue herons, causing colony-wide nest failures (Smith et al. 1997). Herons have abandoned colonies because of housing and industrial development, highway construction, logging, actively used roads, and repeated human intrusion into colonies (Werschkul et al. 1976; Kelsall and Simpson 1979; Parker 1980; Leonard 1985). Herons that have experienced few past disturbances are not likely to tolerate human activities near their colonies (Bowman and Siderius 1984). Butler (1992) has recommended that a 1,000-ft buffer zone be established around active heron colonies to prevent nest failure. In contrast, some studies suggest that herons that are frequently or consistently exposed to disturbance may habituate to human activities (Shipe and Scott 1981; Webb and Forbes 1982; Vos et al. 1985; Calambokidis et al. 1985). Thus, herons nesting in different locations may have different tolerance levels to human activity, with colonies located close to human activity responding less to disturbance than those in more remote areas (Simpson 1984).

Occurrence in the Cedar River Municipal Watershed

Great blue herons are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date.

Great blue herons nest in trees near water and feed along the edges of lakes, ponds, and wetlands. Thus, breeding and foraging habitat for this species occurs in aquatic and riparian habitats in the watershed.

Harlequin Duck

Status

<u>Legal Status</u>. The harlequin duck (*Histrionicus histrionicus*) is a federal species of concern in Washington State. The harlequin duck is not listed as a threatened species, endangered species, or candidate species by the State of Washington.

<u>Population Status</u>. The breeding population south of the Canadian border has been estimated at 500 to 600 pairs (Harlequin Duck Working Group 1993). Schirato (1993) estimated that Washington State had a minimum of 275 pairs, but that the stability of the breeding population was unknown.

Range

The harlequin duck occurs in northeast Asia, Alaska, Canada, the western United States, Greenland, and Iceland (Peterson 1990). In the western United States, the species breeds in mountainous areas from the Aleutian Islands to northern California, and in the northern Rocky Mountains south to Yellowstone National Park (Roderick and Milner 1991).

In Washington, the harlequin duck breeds along fast-moving streams and rivers throughout the Cascade, Olympic, and Selkirk mountains (Bellrose 1976; Brown 1985b). Wintering areas include saltwater habitats within about 150 ft of the shore (Gaines and Fitzner 1987) in northern Puget Sound, northern Hood Canal, the Strait of Juan de Fuca, the San Juan Islands, and the outer coast (Wahl and Paulson 1991; WDFW 1994a).

Habitat

Harlequin duck nests are typically located close to clear mountain streams with rocky substrates and rapids (Harlequin Duck Working Group 1993). Nests may be on the ground in dense vegetation, in piles of woody debris, in undercut stream banks, between rocks, or in hollow trees (Harlequin Duck Working Group 1993). Most harlequin nests are found within 16 ft of streams (Bengston 1972), but they have been found up to 82 ft away (Harlequin Duck Working Group 1993). Dense shrub and/or forest cover on streambanks near nest sites is also considered important (Harlequin Duck Working Group 1993). The species is thought to show a preference for mature or old-growth forests in the Pacific Northwest (Harlequin Duck Working Group 1993; Roderick and Milner 1991). Harlequin ducks nest from April to June. Broods usually remain near the nest site for the first few weeks, then move downstream during the summer to lower-gradient streams that support an abundant macroinvertebrate fauna (Bengton and Ulfstand 1971; Kuchel 1977; Wallen 1987; Cassirer and Groves 1989). Principal food items include crustaceans, molluscs, and aquatic insects (Cottam 1939, as sited in Roderick and Milner 1991).

Foraging habitat includes fast-moving streams (Harlequin Duck Working Group 1993), while resting habitat is generally described as mid-stream loafing sites (Roderick and Milner 1991), such as gravel bars or large woody debris.

Human disturbance greatly affects this species, therefore, WDFW (1994a) recommends that roads and trails should be located farther than 165 ft from streams used by harlequin ducks.

Occurrence in the Cedar River Municipal Watershed

Harlequin ducks are present in the Cedar River Municipal Watershed on the mainstem Cedar River to at least an elevation of 2,100 ft, and on one major tributary downstream of Cedar Falls. However, no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date.

Potential nesting and foraging habitat for the harlequin duck in the watershed includes fast-flowing rivers and streams, and associated bank vegetation and large woody debris.

Merlin

Status

Legal Status. The merlin (*Falco columbarius*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The merlin is a state candidate species in Washington.

Population Status. According to Smith et al. (1997), the status of merlins in Washington "is very much a mystery."

Range

The merlin is found throughout the northern hemisphere. Two distinct subspecies of merlin occur in Washington (Smith et al. 1997), with the Taiga merlin (*F.c. columbarius*) the subspecies most likely to occur in the Cedar River Municipal Watershed. It is likely that the Taiga merlin occurs as a rare breeder in high-elevation Cascades forests that mimic boreal conditions, such as Engelmann spruce and subalpine fir forests (Smith et al. 1997).

Habitat

Merlins are typically found along wooded edges adjacent to open habitats such as meadows, wetlands, and shrubby areas. Merlins utilize old nests of other species, such as crows, and natural cavities for breeding (Smith et al. 1997). They are also known to nest on cliffs. The merlin preys mainly on small, open-country birds such as larks, swallows, and finches. Small mammals and insects are eaten occasionally. Merlins in the Cascade Mountains are found at higher elevations, from the Pacific silver fir zone up, using forest edges and meadows along the Cascade crest (Smith et al. 1997).

Occurrence in the Cedar River Municipal Watershed

Merlins are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date. Large trees, cliffs, and rock outcrops may provide nesting habitat for merlins in the

Cedar River Municipal Watershed; potential foraging habitat includes naturally open upland habitats (grass-forb meadows and persistent shrub communities) and open wetlands (palustrine emergent and palustrine scrub-shrub wetlands).

Olive-sided Flycatcher

Status

Legal Status. The olive-sided flycatcher (*Contopus borealis*) is a federal species of concern in Washington. The olive-sided flycatcher is not listed as an endangered species, threatened species, or candidate species in Washington State.

Population Status. Based on data from the North American Breeding Bird Surveys, the olive-sided flycatcher has apparently been in significant decline throughout much of the western United States and across its boreal North American range as well (DeSante and George 1994; Dobkin 1994; Hejl 1994; Peterjohn et al. 1994).

Range

The olive-sided flycatcher breeds from Alaska east through much of Canada to the Great Lakes region and the northeastern United States, and southward through the mountains of the Pacific Northwest, the Rocky Mountains, and the mountains of California. The species winters in montane Central and South America from southern Mexico through Colombia and Venezuela, south to Peru (Ehrlich et al. 1988).

The olive-sided flycatcher occurs in virtually all forested areas of Washington State (Smith et al. 1997).

Habitat

The olive-sided flycatcher inhabits primarily mature forest, old-growth forest, and wet conifer forest, especially those forests with an abundance of snags (Ehrlich et al. 1988; Sharp 1992). These flycatchers were found to occur in relatively similar abundance in young, mature, and old-growth forest stands in the southern Washington Cascades (Carey et al. 1991; Gilbert and Allwine 1991a; Manuwal 1991; Ruggiero et al. 1991). This species may also use mixed woodlands near edges and clearings. Smith et al. (1997) consider the olive-sided flycatcher an edge species that occurs throughout forested areas where forest stands are adjacent to open areas, such as clear-cuts, burns, montane meadows, and western Washington agricultural areas.

Nests are often located high in conifer trees, usually on a horizontal branch far from the trunk. Olive-sided flycatchers typically forage by sallying for flying insects from prominent, high hunting perches (live trees or snags) with a view of openings (Ehrlich et al. 1988; Marshall 1988; Sharp 1992).

Occurrence in the Cedar River Municipal Watershed

Olive-sided flycatchers are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity has been documented to date.

Potential nesting habitat for the olive-sided flycatcher in the Cedar River Municipal Watershed includes mature and old-growth forest, and wet conifer forest, especially those forests with an abundance of snags. Adjacent and interspersed open habitats (e.g., meadows, persistent shrub communities, early seral forest) provide potential foraging habitat.

Osprey

Status

Legal Status. The osprey (*Pandion haliaetus*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The osprey is a monitor species at the state level in Washington.

Population Status. In Washington, Breeding Bird Survey data show a significant population increase of 10.2 percent per year from 1966 to 1991 (Peterjohn 1991) and an increase of 11.7 percent per year from 1982 to 1991. There is an extremely high concentration of nesting ospreys along the Pend Oreille River in northeastern Washington (Smith et al. 1997).

Range

The osprey breeds along the seacoasts, rivers, and lakes of coastal North America, and winters in the West Indies, Central America, and South America (Roderick and Milner 1991).

In Washington, the osprey is common along large water bodies (the ocean, lakes, and large rivers) in lower-elevation forested landscapes throughout the state except for the Columbia Basin (Smith et al. 1997). Ospreys are less common at higher elevations, but have been found nesting as high as Ross Lake (1,600 ft elevation), and foraging in the Snoqualmie Pass and White Pass areas (Smith et al. 1997).

Habitat

Ospreys build large nests in live trees, on dead snags with flat, broken tops, or on artificial nest platforms, always near water (Smith et al. 1997; Roderick and Milner 1991). Nest trees are typically as tall or taller than surrounding structures. Sites that have additional perches within view of the nest are particularly attractive to ospreys (Zarn 1974).

Osprey pairs apparently vary in their tolerance of human disturbance (Van Daele and Van Daele 1982). Human activities initiated during early nesting and incubation are probably most disturbing to ospreys (Roderick and Milner 1991). Disturbance during this period may cause adults to leave the nest frequently or for extended periods, which can be fatal to embryos and nestlings (Van Daele and van Daele 1982; Levenson and Koplin 1984).

Ospreys feed almost exclusively on live fish captured at the water's surface. Although nests are generally built near productive water bodies, osprey hunting ranges have been estimated to extend as much as 6 to 9 miles from the nest (Henny 1986; Poole 1987; Sidle and Suring 1986).

Occurrence in the Cedar River Municipal Watershed

One to several pairs of osprey have nested annually within the Cedar River Municipal Watershed throughout the last three decades.

Potential foraging areas for osprey in the watershed include lakes, the reservoir, and riparian areas, especially Chester Morse Lake, Masonry Pool, Rattlesnake Lake, and Walsh Lake. Tall trees and snags adjacent to these bodies of water provide potential nesting habitat.

Pileated Woodpecker

Status

Legal Status. The pileated woodpecker (*Dryocopus pileatus*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The pileated woodpecker is a state candidate species in Washington.

Population Status. In the State of Washington, Breeding Bird Survey data show a significant population decline of 5.5 percent per year from 1966 to 1991 for the pileated woodpecker (Peterjohn 1991).

Range

The pileated woodpecker occurs from northern British Columbia south through the Pacific states to central California; in the northern Rockies through Idaho and western Montana; across southern Canada to Nova Scotia; and south to the Gulf Coast and Florida.

The pileated woodpecker is found throughout forested areas of Washington State, primarily at low to moderate elevations (Smith et al. 1997). They can exist in the city when there are suitable trees, and are found in several parks in Seattle including Seward Park, Discovery Park, and Camp long. The species does not occur in the dry, non-forested portions of the Columbia Basin (Smith et al. 1997).

Habitat

Pileated woodpeckers typically utilize mature and old-growth forests and second-growth forests with substantial numbers of large snags and fallen trees. West of the Cascade crest, pileated woodpeckers breed in forest stands older than 70 years (Mellen et al. 1992). They excavate large nest holes (three holes per year per pair on average) in snags or living trees with dead wood, generally excavating through hard outer wood into rotten heartwood. Typical tree species used as nest sites include western larch, black cottonwood, and ponderosa pine east of the Cascade crest, and Douglas fir, grand fir, and western white pine, where available, west of the Cascade crest (Bull 1987; Mellen 1987; Nelson 1988; Lundquist and Mariani 1991). Most nest trees are hard snags with bark and broken tops (Roderick and Milner 1991). In a study in the Oregon Coast Range, nest trees averaged 28 inches dbh, while in a northeastern Oregon study nest trees averaged 33 inches dbh (Bull 1987; Mellen 1987; Mellen et al1992). Typical nest trees in the northeastern Oregon study had been dead more than 10 years, had a broken top, and an absence of limbs near the cavity.

Pileated woodpeckers also use tree cavities for roosting. In the northeastern Oregon study, these cavities were in hollow live or dead trees, mainly in stands of old-growth grand fir (Bull et al. 1992; Mellen et al. 1992)

Pileated woodpeckers forage mainly by excavating wood and chipping bark from large-diameter dead and down logs, stumps, snags, and live trees (USDI 1996d). They feed primarily on ants, beetle larvae, and other insects (Bull et al. 1992). West of the Cascade crest, they spend most time foraging in forest stands older than 40 years, and in deciduous riparian areas (Mellen et al. 1992). They seldom forage in clearcuts, but they are known to feed in timber harvest debris in shelterwood cuts.

Occurrence in the Cedar River Municipal Watershed

The pileated woodpecker is considered common and is known to breed in the Cedar River Municipal Watershed.

Potential nesting and foraging habitat for pileated woodpeckers in the Cedar River Municipal Watershed is found within late-successional and old-growth conifer forests.

Rufous Hummingbird

Status

Legal Status. The rufous hummingbird (*Selasphorus rufus*) currently is not a listed species, candidate species, or species of concern at the federal level or state level in Washington.

Population Status. Concern for this Neotropical migrant species stems from consistent marked declines in rufous hummingbirds detected during the Breeding Bird Survey (BBS) throughout the western portion of its range (Sauer et al. 1997). Between 1966 and 1996, BBS detections of this species exhibited a declining trend of approximately 2.7 percent per year. This translates to population decline of approximately 50 percent over a 25-year period (Sauer 1992). The causes of this decline are unknown.

Range

The rufous hummingbird occurs from southeastern Alaska south through Washington and Oregon, to northwestern California and southern Idaho. It is found throughout western and central Washington, and also in the Blue Mountains and northeastern corner of the state (Smith et al. 1997).

Habitat

Rufous hummingbirds forage over a great variety of habitats, mainly where nectar-producing flowers are available, from valley bottoms to meadows above treeline. They nest in a variety of trees, shrubs, and vines, favoring low, sloping branches of conifers (Zeiner et al. 1994). Diet also includes insects, which are gleaned from flowers and foliage or hawked from the air (Zeiner et al. 1994; Sauer et al. 1997).

Occurrence in the Cedar River Municipal Watershed

Rufous hummingbirds are considered common and are known to breed in the Cedar River Municipal Watershed.

Potential habitat for the rufous hummingbird in the watershed includes meadow complexes, riparian areas, shrub communities, and other areas where nectar-producing flowers are abundant.

Three-toed Woodpecker

Status

Legal Status. The three-toed woodpecker (*Picoides tridactylus)* is not a listed species, candidate species, or species of concern at the federal level in Washington. The three-toed woodpecker is a state monitor species in Washington.

Population Status. Smith et al. (1997) consider the species to be uncommon in Washington. Some of the concern for this species is related to its need for mature, insect-infested timber that has heart rot and bark beetles (Goggans, et al. 1989).

Range

The three-toed woodpecker occurs throughout boreal forests from Alaska, across Canada to Newfoundland, and south into forests of Washington and Oregon, the Rocky Mountains, and New England. It also occurs in northern boreal forests of Eurasia (American Ornithologists' Union 1983).

In Washington, the three-toed woodpecker is an uncommon species that occurs in high-elevation conifer forests in the Cascades, in the northeastern part of the state, and the southeastern part of the state in the Blue Mountains (Smith et al. 1997).

Habitat

Three-toed woodpeckers are generally found in high-elevation, closed-canopy, dense forests, but will utilize open habitats and burns (Smith et al. 1997). This species is found primarily in spruce and true fir forests, but it is also found in lodgepole pine and mixed-conifer forests above 4,500 ft elevation (Bull et al. 1986; Goggans et al. 1989).

Three-toed woodpeckers are cavity nesters. In the Deschutes National Forest of Oregon, three-toed woodpeckers were found to excavate nest cavities in dead and, occasionally, live lodgepole pine trees with heart rot and a mean dbh of 11 inches (Goggans et al. 1989). In addition, roosting occurred in cavities of soft snags in dense, unlogged stands of lodgepole pine or mixed conifer with lodgepole pine (Goggans et al. 1989). This woodpecker feeds mainly on wood-boring insects in dying or recently dead lodgepole pines or Engelmann spruce (Goggans et al. 1989).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of the three-toed woodpecker have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date.

Potential habitat for the three-toed woodpecker in the municipal watershed includes high-elevation mature to old-growth forests.

Vaux's Swift

Status

Legal Status. Vaux's swift (*Chaetura vauxi*) is not a listed species, candidate species, or species of concern at the federal level in Washington. Vaux's swift is a candidate species at the state level in Washington.

Population Status. Breeding Bird Survey data for Washington indicate a significant decline in the number of Vaux's swifts during the 1982-1991 period (Bull and Collins 1993). Concern over the welfare of the Vaux's swifts relates primarily to their use of large, hollow trees for nesting and roosting (Roderick and Milner 1991; Bull and Collins 1993).

Range

Vaux's swifts breed in western North America, from southeastern Alaska and British Columbia south and east into northern Idaho, western Montana, and northeastern Oregon, and south into Washington, Oregon, and northern California (Bull and Collins 1993). The species winters from central Mexico to northern South America (Ehrlich et al. 1988).

Vaux's swift occurs throughout Washington State except for the driest parts of the Columbia Basin (Smith et al. 1997).

Habitat

The species nests in late-successional coniferous forests (Manuwal and Huff 1987; Bull and Collins 1993). In a survey of forests in the southern Washington Cascades, significantly more Vaux's swifts were counted in old-growth forest stands compared with younger seral-stage stands (Lundquist and Mariani 1991).

Vaux's swifts require large, hollow snags or cavities in the broken tops of live trees for nesting and night roosting (WDNR 1996). Nest snags on the west side of the Cascades are at least 39 ft tall and 25 in dbh (Brown et al. 1985). Bull and Cooper (1991) documented 21 Vaux's swift nests in a study in northeastern Oregon. All 21 nests were in large grand fir trees (26.4 inches mean dbh) hollowed out by a fungus and with an entrance excavated by pileated woodpeckers. The nest trees were mainly in old-growth forest stands. In a second study in northeastern Oregon, Bull and Hohmann (1993) found considerably more Vaux's swift nests in old-growth forest stands than in stands that had been logged in some manner. Occurrence of swifts appeared to be related to the number of dead grand fir trees that were at least 20 inches dbh (Bull and Hohmann 1993). Interestingly, swift nests were found in harvested areas if hollow trees remained (Bull and Hohmann 1993).

In fall, Vaux's swifts congregate in large flocks, and hundreds of swifts may use a single large hollow tree for night roosting. Bull (1991) described two roosts in broken-topped, hollow, live grand fir trees in old-growth forest stands in northeastern Oregon. Up to 400 swifts roosted in one of the trees.

Vaux's swifts feed on flying insects (Bull and Collins, 1993), primarily over the forest canopy or open water. Brown (1985b) reported that swifts forage over all seral stages of forest. Bull and Beckwith (1993) reported that they show a strong preference for foraging over open water.

Occurrence in the Cedar River Municipal Watershed

Vaux's swift are present and known to breed in the Cedar River Municipal Watershed.

Potential nesting habitat in the watershed for Vaux's swift includes hollow snags in old-growth forests.

Western Bluebird

Status

Legal Status. The western bluebird (*Sialia mexicana*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The western bluebird is a monitor species at the state level in Washington.

Population Status. In western Washington, the western bluebird has undergone a drastic and well-documented decline during the twentieth century, which has been attributed to a combination of competition with house sparrows (*Passer domesticus*) and European starlings (*Sturnus vulgaris*), widespread removal of snags used as nest trees (bluebirds are cavity nesters), and overall reductions in prey populations (Sharpe 1993, as cited in Smith et al. 1997).

Range

The western bluebird breeds in southern British Columbia and central Montana, south in mountainous areas to northern Baja California and Mexico (Terres 1980). In Washington, the western bluebird is locally common in open conifer forests, farmlands, and steppe habitats on the east side of the Cascades, and in the northeastern and extreme southeastern parts of the state (Smith et al. 1997). It has been virtually eliminated from western Washington except for the Fort Lewis area and a few other locations (Smith et al. 1997).

Habitat

The western bluebird occurs in open oak and coniferous woodlands, natural forest openings and small clearings, burned areas with snags, small agricultural fields (especially fallow fields) and pasture areas, and the forest-steppe ecotone (eastern Washington) (Smith et al. 1997).

The western bluebird builds its nest in natural cavities of oaks and pines and in abandoned nest holes of woodpeckers. Western bluebirds are attracted to and often use nest boxes placed in open areas near forest edge.

The western bluebird is primarily an insectivore (Bent 1949). Typical insects in the diet include grasshoppers, beetles, ants, flies, and caterpillars. Plant items include small fruits such as currants and elderberries.

Occurrence in the Cedar River Municipal Watershed

Western bluebirds are present intermittently in the Cedar River Municipal Watershed and their occurrence is considered incidental. No comprehensive surveys have been conducted and no nests or breeding activity have been documented within the Cedar River Municipal Watershed to date.

Potential habitat for the western bluebird in the watershed includes naturally open habitats, open wetlands, open riparian habitats, and natural forest openings and other forest clearings, particularly where snags are present.

Willow Flycatcher

Status

Legal Status. A subspecies of the willow flycatcher (*Empidonax traillii*), the "little" willow flycatcher (*E. t. brewsteri*), is a federal species of concern in Washington. The willow flycatcher is not a Washington State threatened, endangered, or candidate species.

Population Status. According to Smith et al. (1997), "Washington breeders are representative of the western subspecies *E. t. brewsteri* (American Ornithologists' Union 1957)…Breeding Bird Survey data for Washington show a significant population increase of 8.4 percent per year from 1966 to 1991 (Peterjohn 1991)."

Range

The willow flycatcher breeds throughout most of the coterminous United States, and into southern Canada. The species winters from Mexico to Panama.

In Washington, the willow flycatcher is a common breeding species in lower-elevation wetlands, shrub wetlands, riparian areas, and clearcuts on both sides of the Cascades, on the Olympic Peninsula, in the southwestern part of the state, and in the northeastern and extreme southeastern parts of the state (Smith et al. 1997).

Habitat

The willow flycatcher is commonly associated with low, dense shrubby vegetation, including riparian areas (especially willow thickets), shrubby wetlands, alder thickets, and dense stands of salmonberry and blackberry. In drier areas, the willow flycatcher is almost exclusively a riparian species (Sedgwick and Knopf 1992), occurring in willow thickets and stands of non-native tamarisk. In western Washington lowlands (western hemlock zone), willow flycatchers have been observed using shrubby habitats in regenerating clearcuts (Sharp 1992) and in sapling stands between 10 and 20 years old (WDNR 1996).

Nests are typically built in slanting or upright forks of deciduous shrubs or small trees between 3 and 25 ft above the ground (DeGraaf et al. 1991). They commonly nest in such species as alder, dogwood, willow, elderberry, blackberry, and viburnum (WDNR 1996).

Willow flycatchers feed primarily on flying insects by sallying from a perch (Ehrlich et al. 1988). They often use exposed perches for singing and foraging (Sharp 1992).

Occurrence in the Cedar River Municipal Watershed

Willow flycatchers are present and known to breed in the Cedar River Municipal Watershed.

Potential habitats for the willow flycatcher in the municipal watershed include wetlands, riparian areas, persistent shrub communities, natural forest openings, and meadow complexes, primarily within the western hemlock zone, at lower elevations.

FISH

Coastal Cutthroat Trout, Sea-Run

Status

Legal Status. The anadromous or sea-run form of the coastal cutthroat trout (*Oncorhynchus clarki clarki*) is currently under status review for listing under the Endangered Species Act. One stock, in the Umpqua River in Oregon, has been listed as Endangered under the ESA because of its geographic isolation, genetic distinctiveness, and low population size.

Population Status. Although the status of all Washington sea-run stocks has not been fully assessed, most are considered depressed or critical because of severe habitat degradation and chronically low returns (NOAA 1997). Habitat degradation has resulted from many factors, including stream diversion, urban development, agriculture, timber harvest, and road construction. Adverse impacts of habitat degradation include increased stream temperature and light regime, decreased supply of large woody debris, reduced dissolved oxygen concentration, altered streamflow, increased fine sediment, increased coarse sediment, altered nutrient supply, and blockage to migration (Palmisano et al. 1993). All forms of the coastal cutthroat trout appear to be highly vulnerable to logging activities, showing marked population declines for 6-8 years following clearcutting in Oregon (Behnke 1992). Sea-run coastal cutthroat are at some risk of extinction due to pervasive continuing declines (Nehlsen et al 1991 as reported in Behnke 1992).

In the Lake Washington Basin, the coastal cutthroat trout is the only species of cutthroat trout known to naturally occur and is present in both resident and anadromous forms. The population of sea-run cutthroat in the Lake Washington Basin is most likely a native stock, although coastal cutthroat were stocked in numerous Lake Washington streams as early as 1895 by the U.S. Bureau of Fisheries (Crawford 1979). Between 1932 and 1946, cutthroat trout brood stock were also obtained from several Lake Washington tributaries (Crawford 1979). Hatchery programs for sea-run cutthroat trout are no longer in operation in Puget Sound (Leider 1995).

In recent years, resident cutthroat trout have increased in abundance in the Lake Washington Basin (Fresh 1994). Widespread urbanization around Lake Washington has created more marginal conditions that cutthroat trout are able to use more successfully than other trout and salmon. (Ludwa et al. 1997, Scott et al. 1986). Notably, in areas of co-occurrence with other salmonid species, cutthroat trout appear to take a subdominant role (Johnson et al. 1994); therefore, apparent population increases in the Lake Washington Basin may reflect increased availability of marginal habitats, from which other salmonid species have disappeared as a result of habitat degradation. Cutthroat trout are also the primary fish caught recreationally, as documented by recent creel surveys conducted by the WDFW, although some of these fish are a cutthroat trout/rainbow trout hybrid (Pfeifer, B., WDFW, 1998, personal communication). Data on the number of adult sea-run cutthroat trout entering the basin via the fish ladder at the Ballard Locks is unavailable.

Range

The coastal cutthroat trout (*O. c. clarki*) is one of 13 subspecies of cutthroat trout (*O. clarki*) indigenous to North America. The range of this subspecies extends northward along the Pacific Coast from the Eel River in northern California to the Prince William Sound region of southeast Alaska, with the Cascade Mountain Range creating the eastern boundary (Johnson et al. 1994). This subspecies exhibits both resident fluvial and adfluvial life history patterns (nonmigratory) and is the only subspecies to also exhibit an anadromous (sea-run) life history pattern (Behnke 1992).

Habitat

The life history of the coastal cutthroat is probably the most complex and flexible of any Pacific salmonid (Wydoski and Whitney 1979; Johnson et al. 1994). Cutthroat trout in the Lake Washington Basin exhibit fluvial, adfluvial, and anadromous life histories. Little is known about the relative proportion of each life history in this population, however there is little evidence that a large portion of the Lake Washington population exhibits an anadromous life history pattern.

Coastal cutthroat trout spawn in the smallest headwater streams and tributaries used by any salmonid species, and the young usually remain in these streams about a year before moving down into larger streams (Palmisano et al. 1993). Individuals that migrate to the sea live in these larger streams for another 2 - 5 years (usually 3) before migrating to the Pacific Ocean (Wydoski and Whitney 1979; Johnson et al. 1994). Because sea-run cutthroat spend a considerable proportion of their life cycle in fresh water, stream rearing habitat is a major factor in their survival and productivity (Palmisano et al. 1993). Some stocks, primarily those with limited or no possibility of return migration from the ocean, remain as residents of small headwater tributaries, or migrate only into rivers or lakes (Scott and Crossman 1973; Johnson et al. 1994). Sea-run cutthroat do not migrate to the open ocean; rather, they stay in estuarine habitats near the mouths of their migratory streams for 5-8 months of the year (Palmisano et al. 1993; Johnson et al. 1994). Upstream migration to freshwater feeding/spawning areas occurs from late June through March; re-entry timing is consistent from year to year within streams, but varies widely between streams (Johnson et al. 1994). Spawning generally occurs between December and May in the tails of pools located in streams with low gradient and low flows or in shallow riffles (Wydoski and Whitney 1979; Johnson et al. 1994). Eggs are usually laid under coarse gravel about the size of a walnut (Wydoski and Whitney 1979). Preferred water temperatures for spawning and incubation range from 6°C to 17°C; cutthroat are generally not found in waters above 22°C (Johnson et al. 1994).

Occurrence in the Cedar River Municipal Watershed

The City’s water diversion structures prevent coastal sea-run cutthroat from potentially accessing stream habitat in the watershed above the Landsburg Dam. Prior to construction of the dam, returning adults would have been able to access 17 stream miles in the mainstem Cedar River and tributaries between the naturally impassable Cedar Falls and the Landsburg Dam location. Currently, only the Walsh Lake subbasin in the watershed is potentially accessible to coastal sea-run cutthroat because this subbasin is connected to the Cedar River at a location below the dam (see Map 1). Although coastal cutthroat trout are widespread in this subbasin, it is unknown if sea-run individuals use this habitat.

Resident cutthroat trout are also widely distributed in many of the tributaries downstream of Cedar Falls (see Map 7). They have not been found in the upper municipal watershed. Potential habitats for this species in the watershed include well-shaded headwater streams with areas of low-gradient gravels suitable for redd construction.

Kokanee

Status

Legal Status. Kokanee (*Oncorhynchus nerka*) is not listed as an endangered, threatened, or candidate species at the federal level in Washington State. Kokanee is a resident freshwater form of the sockeye salmon, and is classified as a game fish species in Washington (WDW 1993).

Population Status. Kokanee populations generally exist independently of anadromous sockeye runs, although both forms can be found seasonally in the same lake. Kokanee and sockeye salmon presumably diverged from a common anadromous stock in recent geological time (Ricker 1940, as cited in Burgner 1991).

Range

Kokanee occur naturally in lakes from Japan around the Pacific Rim along the northwest coast of North America to Oregon, and into the Columbia Basin (Scott and Crossman 1973). Native kokanee are present in many Washington lakes, including Lake Washington and Lake Sammamish (Wydoski and Whitney 1979). They have also been successfully introduced into a number of inland lakes. Historical records indicate that kokanee were stocked throughout King County during the first half of the twentieth century, although the locations of where fish were planted is often nondescript.

Habitat

Kokanee typically inhabit deep, cool lakes and reservoirs. Their life history patterns and habitat needs are similar to those of the sockeye salmon, except that kokanee remain in fresh water and do not migrate to marine waters. Also, their smaller body size necessitates the use of smaller gravels for redd construction (Burgner 1991). Adults migrate into tributaries where spawning occurs in clean riffles, usually at temperatures between 37° and 45° F (Scott and Crossman 1973).

From Lake Washington, kokanee spawn in some of the smaller tributaries such as Juanita Creek, Bear Creek, and Swamp Creek (Wydoski and Whitney 1979). In the lake, some spawning also occurs along gravel lakeshores (WDW 1993). In this system, spawning takes place between early November and mid-January, with a peak in mid-November. Fry migrate to the lake between January and April, mostly in March (Wydoski and Whitney 1979).

Generally, kokanee spend 4 years in lake habitats before they mature, spawn, and die (Scott and Crossman 1973). Kokanee living in lakes exhibit a temperature preference of 50° to 59° F; the upper lethal temperature for young sockeye salmon is about 75° F (Scott and Crossman 1973). Kokanee use the upper third of a lake’s water column, feeding primarily on zooplankton and aquatic insect larvae (Scott and Crossman 1973; Wydoski and Whitney 1979).

Because of the kokanee’s diet and open water habitat, it competes very little with other fish, even those that feed upon plankton (Scott and Crossman 1973). Ongoing studies in Lake Washington however, have identified longfin smelt as a potential competitor during the first 1 or 2 months of lake rearing by sockeye fry. Although it is not uncommon for a lake to support both sockeye salmon and kokanee, the similarity of their diets suggests the potential for competition between these two forms (Burgner 1991).

Occurrence in the Cedar River Municipal Watershed

The presence of kokanee in Walsh Lake has been known to several people for at least a decade. The first systematic scientific survey that confirmed and documented their presence, however, was conducted only recently, in 1997 (Appendix 23). The same survey discovered bright-red kokanee spawning in October in Webster Creek, a small Walsh Lake tributary. It is unknown whether this population is native to the lake or was planted, but the probability is that the fish were most likely planted sometime during the recent past or during the first half of the twentieth century. Kokanee were not collected during a 1977 University of Washington fish survey (Congelton et al. 1977), and they were not mentioned in water quality reports from the 1920s.

Walsh Lake is the only lake within the Cedar River Municipal Watershed that was historically accessible to the anadromous form of sockeye because of the natural barrier to anadromous fish at lower Cedar Falls on the mainstem Cedar River. Kokanee are not known to have been stocked or to presently occur in any other lake or basin within the Cedar River Municipal Watershed.

Pacific Lamprey

Status

Legal Status. The Pacific lamprey (*Lampetra tridentatus*) is a federal species of concern in Washington. The species has no designated listing status at the state level in Washington.

Population Status. The limited amount of ecological information currently available about Pacific lamprey is insufficient to evaluate the species' population status in Washington State. However, in Oregon, this species is considered a species of concern, due primarily to its apparent widespread decline. Although the reasons for this decline are poorly understood, it is likely due to conditions both in oceanic and freshwater habitats; passage past hydroelectric and irrigation dams may also be a contributing factor (ODFW 1996). Notably, a related species, the Arctic lamprey (*Lampetra japonica*), faces significant mortality in late spring and summer when low stream levels leave burrowed ammocoetes (larvae) stranded in dry stream edges (Scott and Crossman 1973).

Range

The Pacific lamprey is found in coastal streams from southern California to the Gulf of Alaska; in Washington it occurs in most large coastal rivers (Wydoski and Whitney 1979). Scott and Crossman (1973) describe this species as "penetrating all major rivers, often to headwaters." Pacific lamprey have been seen in the Green River, sometimes spawning on steelhead redds (Foley, S., WDFW, June 29, 1998, personal communication).

Habitat

Like the river lamprey, the Pacific lamprey exhibits an anadromous life history, although landlocked populations have been reported from California, Oregon, and British Columbia (Wydoski and Whitney 1979; ODFW 1996). Adults are parasitic on a wide variety of fish, including sockeye and pink salmon (Scott and Crossman 1973). Between July and October, maturing Pacific lampreys enter streams, gradually move upstream, and spawn the following spring (Hart 1973). The nest usually consists of a shallow depression built in gravel and rock substrates, or in sandy gravel at the upstream edge of a riffle (Hart 1973; Scott and Crossman 1973). Eggs hatch in 2 - 4 weeks (19 days at 59° F); newly hatched larvae remain in their nests for 2 - 3 weeks before drifting downstream and burying themselves in mud at the bottom of pools, or other areas of soft mud and sand (Hart 1973; Moyle 1976). They remain as filter-feeders, subsisting on algae and organic matter for at least 5 years; if a particular area's food supply is exhausted, ammocoetes may emigrate to another area of the stream (Moyle 1976). Increased water flows during runoff can also encourage outmigration, by washing away sand and silt the larvae require for anchoring themselves to the bottom (Hardisty and Potter 1971). After transformation, Pacific lampreys migrate downstream in spring and start parasitic life soon thereafter. The length of the parasitic life phase is uncertain (Hart 1973; Wydoski and Whitney 1979). Adults die after spawning.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Pacific lamprey have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, some dead Pacific lamprey been confirmed below the Landsburg Diversion Dam (Foley, S., WDFW, June 29, 1998, personal communication).

Potential habitat for this species probably includes streams with gravel and small rock substrates for spawning, and downstream areas of soft mud or sand for rearing.

River Lamprey

Status

Legal Status. The river lamprey (*Lampetra ayresi*) is a federal species of concern in Washington, and is a candidate species at the state level in Washington.

Population Status. Little is known regarding the status of river lamprey populations in Washington. Population declines of the related Pacific lamprey (*Lampetra tridentatus*), primarily the result of destruction of spawning and rearing habitat, have prompted concern for the river lamprey species. Results of trawl surveys and surveys of sockeye smolts at the Ballard Locks indicate that river lamprey are a relatively common species in Lake Washington (Fresh, K., WDFW, 1998, personal communication).

Range

River lamprey have been collected from coastal streams and rivers from San Francisco Bay north to Juneau, Alaska (Wydoski and Whitney 1979). Scott and Crossman (1973) report that this species has been found in fresh and salt water across the same range. According to Wydoski and Whitney (1979), no detailed distribution records are available for Washington, but the species probably occurs in most major rivers. The regional distribution or river lamprey is relatively unknown because species identification of juvenile fish is rarely performed during river and stream surveys.

Habitat

Little is known regarding the habitat requirements of the river lamprey. Adults are anadromous and parasitic on a wide variety of fish, including coho salmon and kokanee (Scott and Crossman 1973), and on sockeye smolts while in the freshwater phase in Lake

Washington (Warner, E., Muckleshoot Indian Tribe, 1998, personal communication). River lamprey larvae (ammocoetes) remain in their natal streams for several years, usually in silt-sand backwaters and eddies near the bank (Hart 1973). The ammocoetes are toothless, and they feed on microscopic plants and animals (Scott and Crossman 1973; Hart 1973). In the final stages of metamorphosis, lampreys congregate just upstream from salt water, entering the ocean in late spring (Moyle et al. 1995). After transformation, lampreys apparently spend only 3-4 months in salt water, where they grow rapidly. Adults migrate back into freshwater in the fall, and spawn in the winter and spring in clean gravel areas of small tributaries (Moyle et al. 1995). Adults die after spawning.

Occurrence in the Cedar River Municipal Watershed

River lampreys are present and known to breed in tributaries of the Cedar River as far upstream as the Landsburg Diversion Dam. However, no comprehensive surveys have been conducted upstream of the Diversion Dam and no determination of the species' presence or absence within the Cedar River Municipal Watershed has been established.

Similar to the Pacific lamprey, potential habitat for the river lamprey probably includes streams with gravel and small rock substrates for spawning, and downstream areas of soft mud or sand for rearing.

MAMMALS

Big Brown Bat

Status

Legal Status. The big brown bat (*Eptesicus fuscus*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about big brown bats is insufficient to evaluate the species' population status in Washington State.

Range

The big brown bat occurs from Alaska and Canada south through the United States and Mexico to northern South America, including the Caribbean islands. It occurs throughout Washington, however, it is less common in alpine areas and perhaps less common in the driest parts of the Columbia Basin (Johnson and Cassidy 1997).

Habitat

The big brown bat is considered one of the most versatile of bats (Johnson and Cassidy 1997). In Washington, it has been found in almost every location where surveys have been conducted, although it is less common in alpine and steppe habitats (Johnson and Cassidy 1997). In wet coniferous forests such as those in western Washington, males occur at higher elevations than females (Johnson and Cassidy 1997). The big brown bat is closely associated with man, and uses human structures readily, even in urban areas (Johnson and Cassidy 1997).

Favored roost sites of the big brown bat are in buildings (Barbour and Davis 1969). In summer, the bats form colonies in attics and barns, behind shutters or unused sliding doors, between expansion joints beneath bridges or in similar shelters. Occasionally hollow trees and bark are used. West of the Mississippi River, these bats frequently use rock crevices and sometimes quarry tunnels. Maternity roosts are in buildings, under bridges, in snags, and in caves and mines (Christy and West 1993). In winter, they hibernate singly or in small groups in buildings, caves, mines, tunnels, quarries, storm sewers, and other similar shelters (Barbour and Davis 1969).

Big brown bats are insectivorous. The bulk of their diet consists predominantly of moths, flies, bugs, and beetles. They forage in a variety of locations, including over water, under forest canopies, along roads, in clearings and even in urban areas (Johnson and Cassidy 1997).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of big brown bats have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, Perkins (1988) documented big brown bats at two sites within 3 miles of the watershed during surveys in July 1988. Based on this observation and because the watershed is within the geographic and elevation range of the species in Washington, and because suitable roosting and foraging habitat is present, there is high likelihood that big brown bats occur, at least during summer, in the Cedar River Municipal Watershed. However, few potential natural hibernacula have been identified within the watershed, although a limited number of potential human-created hibernacula (buildings, mines) do exist.

Potential foraging habitats for big brown bats in the municipal watershed include mature to old-growth forests, forested areas in aquatic and riparian areas, open wetlands and other open water bodies, and naturally open habitats (meadows and persistent shrub communities). Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

California Myotis

Status

Legal Status. The California myotis (*Myotis californicus*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. Johnson and Cassidy (1997) consider the California myotis to be common in forested areas, and widely distributed but less common in steppe habitats in Washington. Little quantitative information is published on the status of California myotis populations in Washington.

Range

The California myotis can be found in most forested habitats in Washington, and occasionally in the steppe zone of eastern Washington, especially along watercourses (Johnson and Cassidy 1997).

Habitat

Little is known about the habitat requirements of this species (Johnson and Cassidy 1997). It probably does not breed at high elevations (Johnson and Cassidy 1997). In a field study in the southern Washington Cascades and the Oregon Coast Range, Thomas (1988) captured more California myotis in the western Cascades than in the eastern Cascades and the Oregon Coast Range. He also detected myotis bats (including California myotis) more frequently in old-growth Douglas-fir forests than in mature and young Douglas-fir forest (Thomas 1988). He hypothesized that the higher activity in old-growth stands "likely reflects an increased diversity and/or abundance of day roosts compared with young and mature stands" (Thomas 1988).

Roosting habitat for the California myotis includes buildings, bridges, hardwood foliage, bark, rock crevices, caves, mines, and snags (Christy and West 1993). Maternity roosts are in buildings, under bridges, and in caves and mines (Christy and West 1993). Buildings, caves, and mines are used as hibernacula (Christy and West 1993). Perkins et al. (1990) found hibernating bats in two caves in Oregon, and documented 19 records of California myotis hibernating in buildings.

California myotis are insectivorous. The bulk of their diet consists predominantly of moths, flies, bugs, and beetles. Thomas (1988) found that feeding rates for myotis bats (including California myotis) in the southern Washington Cascades and Oregon Coast Range averaged 10 times higher over water than in forest stands. He concluded that forest stands are not primary feeding sites for these bats.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of California myotis have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is within the geographic and elevation range of the species in Washington, and because suitable roosting and foraging habitat is present, there is moderate to high likelihood that California myotis occur, at least during summer in the Cedar River Municipal Watershed. However, few potential natural hibernacula have been identified within the watershed, although a limited number of potential human-created hibernacula (buildings, mines) do exist.

Potential foraging habitat for the California myotis in the municipal watershed includes open wetlands and other open water bodies, and naturally open habitats (meadows and persistent shrub communities). Potential roosting habitat includes old-growth forest, bridges, buildings, caves, cliffs, and rock outcrops.

Canada Lynx

Status

Legal Status. The Canada lynx (*Lynx canadensis*) has been proposed for listing as threatened under the Endangered Species Act by the U.S. Fish and Wildlife Service (Fed. Reg., July 8, 1998, Vol. 63, No. 130, pp. 36993-37013). The Canada lynx is a threatened species at the state level in Washington. The lynx is also considered a sensitive species by the U.S. Forest Service.

Population Status. Washington's lynx population is estimated to be between 96 and 191 individuals, with the populations responding largely to the abundance of their primary prey, snowshoe hare (WDW 1993c). In northern regions, where hare populations are strongly cyclical, lynx populations fluctuate widely; this pattern appears to be absent in the southern portion of the lynx's range (including Washington State), where lynx and snowshoe hares exhibit life history characteristics similar to those occurring during hare populations lows further north (Ruggiero et al. 1994). In this region, Koehler (1990) found high rates of kitten mortality during the snow-free season in north-central Washington, with only one kitten surviving to the winter from eight kittens present among three litters in July. Primary human-associated threats to lynx populations include the elimination of winter habitat for snowshoe hare and excessive trapping (Roderick and Milner 1991). Roads also provide a threat to lynx populations: lynx use roads for hunting and travel, which may make them more vulnerable to human-caused mortality (Ruggiero et al. 1994).

Range

Canada lynx in Washington are typically found at elevations above 3,200 ft (Brittell et al. 1989), and ranges from Canada into northeast and north-central Washington, eastward over the Cascade Crest and through the Okanogan Highlands into northern Idaho (McCord and Cardoza 1990; WDW 1993c; Ruggiero et al. 1994). Recent research has placed this species reliably as far south as the Yakima Indian Reservation, the Blue Mountains, and the Oregon Cascades (Thomas, T., Wildlife Biologist, U.S. Fish and Wildlife Service, Olympia, Washington, February 17, 1998, personal communication). In recent years, lynx have been found on the west side of the Cascade Crest only in the northern part of the North Cascades (Ruggiero et al. 1994). Ruediger and Naney (1994) identified primary and secondary habitat important to conservation of the lynx as part of the Lynx Conservation Strategy for the Western United States. In Washington, primary lynx habitat occurs primarily north of I-90 north to the Canadian border, while secondary lynx habitat occurs mostly in the Cascade Mountains from I-90 south to the Oregon border.

Habitat

Much of the information on lynx habitat use has been established in ecosystems (e.g., Okanogan Highlands, North Cascades) that are substantially different from those present within the municipal watershed (McCord and Cardoza 1990; Ruggiero et al. 1994). Therefore, the applicability of habitat associations documented in these areas to any lynx that may occur in the Cedar River Watershed is largely speculative.

Lynx are extremely wide-ranging, with home range size varying from between 7 and 115 square miles, depending on sex, age, season, and prey availability (WDW 1993c). This species typically occurs in very remote areas, using extensive tracts of dense forest that are interspersed with rock outcrops, bogs, and thickets (McCord and Cardoza 1990; Ruggiero et al. 1994). Lynx use a mosaic of forest types from early successional to mature coniferous and deciduous forest, as long as snowshoe hares are present (Ruggiero et al. 1994). In most areas, lynx forage primarily in early successional forests where snowshoe hares are plentiful; as a result, most lynx populations tend to rise and fall dramatically, tracking cyclical changes in snowshoe hare availability (Ruggiero et al. 1994). Populations in the southern portion of the range of the Canada lynx, however, do not exhibit the strong cyclical relationship with snowshoe hare abundance characteristic of more northern populations (Koehler 1990). Den sites for lynx tend to be located in patches of mature forest (less than 150 years) that are at least 5 acres in size; have abundant downed woody material; are undisturbed by humans; are within 3.4 miles of foraging areas; and are adjacent to natural travel corridors such as ridges and riparian areas (Koehler 1990; WDW 1993c).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Canada lynx have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, the Lynx Conservation Strategy (Ruediger and Naney 1994) places the watershed in the area designated as secondary lynx habitat within Washington State. High-elevation areas in the Cedar River Municipal Watershed offer vegetation types (mainly clearcuts), which may support adequate concentrations of snowshoe hare, and adjacent late-seral stands with potentially suitable denning structures. However, the small size of the watershed relative to lynx space requirements make it likely that only a few lynx would ever be resident in and include the watershed as a portion of their home range. In addition, the occurrence of reliable lynx sightings south of the watershed within the past 10 years suggests that an occasional individual may travel through the Cedar River Municipal Watershed (e.g., while dispersing).

Potential denning habitat for the lynx in the watershed includes late-successional forest above 3,500 ft elevation. Potential foraging habitat likely includes early seral coniferous forest, and other habitats where snowshoe hare are present.

Fisher

Status

Legal Status. The fisher (*Martes pennanti*) is a federal species of concern, and is listed as endangered at the state level in Washington.

Population Status. Fishers historically occurred at low densities throughout most of the forested areas of Washington (Lewis and Stinson 1998). The fisher was over-trapped in Washington in the 1800s and early 1900s, leading to population declines. Predator control programs and habitat loss and alteration (i.e., timber harvest) nearly caused the extirpation of the fisher in Washington early in the 1900s (Lewis and Stinson 1998). The fisher has been protected from legal harvest in Washington since 1933, but populations have not recovered.

Currently, the fisher is very rare in Washington (Lewis and Stinson 1998). Infrequent sighting reports and incidental captures indicate that a small number may still be present, but no one has been able to document the existence of a viable population in the state (Lewis and Stinson 1998). The lack of fisher detections despite extensive carnivore surveys since 1990, an average of less than four fisher sightings per year since 1980, and very few incidental captures by trappers all indicate that fishers are very rare in Washington and could be extirpated without intensive management efforts (Lewis and Stinson 1998).

Range

The present range of the fisher includes much of the forested region of Canada, New England, northern New York, and northern portions of Michigan, Minnesota, and

Wisconsin. Historically, the fisher occurred as far south as Tennessee and North Carolina in the Appalachian Mountains. In the western United States, the fisher occurs in the northern Rocky Mountains, and in the Cascades, Coast Ranges, and Sierra Nevada of Washington, Oregon, and California (Lewis and Stinson 1998).

On the basis of Aubry and Houston's (1992) review of fisher records and sighting reports in Washington from 1985-1991, the fisher is currently believed to occur in the Cascades (north of Skamania County), in the Olympic Mountains, and in eastern Washington in portions of the Okanogan Highlands. It probably occurs in very low numbers and in a patchy distribution (Aubry and Houston 1992). The fisher apparently is no longer found in the Blue Mountains, southern Coast Range, southernmost Cascades, Kitsap Peninsula, and eastern edge of Puget Sound (Aubry and Houston 1992). West of the Cascade crest, all trapping records of this species are from locations below 5,400 ft elevation and most (87 percent) are from locations below 3,000 ft (Aubry and Houston 1992).

Habitat

Fishers typically use forests with high canopy closure, abundant large woody debris, large snags and cavity trees, and understory vegetation (Buck et al. 1983; Arthur at al. 1989; Jones 1991; Powell 1993; Seglund 1995). They also use a wide variety of vegetation types, including mixed conifer, western hemlock, Pacific silver fir, Sitka spruce, grand fir/Douglas-fir, subalpine fir, and lodgepole pine forests; riparian zones; and swamps (Brown 1985b; Aubry and Houston 1992). Riparian areas, cliffs, ridgelines, and lakeshores located in and adjacent to forests are used by fishers for foraging and as travel corridors (Buck et al. 1983). Buck et al. (1983), Jones and Garton (1994), and Seglund (1995) have shown the importance of riparian habitats for fishers, especially as travel corridors and rest sites (Lewis and Stinson 1998).

Good quality fisher habitat appears to be very diverse, including multi-aged stands interspersed with small openings and containing wetland and riparian habitats that help support a diverse prey base (Banci 1989). Mature and old-growth forests and forested riparian areas with high canopy closure (at least 80 percent) seem to provide the most suitable habitat for this species, although second-growth and clearcuts can be used if sufficient cover is present (Buck et al. 1983; Jones 1991; Roy 1991; ODFW 1992; Jones and Garton 1994; Weir 1995). Stand age may not be as important as stand structural characteristics (e.g., large trees, snags, and large woody debris) that provide foraging, resting, and denning sites for fishers and also affect snow depth and density (Buskirk and Powell 1994; Powell and Zielinski 1994).

Fishers use a variety of structures in live trees and snags as rest sites, including cavities, witches' brooms, mistletoe clumps, large lateral branches, squirrel and woodrat nests, stick nests and forks (Lewis and Stinson 1998). Large diameter trees are used most often (Buck 1982; Seglund 1995; Weir 1995; Zielinski et al. 1997a). Fishers will also use hollow logs, stumps, log and brush piles, burrows, rock outcrops, and dense understory vegetation as rest sites (Lewis and Stinson 1998). Fishers appear to select rest sites based on thermal cover requirements; cavities and ground dens appear to be used more often in winter than are the more open live tree sites (Seglund 1995).

Female fishers typically use elevated cavities in live trees or snags as natal dens (Buck et al. 1983; Weir 1995; Aubry et al. 1996; Paragi et al. 1996). Maternal den trees are typically large (Lewis and Stinson 1998). When the young are older, the female may move them to a maternal den in a hollow, down log (Aubry et al. 1996). These conditions are usually found in forests greater than 80 years old (Thomas 1979). Holthausen et al. (1994) speculated that this specialized requirement for natal and maternal dens might have contributed to the fisher's decline in the Northwest as old-growth forests were cut and converted to even-age stands.

Allen (1983) estimated that at least 100 square miles of suitable, contiguous habitat with 80 percent tree canopy coverage is necessary for a population of fishers. Fisher home range sizes vary widely by region, but male home ranges in the Northwest typically are 15 to 31 square miles, while female home ranges are 8 to 15 square miles (Lewis and Stinson 1998). The fisher is characterized as a species that avoids humans (Douglas and Strickland 1987; Powell 1993).

The fisher's diet generally consists of snowshoe hares, small mammals, squirrels, porcupines, birds, and ungulate carrion (Lewis and Stinson 1998).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of fishers have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. A fisher sighting was recorded in the Cedar River Municipal Watershed in 1963, but despite numerous systematic surveys using track plates and camera stations (summarized in Lewis and Stinson 1998), no fishers have been detected in the vicinity of the Cedar River Municipal Watershed in recent years. Thus, although the watershed is within what is considered to be the current geographic and elevation (less than 5,900 ft) ranges of the fisher in Washington, and although at least some apparently suitable resting and foraging habitat occurs in the watershed, there is low probability that fishers presently occur in the Cedar River Municipal Watershed as resident individuals.

Potential denning and foraging habitat for the fisher in the municipal watershed includes mature, late-successional, and old-growth forests, particularly those below 3,000 feet elevation. Forested riparian areas provide additional foraging habitat and travel corridors.

Fringed Myotis

Status

Legal Status. The fringed myotis (*Myotis thysanodes*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The fringed myotis is a monitor species at the state level in Washington.

Population Status. As with most bats, data regarding population levels and trends for this species are unavailable; as a group, bats in Washington remain virtually unstudied (Christy and West 1993). Reliable records for the fringed myotis in Washington are few and limited to the eastern portion of the state (Johnson and Cassidy 1997). This species may be uncommon in Washington (Perkins et al. 1990). Causes for concern about this species include its general rarity, sensitivity to disturbance, and reduced availability of foraging habitat.

Range

The fringed myotis is patchily distributed over a broad range, extending from south-central British Columbia south to southern Mexico, and east to western Colorado and New Mexico (ODFW 1996). In Washington, the known distribution of the fringed myotis is limited to drier areas in the southeastern part of the state, and possibly the foothills of the southwestern Cascades near Vancouver, Washington (Johnson and Cassidy 1997). Bats that were probably fringed myotis were found in Ape Cave near Mount St. Helens in the 1960s, but heavy human use of the cave apparently caused the bats to move (Johnson and Cassidy 1997).

Habitat Needs

Habitat for the fringed myotis varies considerably, depending on seasonal and diurnal activity patterns. Between October or November and March or April, this species hibernates in caves, mines, rock crevices, or buildings (Christy and West 1993). After springtime emergence, the fringed myotis usually forages over water, along forest edges, and over open habitats; diet consists of beetles, moths, arachnids, and orthopterans, which are caught on the wing or gleaned from foliage (Christy and West 1993; Zeiner et al. 1990). During the day, fringed myotis roost singly in caves, mines, rock crevices, buildings, or under bridges. Similar habitats, although often in separate locations, provide nighttime roosts between feeding forays (Christy and West 1993). Most temperate bat species migrate relatively short distances (6.2 - 310.7 miles) to and from hibernation sites, although some individuals or populations may not migrate at all (Christy and West 1993). The fringed myotis is susceptible to human disturbance at roost sites (ODFW 1996; Zeiner et al. 1990).

From late April to September, pregnant and nursing females collect in large maternity colonies of up to 200 individuals; maternity roosts occur in caves, mines, and buildings (Zeiner et al. 1990; Christy and West, 1993). Temperature and humidity within hibernacula and maternity colonies must fall within certain narrow ranges to be suitable for most bat species, including the fringed myotis. Sites of maternity colonies are generally quite warm, while hibernacula must be cool (Christy and West 1993). Reproductive rates for myotis species are generally low, with females giving birth to one offspring per season (Christy and West 1993).

Although nonbiotic habitat features, such as caves, rock crevices, and water, appear to provide the crucial elements of the fringed myotis' life requisites, forest age also appears to play a role. Foraging activity drops substantially in areas that have been recently clearcut (Christy and West 1993). In the Oregon Coast Range, Thomas and West (1991) detected big brown bats and fringed myotis in old-growth forest 3.3 times more frequently than in mature and young forest.

The fringed myotis appears to be associated primarily with xeric forest types. In British Columbia, the fringed myotis is associated with arid grassland and ponderosa pine/Douglas-fir forest (Johnson and Cassidy 1997). Optimal habitats in California are pinyon-juniper, valley foothill hardwood, and hardwood-conifer, generally between 4,000 and 7,000 ft elevation (Zeiner et al. 1990). In Oregon however, most records for this species come from counties along the coastal strip, where mesic and moist forest types are more common (ODFW 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of fringed myotis have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. In addition, the watershed is not within the recognized or expected range of fringed myotis (reliable censuses lack in the region), no caves have been identified within the watershed, and although potential roost sites (rock crevices, buildings) do exist, it is unknown whether these provide suitable temperature and humidity regimes to support hibernacula or maternity colonies. Also, because ecological information about this species is severely lacking, it is not possible to evaluate the habitat suitability or assess habitat quality of forest types present in the watershed for fringed myotis. However, despite these potential constraints, there is a low to moderate likelihood that fringed myotis may occur in the Cedar River Municipal Watershed.

Potential foraging habitat for the fringed myotis in the municipal watershed includes open wetlands and other open water bodies, forest edges, and naturally open habitats (meadows and persistent shrub communities). Potential roosting habitat includes bridges, buildings, caves, cliffs, and rock outcrops.

Hoary Bat

Status

Legal Status. The hoary bat (*Lasiurus cinereus*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about hoary bats is insufficient to evaluate the species' population status in Washington State.

Range

The hoary bat is the most widespread of all bat species in the United States, occurring in all 50 states (Peterson 1964). It also occurs in the southern two-thirds of Canada and most of Mexico (Peterson 1964).

The hoary bat occurs primarily as a summer resident in low- to mid-elevation wooded areas throughout Washington. In the Columbia Basin it is found only where trees occur. It does not occur at high elevation (Johnson and Cassidy 1997). To date, no breeding females have been found in Washington (Johnson and Cassidy 1997).

Most hoary bats that are summer residents of the Pacific Northwest, Canada, and Alaska apparently winter in coastal areas of southern California and Mexico (Shump and Shump 1982).

Habitat

Hoary bats spend summer days roosting in the foliage of trees, and foraging at night in open areas, fields, and even around streetlights (Johnson and Cassidy 1997). In hardwood forests, they choose roost sites that are well covered above but open beneath, generally 10-15 ft above the ground (Constantine 1966) and usually at the edge of a clearing. Results of a survey in northwestern Oregon (Perkins 1983) suggest that hoary bats prefer mature or old-growth Douglas-fir forests, presumably because larger trees provide better roosts (Johnson and Cassidy 1997).

Hoary bats are insectivores that feed on the wing (aerial foragers) using echolocation to locate prey, and also glean insects from the ground and foliage using sight to locate prey (van Zyll de Jong 1985). Moths make up the bulk of the hoary bat's diet, but the species is also known to feed on flies, beetles, small wasps, grasshoppers, termites, and dragonflies. Hoary bats commonly feed along forest edges, roads, or open areas within the forest (Christy and West 1993).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of hoary bats have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is within the geographic and elevation range of the species in Washington and because suitable roosting and foraging habitat is present, there is moderate to high likelihood that hoary bats occur in the Cedar River Municipal Watershed.

Potential foraging habitat for the hoary bat in the municipal watershed includes forest edges and adjacent openings. Potential roosting habitat includes hardwoods and mature to old-growth conifer forest.

Keen's Myotis

Status

Legal Status. Keen's myotis (*Myotis keenii*) is not a listed species, candidate species, or species of concern at the federal level in Washington. Keen's myotis is a monitor species at the state level in Washington.

Population Status. Little is known about the status of Keen's myotis populations in the wild (Christy and West 1993). Keen's myotis is listed as an endangered species in British Columbia. Keen's myotis may be the least known of all bat species in the Pacific Northwest; virtually no research has been conducted on the species' basic ecology since it was proposed as a distinct species in 1979 (Christy and West 1993).

Range

Keen's myotis (*Myotis keenii*) has only been found in low-elevation forests in Puget Sound and the Olympic Peninsula in Washington, in coastal British Columbia, and in Alaska (Johnson and Cassidy 1997; Parker 1996). Difficulty in distinguishing Keen's myotis from long-eared myotis, which are sympatric over much of their range, has led to uncertainties about the range of Keen's myotis in Washington (Johnson and Cassidy 1997; van Zyll de Jong 1979). After reviewing the taxonomy and distribution of Keen's myotis and long-eared myotis, van Zyll de Jong and Nagorsen (1994) concluded that Keen's myotis is restricted to a relatively narrow coastal strip, largely coinciding with the distribution of coastal forest, while long-eared myotis occurred predominantly further inland.

Habitat

Little is known about the habitat requirements of Keen's myotis, but some data suggest that it prefers old-growth coniferous forests to younger forests (Thomas and West 1991), possibly because of the structural diversity of the older forests (Parker 1996; Johnson and Cassidy 1997).

According to Christy and West (1993), Keen's myotis has not been found roosting in man-made structures, and may rely entirely on natural roost sites. Keen's myotis were observed hibernating in a cave at 3,000 ft elevation on northern Vancouver Island, British Columbia in 1996 (Davis 1996). Air temperature within the cave (greater than 330 ft from an entrance) was stable at 37.7° F, with an outside daily variation of 0.9° F (Davis 1996). Relative humidity was at or near 100 percent (Davis 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Keen's myotis have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, on the basis of current knowledge of the distribution of Keen's myotis in Washington State (Johnson and Cassidy 1997), the species is unlikely to occur in the Cedar River Municipal Watershed.

The specific habitat elements which may provide foraging habitat for the Keen's myotis in the municipal watershed are unknown, but are probably similar to those of other *Myotis* species: naturally open habitats and open water. Potential roosting habitat likely includes caves, cliffs, and rock outcrops.

Little Brown Myotis

Status

Legal Status. The little brown myotis (*Myotis lucifugus*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. Little quantitative information has been published regarding the status of little brown myotis populations in Washington. It is considered to be one of the most abundant bats in the Pacific Northwest. Perkins (1988) found them at a number of locations throughout Olympic and Mt. Baker-Snoqualmie National Forests during surveys in summer 1988.

Range

The little brown myotis occurs throughout North America, and is considered the most abundant bat in the United States (Bourber and Davis 1969).

The little brown myotis occurs throughout Washington except at high elevations and in the driest parts of the Columbia Basin (Johnson and Cassidy 1997).

Habitat

The little brown myotis occurs in most forested habitats in Washington, as well as along riparian areas in the shrub-steppe zone of eastern Washington (Johnson and Cassidy 1997). It is one of the most common bats in urban areas because it readily uses human structures for roosts and will forage around streetlights (Johnson and Cassidy 1997). In the southern Washington Cascades and the Oregon Coast Range, Thomas (1988) detected *Myotis* bats (including little brown myotis) more frequently in old-growth Douglas-fir forests than in mature and young Douglas-fir forest. He hypothesized that the higher activity in old-growth stands “likely reflects an increased diversity and/or abundance of day roosts compared with young and mature stands” (Thomas 1988).

Roosting habitat for the little brown myotis includes buildings, bridges, bark, rock crevices, caves, and mines (Christy and West 1993). Maternity roosts are in buildings, under bridges, in snags, and in caves and mines (Christy and West 1993). Buildings, caves, and mines are used as hibernacula (Christy and West 1993). Perkins et al. (1990) found hibernating bats in a barn and a mine in Oregon. Little brown myotis were observed hibernating in a cave at 2,700 ft elevation on northern Vancouver Island, British Columbia in 1996 (Davis 1996). Air temperature within the cave was stable at 37.7° F, and relative humidity was at or near 100 percent (Davis 1996).

Little brown myotis are insectivorous. The bulk of their diet consists predominantly of moths, gnats, flies, bugs, and beetles. They concentrate on insects with aquatic larval stages, which is likely why they frequently forage over open water. Thomas (1988) found that feeding rates for myotis bats (including little brown myotis) in the southern Washington Cascades and Oregon Coast Range averaged 10 times higher over water than in forest stands. He concluded that forest stands are not primary feeding sites for these bats. In a Canadian study, little brown myotis were 75 times more active over lakes than in forested habitats (Lunde and Harestad 1986). Detections of little brown myotis declined substantially following forest clearcutting in British Columbia (Lunde and Harestad 1986), which may be a result of reduced availability of prey insects within recently clearcut areas or of nearby roosting structures in adjacent areas. Little brown myotis occur in urban areas, and commonly forage around street lights, over parks, and along city streets (Barbour and Davis 1969; Furlonger et al. 1987).

Occurrence in the Cedar River Municipal Watershed

Perkins (1988) documented the little brown myotis in the Cedar River Municipal Watershed in July 1988. They were seen, presumably foraging, at a beaver pond (Perkins 1988). Few potential natural hibernacula or mines have been documented in the watershed.

Potential foraging habitat for the little brown myotis in the municipal watershed includes open wetlands and other open water bodies, and naturally open habitats (meadows and persistent shrub communities). Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

Long-eared Myotis

Status

Legal Status. The long-eared myotis (*Myotis evotis*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The long-eared myotis is a monitor species at the state level in Washington.

Population Status. The amount of ecological information currently published about long-eared myotis and their population status in Washington State is limited. However, according to Johnson and Cassidy (1997), the long-eared myotis “is said to be the most widely distributed bat in eastern Oregon, the most abundant bat in northeastern Oregon, and the most abundant bat in lodgepole pine forests in Washington." The species may be relatively more abundant on the east side of the state than the west (Johnson and Cassidy 1997).

Range

The long-eared myotis occurs in western North America, from British Columbia, southern Saskatchewan and Alberta south along the Pacific coast to Baja California and east to Montana, Idaho, the Dakotas, Utah, Nevada, Wyoming, Colorado, New Mexico and Arizona (ODFW 1996).

The long-eared myotis occurs throughout Washington except in the driest parts of the Columbia Basin (Barbour and Davis 1969; Johnson and Cassidy 1997).

Habitat

Long-eared myotis have been found in a variety of habitats such as mature and immature conifer, alder/salmonberry, arid grasslands, and shrub-steppe (Maser et al. 1981; Nagorsen and Brigham 1993). Cross (1976) found them across southern Oregon in mixed conifer, ponderosa pine, and shrub-steppe habitats. Perkins (1982, 1983) found long-eared myotis in agricultural and riparian areas, oak woodlands, mature conifer forest, Douglas-fir forest (all age classes), and old-growth true fir forest in western and northwestern Oregon. In the southern Washington Cascades and the Oregon Coast Range, Thomas (1988) detected *Myotis* bats (including long-eared myotis) more frequently in old-growth Douglas-fir forests than in mature and young Douglas-fir forest. He hypothesized that the higher activity in old-growth stands "likely reflects an increased diversity and/or abundance of day roosts compared with young and mature stands" (Thomas 1988).

Long-eared myotis use buildings, bridges, rock crevices, pieces of loose bark attached to trees, and snags as day roosts (Maser at al. 1981; Christy and West 1993). Maternity roosts and hibernation sites have been documented in buildings, caves, mines, and rock fissures (Cross 1977; Cross and Schoen 1989; Perkins et al. 1990; Nagorsen and Brigham 1993). Maternity colonies of 12 - 30 individuals have been found in buildings and hollow trees (Maser et al. 1981).

Long-eared myotis are insectivores. Major food items in two Oregon studies were found to be moths, flies, beetles, bees, and ants (Whitaker et al. 1977; Whitaker et al. 1981). The species obtains its prey by aerial foraging and gleaning from foliage. Thomas (1988) found that feeding rates for myotis bats (including long-eared myotis) in the southern Washington Cascades and Oregon Coast Range averaged 10 times higher over water than in forest stands. He concluded that forest stands are not primary feeding sites for these bats.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of long-eared myotis have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is within the geographic and elevation range of the species in Washington, and because suitable roosting and foraging habitat is present, there is moderate to high likelihood that long-eared myotis occur, at least during summer, in the Cedar River Municipal Watershed. However, few potential natural hibernacula have been identified within the watershed, although a limited number of potential human-created hibernacula (buildings, mines) do exist.

Potential foraging habitat for the long-eared myotis in the municipal watershed includes open wetlands and other open water bodies, forest edges, and riparian corridors. Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

Long-legged Myotis

Status

Legal Status. The long-legged myotis (*Myotis volans*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The long-legged myotis is a monitor species at the state level in Washington.

Population Status. The amount of ecological information currently published about log-legged myotis and their population status in Washington State is limited. However, Perkins (1988) found them at several locations in Olympic and Mt. Baker-Snoqualmie National Forests during surveys in summer 1988. According to Johnson and Cassidy (1997), "One researcher estimated that this species is probably the second most abundant bat in northeastern Oregon forests."

Range

The long-legged myotis occurs in western North America from southeast Alaska and western Canada to central Mexico.

The long-legged myotis can be found throughout Washington except for the driest parts of the Columbia Basin (Barbour and Davis 1969; Johnson and Cassidy 1997). According to Johnson and Cassidy (1997), the long-legged myotis "is one of the few myotis bats that regularly occurs at high elevations in cool, wet forests."

Habitat

The long-legged myotis occurs in a variety of habitats such as immature and mature conifer forests, alder forests, and arid rangelands (Maser et al. 1981; Nagorsen and Brigham 1993). Foraging habitat includes all seral stages, but there is a preference for young forest (Brown 1985); they also forage over open water (ODFW 1996). Cross (1976) found them across southern Oregon in all major habitats outside the coastal zone, including oak woodland, mixed evergreen, mixed conifer, ponderosa pine, and shrub-steppe; greatest numbers were encountered in ponderosa pine. Perkins (1982, 1983) reported them from agricultural and riparian areas, oak woodlands, Douglas-fir forest (all age classes), and old-growth true fir forest in western and northwestern Oregon. In the southern Washington Cascades and the Oregon Coast Range, Thomas (1988) detected long-legged myotis more frequently in old-growth and mature Douglas-fir forests than in young Douglas-fir forest. He hypothesized that the higher activity in old-growth stands "likely reflects an increased diversity and/or abundance of day roosts compared with young and mature stands" (Thomas 1988).

Roosts are located in buildings, bridges, crevices in rock cliffs, fissures in the ground, snags, and under large pieces of still-attached tree bark (Nagorsen and Brigham 1993). Ormsbee (no date, as cited in ODFW 1996) found females day-roosting in large-diameter (greater than 39 inches) snags of western redcedar and Douglas-fir along forest edges and in open habitat. The long-legged myotis uses buildings, rock crevices, and trees for maternity colonies (Barbour and Davis 1969; Nagorsen and Brigham 1993). Maternity colonies may contain several hundred individuals (Maser et al. 1981). Hibernation sites occur in caves and mines (Cross 1976; Cross and Schoen 1989; Perkins et al. 1990; Cross and Walden 1994 and 1995; Cross and Kerwin 1995). Long-legged myotis were observed hibernating in a cave at 2,700 ft elevation on northern Vancouver Island, British Columbia in 1996 (Davis 1996). Air temperature within the cave (greater than 300 ft from an entrance) was stable at 37.7° F, with an outside daily variation of 0.9° F (Davis 1996). Relative humidity was at or near 100 percent (Davis 1996).

The long-legged myotis is insectivorous, with moths, flies, bugs, and beetles forming the bulk of the diet (Whitaker et al. 1977; Whitaker et al. 1981). Thomas (1988) found that feeding rates for *Myotis* bats (including long-legged myotis) in the southern Washington Cascades and Oregon Coast Range averaged 10 times higher over water than in forest stands. He concluded that forest stands are not primary feeding sites for these bats.

Occurrence in the Cedar River Municipal Watershed

Long-legged myotis are present in the Cedar River Municipal Watershed. (This determination is based on a single observation of several individuals, presumably foraging, at a beaver pond in July 1988 (Perkins 1988)). No comprehensive surveys to determine the distribution, population size, or to detect breeding activity of long-legged myotis have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented since the July 1988 sighting.

Potential foraging habitat for the long-legged myotis in the municipal watershed includes open wetlands and other open water bodies, forests (all seral stages), and riparian corridors. Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

Marten

Status

Legal Status. The marten (*Martes americana*) is not a listed species, candidate species, or species of concern at the federal level in Washington State. It is considered a game species by Washington State (WDFW 1996).

Population Status. Marten populations in Washington State are considered to be healthy enough to manage as a game species.

Range

The marten occurs throughout the coniferous forests of Canada, Alaska, and the 11 western states except Arizona (Roderick and Milner 1991). To the east, its range includes northern Michigan and Minnesota, northern New York, and the New England states. It was extirpated from the southeastern portion of its historic range between 1850 and 1875, and from adjacent areas by the early 1900s (Hagmeier 1956).

In Washington, the marten occurs in mountain ranges that provide preferred coniferous forest habitat (Cascades, Olympics, Selkirks, Okanogan Highlands, Blue Mountains) (Johnson and Cassidy 1997).

Habitat

Martens are closely associated with late-successional stands of mesic conifers, especially those with complex physical structure at ground level, such as fallen trees, lower branches of living trees, rock fields, dense ground vegetation (Buskirk and Powell 1994). Martens may inhabit talus fields above tree line (Grinnell et al. 1937; Streeter and Braun 1968), but are seldom found in xeric forest types (Buskirk and Ruggiero 1994) or below the lower elevational limit of trees (i.e., forest-steppe ecotone). Jones and Raphael (1990) reported that old-growth forests within the Pacific silver fir and western hemlock zones in the western Cascades were preferred by marten. Canopy closure averaged 71 percent (Jones and Raphael 1990). Clearcuts were used less than expected from their availability (Buskirk and Ruggiero 1994). In Okanogan County, Koehler et al. (1990) found most marten tracks in stands dominated by Engelmann spruce, subalpine fir, and lodgepole pine greater than 82 years of age. In the northern Rocky Mountains, marten have preferred forest stands dominated by mesic subalpine fir, and lodgepole pine (Buskirk and Ruggiero 1994).

Marten use of riparian areas has been reported in several studies. Buskirk et al. (1989) reported that marten showed a preference for riparian areas for resting, while Spencer and Zielinski (1983) reported marten foraging in riparian areas. Jones and Raphael (1990) also reported that marten made heavy use of areas close to streams.

Snags and down woody debris are important to marten because they provide resting spots and den sites, and habitat for prey (Johnson and Cassidy 1997). In a study in the western Washington Cascades, Jones and Raphael (1990) reported that marten preferred larger trees, snags, and fallen trees for resting. In a study in the central Oregon lodgepole pine ecosystem, marten were most frequently found resting in artificial structures (debris piles, tree stumps, cabins); natural woody debris, snags, and live trees were also used (Raphael and Jones, in press). Denning sites were primarily in natural woody debris, but artificial structures, standing dead trees, and live trees were also used (Raphael and Jones, in press). Corn and Raphael (1992) showed that marten gain access to subnivean spaces via openings created by coarse woody debris at low snow depths, and lower branches of live trees in deep snow. In the central Oregon study, Raphael found that many subnivean resting sites were in windthrown areas with stacked, multiple logs.

Marten normally avoid habitats that lack overhead cover (Buskirk and Ruggiero 1994). Martens will use small clearcuts, burns, and meadows for feeding in the summer if suitable prey are available (Johnson and Cassidy 1997). Summer use of nonforested habitats above tree line, especially talus fields, in mountainous area has been reported (Buskirk and Ruggiero 1994).

Marten eat small mammals such as red-backed voles, meadow voles, tree squirrels, and ground squirrels. Snowshoe hares, birds and their eggs, fruits, and insects may also constitute an important part of the marten’s diet on a seasonal basis (Strickland et al. 1982).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of martens have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, in numerous systematic surveys using track plates and camera stations conducted in recent years (summarized in Lewis and Stinson 1998), marten have been detected in the vicinity of the Cedar River Municipal Watershed (e.g., at Hyak Lake on Snoqualmie Pass, which is within 4 miles of the eastern end of the watershed). In addition, the Watershed is within what is considered to be the current geographic and elevation ranges of the marten in Washington and suitable resting and foraging habitat appears to be present. Thus, it is likely that marten presently occur in the Cedar River Municipal Watershed.

Potential denning and foraging habitat for the marten in the municipal watershed includes mature, late-successional, and old-growth forests. Forested riparian areas also provide resting and foraging habitat.

Masked Shrew

Status

Legal Status. The masked shrew (*Sorex cinereus*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. Johnson and Cassidy (1997) state that the masked shrew "is rare over much of Washington," but also note that it is locally common in such places as southern Stevens County.

Range

According to Johnson and Cassidy (1997), the masked shrew occurs "in a wide variety of habitats on this continent (and in Asia)…." In Washington, it occurs on the Olympic Peninsula as far south as Ocean City, on both sides of the Cascade Range, and in northeastern Washington from 2,300 ft up to 6,000 ft elevation (Johnson and Cassidy 1997). It avoids dry habitats such as the shrub-steppe zone of eastern Washington, and is not found in the Puget Trough.

Habitat

The masked shrew occurs in a variety of habitats in Washington, ranging from sea level near the Strait of Juan de Fuca to timberline in the Cascades. It appears to be limited to forested habitats, including alder and willow thickets and forested riparian areas (Johnson and Cassidy 1997). In the Cascades it occurs in all forest types up to tree line. In northeastern Washington, it has been found in all forest types ranging from Douglas-fir at lower elevations up through subalpine fir at higher elevations (Johnson and Cassidy 1997). The masked shrew is said to prefer moist woodlands with abundant plant cover, thick leaf litter, and decaying logs (Kurta 1995).

The masked shrew is insectivorous, and feeds on a wide variety of invertebrates such as caterpillars, beetles, grubs, crickets, moths, ants, slugs, snails, spiders, earthworms, and centipedes.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of masked shrews have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is well within the masked shrew's geographic range and because suitable habitat for the shrew occurs in the watershed, it is highly likely that the masked shrew is both present and breeding in the Cedar River Municipal Watershed.

Potential habitat for the masked shrew in the watershed includes wetlands (especially scrub-shrub and forested), streams, and riparian areas.

Northern Water Shrew

Status

Legal Status. The northern water shrew (*Sorex palustris*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. Little information is available regarding the status of water shrew populations in Washington, but they are assumed to be relatively common wherever appropriate habitats occur.

Range

The water shrew occurs in montane and boreal areas of North America below tree line, from Alaska to the Sierra Nevada, and in the Rocky and Appalachian mountains.

In Washington, the water shrew is found in forested areas of the state where topography is steep enough to produce small, clear, cold streams. This type of topography can be found in the Olympic Peninsula, on both sides of the Cascades, in northeastern Washington, and in southeastern Washington (Blue Mountains) (Johnson and Cassidy 1997). The species does not occur in the relatively flat southwestern portion of the state, the Puget Trough, or the dry Columbia Basin (Johnson and Cassidy 1997).

Habitat

The northern water shrew is strongly dependent on microhabitats associated with cold, clear water in small streams, ponds, and forested wetlands with abundant cover, such as overhanging banks, holes in banks, and overhanging vegetation on banks (Johnson and Cassidy 1997). These requirements are most frequently met in relatively steep, mid- to high-elevation forested areas in Washington. The species does not occur along large streams and rivers or large lakes, presumably because the water is too warm (Johnson and Cassidy 1997).

Water shrews are divers, and often enter the water to feed or to elude predators (Banfield 1974). They are primarily insectivorous, feeding on a variety of primarily aquatic macroinvertebrates, such as stonefly nymphs, mayflies, and caddis flies (Beneski and Stinson 1987). They also eat earthworms, crickets, leeches, spiders, and may even eat fish (Beneski and Stinson 1987).

Occurrence in the Cedar River Municipal Watershed

The northern water shrew is known to be present in the Cedar River Municipal Watershed.

Potential habitat for the northern water shrew in the watershed includes wetlands (especially scrub-shrub and forested), streams, and riparian areas.

Silver-haired Bat

Status

Legal Status. The silver-haired bat (*Lasionycteris noctivagans*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about silver-haired bats is insufficient to evaluate the species' population status in Washington State.

Range

The silver-haired bat occurs in suitable habitat throughout much of North America, from Alaska to the Mexican border (Kunz 1982). It is found throughout forested areas of Washington from sea level probably into alpine parkland (Johnson and Cassidy 1997). The majority of silver-haired bats in the Pacific Northwest are apparently migratory, although a small portion of the population winters in the Pacific Northwest (Perkins et al. 1990). No hibernating silver-haired bats were located during cave and mine searches in Oregon and Washington from 1982 to 1989 (Perkins et al. 1990), but a number of individuals, primarily juvenile males, have been found during winter in Oregon, Washington, and British Columbia (Schowalter et al. 1978b). There appears to be some sexual segregation in the silver-haired bat during the breeding season. In Washington, females generally occur only east of the Cascades during spring and summer, but the distribution of sexes becomes more even by August (Perkins and Cross 1991).

Habitat

Silver-haired bats are closely associated with forests (Johnson and Cassidy 1997) and appear to be most abundant in old-growth Douglas-fir/western hemlock forests. They are less abundant in ponderosa pine types and even less likely to be found in arid areas. Across southern Oregon, Cross (1976) found this species most frequently in areas having high snag densities. Thomas and West (1991) reported this species to be almost 10 times more likely to be detected in old-growth than younger stands in the Oregon Coast Range.

Roost sites are in cavities in snags, in crevices under the bark of old-growth Douglas-firs where the bark has separated from the bole of the tree, and in other types of cracks and crevices resulting from wind and lightning damage. Other day roosts have been documented in buildings, caves, and mines (Christy and West 1993). Maternity roosts are almost exclusively in cavities and crevices in snags and trees, including cavities excavated by woodpeckers. Hibernacula and solitary roosts are found in buildings, rock crevices, caves, mines, and in snags, and under bark (Christy and West 1993).

The silver-haired bat is insectivorous, with flies, beetles and moths comprising most of the diet. On a continental scale, Kunz (1982) reported this species forages over water at ponds, streams, and other water bodies, usually near conifers and/or mixed deciduous forests.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of silver-haired bats have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is within the geographic and elevation range of the species in Washington, and because suitable roosting and foraging habitat is present, there is moderate to high likelihood that silver-haired bats occur in the Cedar River Municipal Watershed. However, few potential natural hibernacula have been identified within the watershed, although a limited number of potential human-created hibernacula (buildings, mines) do exist.

Potential foraging habitats for silver-haired bats in the municipal watershed include mature to old-growth forests, forested areas in aquatic and riparian areas, open wetlands and other open water bodies, and naturally open habitats (meadows and persistent shrub communities). Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

Townsend's Big-eared Bat

Status

Legal Status. Townsend's big-eared bat (*Plecotus townsendii*) is a federal species of concern and a state candidate species in Washington.

Population Status. According to Johnson and Cassidy (1997), "this bat is relatively widespread [in Washington], but there is much concern about the species' future because *P. townsendii* bats in hibernacula and maternity colonies are sensitive to disturbance."

Range

Townsend's big-eared bat occurs in western North America from southern British Columbia to northern Mexico and as far east as South Dakota, Oklahoma, and Texas (ODFW 1992). A narrow range extension extends into the central Atlantic states (Appalachian Mountains).

The species has been documented from a number of locations throughout Washington at elevations lower than 9,600 ft, except in the driest portions of the Columbia Basin (Johnson and Cassidy 1997).

Habitat

Townsend's big-eared bats have been documented from sea level to 9,600 ft (Pearson et al. 1952), but they occur chiefly at low to mid-elevations (Johnson and Cassidy 1997). The presence of suitable undisturbed roost, nursery, and hibernation sites is the most important habitat component dictating the presence of this species (ODFW 1992). Townsend's big-eared bat can occur in nearly any forest type as long as suitable roost, nursery, and hibernation sites are present (Roderick and Milner 1991). In a northwestern Oregon study, these bats were captured (by mist nets) only in mature or old-growth Douglas-fir forests (Perkins 1983).

These bats use caves, mines, buildings, and the undersides of bridges with appropriate temperature and humidity for maternity roosts, day roosts, and hibernation (ODFW 1992; Christy and West 1993). However, caves within clearcuts may not be suitable because the lack of vegetation can affect the cave's microclimate, depending on characteristics of the cave (e.g., number and size of entrances, length and overall volume of cave) (Roderick and Milner 1991). In addition, timber harvest activities around the mouth of a cave may disturb roosting, nursing or hibernating bats, causing them to die or abandon the cave. Townsend's big-eared bats are particularly sensitive to arousal during hibernation, as this can deplete necessary fat reserves and lead to death. Townsend's big-eared bats prefer cold areas near the entrance of caves as hibernacula (Barbour and Davis 1969; Humphrey and Kunz 1976). This makes them particularly susceptible to disturbance around the mouth of the cave. Townsend's big-eared bats are also very sensitive to disturbance while day roosting, because they hang directly from the ceiling of the roost and do not go into torpor during the day in summer colonies (Barbour and Davis 1969).

Food habits studies found that while Townsend's big-eared bat feeds on a variety of insects, its primary prey items are moths (Whitaker et al. 1981), which are obtained both by aerial foraging and gleaning from foliage (ODFW 1992). Townsend's big-eared bats have been observed foraging in upland habitats (forest edges, roads, open areas within the forest) more often than over water (Christy and West 1993).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Townsend's big-eared bats have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is within the geographic and elevation range of the species in Washington, and because suitable roosting and foraging habitat is present, there is moderate to high likelihood that Townsend's big-eared bats occur in the Cedar River Municipal Watershed. However, few potential natural hibernacula have been identified within the watershed, although a limited number of potential human-created hibernacula (buildings, mines) do exist.

Potential foraging habitats for the Townsend's big-eared bat in the municipal watershed include aquatic and riparian habitats, wet meadows, and old-growth forests. Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

Wolverine

Status

Legal Status. The wolverine (*Gulo gulo*) is a federal species of concern in Washington State. The wolverine is a candidate species at the state level in Washington.

Population Status. Wolverines historically occurred at low densities in the Cascades and in northeastern Washington (Johnson and Cassidy 1997). Wolverines declined throughout their range as a result of trapping and habitat loss and modification (Banci 1994). Johnson (1977) suggested that wolverines were present in the Cascade Range of Washington between 1890 and 1919, became absent or rare throughout the state from 1920 through 1959, and then expanded their range in the 1960s and 1970s by dispersal from Canada. Three wolverines, all adult males, were killed and another was seen in central and southern Washington counties in 1964 and 1965 (Patterson and Bowhay 1968). There are approximately 20 records for Washington for the period 1983 to 1993 (Maj and Garton 1994). The wolverine's current distribution and abundance in Washington are unknown (Banci 1994), but the population is certainly very low (Johnson and Cassidy 1997).

Range

Wolverines occur across the boreal and tundra zones of Europe and Asia as well as Canada and Alaska (Banci 1994). In the western United States, wolverines occur in Montana, Idaho, Wyoming, Colorado, Washington, Oregon, and California (Banci 1994).

In Washington, wolverines historically occurred in the Cascades and in northeastern Washington (Johnson and Cassidy 1997).

Habitat

Wolverines are wide-ranging animals that inhabit a variety of habitats, but are generally restricted to boreal forests, tundra, and remote, montane forest areas (Butts 1992). According to Banci (1994), researchers have generally agreed that wolverine "habitat is probably best defined in terms of adequate year-round food supplies in large, sparsely inhabited wilderness areas, rather than in terms of particular types of topography or plant associations" (Kelsall 1981). Banci (1994) believes this is true at the landscape level, but that stand-level habitat use has not been adequately investigated. In a Montana study, wolverines were relocated most frequently in medium density or scattered mature timber, and showed a preference for *Abies* forest types (Hornocker and Hash 1981). Wolverines tend to avoid clearcuts, although they have been observed crossing them (Hornocker and Hash 1981).

Limited information is available on natal dens in forested regions (Banci 1994). Natal dens in Montana were most commonly associated with snow-covered tree roots, log jams, or rocks and boulders (Hash 1987). In northern Lapland, most dens were associated with spruce trees; five were holes dug under fallen spruce trees, two were in standing spruce trees, and one was in a decayed, hollow spruce tree (Pulliainen 1968).

Wolverines appear not to tolerate land-use activities that permanently alter habitats, such as agriculture and urban development (Banci 1994). Remaining populations have been relegated to the last available habitat that has not been developed, extensively modified, or accessed by humans (Banci 1994). The presence of humans may conflict directly with wolverines (Banci 1994). Hornocker and Hash (1981) suggested that human access on snowmobiles or all-terrain vehicles in winter and early spring could disturb wolverine behavior.

All studies conducted to date have shown the importance of large mammal carrion as a principal constituent of the wolverine diet (Banci 1994). Banci (1994) states that "the availability of large mammals underlies the distribution, survival and reproductive success of wolverines." Snowshoe hares, porcupines, red squirrels, ground squirrels, and marmots can be important prey items depending on the geographic areas and season (Banci 1994).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of wolverines have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. No wolverines have been detected in the vicinity of the Cedar River Municipal Watershed, despite numerous systematic surveys conducted in recent years using track plates and camera stations (summarized in Lewis and Stinson 1998). Thus, there is low probability that wolverines presently occur in the watershed as resident individuals.

Patches of large-sized talus/felsenmeer, and mature to old-growth forest provide potential denning habitat for the wolverine in the municipal watershed, and prey species are available both inside and outside the boundaries of the watershed. In addition, the City of Seattle's policy of restricting public access to the Cedar River Municipal Watershed results in a significantly lower level of human activity within the watershed than on adjacent lands. The small size of the watershed relative to wolverine requirements for large amounts of space, however, make it likely that only a few resident wolverines (perhaps two or three at most) would ever use the watershed as a portion of their home range.

Yuma Myotis

Status

Legal Status. The Yuma myotis (*Myotis yumanensis*) is a federal species of concern in Washington State. The Yuma myotis is not listed as a threatened species, endangered species, or candidate species by the State of Washington.

Population Status. The amount of ecological information currently published about Yuma myotis and their population status in Washington State is limited. However, Perkins (1988) found Yuma myotis at a few locations in both Olympic and Mt. Baker-Snoqualmie National Forests during surveys in the summer of 1988.

Range

In Washington, the Yuma myotis is widespread in low- to mid-elevation coastal forests, ponderosa pine forests, Douglas-fir forests, and arid grasslands (Johnson and Cassidy 1997). The species is more closely associated with water than any other bat in Washington (Johnson and Cassidy 1997).

Habitat

The Yuma myotis uses a variety of low- to mid-elevation habitats, including coastal forests, Douglas-fir forests, and arid grasslands, as long as open water is nearby (Barbour and Davis 1969; Nagorsen and Brigham 1993). In the southern Washington Cascades and the Oregon Coast Range, Thomas (1988) detected *Myotis* bats (including Yuma myotis) more frequently in old-growth Douglas-fir forests than in mature and young Douglas-fir forest. He hypothesized that the higher activity in old-growth stands "likely reflects an increased diversity and/or abundance of day roosts compared with young and mature stands" (Thomas 1988).

Breeding habitats (maternity colonies) are frequently located in caves, mines, under bridges, and in buildings (Barbour and Davis 1969; Brown 1985b). This species is known to use snags in old-growth forests for maternity roosts (WDNR 1996). A colony of 2,000 female Yuma myotis had a nursery roost in the attic of an old church in British Columbia (Nagorsen and Brigham 1993) before the church was destroyed by fire. Yuma myotis may use buildings and rock crevices (Nagorsen and Brigham 1993), and cavities in snags as day roosts (WDNR 1996). Their roost sites are almost always located close to open water (Barbour and Davis 1969; Herd and Fenton 1983). Yuma myotis are known to hibernate in caves and mines (Christy and West 1993).

Yuma myotis are closely associated with water for foraging (Maser at al. 1981). Almost two-thirds of foraging time is spent over water (Brigham et al. 1992). Other foraging habitats include grass, shrub, and open sapling stages of hardwood and coniferous forests, as well as hardwood and coniferous wetlands (Brown 1985b).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Yuma myotis have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, because the watershed is within the geographic and elevation range of the species in Washington, and because suitable roosting and foraging habitat is present, there is moderate to high likelihood that Yuma myotis are present, at least during summer, in the Cedar River Municipal Watershed. However, few potential natural hibernacula or mines have been identified within the watershed.

Potential foraging habitat for the Yuma myotis in the municipal watershed includes open wetlands and other open water bodies, and naturally open habitats (meadows and persistent shrub communities). Potential roosting habitat includes bridges, buildings, snags, caves, cliffs, and rock outcrops.

AMPHIBIANS AND REPTILES

Cascades Frog

Status

<u>Legal Status</u>. The Cascades frog (*Rana cascadae*) is a federal species of concern, and is a monitor species at the state level in Washington.

<u>Population Status</u>. Since the mid-1970s, populations of this species have experienced marked declines in Oregon and California (ODFW 1996; Blaustein et al. 1995). One estimate is that 80 percent of 30 populations that have been monitored since the mid-1970s have disappeared at least temporarily (Blaustein and Wake 1990). Causes of population declines may include drought conditions, fish introductions, pathogens, habitat loss, and sensitivity to increased levels of ultraviolet radiation (Blaustein et al. 1995). Lehmkuhl and Ruggiero (1991) compiled a list of species associated with late-successional Douglas-fir forests in the Pacific Northwest and modeled the risk of local extinction for each species from habitat loss or fragmentation. This model was based on frequency of occurrence, abundance, body size, and vagility of various species. The Cascades frog was determined to be a species at moderately high risk (score of 8, where 1 is lowest and 10 is highest).

Range

The Cascades frog is a montane species found in the Olympic Mountains of Washington, and in the Cascade Mountains of Oregon, Washington, and northern California. This species generally occurs above 2,600 ft in elevation in montane meadows and slow-moving streams and ponds.

Habitat

Cascades frogs often are typically found in relatively small bodies of water rather than large lakes. Commonly used habitats include relatively small, unvegetated potholes and marshy areas (Blaustein et al. 1995), however Cascades frogs are occasionally found in forests away from water (Nussbaum et al. 1983). Breeding sites generally occur in shallow, gently sloping margins of pond or lakeshores, generally over soft substrates; eggs usually are laid in shallow water and may be partially exposed to the air (Leonard et al. 1993; Blaustein et al. 1995). Breeding begins as soon as the ice and snow melts in spring. Although the Cascades frogs' association with upland habitats is unknown, dispersal is limited by moisture-temperature conditions (Blaustein et al. 1995). Availability of closed-canopy forest and large woody debris may be a limiting factor in the ability of this species to disperse between potential breeding sites.

Occurrence in the Cedar River Municipal Watershed

Cascade frogs are present and known to breed in the Cedar River Municipal Watershed.

Potential breeding habitat for this species in the municipal watershed includes high-elevation ponds and meadows.

Cascade Torrent Salamander

Status

Legal Status. The Cascade torrent salamander (*Rhyacotriton cascadae*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The Cascade torrent salamander is a candidate species at the state level in Washington.

Population Status. Populations of this species are threatened by removal of riparian old-growth forests, changes in seep hydrology, and increased deposition of fine sediments in streams, primarily resulting from timber management activities (Corn and Bury 1989; Jennings and Hayes 1994; Diller and Wallace 1996). The apparently long (at least 6 years) sexual maturation period of this species makes populations particularly vulnerable to habitat disturbance (Nussbaum and Tait 1977; Jennings and Hayes 1994). Notably, the southern torrent salamander is intolerant to desiccation (Jennings and Hayes 1994).

Range

Until 1992, this species was considered to be part of a species complex known as the Olympic salamander, whose range extended from northern California to the Olympic Peninsula. This complex has now been split into four distinct species. The Cascade torrent salamander occurs along the western slopes of the Cascade Range from northeastern Lane County, Oregon, north to the vicinity of Mount St. Helens (Blaustein et al. 1995). The Washington GAP Analysis Project indicates the Nisqually River as the northern boundary of this species' range (Dvornich et al. 1997).

Habitat

Little has been written specifically about the habitat requirements of the Cascade torrent salamander because of its obscure life history and recent reclassification to species status. Most information comes from studies that did not distinguish among *Rhyacotriton* species, or that focused on other members of this species group. Much of the following discussion is based on studies of the southern torrent salamander (*Rhyacotriton variegatus*); because these two species were similar enough to be considered conspecific until very recently, the Cascade torrent salamander likely has similar habitat needs.

Small cold streams with water seeping through moss-covered gravel are preferred habitats for torrent salamanders (Blaustein et al. 1995). Breeding habitat for these species is generally considered to be forested permanent seeps, streams, and waterfalls with rocky substrates and cold temperatures (optimum 46 to 55°F); foraging occurs in moist areas in or near streams and seeps (Corn and Bury 1991; Leonard et al. 1993; Diller and Wallace 1996; Welsh and Lind 1996). Eggs may be laid at almost any time, but apparently most are laid in May (Blaustein et al. 1995). In California, oviposition appears to occur during fall or winter (Jennings and Hayes 1994).

Welsh and Lind (1996) found that the presence of seep habitat was the single best variable for predicting abundance of the southern torrent salamander in northwestern California. The ecological conditions found in late-successional forests (complex structure, deep litter layer, abundant downed woody debris, and dense herbaceous layer) are assumed to provide the adequate terrestrial and aquatic habitat conditions for torrent salamanders (Bury and Corn 1988; Welsh and Lind 1996). Significantly greater numbers of torrent salamanders have been found in older (greater than 200 years old) forest stands than in younger stands (Welsh and Lind 1988, 1991; Welsh 1990; Corn and Bury 1991). However, undisturbed forests and forests greater than 100 years old are also known to provide habitat for this species (Bury and Corn 1989; Diller and Wallace 1996; Welsh and Lind 1996). The Cascade torrent salamander does not seem to be as closely associated with mid- to late-seral forests as Columbia torrent (*R. kezeri*) and Olympic torrent salamanders (*R. olympicus*) (Dvornich et al. 1997).

Optimum substrate size and proportions to maintain adequate interstitial space used for cover and oviposition by this species consist of at least 68 percent gravel, boulder, and bedrock, and less than 50 percent cobble with gravel, with a low percent sand component (Diller and Wallace 1996; Welsh and Lind 1996). High-gradient stream reaches provide suitable habitat because they are transport areas where finer sediments do not accumulate and gravel and cobble do not become embedded (Diller and Wallace 1996).

Torrent salamanders apparently require fairly low ambient temperatures and high relative humidity. Extremely sensitive to body water loss, or desiccation, they die quickly in a dry environment. Other species of terrestrial salamanders can tolerate body water loss of 29 to 39 percent, but torrent salamanders can tolerate only a 19 percent loss (Nussbaum et al. 1983). Adults may occasionally be found under objects a few feet from water after heavy rains, but this is unusual (Nussbaum et al. 1983). Adults are highly aquatic, often occurring with the larvae in microhabitats. Torrent salamanders, especially larvae, use the crevices and interstitial spaces among and within rocks and rock surfaces to hide from predators. This microhabitat selection makes them highly sensitive to loss of these cover areas by infiltration of fine sediments. Large quantities of fine sediments can effectively fill these crevices making them inaccessible to even the smallest larva. Cloudy water from suspended sediment may also hamper hunting of small aquatic invertebrates (USDI 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Cascade torrent salamanders have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Based on range and habitat availability, torrent salamanders may potentially occur within the Cedar River Municipal Watershed. (Although the watershed is not within the range currently predicted for torrent salamanders, the range limit as currently defined may be an artifact of survey effort.)

Potential habitat for this species in the municipal watershed includes small cold streams and seeps within mature and old-growth forest habitats.

Larch Mountain Salamander

Status

Legal Status. The Larch Mountain salamander (*Plethodon larselli*) is a federal species of concern, and is a sensitive species at the state level in Washington. The species is also considered a "Survey and Manage" and a "Protection Buffer" species in the Northwest Forest Plan (USDA 1994), and a sensitive species by the U.S. Forest Service.

Population Status. Known populations of the Larch Mountain salamander are somewhat isolated, separated by large expanses of unsuitable habitat. The limited distribution, specialized habitat requirements, and low genetic diversity of this species suggest that populations are declining (Herrington and Larsen 1985). The ability of Larch Mountain salamanders to colonize new, unoccupied habitat is unknown. Thus, the future of this species depends upon protection of existing occupied habitat.

Removal of late successional habitat and destruction of talus fields by road construction, timber harvest, and gravel mining and development, are the primary threats to the Larch Mountain salamander (WDW 1993a). Lehmkuhl and Ruggiero (1991) compiled a list of species associated with late-successional Douglas-fir forests in the Pacific Northwest and modeled the risk of local extinction for each species from habitat loss or fragmentation. This model was based on frequency of occurrence, abundance, body size, and vagility of various species. The Larch Mountain salamander was determined to be a species at high risk (score of 9, where 1 is lowest and 10 is highest).

Range

Until recently, the Larch Mountain salamander was thought to be endemic to a narrow region where the Columbia River cuts through the Cascade Mountains between Washington and Oregon (Herrington and Larsen 1987). More recently however, populations of this species have been documented as far north as the vicinity of Kachess Lake, Kittitas County (Darda 1995; Foster Wheeler Environmental field survey data, 1997), and from the Green River Watershed immediately south of the Cedar River Municipal Watershed (Foster Wheeler Environmental field survey data, 1998).

Habitat

In the Columbia River Gorge area, suitable habitat for this species generally consists of forested and non-forested talus areas (Olson 1996). Such areas can occur on or near steep (greater than 40 percent) slopes, and in sites with sparse understories and high litter. Suitable habitat for the Larch Mountain salamander in the Washington Cascade range generally consists of forested talus or boulder fields, cave entrances (basalt tubes), and mature and old-growth forest. Individuals may also occur under exfoliated bark of large Douglas-fir snags and on steep (greater than 40 percent) slopes (Olson 1996). Notably, at two sites found in 1997 on the Mt. Baker-Snoqualmie National Forest, Larch Mountain salamanders were associated with Douglas-fir/western hemlock immature forest and rocky substrates, and one was found on a relatively flat slope. Two other sites also found in 1997 were on the Wenatchee National Forest in the Cle Elum Ranger District. On these sites, Larch Mountain salamanders were associated with fairly open talus (less than 30 percent canopy cover) near mature or old-growth forest.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Larch Mountain salamanders have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, based on range and habitat availability, Larch Mountain salamanders may potentially occur within the Cedar River Municipal Watershed.

Potential habitats for this species in the municipal watershed include forested areas with rocky substrates, talus patches with organic debris, and old-growth forest on steep slopes.

Long-toed Salamander

Status

Legal Status. The long-toed salamander (*Ambystoma macrodactylum*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington. (An isolated subspecies, *A. m. croceum* is federally listed as endangered in Santa Cruz and Monterey Counties, California).

Population Status. Concern for this species derives primarily from concern over population declines observed in other amphibian species both regionally and globally, although population trends for this species remain unknown. However, long-toed salamanders occur in a wide variety of habitats, and may be the most versatile amphibian in the Pacific Northwest (Corkran and Thoms 1996). Of 14 native amphibian species with the potential to occur in the western Washington Cascades, the long-toed salamander was the only species not included in a review of amphibians associated with old-growth forests in the Pacific Northwest (Blaustein et al. 1995).

Range

The long-toed salamander ranges from northern British Columbia south to northeastern California, and east to western Montana (Behler and King 1979). This species occurs throughout much of Washington except for the driest parts of the Columbia Basin (Nussbaum et al. 1983). It is also rare in or absent from most wet forest types of the western Cascades and Olympic Peninsula, occurring only in isolated open areas that might have once supported west-side prairies or bog meadows (Dvornich et al. 1997).

Habitat

The long-toed salamander occurs in a variety of habitats – including sagebrush steppe, dry woodlands, conifer forests, alpine meadows, and disturbed areas – from sea level to about 9,000 ft (Nussbaum et al. 1983; Corkran and Thoms 1996). Breeding occurs during winter to early spring, in seasonal pools, shallow lake edges, or very slow streams through wet meadows. Eggs are attached to submerged vegetation or pebbles (Leonard et al. 1993). Adults remain underground except when breeding, and may be found under rocks and logs during the rainy season (Corkran and Thoms 1996).

Occurrence in the Cedar River Municipal Watershed

Long-toed salamanders are present and known to breed in the Cedar River Municipal Watershed.

Potential breeding habitat for this species in the municipal watershed includes ponds, lakes, marshes, and slow-moving portions of rivers and streams.

Northwestern Salamander

Status

Legal Status. The northwestern salamander (*Ambystoma gracile*) (Figure 3.6-1) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. Egg masses of the northwestern salamander are frequently encountered in ponds in and near forested habitats throughout the western Washington Cascades; adults, however, are rarely seen (Leonard et al. 1993). Similar to those of the Cascades frog and western toad, eggs of the northwestern salamander are sensitive to ultraviolet light, showing decreased hatching success with increased levels of UV-B radiation; population declines have not been documented for this species, however (Hays 1996). Thomas et al. (1993) identified northwestern salamanders as being closely associated with old-growth forest conditions, and Lehmkuhl and Ruggiero (1991) put them at a medium risk of extinction, based on an assessment of their frequency of occurrence, abundance, body size, and vagility.

Figure 3.6-1. Northwestern salamander.

Range

The northwestern salamander ranges from southwestern Alaska through coastal British Columbia, western Washington and Oregon, south to northwestern California (Blaustein et al. 1995; Corkran and Thoms 1996). It occurs throughout western Washington and at a few sites immediately east of the Cascade crest (Dvornich et al. 1997).

Habitat

The northwestern salamander is found from sea level up to about 10,200 ft elevation in humid coniferous forests and subalpine forests (Nussbaum et al. 1983). Breeding occurs in early to mid spring, in relatively permanent quiet bodies of water (e.g., ponds, lakes, and slow parts of streams). Northwestern salamanders are absent from areas lacking aquatic habitat (Beatty et al. 1991; Blaustein et al. 1995; Corkran and Thoms 1996). Eggs are attached to the stems of emergent vegetation, 1.5-6 ft below the water surface (Corkran and Thoms 1996). Larvae remain in their natal ponds for 1-2 years before metamorphosis (Behler and King 1979). Terrestrial adults spend most of their lives underground, and may be found up to 1 mile from their breeding ponds (Nussbaum et al. 1983; Dvornich et al. 1997). Different studies have documented varying degrees of association with old forest, but northwestern salamanders generally show increased abundance with increasing forest age (Blaustein et al. 1995).

Occurrence in the Cedar River Municipal Watershed

Northwestern salamanders are widely distributed and known to breed in the Cedar River Municipal Watershed.

Potential breeding habitat for this species in the municipal watershed includes ponds, lakes, marshes, slow moving portions of streams.

Pacific Giant Salamander

Status

Legal Status. The Pacific giant salamander (*Dicamptodon tenebrosus*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. Concern for this species derives primarily from declines observed in other amphibian species regionally and globally, although population trends for this species remain unknown. Pacific giant salamander populations seem to be sensitive to land management practices, although the mechanism of their sensitivity is unclear (Blaustein et al. 1995).

Range

The Pacific giant salamander occurs from lower Sonoma County, California, through southwestern British Columbia (Blaustein et al. 1995). In Washington, it occurs in the Cascades primarily west of the Cascade crest, although it is also found in the east-central Cascades (Dvornich et al. 1997). It is also found in the eastern Puget Sound lowlands and in the southwestern part of the state (Dvornich et al. 1997).

Habitat

Pacific giant salamanders are restricted largely to moist coniferous forests and mountain lakes and streams from sea level to 7,100 ft elevation (Nussbaum et al. 1983). Terrestrial adults are common in many areas, but are nocturnal and secretive. They can be found under bark, logs, and rocks, and wandering about on the forest floor (Beatty et al. 1991). During the breeding season, they can be found in or near streams (Nussbaum et al. 1983; Stebbins 1985; Beatty et al. 1991). Eggs are laid in secluded microhabitats within cold, clear, lotic and lentic biological systems (Blaustein et al. 1995). Gomez (1992) found Pacific giant salamanders to be most abundant in riparian areas of mature and old-growth forests as compared to upland sites in young, deciduous forests.

This species requires access to large cover to avoid predators and to aid in hunting prey. Individuals often “sit and wait” under cover while hunting, although they will actively hunt. They are affected by increased sedimentation, as sediment-clouded water makes prey detection difficult. When substantial amounts of sediment fill spaces under large cover, these cover areas become unavailable to salamanders (Welsh and Ollivier 1992). Corn and Bury (1989, as cited in Blaustein et al. 1995) found high densities of giant salamanders only in high-gradient sections of logged reaches of streams; in uncut reaches, giant salamanders were found in both high- and low-gradient areas. These results were attributed to the increased levels of fine sediment present in low-gradient, logged areas.

Occurrence in the Cedar River Municipal Watershed

Pacific giant salamanders are widely distributed and known to breed in the Cedar River Municipal Watershed.

Potential habitats for this species in the municipal watershed include riparian areas and associated closed-canopy forest.

Northern Red-legged Frog

Status

Legal Status. The northern red-legged frog (*Rana aurora aurora*) (Figure 3.6-2) is a federal species of concern and a monitor species at the state level in Washington.

Population Status. Concern for this species derives from alarm at declining populations of ranid frogs regionally and worldwide. Red-legged frog populations seem to be declining in areas outside of old-growth forest; factors contributing to losses may include bullfrog introductions, pesticides, and herbicides (ODFW 1996).

Range

The red-legged frog is endemic to the Pacific coast of North America. The northern subspecies occurs from northern California to Vancouver Island, British Columbia (Behler and King 1979). In Washington, it occurs in the western Cascades (all vegetation zones up to and including western hemlock), in the Puget Sound lowlands, on the Olympic Peninsula, and in the southwestern part of the state (Dvornich et al. 1997).

Habitat

This species is found at lower elevations (below 2,800 ft) in moist and riparian forests, marshes, bogs, ponds, springs, seeps, and slow-moving streams (Nussbaum et al. 1983; Stebbins 1985; Blaustein et al. 1995). Although not restricted to old-growth habitat, red-legged frogs are frequently found in old-growth stands (Bury and Corn 1988). In southern Washington, Aubry and Hall (1991) found that this species was most abundant in mature stands and least abundant in young stands. Breeding occurs in small temporary ponds, relatively large lakes, in potholes, in overflows of lakes and rivers, or in slow-moving portions of a river (Blaustein et al. 1995). Early embryos can tolerate temperatures between 39°F and 69°F, a narrow range compared to other ranid frogs, and the time from hatching to metamorphosis is longer than in other species (Licht 1971 as cited in Blaustein et al. 1995). These findings suggest that red-legged frogs are more sensitive than other amphibians to changes in water levels and temperatures resulting from modification of adjacent forested habitat.

Occurrence in the Cedar River Municipal Watershed

Northern red-legged frogs are widely distributed and known to breed in the Cedar River Municipal Watershed

Potential breeding habitat for this species in the municipal watershed includes low- and mid-elevation ponds, wetlands, and slow-moving streams, particularly in areas of mature forest.

Figure 3.6-2. A clasped pair of red-legged frogs.

Roughskin Newt

Status

Legal Status. The roughskin newt (*Taricha granulosa*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The roughskin newt is perhaps the most common salamander in the Pacific Northwest (Nussbaum et al. 1983). Lehmkuhl and Ruggiero (1991) considered the roughskin newt to be at a medium risk of extinction when they assessed the viability risks of species associated with late-successional Douglas-fir forests in the Pacific Northwest.

Range

Roughskin newts range from southeast Alaska to central California, generally west of the crest of the Cascade Range (Blaustein et al. 1995). In Washington they are found in the western and the east-central and southeast Cascades, in the Puget Sound lowlands, on the Olympic Peninsula, and in the southwestern part of the state (Dvornich et al. 1997).

Habitat

The roughskin newt occurs in a variety of habitats in hilly or mountainous country from sea level up to 8,400 ft (Nussbaum et al. 1983). Roughskin newts are most common in mesophytic forests of conifers or hardwoods, although they also occur in open valleys and farmland (Nussbaum et al. 1983). Adults can be found in lakes, ponds, and sluggish streams or on land, either above or just under surface litter (Nussbaum et al. 1983; Dvornich et al. 1997). Most metamorphosed juveniles and adults live in or under soft logs, foraging on the forest floor during damp conditions; some adults however, remain wholly aquatic (Corkran and Thoms 1996).

Breeding occurs in ephemeral and permanent ponds and lakes, as well as streams in areas of slow-moving water (Blaustein et al. 1995). Quiet water with aquatic vegetation seems necessary for breeding, and sites with vegetation surrounding aquatic habitats may be preferred (Pimentel 1960 as cited in Blaustein et al. 1995). Eggs are laid singly, scattered throughout a pond, often attached to the undersurface of vegetation or under rocks (Blaustein et al. 1995; Corkran and Thoms 1996).

This species has been associated with old-growth forest in Washington, exhibiting a trend of increasing abundance with increasing forest age (Blaustein et al. 1995). This newt is the only member of the family Salamandridae to occur in the Pacific Northwest, and is the most aquatic species of its genus (Blaustein et al. 1995).

Occurrence in the Cedar River Municipal Watershed

Roughskin newts are present and known to breed in the Cedar River Municipal Watershed.

Potential breeding habitat for roughskin newts in the municipal watershed includes lakes, ponds, emergent wetlands, and slow-moving streams, particularly in close association with late-successional and old-growth forests.

Oregon Spotted Frog

Status

Legal Status. The Oregon spotted frog (*Rana pretiosa*) is a federal candidate species and a Washington State candidate species. The species is considered a sensitive species by the U.S. Forest Service.

Population Status. This species was considered conspecific with the Columbia spotted frog (*R. luteiventris*) until very recently, when spotted frog populations east of the Cascade Crest were reclassified as Columbia spotted frogs (Green et al. 1996). Limited distribution and isolation of Oregon spotted frog populations have prompted concern for this species' survival (WDFW 1994a). Loss of wetland habitat and/or alteration of the character of wetlands (i.e., introduction of non-native plants such as canary grass, grazing) have been the main reasons for decline of this species (McAllister and Leonard 1997). Other threats to this species include introduction of bullfrogs and predatory fishes, and susceptibility to toxic chemicals (WDFW 1994a; Hayes and Jennings 1986).

Range

Historically, the range of the Oregon spotted frog in Washington State was distributed through the lowlands of the Puget Trough from the Canada border south to Vancouver, Washington, and east into the southern Washington Cascades (McAllister et al. 1993; McAllister 1995; McAllister and Leonard 1997). It has been estimated that this species has been lost from over 90 percent of its original range (Hayes 1997). Three extant populations are known in Washington today: one in the south Puget Sound lowlands (Dempsey Creek) and two in the south-central Cascade Mountains (Trout Lake and Conboy Lake) (McAllister and Leonard 1997). No historical records are known within 6 miles of the Cedar River Municipal Watershed (Dvornich et al. 1997).

Habitat

This species is highly aquatic, inhabiting marshy ponds, streams, and lakes as high as 9,000 ft in parts of its range (Nussbaum et al. 1983). Wetlands must include a shallow emergent component to be capable of supporting spotted frogs (McAllister and Leonard 1997). Though not typically found under a forest canopy, Oregon spotted frogs have been found in riparian forests and areas with dense shrub cover (McAllister and Leonard 1997). This frog is not an old-growth forest obligate, but forested areas may represent important refugia from further population losses (Blaustein et al. 1995).

Stebbins (1985) suggests that this species is more common in relatively coldwater habitats than in warm, stagnant ponds; in Wyoming, however, stagnant pools are used for mating (Turner 1958). In Wyoming, oviposition sites usually occur in the shallow and warmest portions of a breeding pond (Morris and Tanner 1969). In Wyoming and British Columbia, eggs are laid in the open, in clear water, and are not attached to vegetation (Licht 1969; Morris and Tanner 1969). Washington Department of Fish and Wildlife (1994) reports that courtship and breeding occur in the warm, shallow margins of ponds or rivers, or in temporary ponds. Eggs are laid in water that is only a few inches deep, and are usually half-exposed to air. In the lowlands, western spotted frogs are active during February through October and hibernate in muddy bottoms in winter (WDW 1994).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Oregon spotted frogs have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date.

Potential breeding habitat for this species in the municipal watershed includes ponds and marshy areas at all elevations.

Tailed Frog

Status

<u>Legal Status</u>. The tailed frog (*Ascaphus truei*) is a federal species of concern and a monitor species at the state level in Washington.

<u>Population Status</u>. Populations of this species may be on the decline in Oregon (ODFW 1996). Local populations are highly susceptible to extirpation for several reasons, including narrow niche requirements combined with isolated population distribution, long generation time, and loss of mature forest along headwater stream habitats (Welsh 1990). Of seven Pacific Northwest anurans associated with old-growth forest, the tailed frog is probably the species most likely to be affected by old-growth habitat loss and degradation (Blaustein et al. 1995).

Range

The range of the tailed frog extends from southwest British Columbia through western Washington south to northwestern California (Leonard et al. 1993). In Washington, this species occurs in the Olympics, Cascades, and Blue Mountains, and the Willapa Hills of southwest Washington (Dvornich et al. 1997).

Habitat

Tailed frogs are adapted to cold, rocky streams, and their tadpoles are highly specialized for living in fast-moving streams (Leonard et al. 1993). Adults forage mainly on land along streambanks but also underwater, and seek cover under rocks and woody debris in streams (Zeiner et al. 1988). Numerous studies have documented a close association between tailed frogs and late-successional forest (Blaustein et al. 1995). Tailed frogs are sensitive to canopy disturbance and increased sedimentation associated with timber harvest and management operations, modification of historical flooding regimes, and grazing (Corn and Bury 1989; Welsh 1990; Jennings and Hayes 1994).

The tailed frog has been associated with many different forest types, including Douglas-fir, redwood, Sitka spruce, ponderosa pine, and western hemlock (Jennings and Hayes 1994). Older (greater than 200 years) multi-layer forests, downed woody material, ground-level vegetation, ground cover, and canopy closure are all important predictors of the occurrence of tailed frogs in northwestern California and southern Washington (Aubry and Hall 1991; Welsh et. al. 1993). Tailed frogs have also been found in younger-age stands, indicating that on occasion suitable microhabitat conditions appear to be met in forests less than 200 years old (Corn and Bury 1989; Aubry and Hall 1991); however, the quality of these stands for tailed frogs may be greatly reduced by timber management activities.

Breeding and developmental habitat for the tailed frog generally consists of permanent, cool (usually less than 59° F) streams with cobble/boulder substrate and woody debris (DeVlamin and Bury 1970; Welsh et al. 1993). These microclimatic conditions are typically associated with cold, clear headwater to mid-order streams in older forest ecosystems (Welsh et al. 1993). Breeding occurs during late August and September, eggs are laid during the summer, and larvae remain in water for 2 - 3 years (Nussbaum et al. 1983). Because of the tailed frog's exceptionally long period of larval and pre-reproductive adult development (estimated 7 to 9 years), populations are particularly vulnerable to habitat disturbance, and are slow to recover (Brown 1973; Daugherty and Sheldon 1982; Jennings and Hayes 1994).

Occurrence in the Cedar River Municipal Watershed

Tailed frogs are widely distributed and known to breed in the Cedar River Municipal Watershed. Larvae have been observed in numerous streams in both the upper and lower sections of the municipal watershed, and have been incidentally captured during fish distribution surveys and other stream monitoring activities (City of Seattle, unpublished data).

Potential habitat for the tailed frog in the municipal watershed includes clear, cool streams, particularly where associated with mature or old-growth forest.

Van Dyke's Salamander

Status

Legal Status. Van Dyke's salamander (*Plethodon vandykei*) is not a listed species, candidate species, or species of concern at the federal level in Washington. Van Dyke's salamander is a candidate species at the state level in Washington. Its apparent association with riparian habitats in mature and old-growth forests led to this species' inclusion in the list of Survey and Manage species in the Northwest Forest Plan (USDA 1994).

Population Status. Limited distribution and isolation of Van Dyke's salamander populations have prompted concern for this species' survival (WDW 1994). Lehmkuhl and Ruggiero (1991) compiled a list of species associated with late-successional Douglas-fir forests in the Pacific Northwest and modeled the risk of local extinction for each species from habitat loss or fragmentation. This model was based on frequency of occurrence, abundance, body size, and vagility of various species. The Van Dyke's salamander was determined to be a species at high risk (score of 9, on a scale of 1 to 10, with 10 being the highest). Similarly, Thomas et al. (1993) identified this as a high-risk species, closely associated with old-growth forest conditions.

Range

Van Dyke's salamander is endemic to Washington, occurring in three population centers: the Cascade, Willapa, and Olympic Ranges (Leonard et al. 1993). In the Cascade Range, it is known from 26 sites west of the crest to the Puget Trough, from central Skamania County in the south to the north end of Mt. Rainier in the north (Jones 1998). Populations are patchily distributed and of low density; much potential habitat appears to be unoccupied (Blaustein et al. 1995; Jones 1998). Although it is more than 20 miles north of any known Van Dyke's salamander populations, the Cedar River watershed is included within the potential range of this species as it is defined for the Northwest Forest Plan Survey and Manage requirements (Jones 1998).

Habitat

Van Dyke's salamanders are most commonly associated with headwater streambank or seep habitats, often in mature and old-growth coniferous forests (Roderick and Milner 1991; Jones 1998). The Van Dyke's salamander is considered to be the most aquatic species of woodland salamander (Leonard et al. 1993); it has also been collected at considerable distances from free water, however, usually in microhabitats that retain moisture, such as north-facing slopes (Blaustein et al. 1995; Jones 1998). The species is typically located in the splash zone of creeks under rocks, logs, and wood debris (Leonard et al. 1993). It has also been found in wet talus, forest litter, lava tubes, and along montane lakeshores (Roderick and Milner 1991; Jones 1998). Two nests have been reported for this species: one was inside a partially rotten log alongside a stream (Jones 1989 as cited in WDW 1994), another was under a moss-covered stone (Nussbaum et al. 1983)

The principal management recommendation of WDW (1991) is the maintenance of riparian corridors along all stream types, but especially Type IV and V Waters. Additional recommendations exist for protection of wet talus where the species is known to occur.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Van Dyke's salamander have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, based on range and habitat availability, Van Dyke's salamanders may potentially occur within the

Cedar River Municipal Watershed, although the northernmost recorded observation of this species is in Pierce County, approximately 31 miles south of the watershed.

Potential habitats for the Van Dyke's salamander in the municipal watershed include forested seeps and springs, wet talus, and riparian habitats along Type IV and V streams in mature and old-growth coniferous forest.

Western Pond Turtle

Status

Legal Status. The western pond turtle (*Clemmys marmorata*) is a federal species of concern and is listed as a state endangered species in Washington.

Population Status. Removal of habitat, predation from introduced bullfrogs, introduction of non-native species, and pollution are some factors known to negatively affect western pond turtle populations (Holland and Bury 1991).

Range

Documented observations of western pond turtles in Washington appear to be clustered around the southeastern edge of Puget Sound and along a small portion of the Columbia River (Nussbaum et al. 1983; WDW 1993b). Populations are confirmed only in Klickitat and Skamania counties, with recent individual sightings documented in Pierce and King counties (WDW 1993b). Historical records also exist in Clark and Thurston counties (WDW 1993b). One historical record exists near the western end of the Cedar River Municipal Watershed (Dvornich et al. 1997).

Habitat

The western pond turtle forages in marshes, sloughs, moderately deep ponds, and slow-moving portions of creeks and rivers. Resting habitat includes emergent basking sites such as partially submerged logs, vegetation mats, rocks, and mud banks (Nussbaum et al. 1983). Evenden (1948) reported two records of pond turtles occurring in rapid-flowing, clear, cold, rock and gravel streams in the Cascade foothills. Pond turtles hibernate in bottom mud of streams or ponds, or on land up to 1,600 ft from water (Ernst and Barbour 1972; Holland 1989; Slavens 1992).

Breeding habitat for this species is primarily located near the margin of a pond or stream, but pond turtles have also been found hundreds of feet from water (Stebbins 1954; Nussbaum et al. 1983) and will use meadows as well as young seral stages of most forest types including hardwoods, mixed hardwoods, and conifer forests. The western pond turtle appears to be limited to lower elevations, and is not expected to occur above 1,000 ft (Hays, D., WDFW, January 5, 1998, personal communication).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of western pond turtles have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Based on known range and habitat availability, this species is not likely to occur within the municipal watershed. All recent observations have come from Skamania and Klickitat counties, along the Columbia River.

Potential foraging habitat for the western pond turtle within the municipal watershed includes low-elevation ponds, lakes, marshes, and sloughs. Potential breeding and hibernation habitat includes adjacent areas with a substrate that allows burrowing.

Western Redback Salamander

Status

Legal Status. The western redback salamander (*Plethodon vehiculum*) is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The western redback salamander appears to be common and widespread throughout its range. Although it has shown no clear association with old-growth forest (Blaustein et al. 1995), Lehmkuhl and Ruggiero (1991) considered the western redback salamander to be at a moderately high risk of extinction when assessing the viability risks of species associated with late-successional Douglas-fir forests in the Pacific Northwest.

Range

The western redback salamander occurs mainly west of the crest of the Cascade Range from southwestern British Columbia (including Vancouver Island) to southern Oregon (Blaustein et al. 1995). In Washington, it occurs in the western Cascades, on the Olympic Peninsula, and in the southwestern part of the state (e.g., Willapa Hills) (Dvornich et al. 1997).

Habitat

The western redback salamander is a common terrestrial salamander that occurs primarily in dense forests from sea level up to 3,600 ft (Nussbaum et al. 1983; Dvornich et al. 1997). It is common in talus slopes, but also occurs in decaying logs, leaf litter, bark piles, and under other surface debris on the forest floor (Nussbaum et al. 1983; Blaustein et al. 1995). Adults and juveniles are often found on steeper slopes, in talus or under logs (Blaustein et al. 1995). Eggs are laid in clusters of 6 - 19 (mean 10.4); nest sites have been found in moist talus, guarded by adults (Nussbaum et al. 1983; Blaustein et al. 1995). Individual females generally lay eggs every other spring, with hatchlings emerging in fall and taking approximately 2 ½ years to reach maturity (Blaustein et al. 1995; Behler and King 1979).

Occurrence in the Cedar River Municipal Watershed

Western red-backed salamanders are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no breeding activity has been documented to date.

Potential habitats for this species in the municipal watershed include talus slopes and moist coniferous forests, particularly those with large accumulations of debris (e.g., late-successional and old-growth forests).

Western Toad

Status

Legal Status. The western toad (*Bufo boreas*) is a federal species of concern in Washington, and a candidate species at the state level in Washington.

Population Status. Precipitous declines in populations of this and other amphibian species have prompted concern for amphibians as a group; whole populations of western toads have disappeared for unknown reasons in the Cascade Range and elsewhere (Leonard et al. 1993; Corn 1994). Massive die-offs of fertilized eggs and reduced numbers of adults have been documented in remote, undisturbed parts of the Cascades (Blaustein and Wake 1995).

Range

The western toad occurs from southeast Alaska eastward through British Columbia, western Alberta, and western Montana, south to Baja California and east to northern Colorado (ODFW 1996; Behler and King 1979). It is found throughout western Washington and in the mountainous portions of eastern Washington (Dvornich et al. 1997).

Habitat

Western toads occur in forested and brushy areas from sea level to high mountains (ODFW 1996). Moist areas with dense cover are considered optimal (ODFW 1996). During dry weather, toads will spend the day under damp, woody debris or in burrows of other animals; they will also bury themselves in loose soil (Nussbaum et al. 1983; Leonard et al. 1993). Western toads breed in springs, ponds, shallow areas in lakes, and slow-moving streams, and also use stock ponds and reservoirs in arid areas (ODFW 1996). Tadpoles form huge aggregations, generally in the warmest portion of a particular water body; western toad tadpoles are found in a wider variety of water bodies than the tadpoles of Pacific Northwest frogs (Blaustein et al. 1995). Because they can be locally abundant, can live in a relatively wide variety of habitat types, disperse overland, and live many years as adults, western toads may be less affected by land use practices than other anurans (Blaustein et al. 1995).

Occurrence in the Cedar River Municipal Watershed

Western toads are considered common and are known to breed in the Cedar River Municipal Watershed.

Potential breeding habitat for this species in the municipal watershed includes ponds, lakes, wetlands, and slow-moving streams, particularly within densely forested or brushy areas.

INVERTEBRATES: INSECTS

Background

Insects are arthropods, which represent a major source of biodiversity in late-successional forests of the Pacific Northwest and account for about 7,000 species across the range of the northern spotted owl (Olson 1992). The diversity of arthropods in the litter layer approaches the greatest number found anywhere in the Northern Hemisphere, sometimes reaching 250 species per 3.6 square ft (Lattin 1990). Invertebrates, including insects as well as mollusks (discussed below), play many essential ecological roles, especially with regard to nutrient recycling; they begin the process of breaking down forest litter, prey on microbes and microbivores, mix humus and mineral soil, spread microbial inocula, and aerate the soil (Lattin and Moldenke 1992). Twelve of the 14 insects addressed by the HCP are beetles (Order Coleoptera); the remaining insects include one butterfly (Johnson's (mistletoe) hairstreak) and one stonefly (Fender's soliperlan stonefly).

Background Beetle Information (Order Coleoptera)

Twelve species of beetles are covered under the HCP and are discussed below in addition to the other 2 species of insects and 5 species of mollusks addressed and discussed below. The Beller's ground beetle and Hatch's click beetle are listed as candidate species by the U.S. Fish and Wildlife Service. Three beetle species are listed as candidate species by the Washington Department of Fish and Wildlife. These species are Beller's ground beetle (*Agonum belleri*) in the Family Caribidae, Hatch's click beetle (*Eanus hatchii*) in the Family Elateridae, and the long-horned leaf beetle (*Donaica idola*) in the Family Chrysomelidae. All 3 species are associated with lowland sphagnum bogs - a rare habitat in King County, and one that is probably at a higher risk of extinction than any other terrestrial lowland habitat (Bergdahl 1997) (note: sphagnum is defined here as terrestrial habitat because it is '"above water" primarily, regardless of whether there is open water or not on the wetland" (Bergdahl, J., Northwest Biodiversity Center, September 14, 1998, personal communication).

In addition to the above three beetle species, ten species were identified as regional endemics and habitat specialists with the potential to occur in the Cedar River Municipal Watershed: *Bembidion gordoni*, *B. stillaguamish*, *B. viator*, *Bradycellus fenderi*, *Nebria paradisi*, *N. gebleri cascadensis*, *N. kincaidi balli*, *Omus dejeanii*, *Pterostichus johnsoni*, and *P. pumilus* (Bergdahl 1996). All ten of these species are in the Family Caribidae, and all but one species (*P. pumilus*) are covered under the HCP. The U.S. Fish and Wildlife Service (1996) identified individual species from four of these five genera as species that might be significantly affected in a negative way by changes in forest management practices resulting from exemptions for private landowners from the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b). These genera include *Bembidion*, *Nebria*, *Omus*, and *Pterostichus*.

Beetles in the Family Caribidae, or ground beetles, are primarily ground-dwelling predators of soft-bodied invertebrates. As a group, carabid beetles occur in a wide variety of habitat types, although many individual species are highly specialized in their habitat requirements (Bergdahl 1997). Many carabid species are wingless, which limits their dispersal capability, indicating the species have developed over a long period of time in a stable environment (Lattin and Moldenke, 1992). Carabid beetles exhibit a fairly high level of endemism: of approximately 700 species known to occur in the Pacific Northwest, 89 are found nowhere else in the world (Bergdahl, 1997). Because of their strong habitat specificity and low dispersal rates, carabids are excellent bioindicators of habitat quality or change (Kavanaugh 1992). Also, because they are a very rich and abundant group of highly specialized species occurring in a wide variety of habitats, carabid beetles are excellent tools for habitat assessment and monitoring research (Bergdahl 1997).

Each of the 13 carabid species listed above faces a risk of local extinction from stochastic events (e.g., floods, fires) because of their habitat specificity, patchy distribution, and low recolonization potential. Forest management poses a major threat to this species group. One study in the Andrews Experimental Forest in the western Oregon Cascades reported a 90 percent loss of total soil arthropods after clearcutting and burning (Moldenke and Lattin 1990). In addition to relying on the cool moist conditions found at ground level in riparian forests, most of these species require coarse woody debris and litter that provide shelter and habitat for necessary food resources (USDI 1996). Log removal (e.g., through salvage operations) can result in decreased habitat availability, damage to soil horizons, and elimination of sources of recolonization (Olson 1992). Seven of these 13 carabid species are associated with high-order non-fish bearing streams, which historically have received no protection under Forest Practices Rules (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Additional concern for these species stems from the popular misconception that efforts to protect critical habitat for the northern spotted owl will assure the viability of old-growth forests and associated species in the Pacific Northwest (Olson 1992). Most forest floor species, however, are narrowly adapted to conditions of low light, abundant moisture, and moderate temperatures found in late-successional and old-growth forests. Although some types of thinning (e.g., ecological thinning) have been found to accelerate the development of old-growth conditions in conifer forests, thinning may actually cause substantial damage to the fragile understory environment (Olson 1992).

Beller's Ground Beetle

Status

Legal Status. The Beller's ground beetle (*Agonum belleri*) is a federal species of concern, and is a candidate species at the state level in Washington.

Population Status. The limited amount of ecological information currently available about Beller's ground beetle is insufficient to evaluate the species' population status in Washington State. However, threats to this species include the limited availability of healthy lowland sphagnum bogs, land-use practices that may affect water levels in such bogs, and the introduction of non-native fish species into occupied habitat because the fish might eat the larvae (Larsen et al. 1995).

Range

Beller's ground beetle occurs from the Queen Charlotte Islands in British Columbia, south through coastal Washington to Oregon (Opler and Lattin 1998; Larsen et al. 1995). This species has been documented in two sphagnum bogs south of Little Mountain at the east end of Chester Morse Lake (Bergdahl 1997).

Habitat

Beller's ground beetles are restricted to low-elevation (below 3,000 ft) sphagnum bogs. Individuals have been found inhabiting areas immediately adjacent to open water, and not in the surrounding drier areas of the bog (Larsen et al. 1995). This flightless species can be locally abundant at some sites, and may be spotted running around on open sphagnum mats on warm sunny days (Bergdahl 1997). It may be a form of a parasite of the insectivorous sundew (*Drosera* spp.) plants, stealing insects trapped on the sticky leaves (Bergdahl 1997).

Management recommendations for this species include prevention of peat mining or other activities that may disturb bogs (including filling, draining, and removing or damaging natural vegetation), prevention of activities that may affect natural water levels or flow regimes, and restrictions on pesticide use in adjacent areas (Larsen et al. 1995). Because the larval stage of this species is aquatic, prohibitions on the introduction of non-native fish into lakes or wetlands with sphagnum bogs inhabited by this beetle is also a management recommendation.

Occurrence in the Cedar River Municipal Watershed

Beller's ground beetles have been documented at two sites in the Cedar River Municipal Watershed (both bogs south of Little Mountain) (Bergdahl 1997). However, no comprehensive surveys to determine the extent of the distribution of the species within the watershed have been conducted. Potential habitat for Beller's ground beetles in the municipal watershed includes low-elevation sphagnum bogs.

Carabid Beetle (*Bembidion gordoni*)

Status

Legal Status. *Bembidion gordoni*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Bembidion gordoni* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along small, steep, montane streams, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris.

Range

Bembidion gordoni has been found in Oregon, Washington, and British Columbia (Smithsonian 1998).

Habitat

Little is known about the distribution and habitat requirements of this species (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). As with other *Bembidion* species, it may be found on gravel banks of running waters where its staple food consists of dead and dying insects drifting ashore (Lindroth 1961-1969). Bergdahl (1996) associates this species with fast-running montane streams.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Bembidion gordoni* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date.

Carabid Beetle (*Bembidion stillaguamish*)

Status

Legal Status. *Bembidion stillaguamish*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Bembidion stillaguamish* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along fairly large streams, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris.

Range

Bembidion stillaguamish has been found in Oregon, Washington, and British Columbia (Smithsonian Institution 1998). This species is widespread, and is likely to be found in the watershed (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Habitat

Bembidion stillaguamish is most commonly found along the margins of fairly large mid-montane streams, often on stabilized sand/gravel bars (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). It is also found in streamside vegetation (*Salix* and *Equisetum* species) with sandy soil, often at the margins of large pools (Bergdahl 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Bembidion stillaguamish* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, the species is widespread and based on range and habitat availability, it is likely that *Bembidion stillaguamish* is present in the Cedar River Municipal Watershed (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Carabid Beetle (*Bembidion viator*)

Status

Legal Status. *Bembidion viator*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Bembidion viator* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along low-elevation wetlands, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris. Native and non-native fish introductions and water level manipulation may also pose a threat.

Range

This species is known from only a few sites. The Smithsonian Institution (1998) lists its known range as British Columbia. Bergdahl (1997) collected it from four bogs in King County. Because of its range and habitat requirements, *Bembidion viator* is likely to occur in the watershed although it was not found at two bogs sampled in 1996 (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Habitat

Bembidion viator has been found at low-elevation swamps, bogs, and forested marshes (Bergdahl 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Bembidion viator* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. In addition, the species was not found in two bogs (south of Little Mountain) sampled in 1996 (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). However, based on range and habitat availability, it is likely that *Bembidion viator* is present in the Cedar River Municipal Watershed (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). Potential habitat for *Bembidion viator* in the municipal watershed includes low-elevation swamps, bogs, and forested marshes.

Carabid Beetle (*Bradycellus fenderi*)

Status

Legal Status. *Bradycellus fenderi*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Bradycellus fenderi* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along low-elevation wetlands, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris. Native and non-native fish introductions and water level manipulation may also pose a threat.

Range

This species is known only from about a dozen wetlands in Washington and Oregon. Based on its range and habitat requirements, *Bradycellus fenderi* is likely to occur in the Cedar River Municipal Watershed, although it wasn't found at two bogs sampled in 1996 (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Habitat

Bradycellus fenderi is associated with low-elevation swamps and forested marshes, and foothill streamsides (Bergdahl 1996). In contrast with other carabid beetles, most species of *Bradycellus* are primarily herbivorous (Lindroth 1961-1969).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Bradycellus fenderi* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. In addition, the species was not found in two bogs (south of Little Mountain) sampled in 1996 (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). However, based on range and habitat availability, it is likely that *Bradycellus fenderi* is present in the Cedar River Municipal Watershed (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). Potential habitat for *Bradycellus fenderi* in the municipal watershed includes low-elevation swamps and forested marshes, and foothill streamsides.

Carabid Beetle (*Nebria gebleri cascadensis*)

Status

<u>Legal Status</u>. *Nebria gebleri cascadensis*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

<u>Population Status</u>. The limited amount of ecological information currently available about *Nebria gebleri cascadensis* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along small, steep, montane streams, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris.

Range

This species ranges from central Oregon north to southwestern British Columbia (Smithsonian, 1998; Bergdahl, 1996). It has been documented in the watershed, and is probably widespread (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Habitat

The genus *Nebria* is adapted to cold temperatures and represented in northern and mountain regions; most species are strongly hygrophilous (strongly associated with water), but confined to stony, barren margins of running waters. These beetles are carnivorous and nocturnal (Kavanaugh 1992; Lindroth 1961-1969). This species is associated with streams and streamside habitats at most elevations (Bergdahl 1996).

Occurrence in the Cedar River Municipal Watershed

Nebria gebleri cascadensis is present in the Cedar River Municipal Watershed and is probably widespread (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). However, no comprehensive surveys to determine the extent of the distribution of the species within the watershed have been conducted.

Carabid Beetle (*Nebria kincaidi balli*)

Status

Legal Status. *Nebria kincaidi balli*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Nebria kincaidi balli* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along small, steep, high-elevation streams, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris. The U.S. Fish and Wildlife Service (USDI 1996) includes this species in a list of riparian predators that may be negatively affected by exemptions for private landowners from the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b).

Range

This species is known from a few sites in Oregon and Washington (Smithsonian Institution 1998).

Habitat

Nebria kincaidi balli occurs along small high-elevation (subalpine) streams (Bergdahl 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Nebria kincaidi balli* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date.

Carabid Beetle (*Nebria paradisi*)

Status

Legal Status. *Nebria paradisi*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Nebria paradisi* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along small, steep, high-elevation streams, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris.

Range

This species has been found in northwestern Oregon and southwestern Washington (Bergdahl 1996; Smithsonian 1998).

Habitat

Nebria paradisi, like *N. kincaidi*, occurs in small high-elevation (subalpine) streams (Bergdahl 1996).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Nebria paradisi* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date.

Carabid Beetle (*Omus dejeanii*)

Status

Legal Status. *Omus dejeanii*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Omus dejeanii* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions in low-elevation forests, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris.

This flightless, nocturnal beetle is considered by some to be a member of the Family Cicindelidae, or tiger beetles. However, the habits of species of the *Omus* genus are uncharacteristic of its family, and more similar to those of the ground beetles, which are generally diurnal and good fliers (Lattin and Moldenke 1992).

Range

O. dejeanii ranges from southern British Columbia south through the coast ranges of Oregon and Washington, to Jackson County, Oregon. Nearby known localities include Seattle, Easton (Kittitas County), and Electron (Pierce County) (Opler and Lattin 1998).

Habitat

This species is often common in low-elevation forests and forest glades, and along stream banks (Bergdahl 1996). It has been encountered at non-sphagnum swamps in Snohomish County (Bergdahl 1997).

Occurrence in the Cedar River Municipal Watershed

Omus dejeanii is present in the Cedar River Municipal Watershed (Bergdahl , J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). However, no comprehensive surveys to determine the extent of the distribution of the species within the watershed have been conducted. Potential habitat for *Omus dejeanii* in the municipal watershed includes low-elevation forests and forest glades, and stream banks.

Carabid Beetle (*Pterostichus johnsoni*)

Status

Legal Status. *Pterostichus johnsoni*, a Carabid beetle, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. The limited amount of ecological information currently available about *Pterostichus johnsoni* is insufficient to evaluate the species' population status in Washington State. However, threats to this species include activities that may influence microclimate conditions along small, steep, montane streams, such as tree cutting (clearcut logging or thinning), road construction, and removal of large woody debris.

Range

Pterostichus johnsoni is endemic to the west slopes of the Cascades, occurring from northern Oregon to the Skagit River in Washington (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Habitat

The habitat associations of this flightless species are atypical of the genus *Pterostichus*, which is usually found in forested areas. *P. johnsoni* is a stream-dependent species, found at middle elevations in headwaters of wall-based channels and in steep, wet, unstable sand-mud-scree slopes (Bergdahl 1996).

Occurrence in Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Pterostichus johnsoni* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date.

Fender's Soliperlan Stonefly

Status

Legal Status. Fender's soliperlan stonefly (*Soliperla fenderi*, Order Plecoptera) is a federal species of concern in Washington State. The species has no designated listing status at the state level in Washington.

Population Status. Concern for this species stems from its extremely limited known distribution, and the sensitivity of stonefly species to changes in water temperature and chemistry. The U.S. Fish and Wildlife Service (1996) included this species in a list of aquatic detritivores that may be negatively affected by exemptions for private landowners from the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b).

Range

Fender's soliperlan stonefly has been collected from only a few sites on the south and west flanks of Mount Rainier (Opler and Lattin 1998).

Habitat

Stoneflies spend most of their lives in water as larvae (nymphs). Nearly all members of this relatively small group of insects depend on cool, well-oxygenated water and are found in rocky streams with a noticeable current (Nelson 1996). The length of the larval life cycle ranges from 1 to 4 years; mature nymphs climb out of the water (mostly at night) before their final molt, and live only a few days to a few weeks as adults (Gustafson 1995). Adults feed little (if at all) and do not disperse over great distances, as indicated by the rarity of stoneflies on many islands (Gustafson 1995; Ramel 1995). Because of their sensitivity to changes in water temperature and dissolved oxygen levels as larvae, and poor dispersal capability as adults, stoneflies serve as indicators of stream health (Nelson 1996; Gustafson 1995).

Soliperlan stoneflies are members of the Family Peltoperlidae, a small group of medium sized stoneflies found in the mountains of eastern and western North America, whose nymphs function as shredder-detritivores (Stark 1983; Gustafson 1995). Peltoperlids are commonly associated with very shallow flowing water, such as seeps on rock faces (Nelson 1996). Fender's soliperlan stonefly appears to typify this group; known sites are often described as seeps and streams (Opler and Lattin 1998).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Fender's soliperlan stonefly have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. In addition, all sites where this species has been documented in Washington occur more than 31miles south of the watershed, in Mount Rainier National Park. However, despite this potential constraint, based on range and habitat availability, there is a very low likelihood that Fender's soliperlan stoneflies may be present in the Cedar River Municipal Watershed.

Potential habitats for Fender's soliperlan stonefly in the municipal watershed are seeps, streams and riparian areas.

Hatch's Click Beetle

Status

Legal Status. The Hatch's click beetle (*Eanus hatchii*) is a federal species of concern, and is a candidate species at the state level in Washington.

Population Status. The limited amount of ecological information currently available about Hatch's click beetle is insufficient to evaluate the species' population status in Washington State. However, threats to this species include the limited availability of healthy lowland sphagnum bogs, and land-use practices that may affect water levels in such bogs (Larsen et al. 1995).

Range

Hatch's click beetle (Family Elateridae) historically occurred in Snohomish and King counties, but is presently confirmed only at three bogs in King County (Larsen et al. 1995; WDNR 1996). The nearest known site is approximately 6 miles from the Cedar River Municipal Watershed. Presence of this species can be confirmed only by thorough searches during April, which appears to be the only period when this species is active above ground (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Habitat

Similar to the Beller's ground beetle, this species is restricted to eutrophic sphagnum bogs in or near lakes below 3,000 ft (Larsen et al., 1995; Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication). Adults have been found in very low, floating sphagnum mats; larvae have been found near bog margins, above the water line (Larsen et al. 1995). Adults are active during day, probably feeding on pollen, nectar, honeydew, and small soft insects (pers. comm., P. Johnson, as cited in Larsen et al. 1995). Adults are poor fliers, with limited ability to colonize new habitat or recolonize bogs from which they have been extirpated (Bergdahl, J.C., Northwest Biodiversity Center, June 19, 1998, personal communication).

Management recommendations for this species include prevention of peat mining or other activities that may disturb bogs (including filling, draining, and removing or damaging natural vegetation), prevention of activities that may affect natural water levels or flow regimes, restrictions on pesticide use in adjacent areas, and prohibitions on the introduction of non-native fish into lakes or wetlands with sphagnum bogs inhabited by this beetle (Larsen et al. 1995).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Hatch's click beetle have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Potential habitat for Hatch's click beetles in the municipal watershed includes low-elevation sphagnum bogs.

Johnson's (mistletoe) Hairstreak

Status

Legal Status. Johnson's (mistletoe) hairstreak (*Mitoura johnsoni*, Order Lepidoptera) is not a listed species, candidate species, or species of concern at the federal level in Washington. Johnson's (mistletoe) hairstreak is a candidate species at the state level in Washington.

Population Status. Threats to this species include the limited availability of its key habitat (low-elevation old-growth forest), efforts to control dwarf mistletoe infestation, and insecticide use. The U.S. Fish and Wildlife Service (1996) included this species in a list of canopy herbivores that may be negatively affected by exemptions for private landowners from the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b).

Range

Johnson's (mistletoe) hairstreak is found from southern British Columbia south through the Cascades and Coast Range to Mariposa and Solano counties, California (Opler and Lattin 1998; Larsen et al. 1995). In Washington, it is known from low-elevation old-growth forests west of the Cascade crest and on the Olympic peninsula (Larsen et al. 1995).

Habitat

This butterfly species requires conifer forests containing dwarf mistletoes of the genus *Arceuthobium*, on which its caterpillars feed (Opler and Lattin 1998; Larsen et al. 1995). These mistletoes occur mainly on western hemlock, and occasionally on true firs (Larsen et al. 1995; Pojar and MacKinnon 1994). This species does best in low-elevation mature and old-growth forests where western hemlock grows densely enough to support high levels of dwarf mistletoe (Larsen et al. 1995). Younger forests have the potential to support Johnson's (mistletoe) hairstreak, if *Arceuthobium* mistletoes are present (pers. comm., D. McCorkle, as cited in Larsen et al. 1995). Adults spend most of their time in the upper layer of the forest canopy near host trees, but will come down to nectar at plants such as buckbrush (*Ceanothus* spp.), pussy-toes (*Calyptridium* spp.), dogwood, and Oregon-grape (Opler and Lattin 1998; Pyle 1974).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of Johnson's (mistletoe) hairstreak have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. The nearest documented location for this species is in the Green River Watershed, approximately 10 miles south of the Cedar River Municipal Watershed. Therefore, based on range and habitat availability, it is likely that Johnson's (mistletoe) hairstreak is present within the Cedar River Municipal Watershed.

Potential habitat for Johnson's (mistletoe) hairstreak in the municipal watershed includes low-elevation mature to old-growth coniferous forests containing dwarf mistletoe of the genus *Arceuthobium*.

Long-horned Leaf Beetle

Status

Legal Status. The long-horned leaf beetle (*Donacia idola*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The long-horned leaf beetle is listed as a candidate species at the state level in Washington.

Population Status. The limited amount of ecological information currently available about the long-horned leaf beetle is insufficient to evaluate the species' population status in Washington State. However, threats to the long-horned leaf beetle include an extremely limited distribution, producing populations susceptible to disturbance and limited availability of healthy sphagnum bogs in the Puget Trough (Larsen et al. 1995).

Range

The long-horned leaf beetle has been found in lowland sphagnum bogs in Washington and southwest British Columbia. In Washington, it is currently known to occur in only one site, which is in Snohomish County (Larsen et al. 1995; WDNR 1996).

Habitat

Larsen et al. (1995) associate this species solely with low-elevation sphagnum bogs, offering a habitat description and management recommendations nearly identical to those for Beller's ground beetle and Hatch's click beetle. In contrast, Bergdahl (Northwest Biodiversity Center, June 19, 1998, personal communication) says that long-horned leaf beetles can be found in rushes next to open water in a variety of wetland habitats. Adults feed on exposed portions of aquatic plants, especially water lilies and *Potamogeton* (pondweed) species, while the larvae feed inside the submerged portions of aquatic plants (Larsen et al. 1995).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of long-horned leaf beetles have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Potential habitat for long-horned leaf beetles in the municipal watershed includes low-elevation sphagnum bogs, and possibly other wetland habitats.

INVERTEBRATES: MOLLUSKS

Background

The U.S. Fish and Wildlife Service (USDI 1996d) has identified about 350 species of mollusks (slugs, snails, and bivalves) in the range of the northern spotted owl, and speculates that many new species remain to be discovered. Little information is available about the ecology of individual species. The following background information was excerpted from An Environmental Alternatives Analysis for a 4(d) Rule for the Northern Spotted Owl (USDI 1996d).

Freshwater mollusks occur in permanent water bodies and ephemeral streams or seeps in well oxygenated, silt-free, cold water associated with a riparian zone with a closed canopy. They are prey for a variety of insect, fish, amphibian, bird, and mammal species. Many aquatic mollusks in the range of the spotted owl are narrowly endemic and are restricted to a single spring or a complex of nearby springs separated by less suitable habitat. Because these populations are highly localized, they are susceptible to extirpation as a result of land disturbance activities that affect water quality or stream habitat. For such geographically restricted species, the loss of a single population could be crucial to the continued existence of that species or directly result in its extinction. Some species endemic to the Pacific Northwest and northern California have much broader distributions, yet may be susceptible to the cumulative impacts of a variety of land use and water management practices throughout their ranges.

Terrestrial snails and slugs are mainly herbivores or detritivores and eat fungi, lichens, leaves, and inner bark layers, although a few species are carnivores. Mollusks are prey for insects, amphibians, reptiles, birds, and mammals, and are important in the recycling and redistribution of nutrients and minerals in the forest. Because desiccation is a major source of mortality of terrestrial snails and slugs, most species occur in the moist, temperature-modulated microhabitats in the dense understory of undisturbed, closed-canopy riparian zones (including those around small springs or wetlands) and late-successional forests. Woody debris, damp leaves or vegetation, and rocks shelter other those mollusk species occurring primarily on talus slopes from predation and adverse climatic conditions. Low rates of dispersal, coupled with the isolation of colonies, contributes to the evolution of geographically restricted endemics, making terrestrial mollusks particularly susceptible to localized extinctions resulting from fires and various land use practices.

All mollusks addressed by the HCP are either snails or slugs. Only one mollusk species addressed by the HCP, *Valvata mergella*, is an aquatic mollusk; all others are terrestrial species.

Blue-Gray Taildropper

Status

Legal Status. The blue-gray taildropper (*Prophysaon coeruleum*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The blue-gray taildropper is a monitor species at the state level in Washington. Because the blue-gray taildropper is apparently closely associated with old-growth forest and riparian habitats, it is considered a Survey and Manage species in the Northwest Forest Plan (USDA 1994; Frest and Johannes 1993).

Population Status. The blue-gray taildropper is a relatively small slug, distinctive in its eponymous coloration and the equally spaced reticulations along the length of its body (Burke 1994a). Desiccation is the greatest threat to any mollusk species; risk of desiccation increases with activities that reduce forest canopy cover, reduce the availability of large woody debris, or decrease available moisture (Frest and Johannes 1993). Urban development has also likely eliminated some populations of this species. Branson (1977) reported unsuccessful searches for blue-gray taildroppers at the type locality in Olympia, Washington. Other sites of historic records include Portland, Oswego, and Corvallis, Oregon, (Burke 1994a), all of which now have substantial urban development.

Frest and Johannes (1993) reported no success locating blue-gray taildroppers in recent extensive searches across the range of the northern spotted owl. Frest and Johannes (1993) estimated that the Northwest Forest Plan has a 30 percent chance of providing sufficient habitat to maintain well-distributed, interacting populations of this species across its range on federal lands in the next 100 years, and a 20 percent chance of extirpation.

Range

The blue-gray taildropper has been collected from western Oregon and Washington, primarily in counties that overlap the Cascades and the Puget/Willamette Trough. It has been reported as far south as Jackson County, Oregon, and as far north as King County, Washington (Burke 1994a; Frest and Johannes 1993).

Habitat

Habitat associations for this species are not well known. Frest and Johannes (1993) describe the blue-gray taildropper's habitat needs as "Probably similar to other Washington slugs with restricted distributions; i.e., relatively undisturbed, moist coniferous forest, from low to middle elevations." Burke (1994a) reports Randolph (as cited in Pilsbry 1948) found this species "solitary in dark fir woods under damp logs." Branson and Branson (1984) collected it from high woodlands and dry, volcanic areas in Clackamas, Marion, Lane, and Jackson counties, in Oregon. Slugs of the genus *Prophysaon* are found largely in perpetually very moist areas, often in riparian forests or spring and seep borders (Frest and Johannes 1993).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of the blue-gray taildropper have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, based on range and habitat availability, the blue-gray taildropper may occur within the Cedar River Municipal Watershed.

Where microhabitat conditions are adequate, this species may occur at low to middle elevations in mature and old-growth forest, and possibly along streams.

Oregon Megomphix

Status

Legal Status. The Oregon megomphix (*Megomphix hemphilli*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The Oregon megomphix is a monitor species at the state level in Washington. Because the Oregon megomphix is apparently closely associated with old-growth forest and riparian habitats, it is considered a Survey and Manage species in the Northwest Forest Plan (Frest and Johannes 1993; USDA 1994).

Population Status. The Oregon megomphix is a medium-sized snail with a glossy, translucent shell that has a pale, dull green-yellow tint (Burke 1994a). Desiccation is the greatest threat to any mollusk species; risk of desiccation increases with activities that reduce forest canopy cover, reduce the availability of large woody debris, or decrease available moisture (Frest and Johannes 1993). Where it occurs, this species is never abundant (Branson 1980), indicating that local populations are susceptible to extirpation. Frest and Johannes (1993) found the Oregon megomphix increasingly rare over the last decade, and absent from many sites from which it had been previously reported. Frest and Johannes (1993) estimated that the Northwest Forest Plan has a 30 percent chance of providing sufficient habitat to maintain well-distributed, interacting populations of this species across its range on federal lands in the next 100 years, and a 20 percent chance of extirpation.

Range

The Oregon megomphix has been found on the west side of the Cascades, from northern Oregon to northern Washington (Frest and Johannes 1993). Branson (1977) collected it from 14 sites on the Olympic Peninsula, and he found it at 3 sites on the Mount Baker National Forest (Branson 1980).

Habitat

Habitat associations for the Oregon megomphix are not well known. Frest and Johannes (1993) describe the habitat needs of this species as "moist, low-middle elevation, relatively undisturbed forest." Burke (1994a) says Baker (as cited in Pilsbry 1946) found this species along the banks of the Willamette River, and that Baker said of habitat associations, "the aestivating individuals … burrow a few inches into the loose loam under fallen logs on quite steep hillsides, which are dominated by *Pseudotsuga*/*Tsuga* forest. They usually live under those trunks which are supported off the ground by other debris, which insures the snail plenty of air and comparative freedom from excessive accumulations of decaying humus."

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of the Oregon megomphix have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, based on range and habitat availability, the Oregon megomphix may be present within the Cedar River Municipal Watershed. Potential habitat for the Oregon megomphix within the watershed includes moist, low- to mid-elevation, mature and old-growth forest.

Papillose Taildropper

Status

Legal Status. The papillose taildropper (*Prophysaon dubium*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The papillose taildropper is a monitor species at the state level in Washington. Because the papillose taildropper is apparently closely associated with old-growth forest and riparian habitats, it is considered a Survey and Manage species in the Northwest Forest Plan (Frest and Johannes 1993; USDA 1994).

Population Status. The papillose taildropper (*Prophysaon dubium*) is a relatively small slug with a brownish body and prominent papillae on its mantle (Burke 1994a). As with most mollusks, this species has been very poorly studied. Data regarding range, habitat associations, and even the species description are very scarce, based on only a few specimens and sites. Desiccation is the greatest threat to any mollusk species; risk of desiccation increases with activities that reduce forest canopy cover, reduce the availability of large woody debris, or decrease available moisture (Frest and Johannes 1993). Frest and Johannes (1993) estimated that the Northwest Forest Plan has a 50 percent chance of providing sufficient habitat to maintain well-distributed, interacting populations of this species across its range on federal lands in the next 100 years, and a 10 percent chance of extirpation. This was the most optimistic ranking given to any of the 104 mollusk taxa they assessed.

Range

The papillose taildropper has been collected from a few sites in Clackamas County, Oregon, and Pierce, Thurston, and Kittitas Counties, Washington, (Burke 1994a, 1994b; Foster Wheeler Environmental field survey data, 1997). More recently, it has been collected in northern California (Frest and Johannes 1993).

Habitat

The papillose taildropper appears to be strongly associated with riparian vegetation in moist coniferous forests (Frest and Johannes 1993). In the Taneum Creek Watershed (Kittitas County), it was found with moderately decayed woody debris at the outer edges of the vegetated floodplain, shaded by immediately adjacent conifer stands (Burke 1994b). At two other sites in Kittitas County, it was found in vine maple leaf litter within or adjacent to small streams; one site was within old-growth forest, while the other was in a clearcut (Foster Wheeler Environmental field survey data, 1997). Notably, at a third site in Kittitas County, a papillose taildropper was found on the rain-moistened surface of a patch of mossy talus surrounded by old-growth forest, more than 300 ft from the nearest riparian area (Foster Wheeler Environmental field survey data, 1997). Habitat associations from other localities in Washington and Oregon are vague, including "mushroom growth at the edge of a mountain meadow within a few feet of a stream…" (Pilsbry 1948 as cited in Burke 1994a), and "571 m elevation; soil, marginal oak forest" (Branson 1984, as cited in Burke 1994a). Although no clear forest-type association emerges from these sightings, Burke (1994b) notes that old-growth forest may expand the width of suitable microhabitat conditions along streamside habitats where this species is found. Slugs of the genus *Prophysaon* are found largely in perpetually very moist areas, often in riparian forests or spring and seep borders (Frest and Johannes 1993).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of the papillose taildropper have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. In addition, no censuses for this species are known from the vicinity of the watershed. However, it has been collected from sites to the east and southwest of the watershed, the nearest site less than 12.4 miles to the east. Therefore, based on range and habitat availability, the papillose taildropper may be present within the Cedar River Municipal Watershed.

Where microhabitat conditions are adequate, this species may occur along streams and possibly within forested talus in the watershed.

Puget Oregonian

Status

Legal Status. The Puget Oregonian (*Cryptomastix devia*) is not a listed species, candidate species, or species of concern at the federal level in Washington. The Puget Oregonian is a Washington State monitor species. Because the Puget Oregonian is apparently closely associated with old-growth forest and riparian habitats, it is considered a Survey and Manage species in the Northwest Forest Plan (Frest and Johannes 1993; USDA 1994).

Population Status. The Puget Oregonian is a medium-sized snail with a pale yellowish to tan shell (Burke 1994a). Desiccation is the greatest threat to any mollusk species; risk of desiccation increases with activities that reduce forest canopy cover, reduce the availability of large woody debris, or decrease available moisture (Frest and Johannes 1993). Frest and Johannes (1993) estimated that the Northwest Forest Plan has a 0 percent chance of providing sufficient habitat to maintain well-distributed, interacting populations of this species across its range on federal lands in the next 100 years, and a 50 percent chance of extirpation. This was the second-highest risk of extirpation given to any of the 104 mollusk taxa they assessed.

Range

The Puget Oregonian was historically reported from scattered sites extending from southern Vancouver Island, British Columbia, to the west end of the Columbia Gorge in Multnomah County, Oregon (Frest and Johannes 1993; Burke 1994a). Recent collections have occurred in King, Thurston, Lewis, and Skamania counties in Washington (Frest and Johannes 1993; Foster Wheeler Environmental field data, 1997). Branson (1980) collected five specimens from Lake Chelan State Park in Chelan County east of the Cascade crest, but Frest and Johannes (1993) and Burke (1994a) say this record bears further examination.

Habitat

Habitat associations for the Puget Oregonian are not well known. Frest and Johannes (1993) describe the habitat needs of this species as "low to middle elevations; old growth and riparian associate; habitat includes leaf litter along streams, under logs, seeps and springy areas." Burke (1994a) says Baker (as cited in Pilsbry 1940) found this species "… at bases of east-facing slopes along the lake north of Seattle, near damp places with maples and sword ferns." Recent collections from Lewis County near Randle, Washington come from mature conifer forest with patches of hardwoods along streams, and among vine maple leaf litter in roadside talus (Foster Wheeler Environmental field data, 1997).

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of the Puget Oregonian have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, based on range and habitat availability, the Puget Oregonian may be present within the Cedar River Municipal Watershed.

Potential habitat for the Puget Oregonian in the municipal watershed includes low- to mid-elevation mature to old-growth coniferous forests.

Snail (*Valvata mergella*)

Status

Legal Status. *Valvata mergella*, a species of snail, is not a listed species, candidate species, or species of concern at the federal or state level in Washington.

Population Status. *Valvata mergella* is a freshwater snail whose only known population in North America occurs at Paradise Lake in Snohomish County.

Range

Valvata mergella was observed historically in the Pacific Northwest and Alaska in the 1800s, but had not been recorded during the twentieth century until it was confirmed at Paradise Lake, in September 1995 (Richter 1995).

Habitat

Based on historical accounts and the most recent finding, *Valvata mergella* requires lakes with a muddy substrate and well-oxygenated water. Inputs of sediment, nutrients, and aquatic plant growth (which might cause eutrophication) are likely fatal, which probably explains the absence of this species from its former range in the Pacific Northwest (Richter 1995). The snail is a voracious detritivore, consuming large amounts of plant material that drops to the bottom of the lake (personal comm., T. Frest, as cited in Richter 1995). This species may depend on conditions found at low elevations: Paradise Lake is only 255 ft above sea level.

Occurrence in the Cedar River Municipal Watershed

No comprehensive surveys to determine the presence or absence of *Valvata mergella* have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. Because the only known population of this species is approximately 25 miles northwest of the watershed, it is unlikely that this species is present in the Cedar River Municipal Watershed.

Potential habitat for this species in the watershed includes lakes with mud substrates and well-oxygenated water; other water bodies may provide suitable habitat as well.

4. HCP Conservation Strategies

Section 4.1 Contents

4.1 Introduction to HCP Conservation and Mitigation Strategies

4.1.1 Background and Context

The City's HCP is a multispecies plan developed to meet the requirements of the Endangered Species Act with regard to the 83 species addressed in the HCP, and to address a variety of related natural resource issues. These related issues include: (1) resolution of longstanding issues with the State of Washington regarding the blockage to anadromous fish posed by the Landsburg Diversion Dam; (2) resolution of issues with the Army Corps of Engineers regarding water supplied to Lake Washington that is used to operate the Ballard Locks for navigation and fish passage; and (3) completion of a long-running effort with the state and federal agencies to develop technically sound instream flows in the Cedar River that would protect anadromous salmonids.

The City's HCP covers the area and City activities described in Chapter 1 and Chapter 2 (also see Appendix 1). City activities generally include operation of water supply and hydropower facilities on the Cedar River, management of the Cedar River Municipal Watershed, and mitigation and conservation measures included in this HCP. The geographic area covered includes the 90,546-acre municipal watershed and areas outside the municipal watershed that conservation and mitigation activities will affect under the plan. Additional details on City activities important for this HCP are given in this chapter in the discussion of the various conservation and mitigation measures.

Through the HCP, the City seeks to provide certainty for both current operation and future planning related to its water supply and hydroelectric utilities on the Cedar River, while providing for the conservation of species potentially affected by those public utilities (Section 2.4).

The City's HCP is intended to provide a net benefit for the species addressed by the HCP when compared to current conditions. The City's HCP, thus, should contribute to the recovery of any species addressed in the HCP that are currently listed or that could be listed during the term of the HCP.

The HCP represents an ecosystem-based approach. Jensen et al. (1996) stated that ecosystem management is "the skillful manipulation of ecosystems to satisfy specified societal values." Karr (1993) favors the following definition of ecosystem management: "A science-based approach that conserves species and genetic diversity, while maintaining the structural and functional integrity of ecological systems and providing economic benefits that can be sustained indefinitely." The major ecosystems affected by City water supply, hydroelectric, and land management activities on the Cedar River include the aquatic, riparian, and forest ecosystems. It is the City's intent that the watershed be operated in a manner that sustains these ecosystems in the watershed (Section 2.4).

The Cedar River Municipal Watershed represents a very important element and opportunity in any regional effort directed at protecting both salmonid fishes and species dependent on late-successional and old-growth conifer forests. The municipal watershed contains the headwaters for the major river that supplies water to Lake Washington and is a large area of key importance to many at-risk fish and wildlife species. The HCP will make a significant contribution to regional efforts to restore and sustain declining salmonid stocks in the Lake Washington basin, and to federal and state efforts to protect and sustain the late-successional and old-growth ecosystem in the central Cascade Mountains.

As a result of a variety of causes, populations of wild sockeye, coho, and chinook salmon, and steelhead trout have declined in the Lake Washington Basin substantially during the last decade (sections 3.5.8-3.5.11). Recent regional trends have perhaps compounded the effects of a radical alteration of the entire hydrologic system when the Lake Washington Ship Canal was built, the lake was lowered 9 ft, and the Cedar River was rerouted from the Duwamish River into Lake Washington.

The risks now facing salmonids in the Lake Washington basin are many and complex, but certainly two rank very high. Perhaps the most serious is the loss and degradation of habitat in this rapidly urbanizing region (King County 1993). Also important, however are alterations of the system that have fragmented the continuity between marine and freshwater habitats – and among different freshwater habitats – by reducing landscape connectivity. The effect of these impediments to movement is perhaps most obvious at the Ballard Locks and the Landsburg Diversion Dam, but it can also be seen throughout the basin at the many and diverse "small" human-created impediments to fish passage, ranging from creation of hostile conditions in wetlands, to poorly designed culverts, to the various physical barriers that now exist in many streams.

Clearly, the cooperation of many entities – municipalities, state and federal agencies, and Indian Tribes – will be needed to be successful in any endeavor to restore regional salmonid populations, and the City's HCP is a key element in that multi-jurisdictional effort. Important to these cooperative efforts will be maintaining adequate stream flows, protecting habitat from the impacts of continued urbanization, restoration of habitats damaged by past human activities, and improvement of connectivity among key aquatic habitats.

The risks to wildlife species that depend on late successional and old-growth forests are also high (Thomas et al. 1993). With virtually all of the old-growth forest in the Puget Sound lowlands now gone, the watershed offers one of the few significant opportunities to protect and reestablish mature and old-growth forest that links to low elevations, and north and south with the federal late successional reserve (Tuchmann et al. 1996). The I-90 corridor, including the watershed, is considered a critical area for species dependent on old-growth ecosystems such as the northern spotted owl (USDI 1992b, c).

Sustaining populations of fish and wildlife dependent on late-successional and old-growth forests will entail the combination of a system of large late-successional *reserves*, careful management of forests in the intervening *matrix* lands, and riparian protection though *buffers* on water bodies and wetlands (FEMAT 1993). Because of the highly fragmented ownership of land in the central Cascade Mountains, the contribution of nonfederal landowners, such as the City of Seattle, may be key to long-term success in protecting species dependent on the late-successional and old-growth forests ecosystem.

The City's HCP has four major components: (1) management of instream flows to provide habitat for anadromous fish; (2) mitigation for the blockage to anadromous fish at the Landsburg Diversion Dam, including provision of upstream passage for three of the four species currently blocked; (3) management of the municipal watershed to protect and restore aquatic, riparian, and late-successional and old-growth habitats; and (4) research and monitoring to support the first three components. In all, the measures included in these four components entail a commitment by the City of approximately $79 million, in 1996 dollars, over the 50-year term of the HCP.

The first three components of the HCP incorporate a variety of measures that collectively contribute to protection and restoration of the species and habitats addressed by this HCP. These measures are designed to control, reduce, or *minimize impacts* from City operations, to *preserve* habitat elements that are relatively undisturbed, and to *restore* the quality and functionality of some other habitats that have been previously disturbed. The term "conservation strategy" is generally used in Chapter 4 to refer to measures that include one or more of the following: preservation, rehabilitation, enhancement, and restoration. The term "mitigation strategy" or "mitigation" is generally used in this section to describe the alleviation of detrimental effects or environmental damage that results from ongoing anthropogenic actions. For a discussion of these terms, see Kaufmann et al. (1997). The term "management strategy" is generally used in Chapter 4 for a mix of both conservation and mitigation strategies.

The mitigation and conservation strategies presented in Chapter 4 of this HCP are intended by the City to meet the standards of the ESA to minimize and mitigate, to the maximum extent practicable, the impacts of any taking of species addressed in the HCP in a manner that will not appreciably reduce the likelihood of survival and recovery of the species in the wild (Section 2.3.2). The City further intends this HCP to provide a net benefit to the species addressed in the HCP and to contribute to the recovery of any species addressed in the HCP that are listed or may be listed under the ESA during the term of the HCP (Section 2.4).

4.1.2 Development of the City's HCP

The HCP was developed cooperatively with state and federal agencies, and the Muckleshoot Indian Tribe, over a three-year period (Chapter 1). In developing the HCP, the City performed literature reviews, held workshops with experts, and conducted a variety of studies and analyses (Chapter 3).

The HCP specifically addresses 83 species that are at-risk, including species that are listed under the ESA, are candidates for listing, or are otherwise at risk in the region (sections 3.4-3.6). Although the HCP includes conservation and mitigation measures developed for particular species, it is an ecosystem-based approach that focuses primarily on the quality and functioning of the habitats, ecological communities, and ecosystems on which these species rely. Grumbine (1994) defines five goals for maintaining the integrity of ecosystems: (1) maintaining viable populations; (2) representing natural elements of diversity; (3) maintaining ecological processes and natural disturbance regimes; (4) protecting evolutionary (adaptive) potential of species; and (5) accommodating human use in a sustainable fashion.

Because of the relatively small size of the municipal watershed relative to the range of populations of the species addressed, an HCP covering the Cedar River Municipal Watershed is not capable of, in itself, ensuring either that these populations remain viable or that they not lose adaptive potential. However, the City has attempted to design the HCP in a manner that will not reduce the viability or adaptive potential of species addressed in the HCP and that will, in fact, make a positive contribution to their regional viability. Measures developed for the municipal watershed were designed to foster maintenance and restoration of species and community diversity, and the natural ecological, physical, and process and disturbance regimes that create and maintain habitats for species (after Grumbine 1994).

An effort was made to identify key natural processes and disturbance regimes in the municipal watershed, and develop strategies to bring these key natural processes and disturbance regimes back within their normal envelopes of variation, controlling those human-caused processes (e.g., landslides, erosion, and forest disturbance) that impair ecosystem function. A major constraint however, has to do with the scale, intensity, and significance of processes. For example, a large-scale (watershed-wide) forest fire, even if of natural origin, would jeopardize the drinking water supply and the remaining old-growth forest, of critical importance for a number of at-risk species. The HCP was designed, as far as practicable, to limit the risk of such significant disturbance events.

On the other hand, small-to moderate-scale disturbances are often critical to maintaining natural ecosystem functions (Spies and Franklin 1989). The HCP was designed to foster such processes through a combination of measures designed to afford protection to habitats and species and activities designed to rehabilitate degraded habitats or recover species populations. While rehabilitation strategies are key to restoring degraded habitats, active intervention for the purpose of restoration will only be pursued when there is reasonable chance of improving resource conditions and reestablishing natural processes over the long term.

4.1.3 Overall Conservation Objectives

The City's overall planning objectives for the HCP are given in Section 2.4 and in the section above entitled "Background and Context," and more specific conservation objectives are given in the remaining sections of Chapter 4. In general, the HCP is designed to avoid, minimize and mitigate the impacts of any take of species addressed in the HCP; provide a net benefit for all species addressed in the HCP compared to current conditions; contribute to the recovery of at-risk species covered by the plan; and provide a means to deal with uncertainty in an adaptive manner that can meet the overall biological goals of the HCP (sections 4.5.7 and 5.5). In addition to those conservation objectives, the HCP addresses some of the important concerns of scientists and the public about HCPs in general (Section 1.1.3), including the need for broader involvement of the public and scientists (see Section 5.4).

4.1.4 Major Components of the HCP

OVERVIEW

The HCP encompasses overall conservation strategies for three major components of mitigation: (1) watershed management (Section 4.2); (2) mitigation for the Landsburg blockage to anadromous fish (Section 4.3); and (3) instream flows to maintain habitat for anadromous fish (Section 4.4). To support the mitigation strategies, it also includes a monitoring and research program (Section 4.5) to address important uncertainties; to evaluate effectiveness of mitigation, compliance with the plan, and trends in habitats and key species; and to provide for adaptive management. The funding commitments for these components total more than $79 million (in 1996 dollars) over the 50-year term of the HCP, not including the foregone opportunity cost for timber revenues, sale of drinking water, or sale of hydroelectric power, and some additional administrative costs of implementation.

WATERSHED MANAGEMENT MITIGATION AND CONSERVATION STRATEGIES (SECTION 4.2)

The Cedar River Municipal Watershed supports a variety of species that are at risk in the region, largely as a result of habitat degradation and loss. The northern spotted owl, marbled murrelet, bald eagle, and bull trout are found within the watershed, as well as other terrestrial and aquatic species that are at risk regionally. The HCP's watershed management mitigation and conservation strategies are designed to protect and contribute to the restoration of the habitats of at-risk species, and to contribute to the restoration of ecological and physical processes and functions that create and maintain key habitats and habitat features.

The proposed mitigation represents a landscape approach to watershed management that includes a commitment not to harvest timber for commercial purposes within the municipal watershed, effectively creating an ecological reserve that includes all forest outside limited developed areas, and a significant commitment to habitat restoration. These measures were developed collectively to mitigate for impacts of City land management activities, and they were developed in an integrated fashion to foster natural biological diversity and to help restore much of the watershed to more natural conditions.

MINIMIZING AND MITIGATING THE EFFECTS OF THE ANADROMOUS FISH BARRIERS AT THE LANDSBURG DIVERSION DAM (SECTION 4.3)

The anadromous fish conservation strategies are designed to mitigate for the blockage to fish passage created by the Landsburg Diversion Dam. The anadromous fish conservation strategies in this HCP are designed to complement other regional efforts to protect and restore declining stocks in the Lake Washington Basin. The intent is to implement biologically sound solutions that: (1) contribute to the recovery and persistence of healthy, harvestable runs of anadromous fish in the Cedar River and Lake Washington Basin; (2) have a high likelihood of success; and (3) maintain a safe, high quality drinking water supply.

Anadromous salmonids have not entered the protected watershed in nearly a century. The HCP will provide passage for all native anadromous salmonids into the protected watershed, significant regionally as refuge habitat in that it is highly protected and in relatively good condition. Included among these native salmonids are chinook and coho salmon, and steelhead trout. The sockeye salmon stock in the Cedar River was introduced from the North Cascades. Because of risks to public health, the City cannot allow passage above the raw water intake of the mass-spawning sockeye salmon. In lieu of passage, the City commits to artificial propagation for sockeye, with extensive monitoring and appropriate adaptive management provisions to reduce or eliminate risks to wild fish. In addition, the City commits to funding habitat protection and/or restoration for anadromous fish in the Cedar River Basin downstream of Landsburg.

INSTREAM FLOW MANAGEMENT STRATEGY (SECTION 4.4)

The City manages the Cedar River water supply: (1) to provide its customers in the region with a high quality, reliable, and adequate supply of drinking water; (2) to protect fisheries resources in the Cedar River and Lake Washington; and (3) to provide a measure of flood protection compatible with the City's primary water supply mission. The instream flow management strategy will commit the City to binding instream flows designed to improve habitat conditions for chinook, coho, sockeye, and steelhead in the regulated portion of the Cedar River.

Based on an extensive, cooperative, 5-year study and analysis of the needs of all life stages for each of the above four anadromous species, the flows provide habitat for spawning, incubation, rearing of young fish, and holding for adult fish. The flow regime includes not only minimum instream flow requirements but also adaptive provisions for allocation of supplemental flows above minimums in years when available, through operation of a multi-agency commission.

It is important to note that, as used in this HCP, the term *minimum flow* does not connote an instream flow that provides only minimum habitat or benefit for fish. Rather, such flows represent commitments to minimum levels of instream flows that the City will allow to occur, and they were designed to provide substantial benefits and habitat for the fish species addressed. As used in the HCP, *supplemental flows* are increases above minimums that are believe to provide even greater benefits or habitat during certain time of the year. The combination of minimum and supplement flows are termed *guaranteed flows*.

MONITORING AND RESEARCH (SECTION 4.5)

The monitoring and research program in the HCP includes: (1) compliance monitoring to determine whether HCP programs and elements are implemented; (2) effectiveness monitoring to determine whether HCP programs and selected elements result in the anticipated changes in habitat or other conditions for the species of concern; and (3) cooperative research to obtain more information on species of concern, test critical assumptions in the plan, and gain understanding needed to refine management decisions to meet plan objectives. The HCP also includes a commitment to adaptive management, which will be applied where considerable uncertainty exists and as a general mechanism for responding to new information that can be used to make conservation and mitigation strategies more effective.

EFFECTS OF THE HCP ON SPECIES OF CONCERN (SECTION 4.6)

Section 4.6 summarizes information included in this HCP that is relevant to the biological evaluations the Services made for the species to be covered by the incidental take permit. It presents a summary of the minimization and mitigation measures the City proposes to meet the standards of the ESA and an evaluation of effects on individual species and groups of species, both negative and positive, of the HCP and activities allowed under the HCP. It also includes a determination of whether or not the objective of providing a net benefit for the species addressed is likely to be provided under the HCP.

Note that habitat effects, and some effects on species, of the minimization and mitigation measures presented in sections 4.2-4.4 are discussed in those sections in the context of the specific measures for those components of the HCP. The purpose of Section 4.6 is to evaluate in a consistent manner the effects of all minimization and mitigation measures included in the HCP, taken together, and the City activities that will occur under the HCP.

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Section 4.2 Contents

4.2 Watershed Management Mitigation and Conservation Strategies

4.2.1 Introduction to Watershed Management Mitigation and Conservation Strategies

Intent and Coverage

The Watershed Management Mitigation and Conservation Strategies cover the City's land management activities in the Cedar River Municipal Watershed (Map 2). These strategies are intended to provide the following:

- Comprehensive, long-term protection for the watershed ecosystem, encompassing commitments not to harvest timber for commercial purposes in the watershed, effectively placing all forest outside limited developed areas in reserve status;
- Measures to protect and restore stream, riparian, and upland forest habitats;
- Removal of a large part of the existing road network;
- Guidelines for watershed operations designed to minimize and mitigate impacts of those operations; and
- Additional measures to protect species of greatest concern and their habitats.

For the purposes of this HCP, the combination of the above measures are described as *managing the watershed as an ecological reserve*. References in this chapter to a *watershed reserve* or *reserve status* refer to this set of commitments, but do not infer that the municipal watershed will not be managed for water supply and hydroelectric generation. As described in detail below in this section, these watershed management activities include water supply, hydroelectric, and general watershed operations, ecosystem restoration, research, monitoring of habitat and species, educational activities, recreation in designated areas, and a variety of other activities.

Background and Context

Regional Context and Significance of the Municipal Watershed

Although logging has occurred within the land area encompassed by the current municipal watershed for over 100 years, the watershed represents a very important element and opportunity in any regional effort directed at protecting salmonid fishes and species dependent on mature, late-successional, and old-growth conifer forests. A wide variety of animal species in the Pacific Northwest is dependent on mature, late-successional, and old-growth conifer forests, including many species that use aquatic and riparian habitats (Ruggiero et al. 1991a, b; FEMAT 1993). As a result of substantial and widespread loss, fragmentation, and general degradation of old-growth forest habitats, as well as urbanization and removal of forests in the lowlands, these fish and wildlife species collectively represent one of the greatest at-risk groups in the region (Thomas et al. 1993).

The Cedar River Municipal Watershed contains the headwaters of the major river that discharges into Lake Washington. The watershed is important not only as the region's primary water supply but also as the major source of downstream river flows necessary to maintain habitat for anadromous salmonids (sections 3.2.5 and 3.3.2). Finally, it is also a very large tract of land – about 90,546 acres – in an area of key importance to many at-risk species (sections 3.4-3.6).

Virtually all of the low-elevation, old-growth forest in the Puget Sound region has now been logged and much has been developed. The municipal watershed offers one of the few significant opportunities to reestablish a block of mature, late-successional, and old-growth forest below 3,000 ft in a manner that could effectively link this forest block to existing old growth in other areas of the Cascade Mountains.

Logging activity within the municipal watershed began in the 1880s at low elevations in the west end of the watershed, and, over time, progressed eastward and to higher elevations. Although railroad-caused forest fires frequently occurred in many regenerating stands harvested near the turn of the twentieth century (Section 3.2.2), many of these stands in the watershed have been growing without interruption since the 1930s – some even longer. Map 5 spatially depicts the existing age distribution of forest stands in the municipal watershed, and Figure 1.2-1 graphically displays acreages in different age classes.

Although early harvest practices often entailed logging all or nearly all forest adjacent to streams, much of the riparian forest at lower elevations, especially in the western portion of the watershed, is now on its way to recovering its natural functions. Partly because the watershed has been managed primarily as a municipal water supply for nearly a century, about 60 percent of the watershed as a whole now has forest over 50 years of age (Figure 1.2-1). As Map 5 indicates, the second-growth forest in most of the lower watershed is now relatively mature, mostly about 60-79 years old. Many streams flowing through the conifer forests at the lower elevations of the watershed, including the mainstem of the Cedar River between Cedar Falls and Landsburg, represent some of the better stream and riparian habitat in the entire Cedar River Basin (sections 3.2.2 and 3.2.3).

Existing habitats within the watershed are shown on Map 6 and discussed in Section 3.2.2, and cover types are shown on Map 7. Nearly 14,000 acres (16 percent) of the watershed's original native conifer forest remains today, but most is fragmented and isolated in several locations. All of this native forest is over 189 years, most of it is over 250 years old, and some of it is as much as 800 years of age. For perspective, this acreage equals about one-third of the remaining forest over 150 years of age on the 1.1 million acres of state land in western Cascades planning units covered by the Washington Department of Natural Resources' HCP (WDNR 1997).

Ranging from about 540-ft elevation at the Landsburg Diversion Dam to about 5,400-ft elevation near the Cascade crest, the watershed provides a corridor from low to high elevation, from the Douglas-fir and western hemlock forests of the Cascade foothills to the Pacific silver fir forests of middle elevations and the mountain hemlock forests and subalpine parklands of the higher mountains. To the northwest of the watershed is Tiger Mountain State Forest. A recently established natural area on Rattlesnake Ridge that is managed by the WDNR abuts the watershed on its northern boundary near Cedar Falls.

The easternmost portion of the Cedar River Municipal Watershed is also a major north-south link in the federal late-successional reserve system in the Cascade Mountains that was created by the Northwest Forest Plan (Tuchmann et al. 1996). The northern spotted owl Critical Habitat Unit (CHU # WA-33) (Fed. Reg. Vol. 57, Pp. 1796-1838) is also an important element in that reserve system. Federal and state biologists concerned about species dependent on late-successional and old-growth forests, such as the northern spotted owl and marbled murrelet, identified the I-90 corridor area of the Central Cascade Mountains as very important to the well being of such species (WAC 222-16-086; also see sections 2.3.4, 3.5.2, and 3.5.3). Also, the Wilderness Society recently identified the Central Cascade Mountains – containing the municipal watershed – as one of the 15 most "endangered" wild lands in the U. S. (Seattle Times, June 21, 1999), largely because of the fragmentation and loss of old-growth forest.

The I-90 corridor area has two features that make it of great significance with respect to landscape connectivity for species dependent on late-successional and old-growth forests. First, historic checkerboard (intermingled) ownership of federal and private land has resulted in a large degree of forest fragmentation overall and a substantial reduction of old-growth habitat on private lands, on which nearly all old-growth forest has been logged. Second, the federal ownership in the national forests has a relatively narrow east-west width in this area, restricting species dependent on old-growth forest to a very narrow north-south corridor for migration and dispersal (see Map 4).

In view of these landscape-level considerations, federal biologists classified the I-90 corridor, including the eastern portion of the watershed, as an area of critical importance for species dependent on late-successional or old-growth forests and a Special Emphasis Area for the northern spotted owl in Washington (USDI 1995a; see also Section 2.3.4). In essence, this area links habitats in the northern Cascades with those in the southern Cascades of Washington. This area of the I-90 corridor has been identified with repeated emphasis as being very important relative to dispersal of juvenile northern spotted owls and sustaining populations of spotted owls, as discussed in the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992b).

Although the Cedar River Watershed was not identified as a key watershed for anadromous salmonids and resident bull trout in the report of the federal Forest Ecosystem Management Assessment Team (FEMAT 1993) because it was not all federally owned land, the watershed is clearly of great importance for these species. The FEMAT report reviewed a number of options for forest ecosystem management and strategies to protect key watersheds, as well as other watersheds on federal land, all with a focus on restoring ecosystem processes important in old-growth forests. The strategies reviewed included different options for:

- Establishment of a late-successional reserve system;
- Measures to protect and restore riparian areas through riparian reserves, management guidelines, and buffers for streams and other aquatic habitats;
- Implementation of silvicultural methods to restore natural forest processes and habitat;
- Guidelines for timber harvest; and
- Guidelines for forest roads.

After a comprehensive review of these strategy options, FEMAT recommended Option 9, which was ultimately adopted in the Northwest Forest Plan (Tuchmann et al. 1996).

These recommendations formed the basis of many of the conservation and mitigation strategies presented in the Draft HCP, although many of the recommended standards are exceeded substantially in this final HCP with the City's commitment not to harvest timber for commercial purposes.

To summarize, the Cedar River Municipal Watershed has regional significance in five respects that are important for species addressed by this HCP. The municipal watershed:

(1) Is the major source of water to Lake Washington and for riverine habitat important to anadromous fish species in the Lake Washington Basin;

(2) Has some of the healthiest streams and streamside habitat in King County;

(3) Has several large blocks of old-growth forest in a region in which such habitat has largely been either removed or highly fragmented by past logging, and also has large areas of relatively mature second-growth forest at low to middle elevations;

(4) Is an important protected east-west corridor from the Puget Sound lowlands to the crest of the Cascade Mountains; and

(5) Is an important north-south link for species dependent on late-successional or old-growth ecosystems in the Cascade Mountains, and contains a unit of the federal late-successional reserve system (Tuchmann et al.1996), which is also a Critical Habitat Unit (CHU WA-33) for the northern spotted owl (Fed. Reg. Vol. 57, Pp. 1796-1838).

Not only the species that use the municipal watershed itself but also the aquatic species that use the river downstream of the Landsburg Diversion Dam will benefit by long-term City commitments to protect and restore aquatic habitats and water quality in the municipal watershed, which is two-thirds of the Cedar River Basin by area and includes the headwaters of the Cedar River. Thus, the Watershed Management Mitigation and Conservation Strategies are also an important element in the regional strategies to protect and restore anadromous fish populations in the Lake Washington Basin that are addressed by this HCP (sections 4.3 and 4.4).

Importance of Reserves in the Conservation of Biodiversity

Development of a system of reserves, preserves, and refugia has long been recognized as an essential component of any effort to save at-risk species and to preserve biodiversity (Primack 1993; Frissell and Bayles 1996; Moyle and Yoshiyama 1994; Sedell et al. 1990; Franklin 1990; FEMAT 1993). At a landscape level, one designing a reserve must consider the minimum habitat patch size needed for individuals and populations, the spatial relationship among patches, and the habitat needed for effective movement of organisms and dispersal of their offspring or propagules among patches of habitat used for reproduction or other essential functions (Morrison et al. 1992). Effective dispersal among patches of habitat in a reserve system depends on both the distance between patches and the nature of the intervening habitat.

Although it is recognized that reserve designs need to be tailored to specific objectives and situations (Ehrenfield 1989 and Franklin 1985, both as cited in Primack 1993), scientists have proposed several general rules or principles for the design of ecological reserves. There is general agreement that, all else being equal, habitat patches in any reserve design are more likely to contribute to the conservation of species and biodiversity if they are relatively large, more round than linear (minimizing edge), closer together, and connected by corridors (Primack 1993; Payne and Bryant 1994).

For example, smaller, more linear patches have relatively more edge and less *interior* habitat, and are generally of less value to interior forest species (Wilcove et al. 1986; Lehmkuhl and Ruggiero 1991; Primack 1993), and the success of dispersal can be expected to decline with increasing distance between patches (Harris 1984). By committing not to harvest timber for commercial purposes in the municipal watershed, the City will minimize edge effects, maximize beneficial forest interior conditions, and make the greatest contribution to successful dispersal of forest organisms.

There is a debate about the effectiveness of habitat corridors, and some scientists have argued that corridors may not always provide for successful movement of organisms or may sometimes even have adverse effects (Simberloff et al. 1992). By committing to no timber harvest for commercial purposes, the City will minimize reliance on corridors within the watershed to achieve successful dispersal and migration of forest organisms and will make a major contribution to regional habitat protection and restoration, as well as dispersal for many species.

City Policies and Decisions Related to an Ecological Reserve and to Timber Harvest

As noted in Section 2.4, the City had several planning objectives for the HCP that guided development of the Watershed Management Mitigation and Conservation Strategies. The Seattle City Council initially directed that City staff develop an ecological reserve for the HCP consistent with a 1989 City ordinance (Ordinance #114632), which directed designation of a large ecological reserve, but allowed timber harvest outside the reserve to generate revenues that could be used for specific environmental purposes (see Section 2.3.10).

Ordinance #114632 also directed the Seattle Water Department (now Seattle Public Utilities) to negotiate an exchange with the USFS to acquire all of the federal land in the watershed and the “valuable” old-growth forest habitat on that federal land. As described in Section 2.3.11, in 1992, Congress directed an exchange between the City and USFS. This exchange, completed in 1996, transferred to the City all of the federal land in the municipal watershed (nearly 17,000 acres), including many thousands of acres of old-growth forest. As a result of deed restrictions on the land exchanged to the City, the City cannot harvest timber on about 90 percent of the land acquired from the USFS. On the former federal land, no old growth can be harvested, and commercial timber harvest is not allowed on former federal lands within the northern spotted owl CHU in the eastern portion of the watershed (CHU WA-33: Fed. Reg. Vol. 57, Pp. 1796-1838), although some thinning can be done in second-growth forest under exceptions related to safety, water quality, and biological diversity. This deed-restricted land, thus, becomes a *de facto* part of any ecological reserve within the municipal watershed.

The Watershed Advisory Committee that developed the policies codified in the 1989 ordinance recommended a reserve of 55 percent of City-owned land in the municipal watershed at the time the ordinance was passed. At the direction of the Seattle City Council in 1996 and 1997, City staff developed a reserve proposal for this HCP that included this 55 percent of land in the municipal watershed that the City owned in 1989 and the deed-restricted former USFS land. Together, these two areas total approximately

64 percent (56,223 acres) of the land in the municipal watershed. Ordinance #114632 also specified the development of a timber management program, and the Seattle City Council directed City staff to provide flexibility for a carefully controlled timber harvest program to generate revenue for funding environmental efforts, including implementation of the HCP.

During the public review of the Draft HCP, many who commented on the HCP indicated concern about timber harvest in the municipal watershed, and asked the City to commit to no commercial harvest. In the past, public concerns about timber harvest have included the systematic logging of late-successional or old-growth forests, the impacts of forest practices on riparian and aquatic ecosystems, and the overall impacts on species dependent on both old-growth forests and aquatic habitats. There has been considerable public concern regarding the potential impacts on forests and aquatic habitats from what could be termed industrial tree farming. Such past practices in the Pacific Northwest have resulted in the following effects:

- Visual scarring of hillsides caused by very large clearcuts (Curtis 1993);
- Forest fragmentation from multiple clearcuts and roads (Franklin and Forman 1987);
- A significant decrease in the amount of old-growth forest (Bolsinger and Waddell 1993);
- A loss of forest habitat structure and diversity (Franklin 1989);
- Damage to streams and to salmon and trout habitat from landslides and erosion associated with logging or forest roads (Sidle et al. 1985; Bisson and Sedell 1984); and
- Property impacts that have occurred during recent storms from landslides and flooding associated with clearcuts.

In response to the comments received during the public review of the Draft HCP in early 1999, the Mayor and City Council made a decision to forgo opportunities for revenues from a commercial timber harvest program in the municipal watershed and to commit to no timber harvest for commercial purposes in the watershed, effectively placing all watershed forests outside of developed areas in reserve status.

The watershed management strategies included in the Draft HCP were developed with the help of leading regional scientists to allow conservative timber harvest that would sustain the aquatic and upland ecosystems of the watershed over the long term. While a commitment not to harvest timber for commercial purposes could not be construed to be a *requirement* of the ESA, the elected officials of the City of Seattle have chosen to do so as a matter of policy. The City made this decision in response to public comments on the Draft HCP. The commitment in this HCP not to harvest timber for commercial purposes will be described hereafter as managing the watershed as an ecological reserve or the designation of forests outside developed areas to reserve status. This commitment will clearly maximize protection for both aquatic and upland habitats of value to most species addressed in this HCP.

As described below in the section entitled "Administration of the Municipal Watershed and Applicable Management Guidelines," the commitment not to harvest timber for commercial purposes does not prevent the City from cutting trees to protect the drinking water supply, to provide drinking water and hydroelectric power, to meet ecological objectives, to protect the watershed from catastrophic damage, or for general administration of the watershed and management of its facilities. In short, the commitment does not in any way prevent the City from conducting operations and activities associated with water supply, hydroelectric power generation, watershed management, and general administration of the municipal watershed other than timber harvest for commercial purposes.

Landscape Integration: from the Watershed to the Region

To be effective, conservation and mitigation strategies for forest land management must address natural processes and anthropogenic disturbances at a variety of spatial and temporal scales, and site- or stand-based strategies must be integrated at both local and regional scales. Recent attention among conservation biologists has focused on watersheds as appropriate units at which to integrate conservation strategies, particularly for aquatic species (e.g., see Montgomery et al. 1995).

Many scientists have argued that watersheds should be the focus of efforts to protect and restore ecological systems (e.g., Naiman 1992; Reeves and Sedell 1992; Frissell and Bayles 1996). Carey and Johnson (1995) stated that “Streams and drainages...provide the template for landscape management systems for maintaining biodiversity,” and Karr (1991) has argued that watershed management should focus on maintaining the “biotic integrity” of stream ecosystems. Both within and among watersheds, protection of key habitats and maintaining connectivity among these habitats are of critical importance in efforts to conserve at-risk species (see Franklin 1990; Frissell and Bayles 1996).

It is widely recognized that a system of reserves, refugia, and key watersheds is important for protecting those species that depend on late-successional and old-growth forests, including salmonids (Franklin 1990; Sedell et al. 1990; FEMAT 1993; Moyle and Yoshiyama 1994; Frissell and Bayles 1996). Connectivity of lotic systems entails maintaining the linkage among stream corridors (Frissell 1993), allowing the free and safe passage of fish upstream and downstream. This is challenging in an urbanizing environment, where many kinds of impedance to passage are present and habitats can often be hostile to fish. However, maintaining connectivity among upland habitats, as compared to aquatic systems, can be even more challenging, as these systems can lack the unifying features and potential continuity provided by stream corridors in lotic systems (i.e., systems with running water).

Conservation biologists have recently realized that even the combination of reserves and corridors between them cannot always ensure habitat connectivity and the long-term sustainability of populations in upland habitats (Franklin 1990; Morrison et al. 1992), and they have argued that landscapes should be managed as a whole (Franklin and Forman 1987; Jensen et al. 1996). A habitat corridor is only one way to achieve connectivity of habitats at the landscape scale, and corridors may not always achieve the desired result or may sometimes even have adverse effects (Simberloff et al. 1992).

By committing to place forests in the watershed in an ecological reserve will make the greatest possible contribution to this regional connectivity, and the City will not rely on strategies involving designed corridors or “matrix” land management within the municipal watershed. Because the watershed will be managed as an ecological reserve, the quality of water released downstream, of critical importance to anadromous fish and other aquatic organisms in the lower Cedar River and Lake Washington, will be protected. Further, the quality of the water will be improved over time as sediment loading to streams is reduced through restoration efforts in the HCP.

The combination of watershed restoration and protection commitments included in the HCP will incorporate approaches recommended by scientists for restoring and sustaining those natural processes that foster natural biological diversity across watershed landscapes (Franklin and Forman 1987; Franklin 1992; FEMAT 1993; Carey and Curtis 1996). Scientists have identified some of the key ecological processes in Northwest forests that are central to the development and maintenance of late-successional and old-growth forest ecosystems. These processes include "(1) tree growth and maturation, (2) death and decay of large trees, (3) low to moderate intensity disturbances (e.g., fire, wind, insects, and disease) that create canopy openings or gaps in the various strata of vegetation, (4) establishment of trees beneath the maturing overstory trees either in gaps or under the canopy, and (5) closing of canopy gaps by lateral growth or growth of understory trees" (FEMAT 1993).

Avoiding, Minimizing, and Mitigating the Impacts of Allowed Incidental Take

The avoidance, minimization, and mitigation measures applying to the municipal watershed were developed on a long-term, integrated, landscape basis. The City recognizes that certain land management activities in the municipal watershed will create site-specific impacts, which need to be mitigated, although the commitment not to harvest timber for commercial purposes should make such impacts minor and limited. The minimization and mitigation measures are designed to both minimize impacts of such activities on a site-specific basis and produce landscape-level changes that mitigate for any such effects, as well as avoid adverse cumulative impacts. The City expects that the measures included in this HCP will be more than sufficient to support an incidental take permit, by avoiding, minimizing, or mitigating for potential taking in the municipal watershed as a consequence of City operations during the term of the HCP.

The Watershed Management Mitigation and Conservation Strategies (Section 4.2.2) constitute the minimization and mitigation measures for any City land management activities that could occur within the watershed, activities that relate to restoration efforts and general watershed operations. The strategies also serve as mitigation for impacts of reservoir operations on aquatic species within the municipal watershed that are potentially affected by such operations, especially those species such as bull trout and pygmy whitefish that use tributaries to the reservoir during their life cycles.

The conservation measures applied to previously harvested forests are designed to restore structural and biological diversity to conditions similar to what would be present as a result of certain types of natural disturbances and other natural processes. On a landscape level, these conservation measures will result in the following:

- Recruitment of substantial additional late-seral forest habitat through maturation,
- Acceleration of development of late-successional forest characteristics through silvicultural interventions,
- Reduction of anthropogenic sediment input to streams through road improvements and removal, and
- Restoration of aquatic connectivity by replacement, upgrades, or redesign of culverts that impede or block fish passage at road crossings.

All watershed activities will meet or exceed the standards in any Washington State Forest Practice Rules not encompassed by exemptions for the HCP.

Measures that include active intervention, including thinning for ecological reasons and culvert changes at stream crossings, involve some short-term habitat disturbance but will be designed to produce long-term habitat benefits. Thus, these measures, by their nature, are mitigated. When there is some question about short-term impacts of such activities, these concerns are discussed in the applicable text and provisions are made to minimize such impacts. All guidelines presented in this section are also designed to provide protection and to contribute to mitigation for activities with potential to cause impacts to species addressed in the HCP.

Development of the Watershed Management Mitigation and Conservation Strategies

In developing the Watershed Management Mitigation and Conservation Strategies for this HCP, the City integrated recent scientific perspectives on watershed protection and forest management. This integration was accomplished through:

- A review of the scientific literature;
- Consultation with regional experts;
- Coordination with state and federal resource biologists;
- A series of workshops with other agencies and outside scientists;
- An extensive database on watershed conditions and habitats;
- Studies of particular species in the municipal watershed;
- Various other studies and analyses; and
- A policy decision to forgo the opportunity for generating revenues from harvesting timber for commercial purposes (see above).

The City conducted a watershed assessment (Section 3.3.3 and Appendix 15) that was patterned after the State of Washington's watershed analysis process (Washington Forest Practices Board 1993) to characterize current conditions, attempt to identify problems and their causes, and develop strategies for protecting and restoring the aquatic environments in the municipal watershed. The assessment identified these major problems relative to aquatic habitats:

(1) Sediment loading to streams from past and current road failures;

(2) A lack of large woody debris in streams as a result of past removal of riparian vegetation;

(3) Poor recruitment of large woody debris from riparian forests into streams in areas of recent or significant past disturbance; and

(4) A lack of stream connectivity, caused by poorly designed culverts where roads cross streams.

Key to developing the Watershed Management Mitigation and Conservation Strategies were the four workshops held with agency biologists and other scientists on watershed conservation biology, old-growth restoration, and bull trout (Section 3.3.4). These workshops were valuable in identifying different, often competing, perspectives on conservation issues, some of which the City has incorporated into the overall conservation strategies. These perspectives included:

- The importance of reserves to protect both upland and aquatic habitats;
- The importance of stream and forest restoration in previously disturbed areas;
- The value of using silvicultural intervention, based on characteristics of individual site and stands of trees, to accelerate development of old-growth forest conditions; and
- The need for monitoring and research because of the uncertainties regarding the effects of reservoir management on bull trout.

Overall Conservation Objectives for Watershed Management

The mitigation and conservation strategies for watershed management are designed to avoid, minimize, or mitigate for the impacts of any taking of listed species, including the spotted owl and the marbled murrelet, and for the equivalent of taking of unlisted species addressed by the HCP. These strategies are also designed to provide a net benefit for the species addressed by the plan, contribute to recovery of these species, and contribute to the maintenance of natural biodiversity in the watershed and region. The strategies will also benefit many other fish and wildlife species inhabiting the biological communities and ecosystems of the watershed that are not specifically addressed by this HCP. Because this HCP focuses on species dependent on late-successional and old-growth forest, riparian, and aquatic habitats, those species that depend primarily on the earliest seral forest habitats, such as the grass-forb-shrub stage of succession, will receive relatively less benefit from the HCP or will lose habitat under the HCP, as these habitats will be less common that they are today.

The overall planning objectives of the City's HCP are given in Section 2.4. General conservation objectives that are more specifically relevant to the Watershed Management Mitigation and Conservation Strategies are listed and discussed below. More specific biological objectives are described below in Section 4.2.2. The general conservation objectives for watershed management are to:

- Develop strategies for watershed management, consistent with water supply functions, that protect and improve water quality, as well as aquatic and riparian habitats;
- Develop scientifically sound conservation strategies for the watershed that combine mitigation, protection, restoration, research, monitoring, and adaptive management to achieve the conservation objectives of the HCP;
- Develop strategies to restore and sustain the natural processes that create and maintain key habitats for species addressed by the HCP and that foster natural biological diversity of native species and their communities;
- Protect existing old-growth forest in the municipal watershed and promote development of additional mature and late-successional forest that will better

support the native organisms characteristic of late-successional and old-growth forest communities;

- Develop an integrated, landscape approach that addresses the spatial relationship of habitats within the watershed and with regard to nearby areas to improve the ability of the watershed, over time, to support the species addressed by the HCP;

- Pursue land management approaches that, as practicable, help avoid catastrophic events such as forest fires that would jeopardize drinking water or habitats for species addressed by the HCP;

- Protect special habitats in the municipal watershed (described below); and

- Commit not to harvest timber for commercial purposes, effectively establishing the forests in the watershed as an ecological reserve that will protect existing old-growth forest, recruit a significant amount of mature and late-successional forest, and make a significant contribution to the support of regional populations of species that depend on late-successional and old-growth forests and/or aquatic and riparian ecosystems.

Additional, more specific conservation objectives are presented in Section 4.2.2, along with descriptions of the various minimization and mitigation measures.

Overview of Watershed Management Mitigation and Conservation Strategies

The Watershed Management Mitigation and Conservation Strategies have been designed to (1) provide a comprehensive program to mitigate for potential impacts from watershed management activities on species addressed in the HCP, (2) provide a net benefit for the species addressed in the HCP, and (3) contribute to the conservation of these species. The strategies integrate protection through a combination of the following:

- Placing all watershed forests in an ecological reserve,
- Rehabilitation and restoration activities,
- Species- and habitat-specific measures designed to protect species of concern,
- Management constraints and guidelines,
- Other measures that protect individual animals from disturbance, and
- Monitoring and research to ensure the conservation and mitigation strategies are effective.

One major component of these strategies is the set of Watershed Assessment Prescriptions that resulted from the comprehensive watershed assessment conducted in developing the HCP (Section 3.3.3). These prescriptions are referred to throughout Section 4.2, and can be found in their entirety in Appendix 16. These prescriptions were developed under the assumptions in the Draft HCP that timber harvest for commercial harvest would occur outside a designated ecological reserve, which would include buffers on aquatic habitats, old-growth forest stands, and Special Habitats. Because of the City’s commitment not to harvest timber for commercial purposes in the municipal watershed, references in the prescriptions to commercial timber harvest and reserve buffers are not relevant to the final HCP.

The Watershed Management Mitigation and Conservation Strategies include two kinds of conservation and mitigation measures for land management activities within the municipal watershed: (1) *community-based conservation* measures that are focused on the ecosystems, biological communities, and habitats that are most important to the species addressed in the HCP; and (2) additional *species conservation* measures that also address protection of individuals of 14 species of greatest concern during sensitive periods of their life cycles.

The primary ecosystems, biological communities, and habitats addressed in the HCP are Late-successional and Old-growth Forest Communities, the Aquatic and Riparian Ecosystem, and Special Habitats important to some species addressed in the HCP. Three sets of community-based conservation and mitigation measures collectively cover the entire watershed landscape and include:

(1) *Establishment of a watershed ecological reserve*: the commitment not to harvest timber for commercial purposes, effectively placing watershed forests outside limited developed areas in ecological reserve status;

(2) *Habitat restoration*: active intervention to help restore more natural ecological conditions and functions in previously disturbed areas; and

(3) *Management guidelines*: guidelines for land and forest management, including control of watershed access and constraints on cutting trees and managing roads.

While protection and restoration of habitats are the most important strategies for protection of the species addressed in the HCP, additional measures are needed for some of the species of greatest concern, in part to address protection of individuals during critical periods of their life cycles, such as reproductive seasons. The HCP includes a fourth set of measures to protect the 14 species of greatest concern (Section 3.5):

(4) *Species Conservation Strategies*: measures to protect individuals and habitats of the species of greatest concern during sensitive periods of their life history.

In addition to a description of the conservation and mitigation strategies referenced above, Section 4.2 includes a discussion of the rationale for the conservation strategies, brief summaries of related monitoring and research (covered in detail in Section 4.5), and an evaluation of the general effects of the strategies. The effects of the Watershed Management Mitigation and Conservation Strategies on all species addressed in the HCP are evaluated comprehensively in Section 4.6. Table 4.2-1 describes the organization of the remainder of Section 4.2 (Watershed Management Mitigation and Conservation Strategies).

Table 4.2-1. Organization of Watershed Management Mitigation and Conservation Strategies.

Section	Element of Conservation or Mitigation Strategies
4.2.2	**Watershed Management Mitigation and Conservation Measures**: This section includes four major parts. • Community-based strategies that include commitment not to harvest timber for commercial purposes (effectively creating an ecological reserve that includes all forest outside developed areas in the watershed); management

Section	Element of Conservation or Mitigation Strategies
	guidelines; restoration activities in previously harvested areas collectively protecting, restoring, and reconnecting aquatic, riparian, and old-growth habitats, as well as additional habitats; an aggressive program to remove forest roads; and control of public access to minimize human disturbance. • Descriptions of City activities and operations in the municipal watershed, with guidelines for protecting habitats. • Species-specific strategies that build upon the community-based strategies, including specific commitments for some of the species of greatest concern designed to reduce risks by controlling disturbances and impacts to individuals, pairs, and habitat during critical activities, such as reproduction. • A rationale for the mitigation and conservation strategies, based on scientific understanding and integration of conservation and mitigation measures.
4.2.3	**Watershed Research and Monitoring**: Summary of comprehensive monitoring and research designed to track compliance and effectiveness of mitigation measures, test key assumptions, provide needed information, and support adaptive management under the HCP (described in Section 4.5).
4.2.4	**Summary of Effects of Watershed Conservation and Mitigation Measures**: Summary of the overall effects of the mitigation and conservation measures on species addressed in the HCP in terms of overarching objectives.

4.2.2 Watershed Management Mitigation and Conservation Strategies

Basic Approach

Introduction

The City's efforts to sustain and restore the natural functioning of the target biological communities, habitats, and ecosystems for the municipal watershed – aquatic, riparian, late-successional and old-growth forest, and special habitats – are accomplished by a combination of three community-based conservation and mitigation strategies for the 83 species addressed in the HCP: (1) the commitment not to harvest timber for commercial purposes – a commitment that places watershed forests in reserve status; (2) commitments to active intervention to restore previously disturbed habitats; and (3) commitments to management guidelines designed to protect species and habitats. In addition, the Watershed Management Mitigation and Conservation Strategies include Species Conservation Strategies for the 14 species of greatest concern (Section 3.5).

Components of the Watershed: Habitats, Communities, and Ecosystems

Makeup of the Watershed

Most of the species of concern addressed by this HCP (sections 3.4-3.7) depend on, or use in significant ways, one or more of three interrelated ecosystems in the municipal watershed: aquatic, riparian, and upland forest. In addition, a much smaller number of these species of concern use or depend on other habitat types that are much more limited in distribution and yet particularly important to those species for some aspect of their habitat needs. (Table 4.2-3, below, gives the primary habitat associations for all species addressed by this HCP.)

To address the habitat needs of the variety of species addressed by the HCP, measures for three major components of the undeveloped cover types in the municipal watershed were identified:

(1) A Late-successional and Old-growth Forest Communities component, with measures designed to protect existing old growth and recruit additional mature and late-successional forest in a pattern of habitat across the landscape that would improve conditions for species that rely on these plant communities, and designed to link to key areas outside the municipal watershed. The Late-successional and Old-growth Forest Communities component includes all existing old growth and all second growth, which has potential for developing into mature and late-successional forest.

(2) An Aquatic and Riparian Ecosystem component, with measures designed to protect and improve water quality and aquatic and riparian habitat in the aquatic/riparian ecosystem complex. The Aquatic and Riparian Ecosystem component of the watershed includes all ponds, lakes, wetlands, streams, wetland complexes, floodplain and riparian habitats, landslide prone areas associated with streams, and other areas adjacent to aquatic habitats.

(3) A Special Habitats component, with measures designed to protect limited, specific habitats used by some species of concern, and to contribute to overall protection of biodiversity in the municipal watershed. The Special Habitats component includes talus and felsenmeer slopes, rock outcrops and cliffs, upland grass-forb meadows, upland persistent shrub, and other undeveloped, non-forested habitats of value to species addressed in the HCP.

Existing developed areas within the watershed include parts of the Rattlesnake Lake Recreation Area (near Cedar Falls), the area that includes the administrative facilities at Cedar Falls and Landsburg, other areas associated with the Masonry Dam and reservoir complex, and such features as roads, trails, education sites, and power line rights-of-way. The Rattlesnake Lake area contains the 111-acre lake and associated wetlands, and provides forest habitat connectivity with the Rattlesnake Ridge Natural Area on the northern boundary of the municipal watershed. The former town site of Taylor, in the western portion of the watershed, is now largely covered by deciduous forest and is an area of historic significance.

Database and Habitat Modeling Projections

To map existing habitats and project habitat change over time, spatially linked data sets containing geographical and environmental attribute information relative to the municipal watershed were developed from a number of sources. City staff conducted extensive field surveys of both forested and non-forested habitats and conducted analyses of aerial photographs. Additional supporting information was obtained from WDNR, USFS, WDFW, and King County. The data were incorporated into an extensive Geographic Information System (GIS) database for the watershed. Substantial information derived from the City's Watershed Assessment (Section 3.3.3 and Appendix 15) was also incorporated into the system.

The GIS was linked with the Forest Projection System, a computer software application that includes capabilities for forest database management, stand growth modeling, and harvest scheduling (Section 3.3.7). The combined capacity of the GIS and the Forest Projection System provided the means to spatially compare and depict environmental and forest stand information as well as to model future stand conditions.

Acreage of Major Components and Sub-elements in Watershed

The components and sub-elements of the watershed that were described above are shown on maps 6 and 7. Acreages of these components and sub-elements are given in Table 4.2-2 below.

Table 4.2-2. Areas of the three components of the watershed and their sub-elements (in acres).

Components and Sub-elements of the Watershed	Acreage of element	Acreage Contributed
Aquatic & Riparian Ecosystem		
• Reservoir complex	1,787	1,787
• Lakes and ponds	242	242
• Other open water	185	185
• Forested wetlands[1]	1,063	0
• Palustrine scrub-shrub wetlands	464	464
• Palustrine emergent wetlands	236	236
• Riparian habitat (by vegetation)[1]	4,223	0
• Sensitive soils (includes some floodplain)[1]	3,070	0
• Headwalls[1]	1,861	0
• Inner gorges[1]	2,364	0
Subtotal for Component		**2,914**
Late-successional & Old-growth Forest Communities		
• Old-growth conifer forest (>189 years old)	13,889	13,889
• Late-successional forest (120-189 years old)	91	91
• Mature forest (80-119 years old)	1,074	1,074
• Other second-growth forest (potential for recruitment)	70,223	70,223
Subtotal for Component		**85,4**77
Special Habitats		
• Unvegetated talus & felsenmeer & active landslides	1,190	1,190
• Vegetated talus & felsenmeer	329	329
• Rock outcrops & cliffs	54	54
• Upland grass-forb meadows	110	110
• Upland persistent shrub	93	93
• Non-forest (unclassified)	33	33
Subtotal for Component		**1,809**
Other Areas		

Components and Sub-elements of the Watershed	Acreage of element	Acreage Contributed
• Developed areas	346	346
Subtotal for Component		**346**
TOTAL OF WATERSHED COMPONENTS		**90,546**

1 Cover type is forested and is included under Late-successional and Old-growth Forest Communities

Input from Outside Scientists Regarding Watershed Management

As described in Section 3.3.4, the City hosted an old-growth restoration workshop with outside scientists and two watershed conservation biology workshops with agency biologists and other scientists. Although the scientists and agency biologists at the conservation biology workshops did not agree on a single approach to watershed management, they did agree that more of the mature, low-elevation second growth in the lower watershed should be included in an ecological reserve. While the scientists agreed that conservative timber harvest in the watershed could be conducted in a manner that would sustain species dependent on old-growth forest habitats, for policy reasons the City chose not to engage in commercial timber harvests to generate revenue. The scientists also agreed that two other commitments should be included in the HCP: management guidelines consistent with the objectives for the watershed and measures to restore previously altered habitats.

Types of Watershed Management Mitigation and Conservation Measures

As described above, the Watershed Management Mitigation and Conservation Strategies are based on four types of mitigation and conservation measures:

(1) Protection of key areas of habitat by designating them for reserve status, for the purpose of maintaining undisturbed areas and recruiting more future, high-quality forest habitat in previously disturbed areas;

(2) Restoration of aquatic, riparian, and upland forest habitats, and the natural processes that create and maintain them, through a program of active intervention;

(3) Protection of key habitats and areas by implementing management guidelines that constrain certain activities within the watershed; and

(4) Species conservation strategies, targeted at species of greatest concern.

The City believes that the most important contributions it can make to conservation of species within the municipal watershed are protection of existing high-quality habitat of all key types needed by aquatic and terrestrial species addressed by the HCP and recruitment of more mature and late-successional forest habitat in upland and riparian areas. The City's commitment not to harvest timber for commercial purposes will:

(1) Protect sensitive and important non-forested habitats, including all aquatic habitats;

(2) Result, over time, in “blocking up” and connecting older forest habitats as previously harvested stands mature; and

(3) Provide connectivity among aquatic and other non-forested habitats, through a development of a more completely forested environment; and

(4) Through the removal of a large fraction of watershed roads, result in improved water quality and aquatic habitats as sediment loading to steams is reduced.

Botkin (1990) has also argued that “no action” is a form of management, which often is not the wisest course of action when an area has been disturbed by past human activities. Many scientists believe that restoration can also be important for a reserve system in which prior human-caused disturbance may have degraded or otherwise altered key habitats. For any reserve system, initial conditions must be considered in formulating management plans, which should be tailored both to management objectives and to the area (Franklin and Forman 1987; Franklin 1992).

Some forest stands in the watershed could greatly benefit by careful silvicultural intervention to accelerate development of ecological characteristics of late-successional and old-growth habitat or, in streamside forests, to develop structure characteristics of natural, mature riparian forests. The Watershed Management Mitigation and Conservation Strategies include two types of silvicultural intervention: (1) *thinning* to restore structural diversity in upland and riparian forests and to accelerate development of old-growth forest conditions, and (2) *planting* to restore natural diversity in upland forest communities and recruit desired species, such as western redcedar, in riparian forests. In addition to restoration of riparian forests, measures directed at restoring streams include instream habitat projects, projects to restore stream connectivity, and improvement and decommissioning (removal) of roads to reduce sediment loading that could affect aquatic habitat.

However, effective protection in a reserve system created by no commercial timber harvest also requires careful control of human activities so that those activities do not compromise the conservation objectives for the watershed. In recognition of this need, the City developed watershed management guidelines to constrain management activities in a manner that will protect the species addressed in the HCP. Many of the guidelines were based on a Watershed Assessment (Section 3.3) and several workshops with outside scientists (Section 3.4).

Habitat Associations of Species Addressed by the HCP

The primary habitat associations for all species addressed by this HCP are given in Table 4.2-3, which also lists the key habitats for those species that will be protected or improved by habitat restoration measures in the HCP. The species are grouped by the three major components of the Watershed Management Mitigation and Conservation Strategies: Aquatic and Riparian Ecosystem, Late-successional and Old-growth Forest Communities, and Special Habitats.

The literature indicates that wildlife species use riparian habitats disproportionately more than other types of habitat (O’Connell et al. 1993). Results from a study on the habitat use of 414 species of wildlife in western Washington and Oregon indicate that 87 percent of the species use riparian zones or wetlands during some season(s) or part(s) of their life cycles (Brown 1985a). In the Cedar River Municipal Watershed, aquatic or riparian habitat appears to be key habitat for about half of the species addressed by the HCP

(Table 4.2-3), and is key habitat for many other species that are not on the list of species addressed by this HCP.

A wide variety of species in the Pacific Northwest are also dependent on mature, late-successional, and old-growth conifer forests (Brown 1985a; FEMAT 1993). Some species of nonvascular plants (and invertebrates) appear to be more closely adapted to the habitat conditions in old-growth forests than those in earlier seral stages, and some of these species may not occur at all absent such conditions (Ruggiero et al. 1991a; Henderson 1993). However, few species of vertebrates or vascular plants appear to be strictly dependent on old-growth forests (Rugierro et al. 1991a), and many seem to do well in earlier seral forests that have such characteristics of younger *unmanaged* stands as abundant logs, snags, and gaps in the canopy (Ruggiero et al. 1991a; Spies 1991). In the municipal watershed, late-successional and old-growth habitat appears to be key habitat for about 30 percent of species addressed by the HCP (Table 4.2-3) and is also key habitat for many other species in the watershed that are not on the list of species addressed by this HCP.

However, forest conditions over the entire landscape are also important for the dispersal and movement of many organisms that live in existing old-growth forest, and the forested parts of the landscape that are not old growth can provide habitat important to many of the species addressed in the HCP. For example, the home ranges of such characteristic old-growth species as the northern spotted owl and northern goshawk are in the thousands of acres (sections 3.5.2 and 3.5.4, respectively), so the forest conditions over large areas are important to these species. In addition, other species addressed by this HCP - such as brown creeper, olive-sided flycatcher, three-toed woodpecker, and some bat species - regularly use seral stages other than old growth (Harris 1984; Brown 1985a).

Thirteen species addressed in this HCP depend on one or more of the Special Habitat types, although many of these species also use other habitat types as well (Table 4.2-3). For example, peregrine falcons, black swifts, and golden eagles typically nest on cliffs, but forage widely over a variety of open habitats. Nine of the 11 bat species depend on late-successional and old-growth forests, but also use caves and rock crevices for roosting. Grizzly bears, gray wolves, wolverines, Larch Mountain salamanders, and Van Dyke's salamanders – although not known to be present in the municipal watershed – use such open habitats as natural meadows, persistent shrub communities, and talus slopes, and some of these species also use forests.

Close inspection of Table 4.2-3 reveals that many species rely on more than one of the major habitat groupings: Aquatic and Riparian Ecosystem, Late-successional and Old-growth Forest Communities, and the Special Habitats. Of the 83 species listed in Table 4.2-3, about one-fourth depend on more than one of the above three ecosystems, communities, or habitat groups, and about 10 percent of the species depend on all three. Over 80 percent of the species that depend primarily on Special Habitat types also depend on at least one of the two ecosystems and communities (Aquatic and Riparian Ecosystem, and Late-successional and Old-growth Forest Communities).

Table 4.2-3. Primary habitat associations (key habitat) for species addressed by the HCP, and habitat that will be protected or restored by the HCP. An asterisk (*) indicates species of greatest concern.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Aquatic & Riparian Ecosystem		
Bald Eagle* *Haliaeetus leucocephalus*	Mature and old-growth forests near lakes, reservoirs, and rivers (Brown 1985b)	Protection: all lakes, rivers, and the reservoir complex; all streamside and riparian habitat; all forest, including old-growth. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation.
Common Loon* *Gavia immer*	Large wooded lakes (Vermeer 1973)	Protection: all lake habitat, including reservoir complex; associated riparian areas. Restoration: riparian and other forest.
Great Blue Heron *Ardea herodias*	Tall deciduous or coniferous trees near wetlands (WDW 1991)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all streamside and riparian habitat; all wetland habitat. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation.
Harlequin Duck *Histrionicus histrionicus*	Fast-flowing rivers and streams and associated bank vegetation; large woody debris (Cassirer and Groves 1989; Harlequin Duck Working Group 1993)	Protection: all potential streamside breeding habitat. Restoration: riparian and streamside forest.
Osprey *Pandion haliaetus*	Conifer/deciduous forest along lakes, streams, and rivers (Ehrlich et al. 1988)	Protection: all lake and riverine habitat; all streamside and riparian habitat. Restoration: riparian and streamside forest.
Willow Flycatcher *Empidonax traillii*	Swamps; thickets; riparian willows (Ehrlich et al. 1988)	Protection: all riparian and wetland habitat and meadow complexes. Restoration: riparian and streamside forest.
Bull Trout* *Salvelinus confluentus*	Cold, clear streams and lakes with an abundance of cover (LWD) and gravel for spawning; wetlands (WDFW 1994; Bond 1992)	Protection: all river and stream habitat associated with the reservoir and all wetlands used for rearing or spawning; all streamside and riparian habitat. Restoration: streams, riparian and streamside forest.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Chinook Salmon* *Oncorhynchus tshawytscha*	Cool, clear rivers and larger streams; gravel and cobble for spawning (Groot and Margolis 1991)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; increased recruitment of large woody debris; improved water quality for river downstream of Landsburg Diversion Dam.
Coho Salmon* *Oncorhynchus kisutch*	Lakes, ponds, and associated wetlands; structurally complex streams with debris, pools, and gravel and cobble (Scrivener and Andersen 1982)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all accessible wetlands, lakes, and ponds; Walsh Lake wetland complex; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Cutthroat Trout (sea run) *Oncorhynchus clarki*	Cool headwaters of tributaries; streams with gravel bottoms (Scott and Crossman 1973; Wydoski and Whitney 1979)	Protection: all streams in lower watershed; all wetlands associated with streams; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Kokanee (resident sockeye) *Oncorhynchus nerka*	Lakes; streams with gravel for spawning (Scott and Crossman 1973)	Protection: Walsh Lake wetland complex; all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Pacific Lamprey *Lampetra tridentatus*	Streams with gravel, rock, or sandy gravel substrates; pools with soft bottoms (Hart 1973)	Protection: all river and stream habitat below Cedar Falls, all streamside and riparian habitat. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Pygmy Whitefish* *Prosopium coulteri*	Lakes with depth of >20 ft; stream reaches with swift current, cold water, and coarse gravel (Scott and Crossman 1973)	Protection: all river and stream habitat associated with the reservoir and all wetlands used for rearing or spawning; all streamside and riparian habitat. Restoration: streams, riparian and streamside forest.
River Lamprey *Lampetra ayresi*	Streams and rivers with mud or sand bottoms, and gravel bottoms for spawning (Scott and Crossman 1973)	Protection: all river and stream habitat below Cedar Falls, all streamside and riparian habitat; improved water quality for river downstream of Landsburg Diversion Dam. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Sockeye Salmon* *Oncorhynchus nerka*	Cool, clear lakes and streams; gravel and cobble for spawning (Groot and Margolis 1991)	Protection: improved water quality for river downstream of Landsburg Diversion Dam, in part resulting from protection of all aquatic habitat above Landsburg. Restoration: habitat downstream of watershed.
Steelhead Trout* *Oncorhynchus mykiss*	Well oxygenated, cool streams; streams with gravel and cobble (Scott and Crossman 1973; Wydoski and Whitney 1979)	Protection: all river and stream habitat along the Cedar River and tributaries between Landsburg Dam and Cedar Falls; all streamside and riparian habitat. Restoration: streams, riparian and streamside forest; habitat downstream of watershed; improved water quality for river downstream of Landsburg Diversion Dam.
Masked Shrew *Sorex cinereus*	Alder and willow thickets; forested riparian areas (Johnson and Cassidy 1997)	Protection: all streamside and riparian habitat; all forest habitat; all naturally open habitats. Restoration: streamside and riparian habitat.
Northern Water Shrew *Sorex palustris*	Forested areas along small streams and ponds, and forested wetlands with abundant cover (Johnson and Cassidy 1997).	Protection: all wetlands; all river and stream habitat; all streamside and riparian habitats. Restoration: streams, streamside and riparian habitat.
Cascades Frog *Rana cascadae*	Pools adjacent to streams flowing through subalpine meadows (Leonard et al. 1996)	Protection: all ponds and wetlands; all river and stream habitat; all streamside and riparian habitats. Restoration: streams, streamside and riparian habitat.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Cascade Torrent Salamander *Rhyacotriton cascadae*	Cold clear streams, seepages, and waterfalls (Leonard et al. 1996)	Protection: all wetlands; all river and stream habitat; all streamside and riparian habitats; all forest habitat. Restoration: streams, streamside and riparian habitat.
Long-toed Salamander *Ambystoma macrodactylum*	Lowland forests; pastures; high-elevation small lakes and ponds (Leonard et al. 1996)	Protection: all lowland forest; all wetlands, lakes, and ponds; all streamside and riparian habitat; naturally open habitats. Restoration: riparian habitat.
Northwestern Salamander *Ambystoma gracile*	Wetlands adjacent to lakes, ponds, and slow-moving streams; rotting logs (Leonard et al. 1996)	Protection: all wetlands, lakes, and ponds; all streamside and riparian habitat; all forest; recruitment of logs through silviculture. Restoration: streams, streamside and riparian habitat.
Oregon Spotted Frog *Rana pretiosa*	Marshes, ponds, or streams with little or no flow; associated with non-woody wetland plant communities (Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitat; all natural meadows. Restoration: streams, streamside and riparian habitat.
Pacific Giant Salamander *Dicamptodon tenebrosus*	Cold streams; cool, moist, conifer forests near cold clear streams and mountain lakes (Leonard et al. 1996)	Protection: all rivers, streams, lakes, and ponds; all streamside and riparian habitat; all forest.
Red-legged Frog *Rana aurora*	Ponds, lakes, slow-moving streams, wetlands, and riparian areas in forested ecosystems (ODFW 1996; Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitat; all forest. Restoration: streams, streamside and riparian habitat.
Rough-skinned Newt *Taricha granulosa*	Wetlands; slow-moving streams (Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitat. Restoration: streams, streamside and riparian habitat.
Tailed Frog *Ascaphus truei*	Cold rocky rivers and streams (Leonard et al. 1996)	Protection: all rivers and streams; all streamside and riparian habitats. Restoration: streams, streamside and riparian habitat.
Van Dyke's Salamander *Plethodon vandykei*	Usually associated with seepages and streams, some near talus; woody debris near water (Leonard et al. 1996)	Protection: all aquatic habitats; all streamside and riparian habitats; vegetated talus. Restoration: streams, streamside and riparian habitat.
Western Pond Turtle *Clemmys marmorata*	Wetlands and riparian areas and forest edge habitat (WDW 1993); marshes; sloughs; moderately deep ponds; slow moving creeks (Nussbaum et al. 1983)	Protection: all streams, lakes, ponds, and wetlands; all streamside and riparian habitats; all forest. Restoration: streams, streamside and riparian habitat.
Western Toad *Bufo boreas*	Rivers, lakes, and ponds; riparian areas; wetlands; meadows; shrubby thickets; woodlands (Brown 1985b; Leonard et al. 1996)	Protection: all rivers, streams, lakes, ponds, and wetlands; all streamside and riparian habitats; all forest; all permanent shrub communities. Restoration: riparian and upland forest.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Beller's Ground Beetle *Agonum belleri*	Lowland sphagnum bogs (below 1000 m elevation) (Johnson 1979)	Protection: all wetlands, bogs, aquatic and riparian habitats; all forest. Restoration: riparian forest.
Carabid beetle: *Bembidion gordoni*	Fast-running montane streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitats.
Carabid beetle: *Bembidion stillaquamish*	Streams and riparian areas (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitats. Restoration: streamside and riparian forest.
Carabid beetle: *Bembidion viator*	Swamps and forested marshes in lowlands (Bergdahl 1995)	Protection: all wetland habits; all riparian habitat; all forest. Restoration: riparian forest.
Carabid beetle: *Bradycellus fenderi*	Low-elevation swamps and forested marshes (Bergdahl 1995)	Protection: all wetland habits; all riparian habitat; all forest. Restoration: riparian forest.
Carabid beetle: *Nebria gebleri cascadensis*	Streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Carabid beetle: *Nebria kincaidi*	Montane streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Carabid beetle: *Nebria paradisi*	Montane streams (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Carabid beetle: *Omus dejeanii*	Low-elevation woodlands; forest glades (Bergdahl 1995)	Protection: all low-elevation forest; all wetlands; all riparian habitats. Restoration: upland and riparian forest.
Carabid beetle: *Pterostichus johnsoni*	Streams and groundwater-fed streams with unstable, sliding mud and scree; waterfall spray (Bergdahl 1995)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Fender's Soliperlan Stonefly *Soliperla fenderi*	Seeps, streams and creeks (WDFW 1991; Opler and Lattin 1998)	Protection: all streams; all streamside and riparian habitat. Restoration: streamside and riparian forest.
Hatch's Click Beetle *Eanus hatchi*	Lowland sphagnum bogs (below 1000 m elevation) (Johnson 1979)	Protection: all wetlands, including bogs; all riparian habitats. Restoration: streamside and riparian forest.
Long-horned Leaf Beetle *Donacia idola*	Lowland sphagnum bogs (below 1,000 m elevation); other wetland habitats (Johnson 1979; Bergdahl, J., Northwest Biodiversity Center, June 1998, personal communication)	Protection: all wetlands, including bogs, with surrounding forest; all riparian habitats; wetland complexes below 1,000 m elevation. Restoration: streamside and riparian forest.
Papillose Taildropper (slug) *Prophysaon dubium*	Moist coniferous forest, low to middle elevations (Frest and Johannes 1993)	Protection: all riparian habitats; all forest, including old-growth. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Snail *Valvata mergella*	Lakes with mud bottom and well-oxygenated water (Richter, K., King Co. Environmental Division, Bellevue, Washington, October 1995, personal communication.)	Protection: all lakes, ponds, and other aquatic habitats; all riparian habitat. Restoration: riparian forest.
	Late-successional and Old-growth Forest Communities	
Brown Creeper *Certhia americana*	Deciduous, conifer, and mixed deciduous and conifer wetland forests (pole to late stages); mid- to later seral forests; conifer dominated wetlands (Brown 1985b; Smith et al. 1998)	Protection: all forest, including old growth; northern spotted owl CHU; forested wetlands. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation.
Marbled Murrelet* *Brachyramphus marmoratus*	Mature to old-growth conifer forests (Ralph and Nelson 1992)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest.
Northern Goshawk* *Accipiter gentilis*	Mature to old-growth forests (Brown 1985b)	As above.
Northern Spotted Owl* *Strix occidentalis caurina*	Mature to old-growth forests (Thomas et al. 1990)	As above.
Olive-sided Flycatcher *Contopus borealis*	Conifer and mixed deciduous and conifer wetland forests (middle to late stages); forest edges near openings (Brown 1985b; Smith et al. 1998)	Protection: all forest, including old growth; northern spotted owl CHU; forested wetlands; meadows and persistent shrub. Restoration: riparian and upland forest, with significant recruitment of mature and late-successional forest.
Pileated Woodpecker *Dryocopus pileatus*	Mature and old-growth conifer forests (Mellen 1987)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest.
Three-toed Woodpecker *Picoides tridactylus*	Mountainous wet conifer forests (Wahl and Paulson 1991); high-elevation conifer forest (Smith et al. 1997)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest.
Vaux's Swift *Chaetura vauxi*	Conifer and mixed deciduous and conifer wetland forests (mature and late stages); snags (Brown 1985b)	Protection: all forest, including old growth; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest; snag recruitment through silviculture.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Big Brown Bat *Eptesicus fuscus*	Conifer and mixed deciduous and wetland forests (mature and late stages); rivers and streams; cliffs and caves; snags (Brown 1985b)	Protection: all forest, including old growth; northern spotted owl CHU; all wetlands; all cliff and cave habitat; all naturally open habitat. Restoration: significant recruitment of mature and late-successional forest, and snags.
California Myotis *Myotis californicus*	Old-growth forest; various riparian, wetland and edge habitat; cliffs and caves; snags (Thomas 1988; Christy and West 1993)	As above.
Canada Lynx *Lynx canadensis*	High-elevation mature to old-growth forest near areas of high snowshoe hare density (WDW 1993c).	Protection: all forest, including old growth; northern spotted owl CHU; naturally open habitats. Restoration: significant recruitment of mature and late-successional forest.
Fisher *Martes pennanti*	Low-elevation mature and old-growth conifer forest; forested riparian areas; low levels of human activity (Aubry and Houston 1992; Powell 1993)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Fringed Myotis *Myotis thysanodes*	Deciduous, conifer, and mixed deciduous and conifer wetland forests (mature and late stages); naturally open habitats; cliffs and caves (Brown 1985b; Christy and West 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs and caves; all naturally open habitat. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.
Hoary Bat *Lasiurus cinereus*	Forested areas: primarily conifer or mixed conifer and deciduous forest (Maser et al. 1984)	Protection: all forest, including old growth and deciduous forest; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Keen's Myotis *Myotis keenii*	Riparian wetland areas; mixed conifer and deciduous forests; cliffs and caves; snags (Brown 1985b; Maser et al. 1984)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs and caves. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Little Brown Myotis *Myotis lucifugus*	Mature, late-successional, and old-growth forests; open wetlands, stream corridors, and open water bodies; cliffs and caves; snags (Thomas 1988; Brown 1985b)	As above.
Long-eared Myotis *Myotis evotis*	Riparian wetland areas; conifer forest; caves; snags (Maser et al. 1984)	As above.
Long-legged Myotis *Myotis volans*	Mature, late-successional, and old-growth conifer forests; open water; caves; snags (Maser et al. 1984; Thomas 1988)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all persistent shrub and natural meadows; all cliffs and caves. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.
Marten *Martes americana*	Conifer and mixed-conifer forests with snags; riparian areas (Koehler et al. 1975; Allen 1982; Strickland et al. 1987)	As above.
Silver-haired Bat *Lasionycteris noctivagans*	Mature, late-successional, and old-growth conifer forests; snags; open water for foraging (Thomas and West 1991; Christy and West 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Townsend's Western Big-eared Bat *Corynorhinus townsendi*	Caves; wet meadows; riparian areas (Brown 1985b)	Protection: all cliffs, caves, rock outcrops; all wet meadows; all wetlands; all riparian habitat. Restoration: riparian forest.
Wolverine *Gulo gulo*	Remote montane forest areas; large areas with adequate prey levels and low level of human activity (Butts 1992; Banci 1994)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all wetlands and natural meadows. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.
Yuma Myotis *Myotis yumanensis*	Deciduous, conifer, and mixed deciduous and conifer wetland forests (pole to late stages); rivers, streams, lakes, ponds, and swamps; caves; and cliffs; snags (Brown 1985b)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs and caves; all rivers, streams, lakes, ponds, and wetlands. Restoration: significant recruitment of mature and late-successional forest, upland and riparian; snag recruitment through silviculture.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Western Redback Salamander *Plethodon vehiculum*	Coniferous forests in mild climates; talus, boulders, and rock outcrops; logs and woody debris (Leonard et al. 1996)	Protection: all riparian habitats; all conifer forest; talus slopes and rock outcrops; significant areas of coniferous forest. Restoration: riparian and upland forest; recruitment of large woody debris through silviculture.
Blue-gray Taildropper (slug) *Prophysaon coeruleum*	Moist, coniferous forest (low to middle elevations) (Frest and Johannes 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest at low to middle elevation, upland and riparian.
Johnson's (mistletoe) Hairstreak (butterfly) *Mitoura johnsoni*	Lowland coniferous forest containing dwarf mistletoe (Scott 1987)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest. Restoration: significant recruitment of mature and late-successional forest at low elevation, upland and riparian.
Oregon Megomphix (snail) *Megomphix hemphilla*	Moist, low- to middle-elevation, undisturbed forest (Frest and Johannes 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest at low elevation, upland and riparian.
Puget Oregonian (snail) *Cryptomastix devia*	Low- to middle-elevation riparian and old-growth forest (Frest and Johannes 1993)	Protection: all forest, including old growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU. Restoration: significant recruitment of mature and late-successional forest at low elevation, upland and riparian.
	Special Habitat Types	
Band-tailed Pigeon *Columba fasciata*	Mineral springs or other mineral sources; mixed coniferous and deciduous forests with openings (WDFW 1991)	Protection: all deciduous and mixed forest in riparian areas and floodplains. No mineral springs identified, but any will be protected. Restoration: development (through forest maturation and natural disturbances) of a landscape resembling that to which the band-tailed pigeon is adapted.
Black Swift *Cypseloides niger*	Moderate-elevation forests; steep cliffs, behind waterfalls (for nesting); many habitats for foraging (forages widely) (Smith et al. 1997)	Protection: all forest, including old-growth and forested wetlands; all streamside and riparian forest; northern spotted owl CHU; all cliffs; all naturally open habitats. Restoration: significant recruitment of mature and late-successional forest, upland and riparian.

Species	Key Habitat	Potential Key Habitat Protected or Restored
Golden Eagle *Aquila chrysaetos*	Open habitats, especially mountains and hills; edge habitat; cliffs and large trees (for nesting) (Brown 1985b; Ehrlich et al. 1988)	As above.
Merlin *Falco columbarius*	Open woodlands and meadows (Brown 1985b); mid- and late-seral conifer forest (Smith et al. 1997)	As above.
Peregrine Falcon* *Falco peregrinus*	Cliffs; wetlands; meadows (Pac. Coast Am. Per. Fal. Rec. Team 1982)	<u>Protection</u>: all cliffs; all naturally open habitats, including meadows; all wetlands.
Rufous Hummingbird *Selasphorus rufous*	Natural open habitat, open wetlands, open riparian habitats, and other areas where nectar-producing flowers are available (Zeiner et al. 1994)	<u>Protection</u>: all riparian habitat; all naturally open habitats, including meadows, persistent shrub, and talus. <u>Restoration</u>: development of shrub layer following silvicultural treatments.
Western Bluebird *Salia mexicana*	Mixed forest: grass/forb to sapling stage; meadows; emergent and scrub-shrub wetlands; snags (Brown 1985b)	<u>Protection</u>: all naturally open areas, including meadows, persistent shrub, and talus; all wetlands. <u>Restoration</u>: snag recruitment through silviculture.
Gray Wolf* *Canis lupus*	Any type of forest and natural opening; low level of human activity; adequate ungulate prey base (Laufer and Jenkins 1989)	<u>Protection</u>: all forest, including old-growth and forested wetlands; all streamside and riparian forest; all riparian habitat; northern spotted owl CHU; all naturally open habitats, including meadows, persistent shrub, and talus; continued limitations on public access into the Watershed. <u>Restoration</u>: significant recruitment of mature and late-successional forest, upland and riparian; removal of 38 percent of watershed roads.
Grizzly Bear* *Ursus arctos*	Upland meadows, talus, persistent shrub communities, emergent wetlands, riparian areas, and closed canopy forest, especially mature to old-growth forest stages; also, low level of human activity (USDI 1993)	As above.
Larch Mountain Salamander *Plethodon larselli*	Vegetated talus slopes; forested areas with rocky substrates; old-growth forest on steep slopes (Leonard et al. 1993; Olson 1996)	<u>Protection</u>: all vegetated talus slopes and adjacent forest.

Measures Applicable Primarily to Late-successional and Old-growth Forest Communities

Context and Issues

Forest Habitat Opportunities in the Cedar River Municipal Watershed

As noted in Section 4.2.1, virtually all of the old-growth forest at low elevations in the Puget Sound region has been logged. As a result of substantial loss and fragmentation of old-growth forest habitats, as well as urbanization and removal of forests in the lowlands, the wide variety of fish and wildlife species that depend on mature, late-successional, and old-growth conifer forests collectively represent one of the greatest at-risk groups in the region (Thomas et al. 1993).

The Cedar River Municipal Watershed extends from the lowlands to the Cascade crest, and from 543 ft to 5,414 ft elevation. Because of its geographic location and its range of elevations, the watershed represents an unusual opportunity to redevelop, over time, some old-growth forest at low- to middle-elevations, to protect and redevelop old-growth forest at higher elevations, and to provide important connectivity both within the watershed and with other late-successional and old-growth forest reserves in the region.

Because the municipal watershed has been managed as a water supply for nearly a century, the rate of timber harvest has been lower than the rate on much of the private land in the Puget Sound region. Even though timber has been harvested in the watershed since the 1880s, 13,889 acres of old-growth conifer forest remains. This old growth ranges from 190 to nearly 800 years of age, a range that means the older stands in the watershed are some of the oldest in the Cascade Mountains of Washington (Agee 1993).

As indicated on maps 5, 6, and 7, there are several large blocks and smaller, fragmented patches of existing old-growth forest in the municipal watershed. The large blocks are all in the northern spotted owl CHU in the eastern portion of the watershed, whereas the smaller patches are to the west of the CHU, but most are all still within the upper watershed. Protection of the remnant old-growth forest in the CHU, if combined with adjacent second-growth forest, could play a critical role in the protection and recovery of the northern spotted owl. Further, because the CHU is an element of the federal late-successional and old-growth reserve system, the designation of the municipal watershed as a forested reserve that includes the CHU could be critical in the protection and recovery of many additional species that depend on mature, late-successional, and old-growth forests. The marbled murrelet, for example, may benefit because the CHU is entirely within 50 miles of saltwater, the range that encompasses breeding habitat for the species (Section 3.5.3).

In addition, some species of nonvascular plants and invertebrates may also require conditions only present in ancient, old-growth forests (Ruggiero et al. 1991a; Henderson 1993). Thus, protecting existing old-growth habitats is key to protecting those species most dependent on those habitats. However, naturally regenerated mature forest (81-120 years old) and late-successional forest (121-190 years old) also can be important to species dependent on old-growth ecosystems (Brown 1985a; Ruggiero et al. 1991b; Spies 1991; FEMAT 1993).

Some scientists also now argue that many species that rely on late-successional and old-growth forests can experience considerable benefit from previously harvested forests if those forests have such characteristics of naturally regenerated stands as multiple canopy layers, large trees, gaps in the canopy, and abundant logs and snags (Ruggiero et al. 1991a). Over 20 percent (24,478 acres) of second-growth in the municipal watershed is between 61 and 80 years of age (Figure 1.2-1), but only about 1 percent (1,094 acres) of the second-growth is more than 80 years of age (Figure 1.2-1), the age at which the habitat characteristics of *mature* forest may appear (Carey and Curtis 1996). Some scientists believe that the age at which a developing forest stand develops mature or late-successional habitat characteristics can be accelerated through silviculture (Carey et al. 1995, 1996).

Use of Silviculture to Accelerate Development of Mature and Late-successional Forest Characteristics

Carey and Curtis (1996) have argued that, with appropriate silvicultural intervention, previously harvested forests from 80 to 120 years of age or older can have most of the functional value of old-growth forest in terms of conserving biodiversity. The Late-successional and Old-growth Communities component of the Watershed Management Mitigation and Conservation Strategies is based on the assumption that the species addressed in this HCP that depend on old-growth forest will benefit substantially by both (1) a commitment not to harvest timber for commercial purposes, which will result in recruitment of additional mature and late-successional forest, and (2) a program of silvicultural intervention designed to accelerate development of old-growth conditions in selected previously harvested stands. These commitments together should provide a landscape with large, essentially contiguous patches of mature, late-successional, and old-growth forest habitat, which would in turn provide maximum connectivity among patches of older forest habitat in the municipal watershed and with adjacent areas.

The silvicultural intervention will be designed to mimic, to some extent, the actions of natural disturbances that result in the complex habitat structure and biological diversity found in many unmanaged forests. In the absence of human activities related to timber harvest or forest clearing, fire has been the major agent of large-scale disturbance in western Washington forest (Agee 1993). A variety of agents such as wind, disease, and insects produce small- to mid-scale disturbances that create habitat structure in developing stands (Spies and Franklin 1991; McComb et al. 1993).

During many of these large-scale natural disturbances, the ecological functions of the forest are sustained because key elements of the previous forest that are carried over into the regenerating forest (Franklin 1989, 1992). These key elements, or *legacies*, include live trees, snags, down wood, and other ecologically important elements of the mature forest (Agee 1993; Cascade Center for Ecosystem Management 1995). These legacies carry over into the young regenerated stands, which often have higher levels of coarse woody debris than mature stands over 100 years in age (Spies and Franklin 1991). Some of the organisms associated with old trees and snags are literally “carried over” into the regenerating forest as well. Late-successional and old-growth forests, however, also owe their biological diversity to finer-scale disturbances, such as individual tree death, limited windthrow or wind damage, and pockets of insect, disease, fungal, and parasite infestations.

Examples of the results of such fine-scale disturbances include scattered small gaps (Lertzman and Krebs 1991, as cited in Bunnell 1995; Spies and Franklin 1989; Spies et al. 1990); variable light regimes; understory development; trees of different sizes, snags, logs, and broken tree tops; as well as damage in the canopy that supports complex invertebrate communities (Schowalter 1989). Small scale disturbances in the riparian zone, such as when a tree falls into a stream, serve to create habitat complexity and contribute to biological diversity.

Two findings of recent research in the Pacific Northwest must be considered if silvicultural intervention is be used successfully in accelerating development of forests that have the functional characteristics of mature and late-successional forests: (1) coarse woody debris, both standing and down, plays an important role in forest ecosystems (Maser and Trappe 1984: Maser et al. 1988; Brown 1985a) and (2) biological diversity is suppressed during the closed-canopy, competitive exclusion phase of forest development that occurs early in a stand's existence (Oliver and Larson 1990; Carey and Curtis 1996).

According to Brown (1985a), snags are used by nearly 100 species of wildlife in western Washington and Oregon; of these 100 species at least 53 species are cavity dependent. The absence of snags can be the major limiting factor for many snag-dependent species (Balda 1975, as cited in Brown 1985a). Other types of woody debris important ecologically include logs, stumps, and root wads in various stages of decay (Brown 1985a). Down woody material has tremendous ecological significance, both for supporting a diversity of organisms and for sustaining key ecosystem processes (Maser and Trappe 1984; Maser et al. 1988). Large snags and logs can be created in older stands through variable density thinning, which fosters growth of large trees, and by damaging trees in a variety of ways (Carey and Curtis 1996).

Research has shown that it is also possible to shorten the time in the competitive exclusion phase of forest development, which occurs when young stands are densely stocked, the canopy closes, competition among trees is intense, and little light reaches the forest floor (Oliver and Larson 1990; Oliver 1992; Carey and Curtis 1996). The stocking level in naturally and artificially regenerated stands is typically very high at *stand initiation* following an event, such as fire or regeneration harvest, which removes most of the overstory trees (Oliver and Larson 1990). Tree density declines over time through tree competition for light, water, and nutrients, and because of other processes that lead to tree mortality. During this phase, most of the understory vegetation is depressed or dies, and the stand has very little biological diversity (Oliver and Larson 1990; Carey and Curtis 1996).

Thinning in dense, young stands (called *restoration thinning* in this HCP) reduces the density of trees, thus reducing competition, opens the stand for better light penetration, stimulates tree growth, and brings on the next stage of forest development – *understory reinitiation* – sooner (Carey and Curtis 1996). During the understory reinitiation stage, biological diversification increases sharply. When the stocking level of a young stand is particularly high (called a dog-hair conditions), thinning can have a dramatic beneficial effect on biological diversification (see Figure 4.2-1 for a photo of a stand before and after thinning). Such dog-hair stands could also constitute a significant risk of fire, either through accumulation of dead woody material from competition mortality or, indirectly, through stress that fosters heavy disease or insect damage that produces significant tree mortality.

Figure 4.2-1. Examples of (a) a young stand with very high stocking density, and (b) a young stand after thinning.

a.

b.

The City only began thinning younger stands (typically less than 30 years old) in the Cedar River Municipal Watershed in 1995, and less than 2,000 acres of these young stands have been thinned to date. Surveys begun in 1994, and not yet completed, have identified over 8,000 acres of young, overstocked stands in the municipal watershed (SPU, unpublished observations). Stocking in these areas commonly exceeds 4,000 trees per acre with some as high as 10,000 per acre or more (SPU, unpublished observations), an order of magnitude or more higher than densities that would best accelerate forest development and provide beneficial habitat conditions for wildlife (Carey et al. 1995, 1996).

Thinning in stands older than 30 years, called *ecological thinning* in this HCP, can also accelerate development of mature and late-successional forest characteristics in previously harvested stands (Carey and Curtis 1996). Variable density thinning creates light gaps, encourages understory development, and promotes the growth of large trees (Carey et al. 1995, 1996). Short-term changes in forest structure typical of older forests can be effected by creation of snags, logs, and tree cavities by various means, and planting can be done to increase species diversity (Section 3.3.4).

Objectives for the Late-successional and Old-growth Forest Communities Component

The general objective of the Late-successional and Old-growth Communities component of the Watershed Management Mitigation and Conservation Strategies is to develop significantly more mature and late-successional forest habitat in the watershed that will support species addressed in this HCP that are dependent on late-successional or old-growth forests, as well as old-growth biological communities in general.

The more specific primary objectives of this component are to:

- Preserve all remaining old-growth forest in the municipal watershed;
- Recruit a significant amount of additional mature and late-successional forest, especially at lower elevation, providing an interconnected reserve of mature, late-successional, and old-growth forest habitat;
- Make a significant contribution to the federal late-successional reserve system, connecting north and south in the Cascade Mountains;
- Accelerate the development of old-growth conditions in a significant proportion of second-growth stands in the watershed through silvicultural intervention; and
- Significantly increase the long-term ability of the municipal watershed to support species addressed in the HCP that are dependent on, or use late-successional and old-growth forests.

Mitigation and Conservation Strategies for Late-successional and Old-growth Forest Communities

Protection of Late-successional and Old-growth Forest Communities Through Reserve Status

To accomplish the objectives described above, the City commits not to harvest timber for commercial purposes, effectively placing the following forested elements in reserve status (Table 4.2-2 and maps 5, 6, and 7):

- All old-growth forest in the watershed (13,889 acres);
- The entire spotted owl Critical Habitat Unit WA-33 (22,845 acres, including a wide variety of forest seral stages and non-forest habitats, most of the remaining old growth in the watershed, and all former federal land within the CHU); and
- All second-growth forest outside developed areas, including forested wetlands.

Placing all forest in reserve status not only confers protection on the forest ecosystem in the watershed but also confers protection on aquatic, riparian, and non-forested upland habitats, such as meadows, by providing natural forested margins to those habitats and by providing connectivity among them. Many species dependent on late-successional and old-growth forests use some of these other habitats (Table 4.2-3), and the commitment not to harvest timber for commercial purposes provides broad, ecosystem-level benefits for those species.

Restoration Measures for Late-successional and Old-growth Forest Communities

About 84 percent of the forest in the municipal watershed has been logged. Current stand conditions are variable, and many stands are on their way to structural and biological diversification (Section 3.2.2). However, some other stands could greatly benefit by careful silvicultural intervention to accelerate development of ecological conditions characteristic of late-successional and old-growth habitat (see discussion of old-growth restoration workshop in Section 3.3.4).

To accomplish the objectives of the Late-successional and Old-growth Communities component of the Watershed Management Mitigation and Conservation Strategies described above, the City will employ the following types of silvicultural intervention: restoration planting, restoration thinning (in stands typically under 30 years old), and ecological thinning (in stands typically from 30 to 60 years old, occasionally older).

Stands will be selected for these treatments by a City interdisciplinary team that includes watershed foresters, biologists, hydrologists, and other professionals, and outside experts will be consulted as needed. The team will use information from the forest inventory database, the Forest Projection System growth model, and the GIS database (Section 3.3.7), as well as field evaluations. All upland habitat restoration work (not associated with riparian areas) will be prioritized. The highest priority stands will be those with the most potential for accelerating the development of old-growth conditions and for reducing the risk of forest fires and subsequent catastrophic damage.

Restoration Planting

Restoration planting will be done in selected upland second-growth stands where needed to diversify the plant community. The planting program will be designed to develop a diversity of trees and shrubs characteristic of naturally regenerated stands on similar sites and that will support a diversity of native wildlife species. Techniques are likely to include planting native forbs, shrubs, and trees, and spraying lichen fragments in the canopy. Hardwood development will be enhanced by recruiting species such as big leaf maple (*Acer macrophyllum*) and black cottonwood (*Populus trichcocarpa*) to diversify stand structure at lower elevations. The stands that will receive highest priority for restoration planting will be those that have plant diversity much lower than expected, based on site characteristics, and those with the greatest potential for beneficial results.

Restoration planting is an experimental approach, and will be conducted within the adaptive management program described in Section 4.5.7. Projects will be monitored, and techniques will be changed in response to better understanding of how desired effects can be achieved. The program may be reduced or terminated if the City and Services determine that it is not effective in achieving its conservation objectives. If this program is terminated or cut back from that planned, funding for restoration planting will be used for other watershed conservation or mitigation activities (see sections 4.5.7 and 5.3.2)

Funding for restoration planting in upland areas will total $300,000. This includes $75,000 over the first 8 years, $75,000 over the second 8 years, and $150,000 over the remainder of the HCP term. The funding level is based on an estimated approximate average cost of $300 per acre for planting and maintenance. Based on that assumed cost per acre, the City expects that about 1,000 acres could be treated by restoration planting, about half of which would be treated in the first 16 years of the HCP term.

Restoration thinning

Restoration thinning will be done in upland areas where needed in densely stocked, young, second-growth stands (generally less than 30 years old) to move the stands more quickly out of the stem exclusion or competitive exclusion stage (Oliver and Larson 1990; Carey and Curtis 1996). In such over-stocked stands (often called dog-hair stands), understory is typically absent, habitat conditions for wildlife are poor, and competition for limited nutrients, water, and light results in slowed growth and greater risk of insect outbreaks, disease epidemics, and forest fires. Herbaceous and shrub layers valuable for wildlife are typically absent or poorly developed.

The restoration thinning program will be designed to accelerate development of late-successional and old-growth conditions, develop habitat structure that supports a diversity of native wildlife and reduce the chance of catastrophic damage to the forest. Risk of catastrophic damage can be elevated in such dense stands when competition among trees for water, light, and nutrients causes tree death directly or indirectly by creating stress, which may make the stand more susceptible to insect or disease infestations (Oliver and Larson 1990). Large-scale tree mortality can result in buildup of fuels that can increase the risk of fire ignition and the degree of spread of fires.

The stands that will receive highest priority for restoration thinning will be those that: (1) are most over-stocked, based on age, species, and site characteristics; (2) exhibit signs of severe competition and stress and are determined to be at greatest risk of causing catastrophic damage; and (3) have the greatest potential for beneficial results. The decision regarding the density of leave trees will be made on a site-specific basis. As noted above, during the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term impacts of restoration thinning and develop approaches to minimize and mitigate for impacts and produce the greatest overall ecological benefit from this intervention strategy. In addition, the City will hold field trips with the public and interested groups during development of the criteria for restoration thinning, to solicit input and answer questions.

Restoration thinning is an experimental approach, and will be conducted within the adaptive management program described in Section 4.5.7. Prescriptions will vary by site and will focus on creating conditions that resemble naturally regenerated stands. However, the approach is based on the long-established practice of precommercial thinning, which has widely accepted, beneficial effects. Projects will be monitored, and techniques will be changed in response to better understanding of how desired effects can be achieved.

Funding for restoration thinning in upland areas will total $2,620,000. This includes $1,614,000 over the first 8 years and $1,006,000 over the next 7 years. The funding level is based on an estimated approximate average cost of $250 per acre for restoration thinning. Based on that assumed cost per acre, the City expects that about 10,480 acres would be treated by restoration thinning, all of which would be treated in the first 15 years of the HCP term. Nearly 90 percent of stands younger than 30 years old were at least 10 years old in 1997. The restoration thinning treatment has to be applied to stands early in the term of the HCP, before stands mature beyond the age at which such thinning treatments are effective. Conducting this thinning early in the HCP in areas where road removals are planned also will allow road deconstruction to proceed more rapidly.

Ecological thinning

Ecological thinning activities in older stands (typically between the ages of 30 and 60, occasionally older) will be done in some upland areas, where appropriate. The appropriateness of such intervention in older stand will be determined by an interdisciplinary team determines that intervention can improve habitat for wildlife and accelerate the development of late-successional and old-growth forest characteristics (see discussion of the old-growth restoration workshop in Section 3.3.4).

The ecological thinning program will include both thinning to promote long-term development of late-successional forest structure and killing and damaging trees to recruit coarse woody debris to provide short-term habitat benefits. It will be designed to encourage development of the habitat structure and heterogeneity typical of late-successional and old-growth stands by: (1) creating variable spacing among trees, a diversity of tree diameters, and several canopy layers; (2) creating small forest openings to recruit desired plant species and to stimulate growth of large trees and understory shrubs and trees; (3) increasing light levels to *release* intermediate-sized trees and advanced regeneration (small western hemlocks and western redcedars) for increased growth; and (4) favoring desired species and damaged trees. The stands that will receive highest priority for ecological thinning will be those that are the most overstocked based on size, age, and species and have the least biological and structural diversity and have the greatest potential for beneficial results.

The program may employ variable density thinning; creating small forest openings; creation of snags and cavities in trees using various methods, such as topping, damaging, or burning trees; injection of decay-producing fungi; creating logs by felling trees; uprooting trees to create logs, root masses, and holes; and related techniques. Care will be given to leave and protect existing features that generate and contribute to stand diversity, which may include root rot centers. Operations will be carefully planned to minimize impacts. The decision regarding the density and distribution of leave trees will be made on a site-specific basis. As noted above, during the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term impacts of ecological thinning and develop approaches to minimize and mitigate for impacts and produce the greatest overall ecological benefit from this intervention strategy. In addition, the City will hold field trips with the public and interested groups during development of the criteria for ecological thinning, to solicit input and answer questions.

Ecological thinning is an experimental approach, and will be conducted within the adaptive management program described in Section 4.5.7. The program may be terminated if the City and Services determine that it is not effective in achieving its conservation objectives or that it is creating adverse impacts. Projects will be monitored, and techniques will be changed in response to better understanding of how desired effects can be achieved. If this program is terminated or cut back from that planned, funding for ecological thinning will be used for other watershed conservation or mitigation activities (see sections 4.5.7 and 5.3.2).

Funding for ecological thinning and related activities in upland areas will total $1,000,000. This includes $250,000 over the first 8 years, $250,000 over the second

8 years, and $500,000 over the remainder of the term of the HCP. The funding level is based on an estimated average cost of about $500 per acre for ecological thinning, including research and modeling analyses. Based on that assumed cost per acre, the City expects that about 2,000 acres could be treated by ecological thinning, about half of which would be treated in the first 16 years of the HCP term for greatest effect.

The purposes of ecological thinning are strictly ecological in nature. However, if consistent with the biological objectives of an ecological thinning project, logs may be removed from a site and sold, or put to use in other restoration projects. Sale of logs will only be done if tree density, tree spacing, and the amount and distribution of coarse woody debris (snags and logs) meet the biological objectives for the HCP and the thinning operation. So that these objectives will be clearly understood, during the early part of implementation of the HCP, the City will consult with the Services and will solicit public input regarding biological standards for ecological thinning that would be applied in deciding whether logs can be removed from a site and sold, or used for other restoration purposes. If such sales occur, the City will use resulting net revenues only for watershed restoration under the HCP. In some cases, thinning contracts may be arranged to trade the value of the logs for services to perform the restoration activities at the site or restoration activities in other areas.

Guidelines Related to Late-successional and Old-growth Forest Communities

Management guidelines applicable to Late-successional and Old-growth Forest Communities are described below under the section entitled "Administration of the Municipal Watershed and Applicable Management Guidelines." That section includes descriptions of City activities expected within the watershed and management guidelines developed to avoid, minimize, and mitigate impacts of those activities. It includes guidelines applicable to the watershed as a whole, to Late-successional and Old-growth Forest Communities, and to other habitats in the municipal watershed.

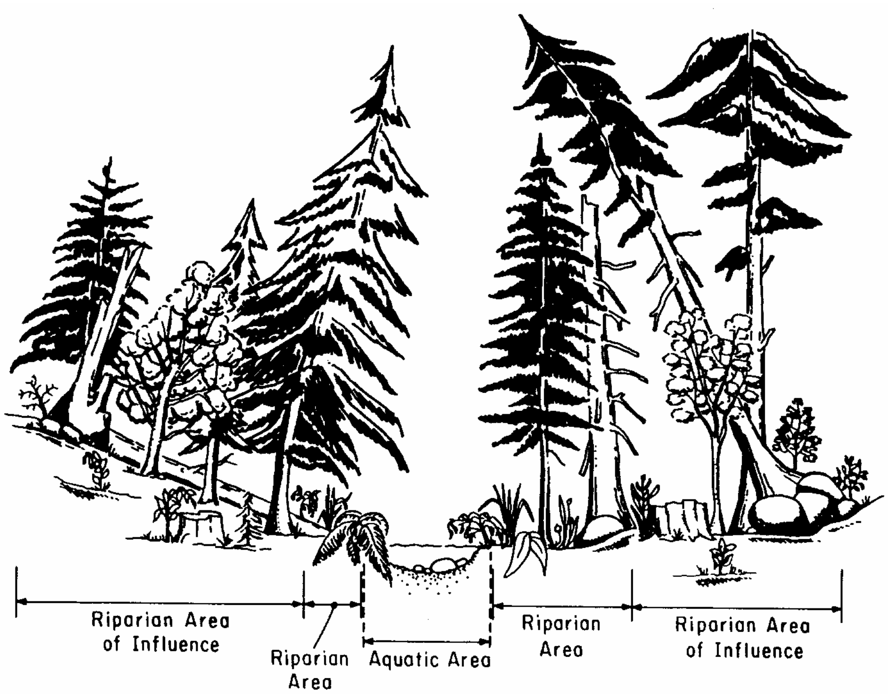
Measures Applicable Primarily to the Aquatic and Riparian Ecosystem Component

Context and Issues

Protection of drinking water quality goes hand in hand with protection of aquatic habitats in the municipal watershed, and both go hand in hand with protection of vegetation near water bodies and minimization of sediment delivery to streams from upland activities. The complex of water bodies that includes streams, lakes and ponds, and wetlands functions as an interrelated, and mostly interconnected, system that provides high quality water and aquatic habitat for a variety of animals addressed by this HCP. Protection of these aquatic habitats requires protection of associated riparian habitats.

The riparian zone is the area adjacent to surface waters and areas of high groundwater levels where the terrestrial system both influences, and is influenced by, the aquatic system (Bilby 1988; Swanson et al. 1992). Riparian ecosystem components include features such as the water's edge, subsurface water, active floodplains and overflow channels, trees that shade the water, vegetation that is frequently flooded, and associated fish and wildlife. Riparian zones can be associated with flowing water systems and with lakes, ponds, and wetlands. The size and structure of the riparian zone is closely related to the size and dynamics of the surface water and the topography that surrounds the body of water, as well as the groundwater at or near the surface. Riparian zones vary from narrow bands along streams in tightly confined channels to broad floodplains along large rivers in wide valleys (Figure 4.2-2).

Figure 4.2-2. The size and structure of the riparian zone reflects the dynamics of the water body and the surrounding topography. From Sedell et al. 1989.



The interactions between the riparian zone and open bodies of water affect both systems, and both systems are influenced by processes, such as soil erosion and water runoff, that originate in the surrounding uplands. Ecological processes significant to stream and riparian ecosystems can be defined by the interactions among vegetation, hydrology, and substrates (Kauffman et al. 1997). For example, soil conditions and available water influence the plant community. In turn, the physical presence and binding capabilities of streamside vegetation can redirect the forces of flowing water and influence bank stability. In a healthy watershed, these ecological processes occur within a natural pattern of disturbances, such as flooding and landslides, which vary in frequency, magnitude, and location. This natural disturbance regime maintains the sustainability, diversity, and vitality of stream and riparian ecosystems (Naiman et al. 1992).

A great variety of species are dependent on aquatic and riparian ecosystems in the Pacific Northwest (Brown 1985a; Raedeke 1988). Although stream and riparian habitats are formed by disturbances (Agee 1988), these habitats can be negatively impacted by disturbance regimes that are altered as a consequence of human activities. It is widely acknowledged that watershed management activities, if not properly planned, can have adverse impacts on the aquatic/riparian ecosystem (Naiman 1992; Raedeke 1988).

For example, in forested watersheds, timber harvesting and road building can affect structure, size, and maturity of the vegetation; reduce shade and increase water temperature; increase erosion and sediment loads; alter nutrient inputs; fragment stream and riparian connections; alter the hydrologic regime; and modify channel morphology (O'Connell et al. 1993). Timber harvest activities near streams, including removal of vegetation, can result in several kinds of adverse impacts. Erosion resulting from substantial vegetation removal and soil disturbance ultimately leads to increased delivery of sediment to streams and subsequent adverse impacts to water quality and aquatic habitat (Bisson and Sedell 1984; MacDonald et al. 1991). Removal of most streamside vegetation, particularly trees, also can increase stream temperatures, which can adversely impact habitat for many salmonid species, including bull trout (Sidle et al. 1985). Removal of vegetation near lakes, ponds, and wetlands can also reduce ecological function by disrupting the intricate interrelationship between the aquatic and riparian elements of the ecosystem (Kauffman 1988).

Landslides related to roads or timber harvest units in *upland* areas that deliver sediments to streams - especially fine sediments - can adversely impact both water quality and aquatic habitat (Appendix 15; Bisson and Sedell 1984; MacDonald et al. 1991). Suspended, fine sediments raise turbidity, a major indicator of drinking water quality that is regulated under the Safe Drinking Water Act (Section 2.2.9). Fine sediments, in suspension or deposited on stream substrates, can have direct and indirect deleterious effects on aquatic organisms. Where suspended material settles out, it can fill pools and the interstitial spaces in gravels, a process that can reduce the quality of spawning and other habitats used by fish, salamanders, and other animals.

Protection of water quality within the Cedar River Watershed is vitally significant both from the standpoint of the Cedar River's role as the major source of municipal water supply for the greater Seattle area, and because of the quality of habitat (aquatic and terrestrial) that is available to resident and anadromous fish and to wildlife species that depend on the river's riparian corridor. Historically, forest road construction and use have resulted in adverse impacts to some streams and water quality in specific areas of the municipal watershed.

In the Cedar River Municipal Watershed, there are approximately 400 miles of streams and associated riparian areas, as well as riparian areas that surround lakes and other aquatic systems (sections 3.2.2 and 3.2.4). Although the stream and riparian conditions have greatly benefited from the lack of urban development in the watershed, many of the watershed streams and riparian areas have been negatively affected by past timber harvest and road building activities and specific practices (Section 3.2.2). Some segments of the existing network of about 620 miles of roads likely is a major contributor of sediment to streams within parts of the municipal watershed.

Altered conditions on some stream reaches also include increased occurrence of, and conversion to, hardwood-dominated riparian forests, loss of shade, changes in stream temperature, lack of large in-channel wood, decreased potential for woody debris recruitment, reduced instream complexity, fish migration barriers, channel widening, and increased sediment inputs (Seattle Water Department 1995). Activities on unstable slopes have subjected some streams to a greater frequency and magnitude of sediment loading from hillslope failures.

Past logging and timber salvage in riparian areas and past stream-cleaning efforts have reduced the frequency and volume of large woody debris (LWD) input to some streams.

The volume of LWD delivery to streams from hillslope failures may have been reduced because of the increased frequency of hillslope landslides occurring after timber removal. Additionally, road construction has fragmented fish habitat by creating barriers to upstream fish movement. Efforts to protect the drinking water supply and the water supply infrastructure have also historically affected the condition of a few streams and riparian areas as a result of manipulation of instream wood, conifer revegetation, and channel alteration (Marshall et al. 1954). These drinking water quality protection efforts primarily affected streams that are downstream of the reservoir.

Of particular concern within the municipal watershed are inner gorges and headwall basins, both of which typically have high or very high surface erosion hazard and are prone to slope failures, especially when root strength and soil retention capabilities are jeopardized by large scale tree removal (Sidle et al. 1985). Sensitive soils, especially soils with relatively high water tables or those derived from alluvial deposits found in floodplain and riparian zones, also typically have high or very high surface erosion potential.

The potential risks of surface erosion and landslides for lands within the watershed were specifically evaluated as part of the Watershed Assessment conducted by the City (Section 3.3.3 and Appendix 15). Watershed Prescriptions (Appendix 16) restricting forest harvest activities on high-risk sites were also developed as part of the assessment process. A more complete discussion of the assessment process, evaluations, and prescriptions is contained in the Watershed Assessment documents (Foster Wheeler Env. Corp. 1995b; Seattle Water Department 1995; Cupp and Metzler 1995), and these prescriptions are incorporated into the Watershed Management Mitigation and Conservation Strategies as appropriate.

In 1993, the Forest Ecosystem Management Assessment Team (FEMAT) concluded an analysis of forest management options on federal land in the Pacific Northwest that was initiated in response to concerns about the northern spotted owl and other species dependent on old-growth ecosystems (FEMAT 1993). The recommendations under FEMAT’s Option 9 were subsequently incorporated into the Northwest Forest Plan (Tuchmann 1996). Based on Option 9, the Northwest Forest Plan includes the following components of an aquatic conservation strategy to restore the productivity and resilience of riparian and aquatic ecosystems:

- Establishment of a system of riparian reserves, including adequate buffers, to protect streamside areas, unstable upland areas, wetlands, and other water bodies;
- Protection of key watersheds as refugia crucial to at-risk fish stocks and water quality;
- Watershed analysis, performed to describe watershed conditions, provide the basis for designing needed management guidelines, and identify priorities for restoration; and
- A program of watershed restoration targeted at reestablishing natural, physical, and ecological processes that create and maintain habitats for riparian species and fish.

The federal scientists on the FEMAT reviewed the research on protection of riparian areas and streams, and developed recommendations for buffers that would address a variety of physical and ecological concerns related to the protection of aquatic ecosystems. In developing the recommendations, they considered the need to maintain streamside forest cover to:

- Retain sufficient conifer trees for shade to maintain cool water temperatures;
- Retain sufficient trees and other plants to provide litter fall as a source of nutrients for aquatic organisms;
- Keep tree root systems intact to maintain bank stability and minimize sediment delivery to streams from bank failure;
- Provide a source of large woody debris from mature streamside conifers;
- Provide adequate microclimate for plants and animals by having a sufficient band of vegetation; and
- Provide a safety factor, or increase, in buffer size to reduce the adverse effects of windthrow at the outer edges of the buffers (edge creep) near timber harvest units.

The recommended buffers are keyed to the size and potential ecological significance of a particular water body, and the FEMAT scientists recommended that all riparian habitat and floodplains be included in the riparian reserves, as well as inner gorges and other landslide-prone areas.

In addition, the federal team recommended that:

- Trees be cut in the riparian reserve only to restore ecological functions; and
- Programs be implemented to decommission and improve forest roads, restore riparian forests, and restore instream habitat.

FEMAT recommended that thinning be done in riparian areas only to meet ecological objectives and only if supported by a watershed analysis. The Watershed Assessment conducted by the City supported such silvicultural intervention in some previously harvested riparian areas, if site conditions warrant and if an interdisciplinary team decides that such intervention would provide overall beneficial results (Appendix 16).

It is clear from the FEMAT analysis that protection of the interrelated system of water bodies in the Cedar River Municipal Watershed can be accomplished by a combination of three actions: (1) restricting activities near streams, lakes and ponds, and wetlands; (2) maintaining and restoring the integrity of habitat near these aquatic features through management guidelines and restoration activities; and (3) restricting activities in upland areas with very steep slopes and erodible soils, where such activities could result in the delivery of sediment to streams, wetlands, and other water bodies.

Habitat continuity and connectivity also may affect the survival of some populations (Frissell 1993). Because of demographic risks to small populations, the long-term survival of a metapopulation of organisms depends on the ability of individuals to move from one habitat patch to another (Gilpin and Soule 1986; Morrison et al. 1992). The City made the following assumptions concerning establishing landscape connectivity among aquatic habitats and maintaining the functions of wetlands:

- For organisms that are strictly aquatic, connectivity within the river and stream network can best be achieved by a combination of removing barriers to movement and protecting and restoring instream habitat.

- For organisms that use both aquatic and riparian habitats, or only riparian habitats, connectivity among aquatic habitats can best be provided by a combination of protecting and restoring true riparian habitat, protecting and restoring other streamside forests, protecting complexes of aquatic elements, and managing upland forests to recruit mature and late-successional forest habitat.

- Sustaining and restoring all key ecological functions of wetlands, such as by protecting recharge areas.

While the City used the FEMAT recommendations in developing this HCP, because the City has committed not to harvest timber for commercial purposes and consequently will be able to remove a large portion of the existing road system, the commitments in this HCP clearly exceed the FEMAT recommendations for protecting aquatic and riparian habitats.

Development of Mitigation and Conservation Strategies for the Aquatic and Riparian Ecosystem

Intent and Analyses

The City's strategies for the Aquatic and Riparian Ecosystem are designed to protect the region's supply of high-quality drinking water, to preserve and enhance stream and riparian ecosystems within the municipal watershed, and to restore and rehabilitate stream and riparian functions. These strategies were developed after considering current ecological theory and the best available information on conditions in the municipal watershed. Site-specific information was gathered through various studies in the watershed including a watershed assessment (Section 3.3.3; Appendix 15), fishery research (Section 3.2.4; Appendix 23), and road and stream-crossing surveys. In addition, the City sponsored several workshops that focused on recent research in the region. The workshops were used as means to gather expert opinions on options available for restoring and rehabilitating stream and riparian systems in the watershed (Section 3.3.4; Appendix 14). In addition, the strategies incorporate and build upon the policy decision not to harvest timber for commercial purposes.

The City used Washington State's stream typing system (WAC 222-16-030), as it existed prior to the Forest and Fish Report, dated April 29, 1999, as the basis for assigning various protection guidelines that will be implemented through this HCP (final rules based on the Forest and Fish report had not been adopted as of finalization of this HCP). These protection guidelines include guidelines for activities near streams and provision for passage of fish where roads cross streams. As defined by the state, stream type classifications are dependent, in part, on the presence or absence of anadromous or resident fish.

The overall condition of stream and riparian habitat in the watershed was assessed through a Cedar River Watershed Assessment that was completed in 1995 (Foster Wheeler Env. Corp. 1995b; Cupp and Metzler 1995; Seattle Water Department 1995). This assessment provided a comprehensive analysis of the current watershed condition. The assessment closely followed the procedures described in the Washington State

Watershed Analysis Manual, Version 2.0 (Washington Forest Practices Board 1993). The results of this analysis provide an overall description of the watershed's geology, geomorphology, landslide potential, hillslope erosion potential, peak flow regimes, riparian conditions, and fish habitat. The assessment also resulted in prescriptions for aquatic ecosystem protection and recommendations for rehabilitation efforts. The descriptions of basin conditions and the resultant prescriptions are integral components in the design of the strategies for the Aquatic and Riparian Ecosystem. A more complete discussion of the objectives, methods, and results from this assessment is provided in Section 3.3.3 and in Appendix 15. The Watershed Assessment Prescriptions are detailed in Appendix 16.

The strategies for the Aquatic and Riparian Ecosystem are designed to be closely integrated with the mitigation strategies for the anadromous fish barrier at Landsburg (Section 4.3). The strategies reflect the complex interactions that define stream and riparian ecological processes and the influences that basin conditions exert on the stream and riparian ecosystem.

Conservation, Restoration, Protection, and Rehabilitation

After several decades of restoration activities on western United States stream and riparian systems, assessments indicate that, although some projects achieve significant biological objectives, many of these efforts have not achieved their stated goals (Beschta et al. 1996). This realization contributed to a philosophical discussion within the scientific community regarding the ecological definition of restoration. In its purest sense, restoration can be defined as the reestablishment of predisturbance conditions where the disturbances are anthropogenic (Kauffman et al. 1997). Within an ecological framework, and because ecosystems are made up of complex interactions among organisms and their environment, some scientists believe the term restoration should not be used to describe activities that benefit only a single species or process. Rather, restoration is a holistic process that affects complex systems (National Research Council 1992). This view of restoration as something larger than the sum of its parts is echoed by Roper et al. (1997), who defined restoration as activities that reconnect fragmented habitats and reconstruct historical ecosystem processes.

The City will use the term restoration in a general sense with respect to the Aquatic and Riparian Ecosystem to characterize different types of active intervention that have the objective of increasing the quality of aquatic and riparian habitats that have been disturbed by past human activities or of returning aquatic and riparian habitats closer to more "natural" (predisturbance) conditions and ecological functioning. The strategies in this HCP for the Aquatic and Riparian Ecosystem use a holistic approach that incorporates aspects of restoration as well as efforts that could be better categorized as preservation, rehabilitation, enhancement, and/or mitigation, or some combination of these categories. According to Kaufmann et al. (1997), preservation is the maintenance of intact ecosystems, and rehabilitation implies making the system useful again, but it does not imply reestablishment of the original conditions. Enhancement is an improvement of a structural or functional attribute that may or may not restore the original linkages to other parts of the ecosystem. Mitigation is the alleviation of detrimental effects or environmental damage that results from anthropogenic actions, including the environmental improvements off site. There is overlap among these categories, as well as overlap between the categories and the definition of restoration.

The strategies for the Aquatic and Riparian Ecosystem are made up of several elements. Each element focuses on achieving a better condition for one or more processes (e.g., sediment loading, LWD recruitment, fish passage). These elements are coordinated to complement one another so that the overall conservation strategy is likely to achieve restoration of the aquatic and riparian ecosystems over the long term. This coordination of specific elements is an especially useful technique for watersheds in an early stage of recovery from disturbances where rehabilitation techniques can help accelerate restoration (Cederholm et al. 1996).

Some of the active interventions included in this HCP will be designed to bridge the gap between current, disturbed conditions under which key ecological functions are impaired and habitat quality is relatively poor and future conditions under which the aquatic/riparian ecosystem sustainably supports processes that create and maintain habitat over the long term without human intervention. For example, large woody debris may be physically added to a stream deficient in large woody debris to improve habitat, but the long-term goal will be to restore the riparian forest’s capability to recruit sufficient quantities of large woody debris *without* human intervention.

The strategies for the Aquatic and Riparian Ecosystem in the municipal watershed were designed using the concept that the implementation of watershed-wide land stewardship is the most important part of any restoration effort (see Beschta et al. 1996; Naiman et al. 1992; Reeves et al. 1991; Harr and Nichols 1993; Bisson et al. 1992). As a result, the strategies will be implemented throughout the watershed and coordinated with other Watershed Management Mitigation and Conservation Strategies in an effort to achieve a holistic approach to watershed restoration. Protection and restoration of the municipal watershed will also provide a foundation upon which to build a comprehensive salmonid conservation program for the Lake Washington Basin as a whole (Section 4.3).

A monitoring and research program (Section 4.5) is another important component of the strategies for the Aquatic and Riparian Ecosystem, because ecological processes and interactions are not fully understood, and because it is impossible to predict with certainty the outcome of all management and restoration activities. Monitoring and research will be used to evaluate project success with respect to the conservation objectives discussed below. Information compiled during monitoring and research will be used in an adaptive management approach that incorporates new information as it becomes available.

If elements are determined to be unsuccessful, or no longer needed, they will be suspended based on the adaptive management strategies outlined in Section 4.5.7. Measures will be abandoned only by agreement of the Services, which will include agreement on use of the funds for alternative mitigation (Section 5.3.2).

Prioritization

Stream reaches and riparian corridors in need of rehabilitation or restoration efforts through the strategies for the Aquatic and Riparian Ecosystem will be identified from the results of several investigations. These include a watershed assessment conducted for the Cedar River Watershed (Section 3.3.3; Appendix 15); continuing research on bull trout, other salmonids, and fish habitat (Section 4.5.5); additional fish distribution surveys (Section 4.5.5); road condition surveys; and a comprehensive field survey of stream-crossing structures in the watershed (Section 3.2.4).

All stream and riparian restoration projects will be prioritized based on their ability to protect the water supply, to enhance natural stream and riparian processes, to protect or enhance resources for species of concern, to have a high likelihood of success, and to produce a relatively high level of benefits for the cost. Projects will be scheduled so that efforts to reduce disturbances that originate in upslope or upstream areas will be addressed prior to initiating projects downslope or downstream of these same disturbances. A City interdisciplinary team will be used to prioritize and schedule projects.

Objectives for the Aquatic and Riparian Ecosystem Component

The specific objectives listed in this section were developed from the more comprehensive set of HCP objectives presented in Section 2.4. These objectives support the goal of avoiding, minimizing, and mitigating the impacts of any incidental take of species listed as threatened or endangered and additionally treat unlisted species of concern as if they were listed. They include a commitment to protect or improve the quality of the surface water in Cedar River Municipal Watershed, to provide a net benefit for species of concern that are dependent on riparian or aquatic habitats, and to contribute to the recovery of these species. The specific objectives established for Aquatic and Riparian Ecosystem will also help restore and rehabilitate stream and riparian functions and stream and riparian habitat, while preserving and protecting the municipal water supply.

The focus of the Aquatic and Riparian Ecosystem component of the Watershed Management Mitigation and Conservation Strategies is to protect water quality and aquatic and riparian habitats through the commitment not to harvest timber for commercial purposes (effectively placing all forests outside limited developed areas in reserve status), management guidelines, and restoration of streams and riparian forests. Of particular concern are the need to maintain intact plant communities and vegetative cover in riparian zones, the need to minimize delivery of sediment to streams from human activities, and the need to provide landscape connectivity.

The primary objectives for the Aquatic and Riparian Ecosystem include the following:

- Through a commitment not to harvest timber for commercial purposes and other measures, protect streamside habitats, both riparian and upland in nature, to maintain or improve stream temperature regimes, to recruit large woody debris, and to maintain bank stability through maintenance and recruitment of large-diameter conifers;

- Through a commitment not to harvest timber for commercial purposes and other measures, protect wetlands, lakes, and ponds and all true riparian habitats from degradation of function and ability to support species addressed in the HCP as a result of land management activities;

- Through a commitment not to harvest timber for commercial purposes and other measures, protect sensitive and highly erodible soils in floodplains and riparian zones from degradation and erosion caused by land management activities;

- Through engineered road improvements, decommissioning, and improved maintenance, reduce the higher rate of fine and coarse sediment loading to aquatic systems from sources influenced by past timber harvest, poor past road design or construction, and continued road maintenance;

- Through a commitment not to harvest timber for commercial purposes and other measures, avoid disturbance of sensitive and highly erodible soils on steep slopes within inner gorges and headwall basins, and in other areas, that can result in sediment delivery to streams, wetlands, and other water bodies;

- Implement management guidelines and prescriptions to provide protection for aquatic and riparian habitats additional to that afforded by a commitment not to harvest timber for commercial purposes;

- By silvicultural intervention, contribute to restoration of natural ecological and physical processes and functions that create and maintain aquatic and riparian habitats;

- Through a commitment not to harvest timber for commercial purposes and other measures, reduce the magnitude and frequency of human-influenced bank failures, landslides, mass wasting, and debris flows;

- Protect stream, wetland, and riparian habitats by following conservative management guidelines for road management activities that influence stream, wetland, and riparian habitats;

- Promote the restoration of natural aquatic and riparian ecological functions;

- Where technically feasible, improve fish access to significant upstream habitat where connections are interrupted by roads;

- Accelerate the reestablishment of diverse and structurally complex riparian forests where past harvest or human-caused alterations to channel dynamics have created early successional riparian forest stands or have replaced conifer stands with hardwoods;

- Protect, enhance, and restore stream and riparian habitat complexity; and

- Use the results of monitoring these and other conservation strategies to help realize the full measure of benefits offered by conservation efforts in the watershed and the Lake Washington Basin.

Additional objectives of this component are to:

- Through natural maturation and silvicultural intervention in riparian and other streamside forests, contribute habitat of value to species dependent on mature, late-successional, and old-growth forest habitats; and

- Provide connectivity among aquatic and riparian habitats through inclusion of upland forests in a reserve status to facilitate the dispersal and movement of organisms dependent on riparian and aquatic habitats.

Mitigation and Conservation Strategies for the Aquatic and Riparian Ecosystem

Protection of Elements of the Aquatic and Riparian Ecosystem in Reserve Status

Several types of open water habitat occur in the municipal watershed, including:

- Lakes, defined in this HCP as bodies of open water that are greater than 20 acres in area and at least 6.6 ft deep at low water;
- Ponds, defined as bodies of open water that are from 0.5 to 20 acres in area and at least 6.6 ft deep at low water;
- Rivers and streams;
- The reservoir complex, defined to include Chester Morse Lake and the Masonry Pool, as well as the channel connecting the two.

Several types of wetland habitat occur in the municipal watershed. *Palustrine wetlands* are wetlands that are not directly associated with salt water (Tiner 1984). In the watershed, these include:

- *Palustrine emergent wetlands*, which are dominated by herbaceous vegetation that extends above the water surface (often called marshes, wet meadows, bogs, or fens);
- *Palustrine scrub-shrub wetlands*, which are dominated by woody vegetation less than 20 ft tall;
- *Palustrine forested wetlands*, which are dominated by trees taller than 20 ft.

There are 110 mapped palustrine scrub-shrub wetlands, 236 mapped palustrine emergent wetlands, and 150 mapped forested wetlands in the watershed. Large wetland complexes occur in the Walsh Lake area and the Rex and Cedar river subbasins. The complex in the Walsh Lake area encompasses a number of large and small palustrine emergent, scrub-shrub, and forested wetlands, as well as Walsh Lake itself and other ponds and streams in this area. The complex in the Rex River and Cedar River encompasses a variety of components: (1) the recharge areas of the extensive palustrine, floating-mat wetlands south of Little Mountain; (2) areas near reaches of the Rex and Cedar rivers in which bull trout are known to spawn (as adults) or rear (as juveniles); and (3) a complex of wet meadows, wetlands, and remnant old-growth stands in the upper Rex River drainage.

All forests in undeveloped areas that are associated with aquatic and riparian habitats are included in reserve status, thus protecting all of the above types of aquatic habitats. In addition, reserve status for forests serves to protect all:

- True riparian habitat as identified by vegetation type (Watershed Assessment Prescription SORZ&W-4) and other streamside habitat;
- Inner gorges (Prescription IG-1), which serves to reduce the risk of slope failures in these unstable areas along streams;

- Headwall basins, which include very steep, usually wet and unstable, concave portions of the headwaters of streams; and

- Sensitive soils, including soils with moderate or high flood hazard potential or very slow drainage rates, soils that were formed in place, and alluvial soils.

The protection, through reserve status, of the interconnecting forest within the wetland complexes described above will also serve to interconnect the aquatic habitats by facilitating dispersal for such animals as salamanders, frogs, and riparian mammals.

Restoration of the Aquatic and Riparian Ecosystem: Road Management

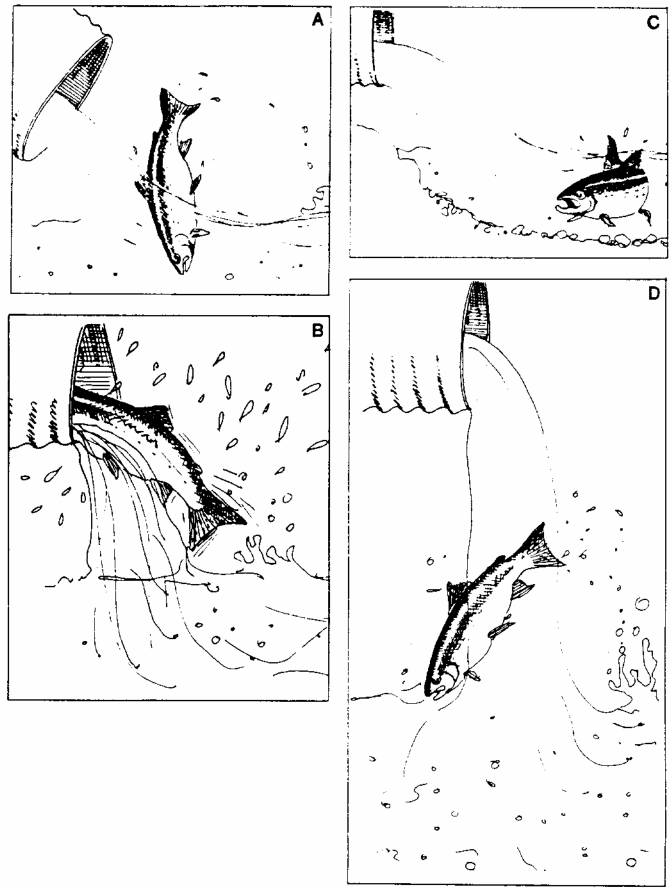
Road-related Problems in the Pacific Northwest

Hillslope and stream erosion are natural and continual processes. In managed watersheds human activities typically accelerate the rate of surface erosion and mass wasting and alter the natural frequency and magnitude of disturbances. In forested watersheds in the Pacific Northwest, roads are the major contributor to accelerated rates of erosion and resulting sediment delivery to streams (Sidle et al. 1985).

Forest roads in the Pacific Northwest have a long history of contributing to stream damage and sedimentation. Many of these roads have been constructed in an environment of relatively steep slopes, erodible soils, steep weathered bedrock, and high precipitation. Road design, construction, and maintenance problems have included poor location, undersized stream crossings, poorly designed ditches, infrequent cross-drains, unstable sidecast and fill material, and inadequate maintenance. Poorly designed and maintained roads in this environment can result in road drainage system failures that allow water to flow over or through the road prism, causing erosion, and delivering sediment to stream channels.

Inadequately sized and poorly installed stream-crossing structures, such as culverts, can negatively influence water quality and aquatic ecosystems by increasing sediment loading and transport, altering channel morphology, and fragmenting stream habitat. If a stream-crossing structure cannot pass peak flows and debris, it can cause water to flow over or through the road. This failure can deliver surface materials or entire road fills into the channel. Plugged culverts can also deliver large quantities of sediment into streams when water is diverted out of the channel and along or over the road bed. Crossing structures that restrict stream flows can cause changes in stream bank and bed configuration upstream and downstream of the structure. In addition to increasing sediment loading and transport, these conditions can cause alterations in stream velocity and flow depth, and can impact water quality and impede or prevent fish passage (Figure 4.2-3).

Figure 4.2-3. Culvert conditions that block fish passage: (A) water velocity too great; (B) water depth in culvert too shallow; (C) no resting pool below culvert; (D) jump too high (from Furniss et al. 1991, after Evans and Johnston 1980).



Hillslope drainage patterns can be altered by roads that intercept groundwater and surface flows, divert the water into road ditches, and concentrate the release of water at specific points. In addition, where cross-drains are infrequently spaced, accumulations of flowing water can cause erosion in the ditch or the area where it is directed away from the road onto the forest floor. This sediment-laden water is sometimes directed into a stream instead of through a ditch-out or cross-drain and onto the forest floor. If ditches are inadequately sized or are plugged, the water can flow across the road and erode the surfacing material. If this water runs into a channel, it typically carries the road sediment into the stream.

During some past road construction in the Pacific Northwest, including the municipal watershed, sidecast and road fill material were sometimes placed in unstable positions on steep slopes. Sometimes this road material contained stumps, logs, and other organic debris that reduce soil strength as they decompose. Landings were often left with large amounts of organic debris mixed with mineral soil in steep locations. Failures can occur where water runs over or through this material. These failures can deliver sediment to streams if there is no deposition zone to intercept the material.

An additional source of sediment to streams can be from road surfacing rock that breaks down under heavy truck traffic and incorrect road maintenance activities. This fine sediment can be washed into ditches and can be carried into streams if ditch water is not diverted into ditch-outs or cross-drains before it enters a stream.

Forest roads in the Pacific Northwest can also contribute to stream and riparian habitat damage in two ways that are not relevant to conditions in the Cedar River Municipal Watershed. Roads outside the boundaries of the municipal watershed often provide public access that can result in increased human disturbance to sensitive areas including streams and riparian zones. Because there is currently no unsupervised public access to the vast majority of the Cedar River Municipal Watershed, this effect is minimized (see section below entitled "Administration of the Municipal Watershed and Applicable Guidelines"). Additionally, on many forest roads, vegetation is controlled with herbicides. City policy prohibits the use of chemicals for vegetation control in the Cedar River Watershed (see section below entitled "Administration of the Municipal Watershed and Applicable Guidelines").

Cedar River Municipal Watershed Roads

The City will commit to a program of road deconstruction, improvement, and management targeted at reducing sediment loading to streams from landslides (mass wasting) and surface erosion related to the kinds of problems discussed in the preceding section. This program is important for improvement of water quality and aquatic habitat.

The Cedar River Municipal Watershed has a current inventory, based on the best available information, of approximately 620 miles of roads (Appendix 17). These road miles include all known active and infrequently used roads (about 520 miles) and overgrown and deconstructed roads. The roads in the municipal watershed were constructed during the course of watershed management by various landowners and to a variety of standards to support management activities. These management activities have included:

- Managing forests;
- Removing timber;
- Hauling rock and construction materials;
- Accessing the water storage dams, water systems, and utility lines;
- Maintaining security and fire protection; and
- Water quality, water quantity, and biological monitoring and research.

The current road density over the entire municipal watershed averages approximately 4.3 miles of road per square mile (Appendix 17). Road densities by specific subbasin (maps 1 and 13) range from approximately 1.6 to 6.6 road miles per square mile. For comparison, one study indicates from extrapolated data that in the Clearwater River drainage on the Olympic Peninsula, salmon spawning habitats have increased fine sediment loading where road density exceeds 2.5 miles per square mile (Cederholm et al.

1981). However, it is important to remember that geology, topography, and precipitation vary greatly between the Olympic Peninsula and the Cedar River Watershed. Also, roads that are poorly designed, constructed, and maintained contribute more sediment through mass-wasting and surface-erosion processes than those that are properly designed, constructed, and maintained.

It should also be noted that the level and type of vehicle traffic on roads can have a major impact on the amounts of sediment entering streams. Heavy truck hauling on roads, such as for commercial timber harvest operations, generates a significantly larger volume of sediment than administrative use of roads, such as by unloaded pickup trucks. Likewise, multiple trips over day over a road generate more sediment than single or a few trips.

Although no timber harvest for commercial purposes, and thus no heavy timber hauling, will occur under the HCP, many of the problems highlighted in the preceding discussion occur on roads in the municipal watershed. Construction and maintenance standards in the Transportation Plan are designed to prevent and correct these problems (Appendix 17). Although implementation of these standards is included as an element of this HCP's strategies for the Aquatic and Riparian Ecosystem, the City has already adopted these standards for the watershed and is following the guidelines in this plan.

Roads in the municipal watershed with the potential to significantly impact aquatic habitat will be either repaired or deconstructed, depending on the use of the road, following the guidelines in the Transportation Plan. In general, roads that provide desirable access are being and will be repaired under the HCP, but many of these roads that have potential to cause serious habitat damage will be deconstructed. Roads that are considered necessary but have severe problems will require reconstruction, which can be expensive. The difficult decisions of whether it is best to repair or deconstruct these roads will be made by an interdisciplinary team. Road projects will be prioritized and scheduled by the interdisciplinary team, with guidance from the results of the Watershed Assessment (Appendix 15). In addition, roads will be deconstructed over time that will no longer be needed under a program of no timber harvest for commercial purposes or for other management activities.

All new road construction supports localized management activities and follows construction standards in the Transportation Plan (Appendix 17). Some new road segments may be constructed as an alternative to existing roads that are in sensitive or unstable locations and need to be removed. New roads may be constructed if needed to provide access to facilities or project locations, or to provide necessary access lost by deconstruction of problem roads. All proposed new roads will undergo an extensive review by an interdisciplinary team. The City will not construct new roads into roadless areas of the Cedar River Watershed, unless unforeseen catastrophic events require access for emergency response or to accomplish repairs. Such roadless areas have had no previous entry or management activities.

The City follows all regulatory laws and will acquire all required permits associated with forest road construction and maintenance activities that will not be exempted by this HCP from state agency regulation. Construction and maintenance of forest roads are regulated by WDNR. Stream-related road activities are regulated by WDFW, WDNR, and WDOE.

Objectives for Road Management

The objectives for the road network (Appendix 17) relevant to the strategies for the Aquatic and Riparian Ecosystem are to improve and protect stream and riparian ecosystems. The program is designed to:

- Reduce the road network to what is needed for watershed management under conditions of no timber harvest for commercial purposes;
- Minimize sediment delivery to streams from roads;
- Improve drainage patterns that have been altered by roads; and
- Reestablish fish passage, where economically and technically feasible, between significant amounts of upstream and downstream aquatic habitats, where these connections are interrupted by roads.

The following strategies were developed to achieve the intent of the above objectives. The strategies are organized by the major activities of road deconstruction (removal), repair of existing roads, road construction, and road maintenance. Standards and guidelines for these activities are included in Appendix 17.

Mitigation and Conservation Measures for Roads

Road Deconstruction

- To reduce the road network to what would be needed under conditions of no timber harvest for commercial purposes and to reduce sediment loading to streams from roads that are not needed, the City will reduce the road network to a long-term *core* road system of approximately 384 miles. This reduction entails removing (deconstructing) approximately 236 miles of roads (about 38 percent of the current total) over the life of the HCP. The City will commit up to $5,000,000 to help pay for road deconstruction, and expects to average about 10 miles of roads per year for the first 20 years of the HCP.
- To minimize sediment delivery to streams and to improve drainage patterns, culverts and fill material at stream crossings will be removed as directed by a hydrologist and an engineer. Each stream crossing will be evaluated for methods to best restore natural drainage and to achieve channel stability at that particular site. Restored streambeds and streambanks will be graded and stabilized if necessary. Some fill material may be retained and stabilized where total removal would cause greater erosion or environmental damage.
- To reestablish fish passage in locations that would provide connectivity between significant amounts of resident or anadromous fish habitat, where technically and economically feasible. Stream channels will be reconstructed to help ensure fish passage and channel stability.
- To minimize sediment delivery to streams and to improve hillslope drainage patterns, roads will be deconstructed with an attempt to increase the frequency of cross-road drainage, using such methods as closely spaced waterbars across road beds. Drainage will be directed away from unstable areas and erodible soils.

- To minimize sediment delivery to streams, unsupported sidecast and fill material will be removed and placed against the cutbank or in a stable location. Priority will be given to removing material that is likely to enter stream channels or to travel for a long distance. Unstable landings will be dismantled and the organic and mineral material will be placed in stable locations. Drainage will be directed away from landing sites. Exposed soils will be protected from erosion and revegetated.

- Road deconstruction activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Improvement and Repair of Existing Roads

- To reduce sediment loading to streams and other water bodies over time, the City will commit up to $7,250,000 for repair and improvements of roads, some of which funding could be used for deconstruction, if more appropriate (see above).

- To minimize sediment delivery to streams and to improve drainage patterns, priority stream crossings will be upgraded to provide passage of 100-year flows. Road fills at problem stream crossings will be armored to reduce erosion.

- To minimize sediment delivery to streams and to improve drainage patterns, ditches will be sized to control hillslope surface and groundwater flows and to protect the road from surface erosion. Cross-drains will be installed at frequent intervals to move hillslope surface and groundwater across the road in a pattern that approximates the drainage pattern upslope of the road. Ditches will discharge to the forest floor or other areas, instead of entering stream channels.

- To minimize sediment delivery to streams, unstable sidecast and fill material will be moved to a stable location. If the resulting road is too narrow, it may be stabilized by constructing a supported fill keyed into native material, or by reconstructing the cutslope. Organic debris will be removed and placed in a stable location. Unstable landings will be dismantled and the material moved to a stable location. Vegetation will be encouraged to grow on cutbanks and fill slopes, but not where it will interfere with maintenance.

- To reestablish fish passage, fish-passable structures will be constructed in locations where road crossings interrupt connectivity between significant habitat for resident or anadromous fish, where it is technically and economically feasible, and where the stream channels are not currently carrying excessive amounts of sediment that would threaten the stability of the structures. These projects will be designed by an interdisciplinary team, comprised typically of a fish biologist, hydrologist, and engineer.

- To reestablish fish passage where a stream channel is carrying excessive amounts of sediment, placement of the permanent crossing structure may be delayed until the sediment volumes being transported decrease to a point where placement of an in-channel structure does not pose a threat to channel or road structures or cause additional channel instability.

- Road improvement and repair activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Road Construction

- New roads may be constructed for emergency response to unforeseen events, to access new facilities or project locations in the watershed, to reestablish necessary access lost as a result of removing roads for environmental reasons, or for other reasons related to management of the municipal watershed. The City expects that approximately five miles of road may be constructed during the term of the HCP, but that total could be larger or smaller under different circumstances.

- To minimize sediment delivery to streams, to improve drainage patterns, and to provide fish passage, any roads in the municipal watershed will be constructed according to the Construction Standards in the Transportation Plan. These standards are designed to establish roads that are stable and do not contribute fill, sidecast, or debris to streams, and that include well designed and constructed drainage structures.

- Road construction standards will be improved as new technology, materials, and equipment become available.

- Road construction activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Road Maintenance

- To minimize sediment delivery to streams, to improve drainage patterns, and to provide fish passage, road maintenance activities will be conducted as specified in the Road Maintenance Standards (Appendix 17). These standards are designed to maintain a stable, functional road system that minimizes adverse impacts on stream and riparian habitat.

- Road maintenance standards will be improved as new technology, materials, and equipment become available.

- Road maintenance activities will be conducted in a manner that complies with agency regulations that are current at the time of the activity, unless the HCP expressly exempts the City from such regulations.

Funding and Schedule for Road Management Measures

Road Improvement, Deconstruction, and Construction Projects

Road improvement, deconstruction, and construction projects will be designed to minimize sediment delivery to streams and to improve drainage patterns that have been altered by roads. Road deconstruction and minimization of new road construction should reduce net active road miles in the Cedar River Watershed by approximately 236 miles (38 percent) over the term of the HCP, with an average of about 10 miles deconstructed per year for the first 20 years of the HCP. Unforeseen events could require construction of additional road miles for emergency response, or new roads may be constructed to access new facilities or project locations, or to reestablish necessary access lost be removal of roads for environmental reasons.

Funding for road improvement and deconstruction projects will total $12,250,000, which includes $7,250,00 for road improvements and $5,000,00 for road deconstruction. Some of the funds for road improvements may be used for deconstruction, if appropriate. For road improvements, the total of $7,250,000 includes $1,750,000 over the first 5 years, $1,000,000 over the second 5 years, and $4,500,000 over the remainder of the HCP term. For deconstruction, the total of $5,000,000 includes $250,000 per year for the first 20 years.   Funding levels are based on an approximate cost of roughly $25,000 per mile for complete deconstruction; $2,000 per mile for stabilization and repair; and $600 for each additional installed cross-drain.

As described above, the decision whether to repair or deconstruct a road with erosion problems will be made by an interdisciplinary team based on management activities served by the road, with costs required to repair and maintain the road also considered. The majority of road deconstruction will be phased over 20 years, and will be coordinated with restoration activities, including restoration and ecological thinning, restoration planting, research and monitoring, and stream restoration. Phasing and coordination is necessary to ensure that restoration activities can be accomplished and that restoration projects are stable before road access is eliminated.

Road Maintenance Activities

Road maintenance activities are designed to reduce sediment delivery to streams and to improve drainage patterns that have been altered by roads. Funding for increased maintenance activities will total $3,268,000. This includes $468,000 over the first 5 years, $400,000 over the second 5 years, and $2,400,000 over the remainder of the HCP term. The funding level is based on estimates that approximately 20-30 percent of total road maintenance costs will be related to correcting and avoiding direct impacts on streams, and that road maintenance costs will decline as total road miles are reduced and road conditions are improved. The funding commitments are for increases in levels of maintenance over current levels, and cover maintenance activities specifically targeted at reducing sediment loading to streams. Road maintenance activities will follow the standards included in the Transportation Plan (Appendix 17). These standards will be updated as new equipment, materials, and methods become available.

Stream Crossing Projects to Improve Flow Patterns

Stream crossing projects are designed to improve drainage patterns that have been altered by roads. Funding for drainage system improvements will total $850,000. This includes $125,000 over the first 8 years, $125,000 over the second 8 years, and $600,000 over the remainder of the HCP term. The funding level is based on the estimated approximate average cost of $1,250 per culvert, and the assumption that culverts may last 20-40 years depending on site conditions such as sediment transport and water pH.

There are approximately 1,300 stream crossing structures on non-fish-bearing streams in the Cedar River Watershed. Many need to be upgraded with regard to size or alignment, except where the road including the culverts is deconstructed. A few will need more expensive repairs. The first repairs will be directed at crossings that are known to have problems, as prioritized by an interdisciplinary team.

Stream Crossing Improvements to Reestablish Fish Passage

Stream crossing improvements are designed, where it is economically and technically feasible, to reestablish fish passage in locations where road crossings interrupt connectivity between significant habitat for resident or anadromous fish. Restoration of access to habitat by upgrading, replacing, and removing inadequate culverts on fish-bearing streams can be one of the most cost effective strategies for fish habitat restoration (Conroy 1997). Removing artificial migration barriers can also restore biological connections between upstream and downstream reaches that are an important part of natural stream functions (Ward 1989). Restored fish access can also result in increased fish production as a result of increased availability of habitat for rearing and spawning (Beechie et al. 1994).

Funding for projects to reestablish fish passage will total $1,220,000. This includes $960,000 over the first 8 years, $130,000 over the second 8 years, and $130,000 over the remainder of the HCP term. The funding level is based on estimated approximate costs of $20,000 to $36,000 per culvert or structural improvements for fish passage; $10,000 for channel reconfiguration; and the assumption that culverts may last 30-50 years.

A total of approximately 20 culverts in the municipal watershed have been identified as potentially non-fish-passable (Seattle Public Utilities 1998). The actual number of fish barrier culverts is likely different, because of limits to sampling methodology or because the culverts are potentially located above natural fish barriers (Section 3.2.4).

Restoration of the Aquatic and Riparian Ecosystem: Streambank Stabilization

Hillslope and streambank erosion are natural and continual ecosystem processes. Streambank erosion can be caused by natural channel migration, for example, which can replenish spawning gravels and create rearing habitat such as scour pools and undercut banks. Material from continually eroding streambanks is transported downstream to maintain spawning habitat throughout the lower portions of the basin. However, excessive localized streambank failures and altered stream channel configurations can be caused by road and land management activities. Inadequately sized stream crossings can constrict and redirect flows that can destabilize downstream streambanks. Flow constriction may also prevent the downstream movement of sediment by reducing flow velocities upstream of the constriction. The accumulated sediment can result in the loss of pool habitat upstream of the road crossing and cause streambank scour below the crossing.

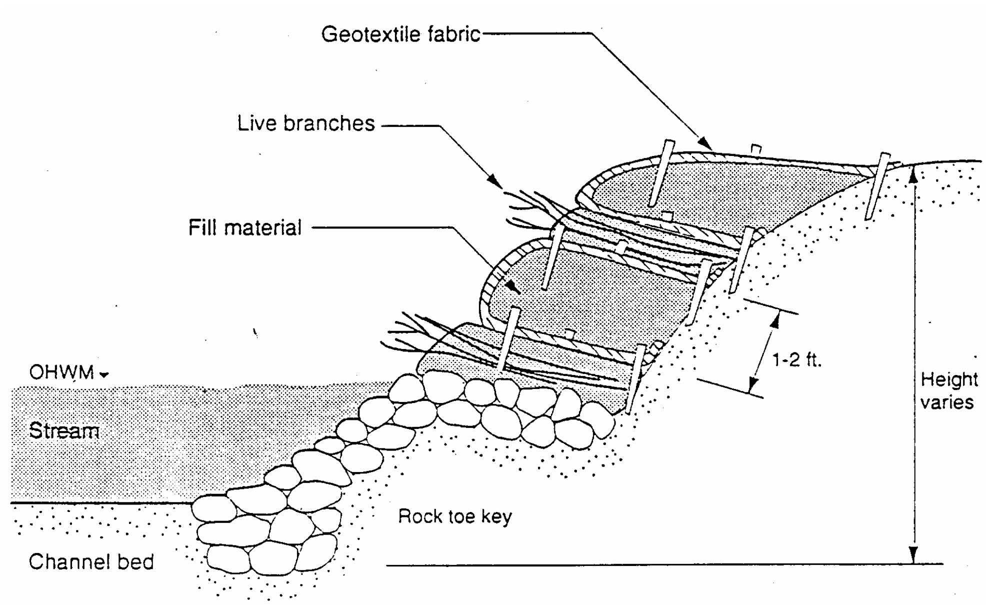
Landslides are also an important natural process. Material transported into streams from landslides is a natural habitat-forming feature, and landslides are a common process for delivering wood to the lower portions of the basin (Maser et al. 1988; Murphy and Koski 1989). However, road failures and hillslope management activities can alter the frequency of landslides in a watershed and result in destabilized streambanks.

Objectives for Streambank Stabilization

The objective of the strategy for the streambank stabilization element is to minimize excessive rates of streambank erosion caused by roads and land management activities. This element is closely linked with other elements of the strategies for the Aquatic and Riparian Ecosystem, including the road management program described above and in Appendix 17. The ecological benefits of the streambank stabilization effort will be improved storm-water quality and reduced magnitude and frequency of disturbance to fish habitat from sediment inputs and bedload movement.

Areas of localized streambank erosion that have been caused by management activities will be prioritized for stabilization by a multidisciplinary identification team. Projects will be prioritized based on a variety of factors including the presence of a channel migration zone, potential benefits from minimizing erosion, ability to successfully reduce erosion, and ease of access for construction and maintenance. Streambank stabilization projects will use materials appropriate to the site conditions, and both conventional and bio-stabilization techniques will be used. Conventional methods typically use the placement of large rocks to protect eroding banks, whereas bio-stabilization methods (Figure 4.2-4) will use a combination of logs, live plants, erosion control fabrics, and other materials to protect eroding banks (Sedell and Beschta 1991; Johnson and Stypula 1993).

Figure 4.2-4. An example of a streambank stabilization project using both conventional and bio-stabilization techniques (from Johnson and Stypula 1993).



Funding and Schedule for Streambank Stabilization

Funding for bank stabilization will total $756,000. This includes $158,000 over the first 8 years, $158,000 over the second 8 years, and $440,000 over the remainder of the HCP term. The funding level is based on an estimated approximate cost of $10,000 per 100 ft of stream bank.

Restoration of the Aquatic and Riparian Ecosystem: Stream and Riparian Complexity

Stream and associated riparian habitats within the Pacific Northwest region are characterized by variable disturbance regimes. Past forest management in the Pacific Northwest has typically affected riparian vegetation by a more chronic change: returning streamside forests to an earlier successional stage. Where mature conifers were harvested and not replanted, pioneer plants such as red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), and big leaf maple (*Acer macrophyllum*) often were established at much higher abundance and wider distribution than would occur after natural disturbances. Conifers that naturally reseed underneath these mixed hardwood stands are typically suppressed by limited light and competition for several decades. In some areas, conifer reestablishment is also hindered by a lack of seed trees and altered soil conditions.

Riparian vegetation has four direct effects on stream structure and function (O'Connell 1993). First, the roots of riparian vegetation can help stabilize streambanks, influence channel morphology, and reduce sedimentation. Second, large-diameter riparian trees are an important source of large woody debris that influences sediment movement, channel complexity, and nutrient cycling. Third, riparian vegetation influences nutrient input, assimilation, and transformation. Fourth, riparian vegetation can shade stream water that influences water temperature and primary production. All of these influences have effects on aquatic habitat and water quality (Juelson 1980; Sedell and Beschta 1991; Beschta 1991).

Streamside vegetation in previously harvested areas of the municipal watershed reflects the historical pattern of timber harvest within the watershed. The lower elevations were logged early in the twentieth century and the streamside vegetation has generally had a longer time to become reestablished than vegetation along streams in the higher elevations that was harvested more recently (Appendix 15). This past harvesting pattern is especially evident along the mainstem Cedar River between Cedar Falls and the Landsburg Dam and the Taylor Creek mainstem. Much of this lower-elevation forest was harvested more than 60-80 years ago, and the riparian forest today has many large conifers and a diverse canopy structure (Section 3.2.2).

Along some streams, naturally seeded trees have resulted in densely overstocked stands. These stands vary in species mix. Some stands are predominantly composed of a single species while others represent a broad species composition. Along other streams, vegetation may have been altered by an increased frequency of landslide material moving down the system and other scouring events. These disturbances can remove streamside trees, widen the unvegetated portion of the stream channels, and bury riparian vegetation under a layer of sediments from upslope.

The City will commit to conservation measures to enhance and restore stream habitats, increasing the structural complexity of riparian and instream habitat, by accelerating the reestablishment of diverse and structurally complex riparian forests and associated ecological functions. These elements are discussed below.

Streamside Revegetation

Objectives for Streamside Revegetation

The streamside revegetation element is a program to revegetate streambanks where past upstream or upslope activities have altered the riparian vegetation to a point where excessive streambank erosion is occurring and channel stability has been reduced. The objective of this element is to help restore the ecological functions associated with streambank stability by accelerating the recovery of vegetation characteristics appropriate to the site conditions. This may include encouraging the development of streamside forbs and shrubs, as well as the development of functional riparian forests. The channel migration zone will also be considered in design of streambank revegetation projects.

Selected streambanks that require revegetation efforts to improve bank stability will be planted with native plants. Scheduling and project prioritization will be closely linked with other elements in the strategies for the Aquatic and Riparian Ecosystem. The major effort for this program will occur within the first 16 years of the HCP. The program will use an experimental approach to revegetation, in which monitoring will be an important component. To help ensure success, projects will occur after excessive upslope or upstream sediment sources have been reduced. Plantings will be repeated and alternative applications will be implemented as needed and appropriate. The revegetation effort may include reconfiguring of streambanks and the use of erosion control materials, where appropriate.

Funding and Schedule for Streamside Revegetation

Funding for streamside revegetation will total $212,000. This includes $53,000 over the first 8 years, $53,000 over second 8 years, and $106,000 over the remainder of the HCP term. The funding level is based on estimated approximate average cost of $2,000 per 100 linear ft of streambank.

Conifer Under-planting and Long-term Maintenance

Conifer under-planting is a revegetation technique in which conifers are planted within an existing vegetation community. There are various methods of conifer under-planting, such as planting small trees with minimal site preparation, planting small trees in conjunction with thinning of the existing stand, and the use of animal browse deterrents. The initial methods used for this restoration effort will be based on the results of research on various techniques to accelerate the recovery of riparian conifer forests in coastal Oregon (Maas 1996; Emmingham 1996; Emmingham and Hibbs 1997).

This program will, where appropriate, promote biodiversity and the restoration of the native conifers in streamside areas that were disturbed by early timber harvest activities. Large conifers are important to developing and maintaining natural instream habitats (Cederholm et al. 1996). In addition, restoration planting will be done in forested areas around wetlands, ponds, and other nonforested aquatic habitats.

Objectives for Conifer Under-planting

The benefits and objectives of the conifer under-planting element are similar to those stated above for the streambank revegetation element. The primary objective of the conifer under-planting element is to reestablish conifers in riparian and streamside areas in order to help accelerate the restoration of diverse and structurally complex riparian stands within the watershed.

The highest priority project sites elected for conifer under-planting will be those in recently disturbed riparian zones that are currently vegetated but have a species composition that is not typical of such sites and that does not contribute to healthy, natural riparian function. The species to be planted are native conifers, which may include western redcedar (*Thuja plicata*), grand fir (*Abies grandis)*, and Sitka spruce (*Picea sitchensis*). The major emphasis of this effort will be in the first 16 years of the HCP. The program will use an experimental approach to revegetation, in which monitoring will be an important component. To increase the likelihood of success, projects will usually occur after excessive upslope or upstream sediment sources have been reduced. Planting techniques will be based on the results from similar programs in Oregon (Maas 1996; Emmingham 1996; Emmingham and Hibbs 1997). Plantings will be repeated and alternative applications will be implemented if needed and appropriate. The channel migration zone will also be considered in the design of overstory thinning projects, in order to avoid reducing bank stability.

Funding and Schedule for Conifer Under-planting

Funding for conifer under-planting and long-term maintenance will total $212,000. This includes $50,000 over the first 8 years, $50,000 over the second 8 years, and $112,000 over the remainder of the HCP term. The funding level is based on estimated approximate average cost of $300 per acre planted, and an approximate average cost of $200 per acre for maintenance.

Ecological and Restoration Thinning in Riparian Areas

Past logging in the watershed typically entailed removal of trees near streams, open water bodies, and wetlands (Section 3.2.2). The disturbance to both the adjacent vegetation and soils resulted in the conversion of many areas originally dominated by conifers to deciduous forest dominated by red alder or black cottonwood at abundances and with wider distributions than would occur as a result of natural disturbances (Section 3.2.2). Many of these disturbed areas could greatly benefit by careful silvicultural intervention to develop forest structure and composition characteristics of the natural, mature riparian conifer forest originally on the site. The City commits to a program of restoration thinning and ecological thinning within the riparian zone of streams, open water bodies, and wetlands.

Restoration and ecological thinning in upland areas are described above under Late-successional and Old-growth Forest Communities. With respect to areas near water bodies, restoration thinning of dense riparian stands younger than 30 years old can accelerate recovery of riparian functions by releasing neighboring trees from competitive constraints on growth (Oliver and Larson 1990; Carey and Curtis 1996) and by favoring multiple species (see Glossary figure G-1.a and G-1.b). Restoration thinning therefore can lead to the development of trees with a range of diameters along streams that can deliver large woody debris to the stream channel over time, as well as provide opportunities for the development of structural and community diversity.

This silvicultural strategy will protect water quality by reducing the risk of large-scale catastrophic damage to the watershed (primarily through development of windfirmness and increased resistance to insect attack, which is exacerbated by the stress caused by intense competition among trees). Techniques for restoration thinning include cutting, girdling, or otherwise killing some trees in variable density thinning patterns, retaining a mix of species that is characteristic of natural site conditions, and leaving small gaps or openings characteristic of naturally regenerated forests that result from small natural disturbances such as wind, disturbance from the stream channel, small fires, or disease.

Ecological thinning of second-growth riparian forests that are at least 30 years old, but typically less than 60 years old, can accelerate the development of diverse and structurally complex stands along municipal watershed streams. Ecological thinning will be done in selected previously harvested stands for which an interdisciplinary team determines that intervention can accelerate the development of natural riparian functions (see discussion of the old-growth restoration workshop in Section 3.3.4). Ecological thinning entails cutting, damaging, or otherwise killing some trees from some areas of older, overstocked, second-growth forest. Ecological thinning methods can be combined with other methods and may include variable-density thinning, retention of a variety of species, retention of sufficient standing and felled trees to provide coarse woody debris, under-planting, and cavity and snag creation (Carey et al. 1995).

As noted above, during the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term adverse impacts of restoration and ecological thinning. By doing so, the City and Services can develop approaches to minimize and mitigate for impacts and thus produce the greatest overall ecological benefit from these intervention strategies.

As explained above under the section on Late-successional and Old-growth Forest Communities, some logs may be sold during ecological thinning operations, but only if the biological objectives of the thinning project are met.

Objectives for Restoration and Ecological Thinning in Riparian Areas

The objective of restoration and ecological thinning in streamside and riparian areas is to accelerate the growth and structural development of trees in riparian stands, thereby providing greater stream protection, and eventual reestablishment of older riparian stands with a high structural and habitat diversity to help restore natural stream and riparian ecosystem functions.

The major emphasis of this thinning effort will be within the first 16 years of the HCP. As part of site prioritization, evaluations will be conducted to ensure that thinning activities will not degrade habitat for key species. The program will use a conservative approach to thinning, an approach that includes the protection of fragile streambanks, monitoring, and necessary follow-up treatments. The channel migration zone will also be considered in the design of overstory thinning projects, in order to avoid reducing bank stability.

Site-specific prescriptions will be developed and monitored over time to determine anticipated versus actual response (Section 4.5). Adaptive management will be used to ensure project objectives are met (Section 4.5.7).

Funding and Schedule for Restoration and Ecological Thinning in Riparian Areas

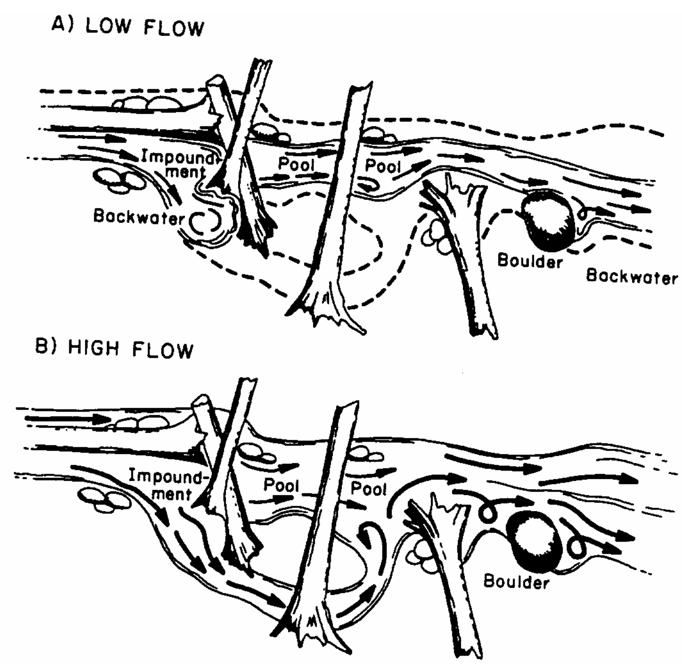
Funding for restoration and ecological thinning in riparian areas will total $180,000. This includes $45,000 over the first 8 years, $45,000 over the second 8 years, and $90,000 over the remainder of the HCP term. The funding level is based on an estimated approximate overall average cost of $316 per acre for thinning, with an assumed cost of $250/acre for restoration thinning and $500/acres for ecological thinning. Based on these assumed costs per acre, the City expects that about 150 acres will be treated by ecological thinning, and that about 420 acres will be treated by restoration thinning. About half of the area will be treated within the first 16 years of the HCP term.

Large Woody Debris Replacement

Large woody debris is a natural component of stream systems in the Pacific Northwest (Murphy and Koski 1989; Bisson et al. 1987; Hatten 1996). LWD interacts with the force of flowing water in several ways to affect biological and channel processes (Andrus et al. 1988; Bilby and Ward 1991; Robison and Beschta 1990). These processes include increased channel stability as a result of decreased stream energy, sediment storage upstream of woody debris, and reduced channel incision as a result of gradient controls (Figure 4.2-5). LWD also benefits fish habitat and fish production by providing areas of fast and slow water for fish to feed and rest, by creating areas of clean gravel for fish to spawn, by providing cover for prey and predators, by enhancing the base of the food web by trapping leaves and other nutritional materials, and by creating complexity that partitions habitat and provides refuge (Sedell et al. 1984; Fausch and Northcote 1992; Lonzarich and Quinn 1994; Cederholm et al. 1996).

In the Cedar River Watershed, many streams have a reduced volume of LWD (Cupp and Metzler 1995) as a result of timber harvest and stream cleaning. Some streams have been depleted of LWD as a result of early railroad logging practices that used streams as corridors for yarding logs to a road (Appendix 15). Other streams lack LWD as a result of reduced input from early successional riparian stands. Additionally, the past harvest of trees from inner gorges and steep slopes has reduced the amount of LWD associated with landslides that would have naturally entered the streams (Maser et al. 1988).

Figure 4.2-5. Diagram illustrating how the interactions between large woody debris and the flow of water influences channel shape and habitat features (from Reeves et al. 1991).



Objectives for Large Woody Debris Replacement

The objective of the LWD replacement element is to enhance stream habitat by placing LWD in selected streams that lack wood as a result of past disturbances. This program will be closely integrated with the three elements designed to restore streamside vegetation (streambank revegetation, conifer under-planting, and ecological thinning).

The placement of LWD in channels will be phased in generally after upstream and upslope influences on channel stability and fish habitat are addressed. Efforts will be emphasized in the second 8 years of HCP, after other integrated measures for the Aquatic and Riparian Ecosystem have been initiated.

A specific plan to manage large woody debris in the mainstem of the Cedar River between Cedar Falls and Landsburg is discussed below. A separate plan was developed for this reach of the river in order to incorporate specific water supply infrastructure, water quality, and personnel safety concerns.

Funding and Schedule for Large Woody Debris Replacement

Funding for large woody debris replacement will total $975,000. This includes $100,000 over the first 8 years, $375,000 over the second 8 years, and $500,000 over the remainder of the HCP term. The funding level is based on an estimated approximate cost of $20,000 per project.

Large Woody Debris Management Plan for the Mainstem Cedar River between the Cedar Falls Powerhouse and the Landsburg Diversion Dam

The Stream and Riparian Conservation Strategy in this HCP includes a specific management plan for the mainstem Cedar River between the Cedar Falls Powerhouse and the Landsburg Dam. A separate LWD plan was developed for this section of the river because downstream movement of fallen trees and large pieces of wood could threaten the integrity of the drinking water intake structure at the Landsburg diversion, as well as several bridges that span the river. This scenario happened during the 1990 flood, when large volumes of wood stacked up against the Landsburg Dam, creating a crisis situation.

The riparian stands along the Cedar River below Cedar Falls were last logged over 60 years ago. The relatively long period of subsequent regrowth has led to a high LWD recruitment potential of predominantly coniferous trees (see Maser et al. 1988). The amount of large coniferous woody debris entering the Cedar River over the 50-year term of the HCP is expected to gradually increase as riparian trees mature, and some larger trees fall into the stream channel (Seattle Water Department 1995).

Studies report no short- or long-term LWD recruitment deficiencies for the mainstem Cedar River between the powerhouse at Cedar Falls and the Landsburg Diversion Dam (Seattle Water Department 1995). Additional LWD inputs to this reach would enhance rearing habitat and refuge cover along the margins of the river, but would not be expected to significantly change the pool to riffle ratio of this section of river (Seattle Water Department 1995; Cupp and Metzler 1995). The City has no specific plans for bringing additional LWD into this reach. If necessary, however, LWD could be brought in from a different source in the future as part of the overall LWD program described above. LWD would only be brought in from an outside source if needed and if the process could be accomplished without risk to downstream facilities.

The City’s current policy has been to remove large woody debris (LWD) at Landsburg to prevent damage to the diversion structure and water intake facility. In addition, LWD removal was believed to reduce navigational hazards to boaters and reduce shoreline erosion on the lower river (downstream of Landsburg). Future improvements planned for the Landsburg Diversion include the addition of a floodway on the left side of the diversion structure to pass high flows around the structure. This new structure could facilitate passage of some LWD downstream. In view of the contribution LWD would make toward improving fish habitat in the lower Cedar River, the City will evaluate the floodway as a means of passing some woody debris downstream of the Landsburg

Diversion, should this new floodway be constructed. Logs removed from the dam may also be made available for use in habitat restoration projects in the municipal watershed or downstream of Landsburg.

Interactions between large woody debris and sediment movement can also cause increases in turbidity (Bilby 1981; Beschta 1979; Bilby and Ward 1989) and can cause exceedance of drinking water quality standards at the Landsburg intake structure. The separate LWD plan for this section of the river is discussed here. The HCP provides goals and guidelines for managing LWD for structural safety, water quality, stream function, and fish habitat.

Objectives for Large Woody Debris Replacement above Landsburg

The objectives of the Large Woody Debris Management Plan for the Cedar River between Cedar Falls and the Landsburg Dam are to maintain drinking water quality, personal safety, and the integrity of river crossings and the Landsburg structures while optimizing the amount of large wood in the Cedar River to improve fish habitat and stream functions.

The large woody debris management plan for the mainstem Cedar River between Cedar Falls and the Landsburg Dam will be initiated in HCP year 1. This plan includes the following major elements:

- *Monitoring*. Periodic monitoring of the river and banks will be conducted at least once a year for the presence of newly fallen trees, trees about to enter the channel, and log jams in the channel.
- *Assessing Stability of Pieces*. Large woody debris along the river margins will be assessed for stability during high flow events. An interdisciplinary team comprised of a City biologist and/or hydrologist and an operations staff person will assess large woody debris pieces to determine how they can best benefit riparian or fish habitat while minimizing potential damage downstream.
- *Repositioning and Securing Pieces*. In general, any large wood that appears unstable will be repositioned or removed to a more hydraulically stable location or will be secured in place. Wood that cannot be secured and that threatens drinking water quality or structural safety of facilities will be removed and, if possible, used for fish habitat enhancement projects at other locations.
- *Assessing Log Jams*. An interdisciplinary team comprised of a City biologist and/or hydrologist and an operations staff person will assess logjams for potential controlled breaching.
- *Breaching Log Jams*. If a river-spanning logjam occurs that could cause unacceptably significant bank scour or channel migration, the jam may be partially breached or removed to reduce the risk of increased turbidity and compromised drinking water quality.
- *Removal of Wood from Structures*. Wood that becomes lodged against bridges and other structures may be removed by the City for structural integrity or safety reasons, either by removal from the channel or by release downstream.

Implementation Guidelines

General implementation guidelines specific to the Large Woody Debris Management Plan for the Mainstem Cedar River between the Cedar Falls Powerhouse and the Landsburg Dam are outlined below. Stabilization of large woody debris in the Cedar River will be accomplished according to these general guidelines unless the City determines that its safety and water quality goals cannot be met, or unless the guidelines prove impractical to implement in particular cases.

- Wood that is naturally secured in place (such as partially buried logs or trees with the roots still connected to the bank) will generally not be anchored by artificial means or moved from its present location to a different location.
- If wood is to be anchored and it is not in a position that can resist peak flows, it will be repositioned in a more stable place. Disturbance to the riverbed, banks, and vegetation will be minimized.
- Wood will be anchored in a position that can resist the extreme forces of peak flows. In the Cedar River between Cedar Falls and the Landsburg Dam, the most stable positions for logs are usually along the channel margins, associated with a boulder or another anchored log, or where the log is partially on the bank.
- In general, only coniferous trees (such as Douglas-fir, Sitka spruce, western redcedar, and western hemlock) of 12 inch or greater diameter and a minimum of 12 ft long will be anchored. Smaller conifers and deciduous trees (such as red alder, cottonwood, and big leaf maple), which tend to break apart after only a few years, will be allowed to move downstream and lodge behind larger, coniferous wood. In this way, the stabilized large wood will trap smaller logs and tree tops.
- Cutting, shortening, or trimming fallen wood will be avoided, if possible, because longer wood is more stable during high flow events, and attached branches and roots help to naturally anchor large wood in the river.
- Cables or other fastening devices will be anchored to stumps or boulders. If a live tree is used as an anchor, protective bumpers will be used so the tree will not be girdled.
- Cabling or other anchoring devices will be installed to allow the wood to move up and down with rising and falling water, where appropriate.
- Large coniferous wood that is removed at the Landsburg Dam or the bridges will generally not be trimmed or cut, unless necessary for operational or safety purposes. This wood will be reserved for riparian or fish habitat enhancement projects, if possible.
- In particular locations where risks outweigh the benefits of stabilized wood (such as immediately upstream of the Landsburg Dam and the bridges), the wood will be removed for use in rehabilitation projects elsewhere.
- During emergency flood conditions, practices to ensure structural and personal safety and water quality will take precedence over all other implementation guidelines.

- Operational guidelines will consider personal safety constraints that may exist or be exacerbated by flood conditions.

- The City will obtain all applicable permits to remove, reposition, or stabilize large wood. State and federal agencies agree to cooperate with the City and to provide assistance in obtaining any approvals or permits that may be required, and to write permit conditions consistent with this "Large Woody Debris Management Plan for the Mainstem Cedar between Cedar Falls and the Landsburg Dam."

Funding for Large Woody Debris Replacement above Landsburg

Funding for the Large Woody Debris Management Plan for the Mainstem Cedar between Cedar Falls and the Landsburg Dam is incorporated into the funding for the large woody debris replacement program described above.

Guidelines Related to the Aquatic and Riparian Ecosystem

Guidelines applicable to the Aquatic and Riparian Ecosystem are described below under the section entitled "Administration of the Municipal Watershed and Applicable Management Guidelines." That section includes descriptions of City activities expected within the watershed and management guidelines developed to avoid, minimize, and mitigate impacts of those activities. It includes guidelines applicable to the watershed as a whole, to the Aquatic and Riparian Ecosystem, and to other habitats in the municipal watershed.

Measures Applicable Primarily to Special Habitats

Most wildlife species require a combination of habitat types or features within a certain spatial proximity in order to meet their biological requirements for food, cover, and reproduction over their life cycles (Brown 1985a; Morrison et al. 1992). Depending generally upon differences in size, mobility, and behavior, habitat requirements for different species can range from a micro-site or single habitat feature, such as a snag or a cave, to a landscape pattern of habitats or habitat features. In addition, habitat needs typically vary for most species on a seasonal, and often on a daily basis.

Special Habitats and Associated Species

Support of the natural biodiversity of the Late-successional and Old-growth Forest Communities in the municipal watershed requires protection of a variety of *special habitat types* that are embedded in the forested landscape, including talus and felsenmeer slopes; rock outcrops, cliffs, and caves; upland grass-forb meadows; and persistent shrub communities. These special habitat types are minor in terms of total area (Table 4.2-2) and occur primarily as small, scattered units (maps 6 and 7). However, some of the special habitat types are highly important to a number of the species addressed by this HCP (Table 4.2-3).

For example, several species use cliffs, rock outcrops, and caves. Peregrine falcons, black swifts, and golden eagles typically nest on cliffs. Although most bat species depend on late-successional and old-growth forests, nine species use caves and rock crevices for roosting (Table 4.2-3). Natural meadows, persistent shrub communities, and other open habitats are important as foraging areas for a number of species. Grizzly bears, gray wolves, and wolverines are not known to be present in the municipal watershed, but could use these open habitat types if they eventually invade, or are introduced into, the area. In addition, golden eagles and western bluebirds use one or more of these open habitat types for foraging. Existing open habitats created by logging (early seral forest) will diminish over the term of the HCP as these young stands mature.

Both the Larch Mountain salamander and the Van Dyke's salamander regularly use talus slopes. While neither of these salamanders is known to occur in the municipal watershed, which is north of the reported range of both species in the Cascade Mountains (Leonard et al. 1993), both of these species are poorly known and could occur here.

Mapped, non-vegetated rock formations (talus and felsenmeer, cliffs, and rock outcrops) total 1,244 acres. Mapped vegetated talus and felsenmeer formations in the municipal watershed total 329 acres.

Except for prairie communities, which are not present in the municipal watershed, natural meadow communities typically occur in the Puget Sound region largely in alpine areas or areas of alpine parkland, to a lesser extent in the Mountain Hemlock Zone, and even more rarely in the Pacific Silver Fir Zone (Franklin and Dyrness 1973). The primary type of persistent shrub community in the region is dominated by Sitka alder (*Alnus sinuata*) and is found in unstable areas of deep snow accumulation at higher elevations, often in avalanche chutes (Franklin and Dyrness 1973).

Natural grass-forb meadows are defined for this HCP as naturally maintained, persistent, plant communities dominated by grasses and forbs; such meadows may have some shrubs and a few scattered trees. Persistent shrub communities are defined for this HCP as naturally maintained, persistent plant communities dominated by shrubs. Many of the mapped natural meadow and persistent shrub communities are less than 1 acre. Mapped natural, upland grass-forb meadow communities total 110 acres, and mapped, persistent shrub communities total 93 acres. Examples of either of these community types often occur on wet sites (Franklin and Dyrness 1973) and could also qualify as wetlands.

Two other cover types within the municipal watershed that could be described as a miscellaneous category were added to the Special Habitats component for reasons other than the objectives of this HCP. These include the former town site of Taylor (98 acres), a culturally significant site that is now covered largely by deciduous forest, and 33 acres of unclassified, nonforested habitats, which occur in very small and scattered patches.

Objectives for the Special Habitats Component

The objectives of the Special Habitats component of the Watershed Management Mitigation and Conservation Strategies are to:

- Protect the key habitats, communities, and landscape features – separate from those included in Late-successional and Old-growth Forest Communities and the Aquatic and Riparian Ecosystem – that are important to species addressed by this HCP; and

- Contribute to the long-term maintenance of biodiversity in the municipal watershed and the region.

Protection of Special Habitats Through Reserve Status

All forests in undeveloped areas are protected through reserve status, including those that are associated with Special Habitats. Reserve status for forests thus serves to protect all special habitat types in the municipal watershed (maps 6 and 7), including:

- All mapped vegetated talus and felsenmeer slopes (329 acres);
- All rock formations (total of 1,244 acres), which include non-vegetated talus and felsenmeer (1,188 acres), rock outcrops (50 acres), cliffs (4 acres), and other areas (landslides, 2 acres);
- All natural upland grass-forb meadows (110 acres) and persistent shrub communities (93 acres); and
- The former town site of Taylor (98 acres of largely deciduous forest) and 33 acres of unclassified nonforested habitats.

The above elements, which do not overlap spatially, total 1,907 acres.

Guidelines Related to Special Habitats

Guidelines applicable to Special Habitats are described below under the section entitled "Administration of the Municipal Watershed and Applicable Management Guidelines." That section includes descriptions of City activities expected within the watershed and management guidelines developed to avoid, minimize, and mitigate impacts of those activities. It includes guidelines applicable to the watershed as a whole, to Special Habitats, and to other habitats within the municipal watershed.

Administration of the Municipal Watershed and Applicable Management Guidelines

Administration of the watershed requires provisions for City operations and facilities within the municipal watershed. This section includes descriptions of many of the City activities and operations that will be covered by the incidental take permit (see Section 1.3). The City has also established the guidelines and provisions discussed below for covered operations and activities, including guidelines applicable to the watershed as a whole and to Late-successional and Old-growth Forest Communities, to the Aquatic and Riparian Ecosystem, and to Special Habitats. These guidelines are described below, following the description of City operations and activities.

City Operations and Activities within the Municipal Watershed

A general description of Covered Activities under the HCP is given in Section 1.3, and additional details are given below for those activities that are within the municipal watershed. Current City facilities and operations in the municipal watershed occur on many sites. Provisions are made in this HCP for the operation, maintenance, improvement, and/or modification of these facilities, and for City operations and other activities within the watershed in general. In addition, provisions are made for any mitigation or conservation activity in this HCP that would involve activities within the watershed, such as construction of fish ladders. Covered Activities that are outside the municipal watershed are described in Section 1.3 and in the Implementation Agreement (Appendix 1). Operation of pipelines and other water system facilities that are outside the municipal watershed are not Covered Activities under this HCP. Such facilities include the segment of the transmission pipeline to Lake Youngs west of the municipal watershed, Lake Youngs, and other distribution and operating facilities outside the municipal watershed.

The primary activities within the municipal watershed that are Covered Activities under this HCP are described below, along with any limitations that apply to such activities. Covered Activities within the municipal watershed generally include the following categories of activities:

- Activities associated with general management and administration of the municipal watershed, including all activities and facilities in and around the Cedar Falls administrative complex, Landsburg facilities, and Seattle City Light power plant; maintenance, removal (deconstruction), and improvement of roads; use of existing and new gravel pits and rock sources; and watershed security operations, including trail and fence maintenance, surveillance, and environmental sampling.

- Maintenance of rights-of-way for power lines, pipelines, roads, and trails, including removal and control of trees, non-native vegetation, and other vegetation for safety reasons (such as visibility), to maintain the integrity of road surfaces, or to maintain or gain access.

- Activities associated with operation of the municipal water supply and hydroelectric power supply, including the operation, maintenance, improvement, reconstruction, and replacement of attendant facilities at Landsburg, Cedar Falls, the Masonry Dam, the Overflow Dike, the hydroelectric penstocks to Cedar Falls, and the hydroelectric plant at Cedar Falls.

- Activities associated with public education, including the management and use of sites on Chester Morse Lake, at Cedar Falls (the waterfalls), the Cedar Falls administrative complex, and Rattlesnake Lake; the construction, maintenance, and operation of the new watershed educational center at Rattlesnake Lake; and the maintenance of trails in old growth and other forested areas or areas near wetlands or streams, and certain established vistas and observation points.

- Activities associated with watershed surveillance and protection, including maintenance of weather measurement facilities, performance of environmental observations and data collection, collection of hydrological data, and other surveillance activities;

- Activities associated with scientific research, including facilities and operations at Findley Lake and the Thompson Research Center, City monitoring and field studies not associated with the HCP, and monitoring and field studies by WDFW and other state or federal agencies.

- Habitat restoration, enhancement, or rehabilitation projects not associated with the HCP.

- Activities associated with public recreation, including construction, maintenance, improvement, and use of the recreational areas at Rattlesnake Lake and Landsburg; construction, maintenance, improvement, and use of recreational trails on the watershed periphery and near Rattlesnake Lake; and the construction, maintenance, improvement, and use of trailheads by Washington State Parks near Rattlesnake Lake.

- Activities associated with management of cultural resources, including protection and management of cultural resource sites, operation of new facilities within the planned education center at Rattlesnake Lake, and management and protection of the former town sites of Taylor and Barneston and sites of prior Native American use.

- Activities associated with mitigation and conservation measures for this HCP, including, but not limited to:

    + The operation, maintenance, improvement, and/or dismantling of the interim sockeye salmon hatchery south of the Landsburg Diversion Dam (Section 4.3);

    + The potential construction, maintenance, improvement, and/or dismantling of a replacement sockeye salmon hatchery at or near Landsburg (Section 4.3);

    + The construction, maintenance, improvement, and/or dismantling of fish passage and protection facilities at Landsburg Diversion Dam and the pipeline crossing (see Section 4.3);

    + The construction, maintenance, improvement, and/or dismantling of bull trout passage facilities in Chester Morse Lake (see Section 4.5);

    + The installation maintenance, improvement, and/or dismantling of gages or other measuring devices related to monitoring of instream flows, water quality, or aquatic habitats, and sampling and other activities to support the HCP aquatic monitoring and research program;

    + The installation maintenance, improvement, and/or dismantling of equipment or other measuring devices related to research and monitoring for terrestrial habitats or species, and sampling and other activities to support the HCP terrestrial monitoring and research program

    + Silvicultural activities to restore watershed habitats, including planting, thinning and other types of intervention;

    + Improvement, reengineering, repair, decommissioning, and maintenance of forest roads, including modification, replacement, or removal of stream crossing structures and use of gravel pits and rock sources;

    + Projects to restore streams, riparian habitats, and other aquatic habitats; and

    + Research and monitoring activities.

Any of the activities as listed above could entail construction, reconstruction, maintenance, operation, improvement, modification, and/or dismantling of facilities within the watershed and other human activities needed to implement the various programs and functions of watershed and water supply management and the HCP. Any and all such activities, or other normal City operations and activities within the watershed, are permissible as long as they do not materially increase levels of incidental take from those assumed for the incidental take permit as issued for this HCP.

As described in Section 1.3, during the term of the HCP, the City may make significant modifications to, or may reconstruct or construct facilities within the municipal watershed for reasons that do not relate to the conservation and mitigation measures in the HCP. The City will notify and consult with the Services prior to such currently undescribed construction activities if there is a potential for take of Covered Species (Section 1.4). The City agrees to notify the Services prior to such construction activities related to the Masonry Dam, hydroelectric facilities, and the water intake at Landsburg, and prior to construction of any new bridges over the Cedar River between lower Cedar Falls and Landsburg.

The primary impacts of water supply operation, hydroelectric power generation, and forest management are discussed elsewhere in Chapter 4, and the measures included in the mitigation and conservation strategies presented in this chapter are intended to minimize and mitigate for any impacts of taking related to these activities. For example, use of roads will be mitigated by improved maintenance, engineering improvements, substantial decommissioning (reduction of the road system), and the lack of log hauling to support a commercial timber harvest program. Use and development of gravel pits will be needed to provide a level of road maintenance that will keep sediment loading from road erosion to a minimum, and larger rocks will be needed for stream restoration and other activities. When constructing new gravel pits within the municipal watershed, the City will develop and implement measures to minimize and mitigate any potential take of Covered Species.

The City does not expect that normal operations around its facilities in the municipal watershed will represent any significant impacts on species addressed in the HCP, or result in any material level of take. The habitats in these areas are largely highly disturbed, and the activities in such areas pose little or no risk to species addressed in the HCP, most of which rely primarily on relatively natural habitats. Nor does the City expect that maintenance of rights-of-way, which are also disturbed habitats, will result in any significant impacts to species addressed in the HCP, unless an individual with poor mobility is inadvertently affected by heavy equipment, an event that should be relatively uncommon. No chemicals are used in the watershed for control of vegetation (see below).

The planned education center near Cedar Falls and Rattlesnake Lake will be built in a highly disturbed area also unlikely to support large numbers of any of the species addressed in the HCP, or any species listed at the time of permit issuance. Thus, impacts of construction and operation of that facility should not produce significant impacts to the species addressed in the HCP, nor should such activities as recreational use of the two parks in the watershed, conduct of the City’s public education program, maintenance of trails, scientific research, and management of cultural resources. *Construction* of the education center is not a covered activity under this HCP.

Habitat restoration, enhancement, or rehabilitation projects are designed to improve habitat, and thus inherently include mitigation. Construction or reconstruction of facilities would have to be done with appropriate environmental review and permits, which typically entail mitigation for site-specific impacts.

Management Guidelines Applicable to the Entire Municipal Watershed

Controlled Public Access to the Watershed

The Cedar River Municipal Watershed is currently closed to unsupervised public access, and access is by permit or with supervision (see sections 2.2.2 and 2.3.10). Gates at road entry points to the interior of the watershed are closed and locked at all times, and the watershed is patrolled to find and exclude any trespassers. Access for hunting or fishing is not allowed, with the exception of fishing in the Rattlesnake Lake area for stocked trout. The City intends to continue this policy of watershed closure to protect water quality and minimize treatment costs, although this policy could be modified by the Seattle City Council in the future if treatment methods and/or regulatory requirements change, or for other reasons.

The watershed closure policy has distinct benefits for species addressed in this HCP. Human disturbance is known to adversely affect many species. For example, a major cause of nesting failure in common loons is disturbance along shorelines and boating activity (Section 3.5.5). Such activities in the municipal watershed are restricted to watershed staff, authorized consultants, agency biologists, scientific researchers, and permitted visitors, with the specific intent to minimize this kind of disturbance to fish and wildlife, especially during the breeding season. In addition, the watershed closure policy provides benefits to those species, such as grizzly bear (e.g., McLellan and Shackleton 1988), gray wolf (USFWS 1984, as cited in WDNR 1997), and bald eagle, that are particularly sensitive to the impact of human activities in their habitat.

Another major concern for many species is poaching. For example, poaching is believed to be a major threat to bull trout in Montana (Long, undated). Poaching of covered fish and wildlife can be expected to be much lower in the closed watershed than in areas open and accessible to the public. Furthermore, because the watershed is closed to unsupervised public access for fishing or other such activities, fishing mortality in general should be very low within the municipal watershed.

Prevention and Suppression of Forest Fires

A large-scale forest fire would jeopardize the drinking water supply and habitats of covered species. A heavily burned area can experience higher peak flows and increases in the rates of erosion and landslide activity as vegetative cover and soil litter is lost (Agee 1993). According to Agee (1993), in a Douglas-fir forest, sediment loading can increase five-fold in a burned area immediately following a severe fire, and may take 25 years to recover to base conditions. Increased sediment loading of this magnitude and duration would also have significant impacts on aquatic habitats. In addition, a severe wildfire in the municipal watershed would jeopardize remaining old-growth forest habitats, which are already scarce in the region.

Forest fires in this region are relatively rare and typically severe (Agee 1993; Henderson 1993; Bunnell 1995). Federal scientists have recommended that "Until we have fire management plans, all fires in west-side Late-Successional Reserves should be suppressed," and that "matrix management should reduce risk of fire and other large-scale disturbances that would jeopardize the reserves" (FEMAT 1993).

Based on the above considerations, the City's policy is to aggressively suppress all forest fires in the municipal watershed. The commitment not to harvest timber for commercial purposes should also reduce the risk of fire initiation overall relative to nearby areas by removing the risk associated with logging operations. Aerial application of retardants pre-approved (as safe for use) by the Director of SPU may be used to suppress fires within the municipal watershed, but, under current SPU regulations, no water may be drafted from the Chester Morse Reservoir. The risk of forest fires caused by human activity is also relatively less as a result of the watershed access policies described in sections 2.3.10 and above (see also Pasin et al. 1983). One of the reasons for maintaining a core road system is to allow access for suppression of forest fires.

Watershed Assessment Prescriptions

All Watershed Assessment Prescriptions (Appendix 16) will be followed, except those that apply only to timber harvest for commercial purposes, which will not occur under the HCP. References to stream and wetland buffers in specific prescriptions are no longer applicable as a result of the City's commitment in the HCP not to harvest timber for commercial purposes.

Forest Management

The following definitions will apply to forest management activities within the municipal watershed:

- <u>Restoration thinning</u>: Thinning of trees in over-stocked, younger stands (typically less than 30 years old), to create better habitat conditions by fostering development of understory vegetation and natural species diversity, increasing growth rate of trees, and reducing the risk of catastrophic events, including forest fires.

- <u>Ecological thinning</u>: Thinning of trees in older stands (typically over 30 years old but less than 60 years old) to foster development of understory vegetation and forest structure beneficial to species of concern, and to protect or help restore key ecological functions.

- <u>Restoration planting</u>: Planting vegetation for restoration of upland and riparian forests, and to stabilize soils.

- <u>Catastrophic event</u>: A large-scale, high-intensity natural or human-caused disturbance that occurs infrequently, such as insect or disease outbreaks, extraordinary flooding, or severe fire, that would require a prudent municipal watershed manager to take action to protect drinking water quality, protect public safety, prevent significant damage to natural resources, avoid significant failure to meet the habitat objectives of the HCP, or otherwise practice responsible environmental stewardship.

The following guidelines will be followed for salvage of trees:

- <u>Incidental salvage</u>: Removal of trees, down or standing, will be allowed along existing or new rights-of-way, including roads, to protect public safety and facilities and to allow access. Trees removed for such reasons may be sold by the City, as long as any net revenues are used to offset costs of the HCP or watershed management.

- <u>Catastrophic salvage</u>: Removal of down trees after a catastrophic event will be allowed, provided that the City consults with the Services and appropriate professionals to ensure that the salvage operation is needed to protect drinking water quality, protect public safety, prevent significant damage to natural resources, or avoid significant failure to meet habitat objectives of the HCP. Prior to such salvage operation, a salvage plan will be developed and subjected to appropriate review, and measures will be developed and implemented to protect water quality and aquatic habitats, and to minimize and mitigate the impacts of the salvage on the species addressed in the HCP. The commitment to develop a plan for catastrophic salvage shall not prevent the City from clearing road access and taking whatever emergency actions it deems necessary to protect public health, the drinking water supply, the safety of the public and City workforce, City facilities, or the watershed's natural or cultural resources. Logs will be removed from sites only if all biological objectives are met, including appropriate standards for coarse woody debris.

Any salvage plan developed for catastrophic salvage will include prescriptions for leaving coarse woody debris (snags and logs) for wildlife species, consistent with the need to control further risk of fire, the need to protect water quality, and objectives for the HCP. The impacts of such an event on the species addressed in the HCP cannot be determined in advance, but, during any salvage operation, efforts will be made to minimize and mitigate the impacts of the salvage on the species addressed in the HCP.

The following general guidelines will be followed for forest management:

- Restoration and ecological thinning: Restoration and ecological thinning will be conducted as mitigation under the HCP, as described above.

- Tree species diversity: Native tree species diversity will be promoted in the reforestation and restoration planting program by retaining and planting a variety of species appropriate to specific sites, and by planting for species diversity.

- Use of revenues: Any net revenues associated with selling logs from ecological thinning, incidental salvage, or catastrophic salvage may be used by the City only to offset the cost of the HCP or for watershed management and restoration.

Guidelines for forest management near streams and other aquatic habitats are described below under the section entitled "Additional Guidelines for the Aquatic and Riparian Ecosystem."

Smartwood Certification

When the HCP is approved, the City intends to apply for certification of forest management under the SmartWood program, founded by the Rainforest Alliance in 1989. The SmartWood certification program promotes an ecosystem-based approach to forest management for a variety of reasons, including sustainable forest management and watershed restoration (Jones, L., Northwest Natural Resource Group, 1999, personal communication).

SmartWood independently evaluates and audits forestry operations and certifies those that meet a strict set of environmental standards. Under the certification program, watershed forest management plans and activities are assessed and audited annually by an independent, multi-disciplinary team of scientists and professionals that evaluate environmental, economic, and social impacts.

The SmartWood Program operates in all forest types (tropical, temperate, and boreal) through the SmartWood Network, a cooperative effort among regional nonprofit forestry organizations around the world. The Quabbin Watershed, which provides drinking water to the city of Boston, was certified during the summer of 1997 by the Northeast Natural Resources Center, which is the Northeast chapter of the National Wildlife Federation and serves as the Northeast affiliate of the SmartWood Network.

Use of chemicals

Herbicides will not be used in the municipal watershed.

Revegetation of Disturbed Soils

Natural revegetation of disturbed soils will be augmented with native seed and/or plant species consistent with conservation goals and objectives of the HCP and other pertinent watershed management policies.

Additional Management Guidelines for Late-successional and Old-growth Forest Communities

All guidelines for Late-successional and Old-growth Forest Communities are encompassed by the guidelines described above for the municipal watershed as a whole, and the guidelines described below for the Aquatic and Riparian Ecosystem.

Additional Management Guidelines for the Aquatic and Riparian Ecosystem

The City commits to restrictions on activities within the Aquatic and Riparian Ecosystem component of the municipal watershed as described below.

Forest Management

The following general guidelines will be followed for areas near streams and other aquatic habitats:

- Tree removal will be limited to restoration thinning and ecological thinning to restore riparian ecosystem function, maintain or improve bank stability, accelerate development of late successional/old-growth stand conditions, or to maintain rights-of-way, including roads, or conduct salvage after catastrophic events.
- During restoration thinning or ecological thinning, no ground-based equipment will be allowed within 50 ft of streams or other aquatic habitats.
- No trees will be cut near streams in a manner that would reduce bank stability.
- Within wetlands, no cutting of trees will be allowed, except in limited circumstances where needed for restoration of natural wetland functions, and no ground-based equipment will be allowed within wetlands.

All silvicultural interventions near streams, lakes, ponds, or wetlands will be to provide long-term ecological benefits for species addressed in the HCP. While the City recognizes that cutting trees near streams must be done with care to minimize the risk of reducing bank stability, the City intentionally allowed flexibility to cut some trees near streams for restoration purposes. This flexibility may be needed to restore riparian forest function in some areas and will almost certainly be needed to accommodate or implement some instream restoration projects that entail placement of large woody debris (LWD). For example, restoration thinning of dense young stands (such as so called "dog hair" stands) near a stream may be needed to encourage tree growth and increase bank stability over the long term, and some trees near a stream may need to be felled to recruit LWD to the stream.

However, the City recognizes that such interventions near streams and other aquatic habitats could cause short-term, site-specific impacts, and the restrictions on such activities listed above were intended expressly to minimize such impacts. In addition, any silvicultural activities conducted for restoration purposes near streams and other aquatic habitats will be designed by an interdisciplinary team to minimize and mitigate any impacts on species addressed in the HCP. During the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify such short-term adverse impacts and develop strategies to minimize and mitigate for such impacts and produce the greatest overall ecological benefits from intervention.

Roads

- New road construction will be minimized. Proposed new road construction will be evaluated on a site-specific basis by an interdisciplinary team, which typically will include a watershed hydrologist, engineer, and biologist. New roads will be designed to minimize impacts to stream and riparian functioning.

- To minimize the risk of human-caused mass-wasting failure (landslides) that may deliver excessive sediment or other debris to streams or other surface waters, prior to construction of any new road, a geotechnical slope stability analysis may be conducted in accordance with Watershed Assessment Prescription HLP-1, based on an initial assessment by a City interdisciplinary team on sites with slopes averaging greater than 30 percent mapped as having moderate or high landslide potential and on sites with an average slope greater than 30 percent mapped as having high landslide potential or a moderate or high delivery potential, or for other areas later identified as having such potential. Site-specific prescriptions for road construction or timber harvest will be developed in accordance with Watershed Assessment Prescriptions HLP-2 through HLP-5 for areas having shallow-rapid mass wasting, or deep-seated landslide potential.

As noted above, construction of new roads will be minimized. Because the road system is now extensive and will be substantially reduced, the City expects to construct no more than about 5 miles of roads (less than 1 percent of the current total road miles) during the 50-year term of the HCP, with a net overall loss of total road miles estimated to be about 236 miles. Some new road construction could be required to access new facilities or project areas, or to reestablish access lost as a result of decommissioning roads causing severe environmental problems by constructing alternative routes in areas with lower risks.

When the City has plans to construct a new road, an interdisciplinary team will make a site evaluation, and the City will consult with the Services regarding measures to minimize and mitigate the impacts. If 5 miles of new road were to be constructed over the term of the HCP, then only about 18 acres (0.02 percent) of the total of 85,477 acres of forested habitat in the watershed would be removed. For perspective, the deconstruction of 236 miles of roads planned under the HCP would result in a net increase of about 858 acres of forest as the roadbeds are reforested.

The City commits to a variety of additional prescriptions that will collectively minimize or avoid impacts to streams through protection of streamside vegetation and reduction of sediment delivery to streams. These prescriptions are presented in detail in Appendix 16. Collectively these prescriptions accomplish the following:

- Restrict road construction in inner gorges and on steep slopes;
- Provide strict standards for construction and maintenance of roads; and
- Reduce sediment delivery through engineering improvements to roads, decommissioning of problem roads, and a substantial net reduction of road miles in the municipal watershed (approximately 38 percent reduction).

The Watershed Assessment Prescriptions (Appendix 16) that are most directly related to the Aquatic and Riparian Ecosystem include those that guide and constrain road construction and maintenance so that impacts to stream and riparian areas are minimized. These include prescriptions related to road erosion (RE-1), high landslide potential (HLP-5), high surface erosion hazard (HSEH-9), and blockages on streams, open water bodies, riparian zones, and wetlands (SORZ&W-7 and SORZ&W-8).

RE-1 Road Decommissioning and Stabilization

To minimize sediment delivery from the exposed surfaces of roads, drainage facilities, and associated cut and fill slopes in the Cedar River Watershed, this prescription states that, "All proposed road decommissioning and road stabilization projects will follow accepted Road Construction and Maintenance standards (Chapter 222-24 WAC) and will be implemented according to the timeline identified in the comprehensive 'Transportation Plan' [Appendix 17] developed for the Cedar River Watershed and discussed as site-specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995). It also states that accepted Road Construction and Maintenance Standards will be used.

HLP-5 Road Decommissioning and Stabilization

To avoid and minimize landslides caused by management activities, including timber harvest and road construction and maintenance, this prescription states that, "All proposed road decommissioning and road stabilization projects will be implemented as part of the comprehensive 'Transportation Plan' [Appendix 17] developed for the Cedar River Watershed and discussed as site-specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995).

HSEH-9 Road Decommissioning and Stabilization

To minimize surface erosion, soil compaction, and sediment delivery to streams caused by management activities, including timber harvest and road construction and maintenance, in the Cedar River Watershed, this prescription states that, "All proposed road decommissioning and road stabilization projects will be implemented as part of the comprehensive 'Transportation Plan" [Appendix 17] developed for the Cedar River Watershed and discussed as site specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995).

SORZ&W-7 Culvert Blockages to Fish Passage

To protect and restore aquatic and riparian ecosystems in the Cedar River Watershed by avoiding potential adverse impacts to streams, lakes, ponds, other open water bodies, riparian zones, and wetlands from cumulative effects caused by management activities, this prescription states that, "All potential blockages to fish passage identified as part of the '1994 Cedar River Watershed Survey of Culverts Draining Stream Types I - IV' (see Seattle Public Utilities 1998) will be evaluated to determine whether or not a blockage actually exists. If the investigation determines that a blockage exists, then the culvert or culverts responsible for the barrier will be repaired or replaced as necessary so that upstream and downstream passage of fish is provided."

SORZ&W-8 Road Decommissioning and Stabilization

To protect and restore aquatic and riparian ecosystems in the Cedar River Watershed by avoiding potential adverse impacts to streams, lakes, ponds, other open water bodies, riparian zones, and wetlands from cumulative effects caused by management activities, this prescription states that, "All proposed road decommissioning and road stabilization projects, including the replacement of inadequately sized culverts and failing stream crossings, will be implemented to control potential sediment delivery problems as part of the comprehensive 'Transportation Plan' [Appendix 17] developed for the Cedar River Watershed and discussed as site specific recommendations in the 'Cedar River Watershed Assessment – Basin Condition Reports, Prescriptions, and Restoration Opportunities'" (Seattle Water Department 1995).

HLP-3 and 4 Geotechnical Analyses for Road Construction

If the ID Team determines that a geotechnical analysis is needed, then site investigations will be conducted by a qualified soil scientist, geomorphologist, engineering geologist, geotechnical engineer, and/or forest engineer to identify potential landslide types, analyze risks, and develop site-specific prescriptions for road construction. If site investigations determine that the site is stable and has a low potential for shallow-rapid mass-wasting, road design would be based on a slope stability analysis, and prescriptions could vary from road construction using standard best management practices in areas of low risk, to either no road construction or a fully engineered road on areas of high risk.

HSEH-7 and 8 Road Construction and Maintenance

The contribution of sediment delivery to streams from all new roads will be minimized through road design and placement consistent with accepted Road Construction and Maintenance Standards (Chapter 222-24 WAC). No new roads will be constructed on sites designated as high and very high surface erosion hazard areas unless: A) the roads can be engineered to minimize the delivery of sediment to streams; and B) best management practices for road construction can be implemented to minimize delivery of sediment to streams.

Additional Management Guidelines for Special Habitats

During watershed operations near any natural grass-forb meadow, persistent shrub, talus and felsenmeer slopes (both vegetated and non-vegetated), cliffs, caves, or other rock formations, operations will be regulated within 200 ft of the habitat element. Restoration and ecological thinning, as well as restoration planting, will be allowed within this 200-ft zone to improve the protection of the Special Habitat, thus providing a benefit to species using this habitat. During the early part of implementation of the HCP, the City will consult with the Services regarding how best to identify any short-term impacts of thinning near Special Habitats and develop approaches to minimize and mitigate for impacts in order to produce the greatest overall ecological benefit from this intervention strategy.

New road construction will be minimized within 200 ft of Special Habitats, and proposed new road construction will be evaluated on a site-specific basis by an interdisciplinary team that typically will include an engineer and a biologist. Roads will be designed to minimize impacts on the adjacent forest and thus on the protected habitats. When the City has plans to construct a road that could pass within 200 ft of a Special Habitat, an interdisciplinary team will make a site evaluation, and the City will consult with the Services regarding measures to minimize and mitigate the impacts. In addition, operations near breeding individuals of the species of greatest concern, including all listed species, will be restricted as described below.

Species Conservation Strategies

Introduction

To identify species of regional concern that occur or could occur in the municipal watershed, the City solicited input from over 30 taxonomic experts, 22 of whom responded (Section 3.4; Appendix 18). From the comments of these experts, and additional consultation with the Services, the City developed the list of 83 species addressed in this HCP (Section 3.4). The primary habitat associations of each of these 83 species are given in Table 4.2-3.

Also, based on the comments from the taxonomic experts and consultation with the Services, the City identified 14 of the 83 species as those of greatest concern, including the 10 species considered by the taxonomic experts to be at greatest risk (Species of Greatest Concern, Section 3.5) and 4 additional species that are currently listed as threatened or endangered by the USFWS under the ESA. The 10 species considered at greatest risk are: bull trout, chinook salmon, coho salmon, common loon, marbled murrelet, northern goshawk, northern spotted owl, pygmy whitefish, sockeye salmon, and steelhead trout. The four additional listed species include three species - gray wolf, grizzly bear, and peregrine falcon - that are not known to occur in the municipal watershed at this time, but that could occur in the future. Also included is the bald eagle, which, along with the peregrine falcon, is now under consideration for delisting as a result of its substantial recovery in many areas.

Developing specific strategies for all of the 83 species addressed in this HCP is not feasible, but the City has developed strategies for the 14 species of greatest concern (termed "Species Conservation Strategies"). Furthermore, as discussed above in this section, the City believes that a community- or ecosystem-based approach is the most effective way for the City to contribute to sustaining populations of most of the species addressed in the HCP over the long term. However, the City also recognizes the need for specific measures targeted at some of the species of greatest concern. For example, specific measures are obviously needed to protect the four species of anadromous fish that now occur outside the municipal watershed. These species depend on water released into the Cedar River downstream of the Landsburg Diversion Dam, and the Landsburg Dam itself currently blocks the passage of these species upstream into the municipal watershed.

Measures are also needed to protect, especially during the sensitive reproductive period, some of the most "at-risk" wildlife species that now occur or could occur in the municipal watershed. To respond to this concern, the City developed some of the species strategies to add protection for reproductive adults and their offspring during the breeding season. For other species, the City believed it appropriate to add measures that would provide habitat and habitat elements specifically needed by the individual target species or that would increase the level of habitat protection greater than that included in the community-based strategies described above in this section.

Although most of the Species Conservation Strategies have unique measures targeted to the individual species, the strategies for all of the 14 species are based primarily upon other conservation and mitigation strategies and measures. The community-based conservation strategies described above apply to all 14 species. All of these species either occur or could occur in the Cedar River Basin. All of these species, except sockeye salmon, either occur within the municipal watershed, could occur within the watershed, or will occur within the watershed after HCP fish passage facilities are completed at the Landsburg Diversion Dam (allowing chinook, coho, and steelhead, and other native species into the municipal watershed) (Section 4.3). The community-based conservation strategies apply to sockeye salmon largely by their expected effect in improving, over time, the quality of surface water that is passed downstream over the Landsburg Diversion Dam. In addition, the mitigation strategies for the anadromous fish barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4) apply to all species of anadromous fish.

For the purpose of presenting the Species Conservation Strategies, the 14 species of greatest concern have been categorized by their primary habitat associations (Table 4.2-3) as follows:

- *Species dependent on Late-successional and Old-growth Forest Communities:*
  Marbled murrelet, northern goshawk, and northern spotted owl

- *Species dependent on the Aquatic and Riparian Ecosystem:*
  Resident fish: bull trout and pygmy whitefish
  Anadromous fish: chinook, coho, and sockeye salmon, and steelhead trout
  Birds: bald eagle and common loon

- *Species dependent primarily on Special Habitats:*
  Gray wolf, grizzly bear, and peregrine falcon.

As described above in this section, the Special Habitats include cliffs, rock outcrops, caves, vegetated and non-vegetated talus and felsenmeer slopes, natural grass-forb meadows, and persistent shrub communities.

The Species Conservation Strategies incorporate the other conservation and mitigation strategies shown in Table 4.2-4 below. The following parts of this section describe the specific Species Conservation Strategies that will be implemented for each of these 14 species, briefly summarize measures presented elsewhere in Chapter 4 that benefit the individual species or above three groups of species, and describe any additional measures developed for any of the species. The species strategies may be updated if any threatened or endangered species are delisted or if any new species are listed, or change status in a significant way, during the term of the HCP.

For the 69 other species of concern, the conservation strategies are based entirely on the community-based conservation strategies described above in this section. The biological goals and measurable objectives for those other species of concern are described below in the section entitled "Biological Goals and Objectives for Other Species of Concern."

Development of Species Conservation Strategies

The development of the Species Conservation Strategies was based on the habitat needs of the 14 species of greatest concern, federal programs for species listed under the ESA (see Chapter 3), and the need for additional protection during sensitive periods of the annual life cycle of some of the species. The status of each of these species is discussed in detail in Chapter 3 and is summarized only briefly below to provide context.

As indicated in Table 4.2-4, the Species Conservation Strategies for species that now occur or may occur in the municipal watershed - with the exception of the four anadromous fish species - depend largely on the Community-based Conservation Strategies described above, as well as parts of the Monitoring and Research Program for the watershed (Section 4.5). The strategies for anadromous fish species are composed of elements of the Anadromous Fish Conservation Strategy (Section 4.3), Instream Flow Conservation Strategy (Section 4.4), Monitoring and Research Program related to instream flows and anadromous fish mitigation (sections 4.5.2 and 4.5.3), and the community-based parts of the Watershed Management Mitigation and Conservation Strategies described above in this section that affect water quality and aquatic and riparian habitat in areas that are or will be accessible to anadromous fish when fish passage facilities are built at Landsburg (see Section 4.3).

Table 4.2-4. Community-based conservation and mitigation strategies that are incorporated into the 14 Species Conservation Strategies, with species grouped by habitat association[1]. Shaded areas indicate those strategies that benefit particular species.

Ecosystem or Habitat Species	**Aquatic & Riparian Ecosystem**	**Late-Successional & Old-growth Forest Communities**	**Special Habitats**	**Watershed Management Guidelines**	**Mitigation Strategies for Anadromous Fish Barrier at Landsburg**	**Instream Flow Management Strategy**
Section:	*4.2.2*	*4.2.2*	*4.2.2*	*4.2.2*	*4.3.2*	*4.4.2*
Late-successional & Old-growth Ecosystem						
Marbled murrelet						
Northern goshawk						
Northern spotted owl						
Aquatic & Riparian Ecosystem						
Resident fish						
Bull trout						
Pygmy whitefish						
Anadromous fish						
Chinook salmon						
Coho salmon						
Sockeye salmon	Water quality					
Steelhead trout						
Birds						
Bald eagle						
Common loon						
Special Habitats						
Gray wolf [2]						
Grizzly bear[2]						
Peregrine falcon[2]						

1 Excludes Monitoring and Research (Section 4.5), which applies to all 14 species.
2 If present.

The community-based conservation strategies described above in this section were designed to preserve, protect, and enhance key habitat in the Cedar River Watershed that is used by species addressed by the HCP for reproduction; roosting, denning, and holding; foraging; rearing; and dispersal. The strategies for anadromous fish were developed cooperatively with state and federal agencies, with input from the Muckleshoot Indian Tribe, during negotiations, studies, and analyses conducted over the last 13 years. The strategies for the remaining 10 species were developed cooperatively with the agencies, with input from the Muckleshoot Tribe, during preparation of this HCP.

Conservation Objectives for Species Conservation Strategies

The objectives of the Species Conservation Strategies derive from the more comprehensive set of HCP objectives presented in Section 2.4. The objectives of the Species Conservation Strategies generally are to avoid, minimize, or mitigate for impacts of any incidental take of the species addressed in the HCP, including potential take of species listed under the ESA and the equivalent of take for the unlisted species, and to provide additional protection during sensitive periods of the annual life cycles of some of the species. Each strategy is intended to produce a net benefit for the species addressed, over the term of the HCP, compared to current conditions, and to contribute to recovery of any of the species that are or may be listed.

Strategies for Species Dependent on Late-successional and Old-growth Forest Communities

Species Addressed

Strategies are provided for three species dependent on Late-successional and Old-growth Communities: the northern spotted owl, marbled murrelet, and northern goshawk.

Summary of Status for Species Dependent on Late-successional and Old-growth Forest Communities

<u>Northern Spotted Owl</u>

The northern spotted owl (*Strix occidentalis caurina*) in western Washington depends on late-successional and old-growth forests (USDI 1992b; Thomas et al. 1993). The species is listed as threatened by the federal government (Fed. Reg. Vol. 55, Pp. 26114-26194), and it is listed as endangered by Washington State (WAC 232-12-014). The most significant factor contributing to the overall decline of the northern spotted owl is the loss of nesting, roosting, and foraging habitat (Thomas et al. 1990) as a result of a reduction in late-successional and old-growth forests (Section 3.5.2).

Within the municipal watershed only two northern spotted owl reproductive site centers have been found. Only one of the reproductive site centers is currently active; the second has not been active since 1981. Similarly, two single-resident site centers have been found, but only one center is currently active. The other site center has not been active since 1987. One single-resident northern spotted owl site center also has been reported within the municipal watershed (WDFW 1997d), but its current status is unknown. In addition, two reproductive site centers located outside of the watershed boundary have owl circles (of 1.8 mile radius: see Section 3.5.2) that partially overlap the municipal watershed (WDFW 1997d). All reported site centers have been within old-growth forest.

The boundaries of all known reproductive site centers of the northern spotted owl, both inside and outside the municipal watershed, are within the designated boundaries of CHU WA-33, which includes 22,845 acres of City land in the eastern portion of the watershed. All areas of known reproductive site centers for the spotted owl that are within the municipal watershed are protected by the City's commitment not to harvest timber for commercial purposes, placing all forest outside limited developed areas in reserve status. The state has also designated a Spotted Owl Special Emphasis Area (SOSEA) (the I-90 West SOSEA) that incorporates 48,877 acres of the municipal watershed and overlaps all of the CHU (Figure 3.5-2). The state designated the SOSEA land in the municipal watershed for either *demographic support* or *dispersal support*.

Demographic support lands offer appropriate habitat for nesting, roosting, and foraging ("NRF" habitat), while dispersal support lands offer minimum necessary habitat for young to cross from the natal stand to a new territory. There is 25,501 acres of demographic support land in the municipal watershed, 22,167 acres of which overlap the CHU. An additional 23,367 acres of the municipal watershed within the SOSEA is designated for dispersal support, 668 acres of which are in the CHU.

Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) is a marine bird that occurs inland only during the breeding season. Mated pairs typically nest in old-growth trees, specifically on large branches and usually more than 100 ft above ground. They nest on naturally formed platforms that are usually composed of large, wide limbs with thick moss or duff, mistletoe brooms, or other structural deformities that provide a surface of sufficient size to rear a chick. Adult marbled murrelets approach and leave the nest at high speed primarily at dusk and dawn (WDW 1993d) and appear to favor forest with the irregular canopies typical of old growth, which likely provide openings in the canopy through which birds can enter and emerge.

"Suitable marbled murrelet habitat" (for nesting) is generally considered to be contiguous forest at least 7 acres in area, within 50 miles of marine waters, that contains trees capable of providing nesting opportunities (WAC 222-16-010). These opportunities are considered to be present in stands in which at least 40 percent of the dominant and codominant trees are Douglas-fir, western hemlock, western redcedar, or Sitka spruce, and there are two or more potential nesting platforms per acre. Adequate nesting platforms are considered to be branches at least 7 inches in diameter and at least 50 ft above ground, on trees at least 32 inches dbh.

The marbled murrelet is federally listed as threatened in Washington, Oregon, and California (Fed. Reg. Vol. 57, No. 191). The species is also listed as threatened by Washington State (WAC 232-12-011). Listing was a result of population declines resulting primarily from loss of old-growth nesting habitat, and secondarily because of mortality caused by ocean fishing with gill nets (USDI 1992a). Critical Habitat for marbled murrelets was designated on former USFS lands within the municipal watershed (USDI 1996); all the Critical Habitat falls within the spotted owl CHU. A final Recovery Plan for marbled murrelets was published in 1997 (USDI 1997a).

Currently, insufficient information exists on abundance and regional distribution to definitively determine population trends in the western Cascade region. However, the recent estimate of 5,500 marbled murrelets in Washington (Speich and Wahl 1995; Varoujean and Williams 1995) reflects a possible region-wide decline in the population.

This regional decline is thought to be caused by a combination of many factors, including a reduction in old-growth forests, oil spills in marine waters, and entanglement in gill nets (Marshall 1988; Leschner and Cummins 1992).

In 1991, City staff consulted with WDNR personnel who were actively studying marbled murrelet ecology in other areas of the western slope of the Cascades. Existing habitat conditions within the municipal watershed were reviewed based on topography, relative forest age, and existing knowledge of forest stand structural development. One area was identified as having the greatest potential for providing nesting habitat for murrelets. The area was surveyed late in the nesting season, and no murrelets were detected. However, in 1992, WDFW surveyed the same area during the nesting season and detected murrelet calls on two occasions (WDFW 1994b). No nest site was located, and no additional surveys have been conducted to date (Section 3.5.3).

Northern Goshawk

In the Pacific Northwest, the northern goshawk (*Accipiter gentilis*) is most abundant in old-growth habitat and is also associated with late-successional coniferous forests (Thomas et al. 1993). Nesting habitat selected by northern goshawks is similar to that selected by northern spotted owls (Marshall 1992; Buchanan 1992).

The northern goshawk is a federal species of concern and a state candidate for listing as a threatened species (WAC 232-12-297). On September 29, 1997, the USFWS published a 90-day finding on a petition to list the northern goshawk in the Western United States under the ESA (Fed. Reg. Vol. 62, No. 188, Pp. 50892-50896), which announced that listing of the northern goshawk was not warranted. Another finding was published in June of 1998 (Fed Reg. Vol. 63, No 124, Pp. 35183-35184) after a one-year finding on another listing petition, announcing also that listing was not warranted. The principal reason for the decline of the species that led to the concern of regulatory agencies is considered to be habitat loss resulting from intensive timber harvest.

No comprehensive studies of northern goshawk numbers or distribution have been conducted within the Cedar River Municipal Watershed, and specific knowledge concerning the species' use of existing habitat is limited. Presently, only one northern goshawk nesting territory has been documented within the municipal watershed. The site was identified during surveys by WDW personnel in the summer of 1992, in unharvested native forest included within the spotted owl CHU in the eastern section of the watershed. The site was also occupied during 1996, but no offspring were observed (Spencer, R., WDW, 1997, personal communication). This northern goshawk nesting territory is located within a defined 1.8-mile northern spotted owl circle near the spotted owl reproductive site center (Section 3.5.4).

Conservation Objectives for Species Dependent on Late-successional and Old-growth Forest Communities

Northern Spotted Owl

The objectives of the northern spotted owl conservation strategy are to avoid, minimize, or mitigate for the impacts of any incidental take of spotted owls, to provide a net benefit for the owl, and to contribute to its recovery. These objectives will be pursued by protecting existing old-growth habitat; by enhancing and recruiting significantly more of its nesting, roosting, foraging, and dispersal habitat; and by protecting nest sites and reproductive pairs and their offspring.

Marbled Murrelet

The objectives of the marbled murrelet conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of marbled murrelets; to provide a net benefit for the murrelet; and to contribute to its recovery. These objectives will be pursued by protecting existing old-growth habitat, by enhancing and recruiting more of its potential nesting habitat, and by protecting nest sites and reproductive pairs and their offspring.

Northern Goshawk

The objectives of the northern goshawk conservation strategies are to avoid, minimize, or mitigate for impacts of any incidental take of northern goshawks; to provide a net benefit for the species; and to contribute to its recovery, if it is listed. These objectives will be pursued by protecting existing old-growth habitat; by enhancing, and recruiting significantly more of its potential nesting, roosting, foraging and dispersal habitat; and by protecting nest sites and reproductive pairs and their offspring during the breeding season.

Common Elements of Conservation Strategies for Species Dependent on Late-successional and Old-growth Forest Communities

Conservation strategies for the northern spotted owl, marbled murrelet, and northern goshawk are based largely on the component of the Community-based Conservation Strategies that focuses on Late-successional and Old-growth Communities. The commitment not to harvest timber for commercial purposes and the designation of all forest outside developed areas for reserve status should provide substantial protection for the habitat of these species and recruit substantially more habitat over the 50-year term of the HCP.

The total mature, late-successional, and old-growth forest projected at year 2050 for the watershed is 72,739 acres; compared to 15,054 acres of these seral stages in 1997, this represents nearly a fivefold increase. Approximately 15,000 acres of forest is expected to receive silvicultural treatments that will accelerate the development of natural biodiversity and structural characteristics of late-successional and old-growth forests.

These silvicultural methods will encourage the development of multi-layered stands that have vertical and horizontal structural complexity, large trees, large snags and logs, and understory development. These characteristics will provide perching and roosting sites for owls, and will promote the creation of nest platforms for owls as older trees mature and the tops break off. They will also promote development of large branches of the type that are used by murrelets for nesting.

As a consequence of the City's commitment not to harvest timber for commercial purposes, early seral forest (less than 30 years old) will not be created by commercial harvest under the HCP, and the current early seral forest habitat will have matured into later seral stages by year 2027. Some early seral forest habitat, however, can be expected to be created by natural disturbances such as windstorms, disease, or fire. This reduction in early seral forest should facilitate dispersal of spotted owls and goshawks and reduce mortality during dispersal. Designation of the entire spotted owl CHU for reserve status will allow forest in this area to mature, increasing the CHU's effectiveness within the federal late-successional reserve system and providing regional connectivity for spotted owls and goshawks. The thirteen-fold increase in mature, late-successional, and old-growth forest below 3,000 feet and the substantial increase in this habitat in the western portion of the watershed should also provide increased nesting habitat for marbled murrelets over the long term. The reduction in forest fragmentation should benefit all three species, as it should reduce the numbers of potential predators that use forest edges, and it should ameliorate environmental effects of recent clearcuts on forest interior conditions.

The above measures, and the effects of those measures collectively, should contribute significantly to demographic support for all three species and to dispersal support for the spotted owl and goshawk. In addition, the current closure of the municipal watershed to unsupervised public access and the substantial reduction in the watershed road system will reduce disturbance to individuals and pairs of all three species.

Additional Mitigation and Conservation Measures for Species Dependent on Late-successional and Old-growth Forest Communities

Measures Benefiting the Northern Spotted Owl

The City will implement the following measures for the northern spotted owl:

(1) The City will protect all documented spotted owl nest sites and suitable habitat within the watershed, documenting such sites either by survey or incidental observation.

(2) The City will conduct a baseline survey of northern spotted owl presence in old-growth forest within the watershed, if those areas are not actively being monitored by other agencies or interested parties, such as adjacent landowners.

(3) The City will conduct an annual survey of reproductive site centers within the watershed, or coordinate with other agencies or interested parties to conduct an annual survey, for a period of 5 years after the last documented activity of spotted owls within such sites.

(4) Unless affected owls are not actively nesting, the City will avoid road construction activities, operation of heavy equipment, slash burning, blasting, and helicopter operations that could disrupt successful nesting within 0.25 miles of any active reproductive site center between March 1 and August 31 (the nesting season, as defined in WAC 222).

Funding for the conservation and mitigation measures for the northern spotted owl is covered under other mitigation and conservation strategies. Funding for monitoring related to the spotted owl is covered in Section 4.5.5.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the northern spotted owl achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on Late-successional and Old-growth Forest Communities, including the northern spotted owl, include the following:

- a project to improve the forest habitat inventory and database;

- a project to track changes in forest habitat characteristics;
- a study to classify old-growth forest types in the watershed; and
- projects to monitor forest restoration projects.

Additional monitoring and research pertinent to spotted owls include a baseline survey of the watershed and surveys of reproductive site centers following their last use.

Measures Benefiting the Marbled Murrelet

The City will implement the following measures for the marbled murrelet:

(1) The City will protect all documented marbled murrelet nest sites and suitable habitat, documenting such sites either by survey or incidental observation.

(2) A habitat assessment program will be conducted to identify potential suitable marbled murrelet habitat (as defined above) in second growth along with site-occupancy surveys, as described in Section 4.5.5, to provide information for choosing sites for habitat restoration and for monitoring changes in murrelet habitat use over time.

(3) The City will avoid cutting any trees during ecological thinning that meet requirements for murrelet nesting trees (as described above).

(4) The City will avoid road construction and operation of heavy equipment, which could disrupt successful nesting, within 0.25 miles of an occupied marbled murrelet site during the daily peak activity periods within the critical nesting period and will avoid blasting within 0.25 miles of an occupied marbled murrelet site during the critical nesting period.

(5) If the USFWS agrees to cooperate in the project, the City will conduct an experimental project to develop nesting habitat for murrelets within selected second-growth forest within the watershed. The timing and details of this project are discussed in Section 4.5.5.

Funding for the conservation and mitigation measures for the marbled murrelet is covered under other mitigation and conservation strategies. Funding for monitoring related to the marbled murrelet is covered in Section 4.5.5.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the marbled murrelet achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on Late-successional and Old-growth Forest Communities, including the marbled murrelet, are as described above for the northern spotted owl. Additional monitoring and research pertinent to marbled murrelets includes:

- Baseline surveys;
- Determination of potential suitable murrelet habitat in second-growth forest;
- Occupancy surveys in potential suitable habitat in second growth;
- Long-term occupancy surveys; and

- Monitoring of experimental projects to develop nesting habitat.

Measures Benefiting the Northern Goshawk

The City will implement the following measures for the northern goshawk:

(1) The City will protect all documented northern goshawk nest sites and suitable habitat, documenting such sites either by survey or incidental observation.

(2) The City will avoid road construction, operation of heavy equipment, and blasting, which could disrupt successful nesting, within 0.50 miles any known active northern goshawk nest site from April 1 to August 31.

While no surveys for goshawks are planned as part of this HCP, some of the $150,000 in contingency funds for additional wildlife species surveys included in the monitoring and research program (Section 4.5.5) may be used for such surveys if the Services agree, or surveys may be conducted by another agency. However, the major protections afforded goshawks under the HCP are the commitment not to harvest timber for commercial purposes and the designation of all forest outside developed areas for reserve status. This is projected to result in an overall five-fold increase in mature, late-successional, and old-growth forest over the term of the HCP.

The monitoring and research program outlined in Section 4.5.5 regarding development of habitat with late-successional and old-growth characteristics will be used to determine if the conservation strategy for the northern goshawk achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on Late-successional and Old-growth Forest Communities, including the northern goshawk, are as described above for the northern spotted owl.

Strategies for Species Dependent on the Aquatic and Riparian Ecosystem

Species Addressed

Strategies are provided for eight species dependent on the Aquatic and Riparian Ecosystem:

- Resident fish: bull trout and pygmy whitefish
- Anadromous fish: chinook, coho, and sockeye salmon, and steelhead trout
- Birds: bald eagle and common loon.

Summary of Status of Species Dependent on the Aquatic and Riparian Ecosystem

Status of Bull Trout

The USFWS listed the Puget Sound Distinct Population Segment as threatened on November 1, 1999 (Fed. Reg. Vol. 64, No. 210). The U.S. Fish and Wildlife Service has also recently listed the Columbia River Basin populations as threatened (Fed. Reg. Vol. 64, No. 210, page 58909). Currently, Washington State does not give bull trout a listing status, but does classify bull trout as a priority species because it is considered to be vulnerable to significant population declines (WDFW 1996a).

The Cedar River Municipal Watershed supports a reproductively isolated stock of bull trout in the reservoir complex and its tributaries. In a 1998 study, WDFW assessed the status of individual populations of bull trout and Dolly Varden (*Salvelinus malma*) in Washington State and found that of the 80 identified stocks placed into five rating categories (healthy, depressed, critical, unknown, or extinct), the status of 72.5 percent are unknown, and 17.5 percent are categorized as healthy. The status of the Chester Morse Lake stock is classified as unknown. However, the assessment states "there are no data suggesting a chronically low condition, or short-term severe decline" in the population (WDFW 1998). A detailed discussion of the Chester Morse Lake bull trout population is provided in Section 3.5.6. Bull trout are rare in the Cedar River Basin downstream of Chester Morse Lake, and any individuals found in this area could be from the reservoir.

Status of Pygmy Whitefish

The pygmy whitefish (*Prosopium coulteri*) was listed as a Washington State sensitive species on October 27, 1998 (WDFW 1998c). The listing became effective in December 1998. The pygmy whitefish is found in only nine lakes in Washington State (Hallock and Mongillo 1998), and its populations are especially vulnerable to local extinction, because recruitment of new individuals is usually impossible in isolated systems. Introductions of non-native fishes are believed to have extinguished pygmy whitefish populations in other systems (Section 3.5.7).

The Chester Morse Lake system supports a relatively large population of pygmy whitefish. The fish are the most abundant salmonid in the lake, and they are one of the major prey items for the Chester Morse Lake bull trout population (R2 Resource Consultants, in preparation). A detailed discussion of the pygmy whitefish in the Cedar River Watershed is provided in Section 3.5.7. The pygmy whitefish is not known to occur in the Cedar River Basin below Chester Morse Lake.

Status of Chinook Salmon

The Washington Department of Fisheries et al. (1993) identified 26 stocks of chinook salmon (*Oncorhynchus tshawytscha*) in Puget Sound. At the time of their report, the authors classified the population status of approximately half of the stocks as depressed. Since that time, there has been a sharp decline in the abundance of Puget Sound chinook, resulting from poor ocean survivals, habitat alterations, and harvest pressures (Johnson et al. 1997). The continued downward trend has led the State of Washington to reclassify the status of Puget Sound chinook as depressed. Following a status review by NMFS, chinook salmon in Puget Sound were proposed for listing as threatened under the federal ESA in 1998 (Fed. Reg. Vol. 63, No. 45, March 9, 1998) and were listed by NMFS as threatened on March 24, 1999 (Fed. Reg. Vol. 64, No. 56, page 14307). No final regulations regarding chinook under Section 4(d) of the ESA have been published by NMFS to date.

Washington Department of Fisheries et al. (1993) classified the status of Lake Washington chinook salmon as unresolved because of differing viewpoints of state and Tribal resource managers. Since this analysis, chinook abundance has declined sharply, and the State of Washington now classifies the demographic status of Lake Washington chinook as depressed (Smith, C., WDFW, 1998, personal communication). Since the completion of the Landsburg Dam, chinook salmon have been unable to migrate past the dam and into the waters between Landsburg and the natural barrier at lower Cedar Falls. A detailed discussion of chinook salmon is provided in Section 3.5.10.

Status of Coho Salmon

In 1995, NMFS completed a comprehensive status review of coho salmon (*Oncorhynchus kisutch*) along the west coast of the United States. The status review identified six populations of coho within this range. Because coho from Puget Sound and the Strait of Georgia formed a coherent genetic cluster, it was determined that this population was unique. The population includes coho from Lake Washington and the Cedar River. In comparison to other populations along the California and Oregon coasts, NMFS determined that coho salmon in Puget Sound and the Strait of Georgia were generally stable and a listing was not warranted. However, because of limited information regarding the health of this population and definitive information on the risks to naturally reproducing fish, NMFS decided to add the Puget Sound/Strait of Georgia population to the federal list of candidates for threatened and endangered species. Upon reevaluation at any time, NMFS may reconsider the present candidate listing and propose to list the Puget Sound/Strait of Georgia population as threatened or endangered.

Coho populations in the Lake Washington Basin have undergone significant declines in recent years. Coho escapement peaked at over 30,000 fish in 1970, but declined to less than 2,000 fish in 1992 (Fresh 1994). The desired escapement for Lake Washington is 15,000 fish, an escapement level that has not been achieved since 1979. Although the status of Cedar River coho salmon was determined to be healthy in 1992 (WDFW et al. 1993), this assessment acknowledged that the stock would fall into the depressed classification if future returns similar to those in 1991 were observed. Because of the continuation of the downward population trend, coho salmon are now considered depressed in the Cedar River and elsewhere in the Lake Washington Basin. Since the completion of the Landsburg Dam, coho salmon have been unable to migrate past the dam and into the waters between Landsburg and the natural barrier at lower Cedar Falls. A detailed discussion of coho salmon is provided in Section 3.5.9.

Status of Sockeye Salmon

NMFS completed a comprehensive status review of west coast sockeye salmon (*Oncorhynchus nerka*) populations in Washington, Oregon, and California in 1998 (Fed. Reg. Vol. 63, No. 46, March 10, 1998). NMFS concluded that only the Ozette Lake sockeye is likely to become endangered in the foreseeable future, and proposed them for listing. NMFS also added Baker River sockeye to the candidate species list. NMFS considered the sockeye salmon stock from the Cedar River to be apparently introduced from outside the Lake Washington Basin and did not recognize this stock as an Evolutionarily Significant Unit (ESU).

Washington Department of Fisheries et al. (1993) identified four populations of sockeye salmon (*Oncorhynchus nerka*) in Puget Sound: three populations in the Lake Washington Basin and one population in Baker River. In the Lake Washington Basin, the sockeye salmon is the most numerous reproducing salmonid. In years of high abundance, sockeye salmon support a significant Tribal treaty harvest and one of the largest sport fisheries in the state (Fresh 1994). The summer migration of adult sockeye salmon through the fish ladder at the Ballard Locks attracts thousands of visitors each year and the observation of spawning sockeye in the Cedar River, Bear Creek, and Issaquah Creek has become a popular outdoor recreation activity.

After building to relative robust levels in the 1960s and 1970s, the Lake Washington Sockeye population has experienced a period of significant decline. Since 1967, the escapement goal for Lake Washington of 350,000 adult fish has been met or exceeded only four times. Because the escapement goal was last achieved in 1988, WDF et al. (1993) classified the Lake Washington sockeye population as depressed in the Cedar River and elsewhere in the Lake Washington Basin.

Sockeye harvest opportunities have recently declined in frequency. In 8 of the 22 years between 1967 and 1988, Tribal and sport harvest included substantial numbers of sockeye in Lake Washington. Since 1988, Tribal and sport harvests have been conducted in Lake Washington only in 1996 (WDFW, unpublished data). Although the 1996 return of approximately 450,000 adult fish indicates that the system has retained some potential to produce significant numbers of fish, the general trend in the sockeye population remains one of relatively steep decline. A detailed discussion of sockeye salmon is provided in Section 3.5.8.

Status of Steelhead Trout

There are 60 wild steelhead (*Oncorhynchus mykiss*) stocks inhabiting the Puget Sound drainage (WDF et al. 1993). Of these stocks, 16 are considered healthy, 14 are classified as depressed, and 1 stock is considered to be in critical condition. The remaining 29 stocks in the Puget Sound drainage are designated “status unknown.” A regional status review of steelhead stocks by NMFS in 1994 determined that steelhead in Puget Sound, which includes the Lake Washington stock, did not warrant listing under the federal ESA.

The Lake Washington Basin is considered to have only one stock of native/wild steelhead trout. This steelhead stock is considered to be depressed, and there is no longer significant natural production from any stream in the basin other than the Cedar River (Foley, S., WDFW, 1997, personal communication). Between 1983 and 1997, escapement estimates for the Lake Washington Basin ranged from 2,575 fish in 1983 to 70 fish in 1994. Low returns in the early 1990s resulted in closing of all recreational fisheries until steelhead numbers returned to healthy levels. Since the record low return in 1994, steelhead escapement has generally increased, with escapement ranging from 126 to 616 fish per year.

Since the completion of the Landsburg Dam, steelhead trout have been unable to migrate past the dam and into the waters between Landsburg and the natural barrier at lower Cedar Falls. A detailed discussion of steelhead trout is provided in Section 3.5.11.

Status of Bald Eagle

A subspecies of the bald eagle (*Haliaeetus leucocephalus*) was federally listed as endangered (Fed. Reg. Vol. 32, Pg. 4001, March 11, 1967) under the Endangered Species Protection Act of 1966 (16 U.S.C. 668aa-668cc). In 1978, the legal status of the bald eagle in North America was clarified by listing the bald eagle population as endangered for the entire lower 48 States, without referring to subspecies (Fed. Reg. Vol. 43, Pg. 6233, February 14, 1978). In a special rule, the U.S. Fish and Wildlife Service reclassified the bald eagle from endangered to threatened in the lower 48 States (Fed. Reg. Vol. 60, No. 133, July 12, 1995). The bald eagle also occurs in Alaska and Canada, where it is not at risk and is not protected under the ESA. Washington State lists the bald eagle as threatened (WAC 232-12-011). Because of significant recovery in large parts of its range, the bald eagle is now under consideration for delisting under ESA.

Bald eagles are present year-round throughout Washington. Most nesting in the state occurs on the San Juan Islands and along the Olympic Peninsula coastline. Nesting territories are also found along Hood Canal, on Kitsap Peninsula, along the Columbia River in southwestern Washington, in the Cascade Mountains, and in eastern Washington (USFWS 1986), as well as on Lake Washington. Primary wintering areas include the Olympic Peninsula, the San Juan Islands, Puget Sound and its tributaries, Hood Canal, the Cowlitz and Columbia rivers (Taylor 1989), and rivers of the western Cascade slopes such as the Skagit River.

Bald eagles are common visitors to the watershed during spring and fall migrations, but are not known to nest within the boundaries of the municipal watershed. During the fall and spring, bald eagles are regularly seen in trees around the lakes of the watershed.

Status of Common Loon

The common loon (*Gavia immer*) is a Washington State candidate species under WDFW Policy POL-M6001. The candidate status of the loon is a result of a suspected decline in breeding population size and the increase in human activities near loon breeding and nesting habitat. Nest sites have been confirmed on at least five lakes in King County during the last decade. Nest sites have also been confirmed in four other counties in the state, three of which are in eastern Washington (Richardson and Spencer 1999). Only 5-11 common loon breeding sites are known to have been active at any time during the last decade in Washington State (Richardson and Spencer 1999).

Three mated pairs of common loons have been present on Chester Morse Lake and Masonry Pool during each pair-bonding and nesting season for the years 1989-1997. Two of the nesting territories have been occupied by reproductive pairs in each of the 9 years of the City study described in Section 3.5.5. A pair of loons has been present in a third territory in each of the 9 years of the study, but the pair failed to establish a nest during 3 of those years. Low water levels or other factors may have prevented successful reproduction during these 3 years.

Since 1990, the City has conducted an experimental project designed to ameliorate the effects of reservoir fluctuations on common loon nesting success (Section 3.5.5) and has been conducting research on the breeding biology of loons in the municipal watershed. The experimental project entails deployment of artificial nest platforms, which have been made available within each of the three loon nesting territories on the reservoir complex each year since 1990. The floating platforms provide nesting loons with an alternative, more stable, nest site that can more effectively adjust for most rising water conditions, but only to some degree for falling lake levels. Platforms have been used in at least one, and typically in two, of the three nesting territories in each of the 8 years during which platforms have been deployed.

Of the 21 common loon nests established during the 8-year period 1990-1997, 7 have been on natural nest sites and 14 have been on experimental platforms. A total of 24 chicks have hatched: 6 on natural nests (5 of which survived to fledging) and 18 on platforms (16 of which survived to fledging). Four chicks hatched and survived to fledging from three natural nests in 1989, before any experimental platforms were deployed. A detailed discussion of common loons is provided in Section 3.5.5.

Conservation Objectives for Species Dependent on the Aquatic and Riparian Ecosystem

Objectives for Bull Trout

The objectives of the bull trout conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of bull trout, to provide a net benefit for the bull trout, to contribute to its recovery, if it is listed, and to maintain the health and viability of the Cedar River Watershed bull trout population. These objectives will be pursued by protecting and enhancing bull trout habitat in tributaries to the reservoir complex, by monitoring population trends, and by controlling risks to the population that could result from water supply and watershed management activities.

Objectives for Pygmy Whitefish

The objectives of the pygmy whitefish conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of pygmy whitefish, to maintain the health and viability of the Cedar River Watershed pygmy whitefish population, to provide a net benefit for the pygmy whitefish, and to contribute to its recovery, if it is listed. These objectives will be pursued by protecting and enhancing pygmy whitefish habitat in tributaries to the reservoir complex, by gaining a better understanding of its life history, and by controlling risks to the population that could result from water supply and watershed management activities.

Objectives for Chinook Salmon, Coho Salmon, Steelhead Trout, and Sockeye Salmon

The conservation objectives of the strategies for chinook, coho, and sockeye salmon, and steelhead trout are to avoid, minimize, or mitigate for impacts of any incidental take of any of these species, to provide a net benefit for each species, and to contribute to the recovery of any of these species that becomes listed under the ESA. As described in Section 4.3, additional objectives with respect to mitigation for the blockage to passage at the Landsburg Diversion Dam are to:

(1) Implement biologically sound, short- and long-term solutions that help provide for the recovery and persistence of well-adapted, genetically diverse, healthy, harvestable populations of these species in the Cedar River;

(2) Provide fish passage over the Landsburg Diversion Dam, consistent with water quality protection, and in a manner that is coordinated with run recovery, biological need, water supply operations, and facility maintenance requirements;

(3) Implement solutions that have a high likelihood of success and that provide substantial value for target resources and the ecosystems upon which they depend; and

(4) Coordinate with and support other compatible rehabilitation activities to help realize the full benefits offered by aquatic resource conservation efforts in the Lake Washington Basin.

For chinook, coho, and steelhead, the objective is to restore access to the municipal watershed for spawning and rearing by construction of passage facilities at the Landsburg Diversion Dam. As explained in Section 4.3, sockeye cannot be passed above the Diversion Dam without jeopardizing the quality and safety of the drinking water supply.

The objective for sockeye is to otherwise mitigate for the lost spawning and incubation capacity for sockeye upstream of Landsburg Dam.

As described in Section 4.4, additional objectives with respect to instream flows are to:

(1) Implement a beneficial instream flow regime, based on the best current scientific information, that will help provide high quality fish habitat throughout the potential range of anadromous fish in the Cedar River from Lake Washington to the natural migration barrier formed by lower Cedar Falls;

(2) Reduce the risks of stranding juvenile salmonids and dewatering salmonid redds to levels that will help promote the full recovery and persistence of anadromous salmonid populations in the Cedar River;

(3) Provide an instream flow regime that significantly improves existing habitat conditions for all four species of anadromous salmonids in the Cedar River over existing conditions;

(4) Maintain the supply capacity from the municipal water system, including the Cedar River, as measured by average annual firm yield, protect drinking water quality and public health, and preserve the operational flexibility necessary to water supply operations;

(5) Help support measures that will contribute to improving downstream migration conditions for juvenile salmonids at the Hiram Chittenden (Ballard) Locks; and

(6) Preserve flexibility to meet water needs for people and fish that may be identified in the future.

Objectives for Bald Eagle

The objectives of the bald eagle conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of bald eagles, to provide a net benefit for the eagle, and to contribute to its recovery by protecting potential nesting, roosting, perching, and foraging habitat within the watershed, and by recruiting additional nesting, roosting, and perching habitat.

Objectives for Common Loon

The objectives of the common loon conservation strategies are to avoid, minimize, or mitigate for impacts of any incidental take of common loons, to provide a net benefit for the loon and contribute to its recovery, if it is listed, by protecting and improving nesting conditions and nesting success. An additional objective is to collect biological information that will help identify and design effective and biologically sound, short- and long-term conservation measures.

Common Elements of Conservation Strategies for Species Dependent on the Aquatic and Riparian Ecosystem

Conservation strategies for the bull trout, pygmy whitefish, bald eagle, and common loon are based on the components of the Community-based Conservation Strategies described above that focus on the Aquatic and Riparian Ecosystem. The conservation strategies for the four species of anadromous fish – chinook salmon, coho salmon, sockeye salmon, and steelhead trout – are dependent largely on the mitigation and conservation measures for the anadromous fish barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4), but these species will benefit from Watershed Management Mitigation and Conservation Strategies for the Aquatic and Riparian Ecosystem also.

The strategy for the Aquatic and Riparian Ecosystem within the municipal watershed (Table 4.2-4) is designed to contribute to sustaining populations of species dependent on aquatic and riparian habitats by: (1) protecting all aquatic habitats in the watershed, consistent with operation of the water supply; (2) improving aquatic and riparian habitats and water quality through restoration projects; (3) sustaining natural processes and functions that create and maintain habitats, and restoring to a more natural range of variation those processes that have been disturbed by past human activities; and (4) providing landscape connectivity within stream systems and among significant wetlands and associated riparian areas. Protection of aquatic and riparian habitats will be accomplished through a combination of the commitment not to harvest timber for commercial purposes, protection of all forest outside developed areas through reserve status, and implementation of the management guidelines.

In addition to protection of nearly all aquatic and riparian habitats through reserve status, the Aquatic and Riparian Ecosystem is protected through a variety of guidelines. These management guidelines are designed to reduce anthropogenic sediment loading to aquatic habitats and improve water quality over the long term by improved construction and maintenance standards for forest roads, a commitment to remove a large portion of the watershed road system, and a commitment to reengineer other roads to reduce sediment loading to streams. Aquatic and riparian habitats will also be improved by restoration projects for stream and riparian habitats, and stream habitat accessibility will be restored by a program to upgrade stream-crossing structures that block passage.

All four species of anadromous fish will benefit by the Instream Flow Management Strategy (Section 4.4). Instream flow is a major factor determining habitat quality in the Cedar River, as habitat quality depends on the total available area of habitat that meets species requirements for water depth and velocity, and for substrate type and cover (Section 3.3.2). The flow regime in the HCP was developed over an 11-year period through cooperative studies by a group that included state and federal resource agencies with input from the Muckleshoot Indian Tribe (Section 3.3.2), and subsequent negotiations and modeling based on those studies (Section 4.4). The flow regime provides flows for spawning, incubation, rearing (of juveniles), holding of adults, and outmigration of fry, as well as standards for downramping (rate of reduction of flows) designed to minimize stranding of juvenile fish as river water levels drop. The four species and the life stages of those four species have different flow needs by season, and the interagency group selected a species and life stage that should receive primary emphasis for each period of the year (Section 3.3.2).

Because hydrologic conditions can vary substantially by year, many operational decisions need to be made to best allocate available water for the various species and life stages of fish in any given year. The Instream Flow Management Strategy incorporates provisions to capitalize on better hydrologic conditions by enhancing instream flows. To manage decisions on flow augmentation adaptively, implementation of the instream flow regime will be overseen by a multi-agency commission (Appendix 27). Data collected in the cooperative study indicate that the improved flows, particularly when combined with adaptive management of flows through the commission, should create better conditions for all four species than currently exist in the Cedar River (Section 4.4). In response to citizen comment seeking to have the City ensure that some of the water which it may be entitled to withdraw under its 300 mgd water right claim should instead be left in the river for the benefit of fish over the term of the HCP, the also is committing to seek a means to dedicate a large portion (one-third, or 100 mgd) of its water right claim to fish, or 150 mgd if and to manage its water supply to more closely mimic natural patterns of river flows in response to new understanding should allow considerable flexibility to provide additional benefits for the riverine ecosystem and the individual species in the future (Section 4.4.2). It is also the City's intent to reserve an additional one-sixth or 50 mgd of its water right claim (on an annual average basis), subject to the additional condition that the City resolves some outstanding issues with the Muckleshoot Indian Tribe.

The Ballard Locks is a bottleneck for all anadromous fish entering and leaving the Lake Washington Basin because the Lake Washington Ship Canal is the sole access route to the basin. Mortality and injury of smolts leaving the lake occurs at the Locks. The instream flow component of the HCP includes funding by the City for improvements at the Ballard Locks that will be designed to increase survival of smolts of all four anadromous salmonids (Section 4.4.2). In addition, the City will commit as additional mitigation approximately $3.3 million for habitat protection and restoration downstream of the Landsburg Diversion Dam and in the Walsh Lake system for the benefit of anadromous fish species.

All four species of anadromous fish will also benefit by the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3). A major feature of this strategy includes construction of upstream and downstream fish passage and protection facilities at the Landsburg Diversion Dam and the City's water supply line crossing the Cedar River near the dam. The passage facilities will allow passage of chinook, coho, and steelhead into about 17 miles of mainstem and tributary "refuge" habitat within the highly protected municipal watershed for the first time in a century and will increase the total miles of mainstem habitat available by 55 percent. For the period prior to construction of fish passage facilities, the strategy also includes interim mitigation in the form of funding for much needed studies or, potentially, for emergency supplementation. Once fish passage is effected at Landsburg, the benefits of mitigation and conservation measures for the Aquatic and Riparian Ecosystem will also accrue to these species. In addition, the City will commit as additional mitigation more than $1.6 million for habitat protection and restoration downstream of the Landsburg Diversion Dam and in the Walsh Lake system for the benefit of anadromous fish species (this $1.6 million adds to the $3.3 million described above to total approximately $5 million).

In addition, the current closure of the municipal watershed to unsupervised public access will protect all species that are now or will be within the municipal watershed from many sources of human disturbance and mortality, including poaching. Because passing the mass-spawning sockeye salmon above the raw water intake at Landsburg would jeopardize the safety of the drinking water supply, alternative mitigation was developed for sockeye, as described below.

Additional Mitigation and Conservation Measures for Species Dependent on the Aquatic and Riparian Ecosystem

Measures Benefiting Bull Trout

Several measures are of particular importance to bull trout: (1) the commitment not to harvest timber for commercial purposes, (2) the designation of all forest outside developed areas in reserve status, (3) commitments to restoration of stream and riparian habitats, (4) replacement of stream crossing structures that block fish passage, and (5) removal (deconstruction) of about 38 percent of watershed roads. Through these commitments, all known or potential spawning and rearing areas will be protected, access to these areas will be improved, and some areas will be rehabilitated. The restriction of public access into the watershed will also protect the bull population from the impacts of possible poaching, which has adversely affected populations in other areas.

Integral to the bull trout conservation strategy is a comprehensive program of monitoring and research (sections 4.5.4 and 4.5.6). Elements within this program are designed to provide a better understanding of the life history, habitat needs, and population status of the Chester Morse Lake bull trout, to assess the success of habitat restoration projects, to determine the impacts of reservoir management on reproductive success, to mitigate for potential adverse impacts on the bull trout population from reservoir management, and to provide information needed for adaptive management.

Funding for the conservation and mitigation measures for the bull trout is covered under other mitigation and conservation strategies. Funding for monitoring related to the bull trout is covered in sections 4.5.4 and 4.5.6.

The monitoring and research program outlined in sections 4.5.4 and 4.5.6 will be used to determine if the conservation strategy for bull trout achieves its conservation objectives. The monitoring and research program will also be used to support the adaptive management program (Section 4.5.7), which is designed to provide a means by which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on the Aquatic and Riparian Ecosystem, including bull trout, include the long-term stream monitoring program, designed to evaluate trends in aquatic habitat and water quality, and the monitoring of individual stream and riparian restoration projects. Additional monitoring and research pertinent to bull trout include:

- Population monitoring; spawning surveys;
- Juvenile and fry surveys; telemetry studies of adult movement;
- Stream distribution surveys; and
- A redd inundation study to determine the extent of the suspected egg and fry mortality as a result of spring reservoir refill.

As part of the evaluation of the Cedar Permanent Dead Storage Project (contained in Section 4.5.6), additional studies will focus on:

- The potential project impacts of reservoir elevation changes on the fall spawning migration of bull trout;
- Development of a passage assistance plan for bull trout in the fall should passage be impeded by increased reservoir drawdown in the summer and fall;

- Studies of pygmy whitefish life history (pygmy whitefish are a major prey species for adult bull trout in the reservoir); and
- Monitoring of wetland plant communities in the Cedar and Rex river deltas.

Measures Benefiting Pygmy Whitefish

Several measures are of particular importance to pygmy whitefish: (1) the commitment not to harvest timber for commercial purposes, (2) the designation of all forest outside developed areas in reserve status, (3) commitments to restoration of stream and riparian habitats, (4) replacement of stream crossing structures that could block fish passage, and (5) removal (deconstruction) of about 38 percent of watershed roads. Through these commitments, all known or potential spawning and rearing areas will be protected, access to these areas will be improved, and some areas will be rehabilitated. The restriction of public access into the watershed will also protect the pygmy whitefish population from the impacts of possible unregulated introductions of non-native fishes, which have adversely affected populations in other areas.

Integral to the pygmy whitefish conservation strategy is a program of monitoring and research (section 4.5.4 and 4.5.6). Elements within this program are designed to provide a better understanding of the life history and habitat needs of the Chester Morse Lake pygmy whitefish population, to assess the success of habitat restoration projects, to determine the impacts of reservoir management on reproductive success, to mitigate for potential adverse impacts on the pygmy whitefish population from reservoir management, and to provide information needed for adaptive management.

Funding for the conservation and mitigation measures for the pygmy whitefish is covered under other mitigation and conservation strategies. Funding for monitoring related to the pygmy whitefish is covered in sections 4.5.4 and 4.5.6.

The monitoring and research program outlined in sections 4.5.4 and 4.5.6 will be used to determine if the conservation strategy for pygmy whitefish achieves its conservation objectives. The monitoring and research program will also be used to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on the Aquatic and Riparian Ecosystem, including pygmy whitefish, are as described above for bull trout. As part of the evaluation of the Cedar Permanent Dead Storage Project (Section 4.5.6), additional studies will focus on the life history of pygmy whitefish, including distribution and reproductive strategies; potential impacts of lowered reservoir levels on pygmy whitefish; and monitoring of wetland plant communities in the Cedar and Rex river deltas.

Measures Benefiting Chinook Salmon, Coho Salmon, and Steelhead Trout

The conservation strategies for chinook salmon, coho salmon, and steelhead trout are based primarily on the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4), but these species will also benefit by the mitigation and conservation measures for the Aquatic and Riparian Ecosystem. Of particular importance for these three species are the following:

- The construction of fish passage and protection facilities at the Landsburg Diversion Dam, which now blocks passage into the municipal watershed;
- Funding for interim mitigation before passage is effected—funding that may cover much needed studies or emergency supplementation;
- Instream flows to protect habitat for spawning adults and juveniles, and to protect redds from dewatering;
- Flow downramping standards to protect young fish from stranding;
- Funding for projects at the Ballard Locks designed to increase survival of outmigrating smolts; and
- Management to more closely mimic natural flow patterns important to the riverine ecosystem and its species.

Passage above the Landsburg Diversion Dam will provide access to about 17 miles of mainstem and tributary stream habitat that is highly protected and that could be considered refuge habitat, and will increase the miles of mainstem habitat by 55 percent.

Once these three species are passed above the Landsburg Diversion Dam, they will benefit by strategies for the Aquatic and Riparian Ecosystem as described above. Of particular importance are: (1) the commitment not to harvest timber for commercial purposes, (2) the designation of all forest outside developed areas in reserve status, (3) commitments to restoration of stream and riparian habitats, (4) replacement of stream crossing structures that block fish passage, and (5) removal (deconstruction) of about 38 percent of watershed roads. Coho will also receive additional benefit from the protection of wetlands in the Walsh Lake area, which is accessible through the Walsh Lake Diversion Ditch (Section 3.2.4), from the protection of the Rock Creek subbasin, and from the commitment to restoration measures in the Walsh Lake and Rock Creek subbasins (Section 4.4.2).

Funding for the conservation and mitigation measures for chinook, coho, and steelhead is covered under other mitigation and conservation strategies. Funding for monitoring related to these species is covered in sections 4.5.2 and 4.5.3.

The monitoring and research program outlined in sections 4.5.2 and 4.5.3 will be used to determine if the conservation strategies for these three species achieve their conservation objectives and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all these include:

- Instream flow compliance;
- Downramping compliance;
- A study of the accretion inflow assumptions used to establish instream flows, which deals with inflows to the Cedar River from infiltration and tributaries;
- A study to improve flow-switching criteria, which deals with decisions to reduce flows under poorer hydrologic conditions;
- Fish ladder counts at Landsburg; and

- Evaluation and monitoring of the protective screens to be installed on the raw water intake at Landsburg.

In addition, steelhead will benefit by the continued redd incubation monitoring study (Section 4.5.2), in which redds are located and evaluated with respect to vulnerability to reduced flows. This monitoring study will be used to support decisions regarding instream flows in order to reduce impacts to steelhead eggs and fry during summer. Chinook will benefit by the commitment of $1 million for studies related to early life history and other issues in the Cedar River and Lake Washington (Section 4.5.2). All three species will benefit by the monitoring related to the Aquatic and Riparian Ecosystem, as described above for bull trout.

Measures Benefiting Sockeye Salmon

The conservation strategy for sockeye salmon is based primarily on the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4), but sockeye will also benefit by long-term improvements in water quality and restoration of natural ecological processes that should result from the strategy for the Aquatic and Riparian Ecosystem described above. Of particular importance for sockeye are the continued operation of the interim hatchery at Landsburg (Section 4.3.2); funding for habitat protection and restoration in the Cedar River below Landsburg (Section 4.4.2); and construction of a replacement hatchery for long-term artificial production of sockeye fry (Section 4.3.2). Because sockeye redds are vulnerable to scour at high river flows, the interim and replacement hatchery will effectively provide *incubation refuges* to help protect incubating eggs and alevins from damage during peak flow events and to increase egg-to-fry survival. The return of additional adult sockeye salmon through supplementation will increase the likelihood that natural spawning areas in the river are fully seeded, and the interim and replacement hatcheries should help reverse the decline of the sockeye population in Lake Washington and provide more opportunities for sport and Tribal fishers. Sockeye will also receive additional benefit from the commitment to restoration measures in the Walsh Lake subbasin (Section 4.4.2).

In response to concerns related to potential impacts of artificial production of sockeye fry on wild sockeye and other salmonids in the Lake Washington Basin, an extensive monitoring and research program will be conducted (sections 4.5.2 and 4.5.3) within an adaptive management paradigm (Section 4.5.7; Appendix 28). Monitoring, research, and adaptive management will be based upon the four primary objectives of the sockeye production program:

(1) The replacement hatchery should be designed to produce up to 34 million fry;

(2) The production program should be designed to produce fry equivalent in quality to those produced naturally;

(3) The program should avoid or minimize detrimental impacts on the reproductive fitness and genetic diversity of naturally reproducing sockeye salmon populations in the Cedar River and Bear Creek subbasins; and

(4) The program should avoid or minimize detrimental ecological impacts on native salmonids throughout the Lake Washington Basin.

Guidelines will be developed to govern the design, construction, operation, and monitoring phases of the sockeye fry production program. These guidelines will include procedures for developing and modifying annual production targets. If the monitoring indicates that the program is not meeting program objectives, the program can be altered. If the sockeye fry production program is discontinued, the City will commit remaining funds for sockeye to alternative mitigation as agreed by the parties to the Landsburg Mitigation Agreement (Appendix 28), including the City, the Services, and the WDFW.

Funding for the conservation and mitigation measures for sockeye is covered under other mitigation and conservation strategies. Funding for monitoring related to sockeye is covered in sections 4.5.2 and 4.5.3.

The monitoring and research program outlined in sections 4.5.2 and 4.5.3 will be used to determine if the conservation strategy for sockeye salmon achieves its conservation objectives, and to support the adaptive management program (sections 4.3.3 and 4.5.7; Appendix 28), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. The monitoring related to instream flows described above for chinook, coho, and steelhead is also relevant to sockeye. Additional monitoring and research specific to sockeye includes:

- Marking and evaluation of condition of hatchery fry;
- Trapping and counting both hatchery and wild fry to provide a basis for estimating recruitment into Lake Washington and for evaluating relative survival;
- Fish health monitoring at hatchery;
- Studies of zooplankton in Lake Washington, which is the major food supply for young sockeye;
- Studies of adult sockeye designed to detect phenotypic and genetic changes; and
- Studies of adult sockeye to determined relative survival of hatchery-produced versus wild fish, and potential impacts of straying of hatchery fish into Bear Creek.

Measures Benefiting Bald Eagle

Eagles prefer structurally heterogeneous forest stands for nesting and roosting habitat (Grubb 1976, as cited in Brown 1985a). Snags and large trees are important to the eagle as perches and are an important feature of old-growth and riparian forests that will be protected within the watershed. While nest sites are usually located near water, bald eagle winter-roost site selection is thought to depend more on protective landforms and availability of coniferous forests than on proximity to water (Brown 1995a). Therefore, riparian protection and enhancement, protection of old-growth forest, and development of second-growth stands into mature and late-successional uneven-aged stands are all important conservation strategies for the bald eagle. Furthermore, eagles feed on fish that depend on high-quality stream and riparian habitat.

Of particular importance for the bald eagle are the designation of all forest to reserve status and silvicultural activities to accelerate the development of late-successional forest characteristics, both of which will result in maintenance and recruitment of a substantial amount of mature and late-successional forest in the future. Both the designation of forest to reserve status and the silvicultural activities will provide for the maintenance and recruitment of suitable nesting and perching trees. In its objective of improving fish habitat and restoring mature riparian forests, the strategy for the Aquatic and Riparian Ecosystem should also improve foraging conditions for bald eagles over time. Foraging opportunities should also be increased after fish passage is effected at the Landsburg Diversion Dam (Section 4.3). Finally, because disturbance during foraging can adversely affect bald eagles, the restriction of public access into the watershed will also provide distinct benefits for foraging and nesting eagles, should eagles eventually nest within the municipal watershed.

In order to protect eagles that may nest within the municipal watershed or groups of eagles that may use the watershed for foraging, the City will not cut trees or construct roads within 0.5 mile of a known active bald eagle nest site between the dates of January 1 and August 15 or within 0.25 mile of a known active bald eagle nest site at other times of the year, or within 0.25 mile of an active communal roosting site.

Funding for the conservation and mitigation measures for the bald eagle is covered under other mitigation and conservation strategies. The monitoring and research program outlined in sections 4.5.2, 4.5.3, and 4.5.4, and the program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the bald eagle achieves its conservation objectives. The monitoring and research program will also be used to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. The monitoring and research program described above for anadromous fish (sections 4.5.2 and 4.5.3) will have direct relevance for bald eagles, which feed on these species. Forest habitat monitoring described above for the northern spotted will also be relevant as a means to track changes in habitat that could be used for perching and roosting and, potentially, for nesting. In addition, the aquatic monitoring program described in Section 4.5.4 will provide information on trends in the overall quality of stream habitats in the municipal watershed.

Measures Benefiting Common Loon

The incremental effects of changed reservoir management to support the instream flow regime in the HCP (Section 4.4) are reviewed in Section 4.5.6. As indicated in that review, these effects are expected to be very minor with regard to loons and several of the fish species on which they may feed. However, there are still concerns and uncertainties with regard to the effects of current operations on nesting loons. For example, recent changes in vegetation around the reservoir complex may have reduced nesting cover for loons, and thus may affect their choices of nest sites and their nesting success (Section 3.5.5).

Because common loons typically nest at or near the waterline or on emergent surfaces such as logs, relatively small water level changes can make their eggs and nests vulnerable to inundation, stranding, or disturbance from overhanging vegetation. Adverse effects of changed operations thus may occur as a result of manipulation of reservoir levels during the nesting stage, or from adverse effects on the reservoir fish population. As discussed in Section 3.5.5, loons are also sensitive to human disturbance during nest-site selection and nesting and when rearing chicks.

Through the Community-based Conservation Strategies described above, the riparian vegetation (above the normal high waterline) surrounding the reservoir complex – on which common loons nest within the municipal watershed – will be protected and restored over the long term, as will wetlands and riparian areas associated with other water bodies in the watershed. Recovery and maturation of the forest above the normal high water line around the reservoir complex and along tributaries to the reservoir are expected to provide additional nesting surfaces in the form of large logs in the reservoir as this material is routed through some stream channels. As mentioned above, however, the changes in coniferous and deciduous vegetation in the zone of inundation around the reservoir have occurred recently and may continue for some time, which may delay recovery of parts of the riparian vegetation around the reservoir.

The City's policies of controlling access to the municipal watershed will continue to provide a substantial level of protection for nesting loons against human disturbance. Although some use of boats on the reservoir complex will be needed for fisheries research, for water quality sampling, and for watershed protection, the City's policy of carefully controlling the use of boats on the reservoir complex, especially during the loon's nesting and rearing season (April through August), will minimize disturbance and provide added protection for loons during the sensitive reproductive period.

In addition, the City intends to continue the experimental nest platform project for loons described above, although the City may discontinue or change this program as appropriate, depending on the results of monitoring. One or more nest platforms are typically deployed annually within each of the territories of the three current nesting pairs on the reservoir complex, but deployment may not be needed or appropriate in some years or for particular territories within a given year. For example, if reservoir elevations are very low, platforms would have to be deployed in open water, away from cover, which could result in detrimental effects on reproductive success if the platforms were used by loons. Under such suboptimal conditions, vulnerability of nests to predation and exposure would be increased. The City will consult with the Services prior to terminating the platform project.

Funding for the conservation and mitigation measures for the common loon is covered under other mitigation and conservation strategies. Funding for monitoring related to the common loon is covered in section 4.5.4 and 4.5.5.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the common loon achieves its conservation objectives, and to provide information necessary for adaptive management, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Elements of the monitoring and research program important for all species dependent on the Aquatic and Riparian Ecosystem, including the common loon, are as described above for bull trout. Additional monitoring and research pertinent to common loons includes: (1) annual surveys in Chester Morse Lake and Masonry Pool to document the reproductive status of common loons using the reservoir system, including the use of nesting platforms; and (2) studies of new reservoir operating regimes to evaluate potential impacts to common loon nesting habitat and food resources resulting from fluctuating lake levels.

Strategies for Species Dependent Primarily on Special Habitats

Strategies are provided for three species dependent primarily on Special Habitats: the gray wolf, grizzly bear, and peregrine falcon. All three of these species also depend, to some extent, on Late-successional and Old-growth Forest Communities and the Aquatic and Riparian Ecosystem within the municipal watershed.

Summary of Status for Species Dependent Primarily on Special Habitats

Status of Gray Wolf

In 1967, a subspecies of gray wolf, the timber wolf (*Canis lupus lycaon*), was listed as endangered (Fed. Reg. Vol. 32, Pg. 4001). In 1973, the northern Rocky Mountain subspecies (*C. l. irremotus*), as then understood, was also listed as endangered, as was the Texas subspecies (*C. l. monstrabilis*) (Fed. Reg. Vol. 38, Pg. 14678). In 1978, the legal status of the gray wolf in North America was clarified by listing the Minnesota wolf population as threatened and other members of the species south of Canada were listed as endangered, without referring to subspecies (Fed. Reg. 43, Pg. 9607). The gray wolf is listed as endangered by Washington State (WAC 232-12-014). The gray wolf is now under consideration for delisting under ESA.

There have been two confirmed sightings of wolf family groups in Washington in the past 10 years, in Ross Lake National Recreation Area of the North Cascades National Park Complex and in Okanogan County. Three other reported sightings appear to be reliable but are unconfirmed (Almack, J., WDFW, November 18, 1997, personal communication).

Gray wolves use a variety of habitat types including open areas, forests, and brush lands, and in British Columbia they have been observed in high areas above timberline and in forests along the coast (Cowan and Guiguet 1965). Wolves in British Columbia feed mainly on large ungulates such as deer, but also prey on smaller mammals and birds. Like all species in the family Canidae, wolves use dens for reproduction.

No gray wolf sightings in the municipal watershed have been verified, and gray wolves are not known to inhabit the municipal watershed currently. The watershed is within the potential range of the gray wolf, however, and contains elements of suitable habitat, including a substantial ungulate prey base and an environment relatively secure from most human intrusion and disturbance.

Status of Grizzly Bear

The grizzly bear (*Ursus arctos*) is listed as a federal threatened species in the lower 48 States (Fed. Reg. Vol. 40, No.145, Part IV, Pp. 3173-3174), and it is listed by Washington State as endangered (WAC 232-12-014).

The grizzly bear is a wide-ranging species that typically uses many vegetation types to fulfill its life requisites. Areas with low human activity are considered to be more suitable for this species (IGBC 1994). Grizzly bears occurred historically throughout most of central and western North America (FWS 1982). In 1997, approximately 5-10 grizzly bears were believed to reside in the North Cascades (Almack, J., WDFW, November 18, 1997, personal communication), with most of the sightings occurring north of the Skykomish Ranger District of the Mt. Baker-Snoqualmie National Forest.

The Cedar River Watershed is within the potential range of the grizzly bear and contains elements of suitable habitat, including an environment that is relatively secure from human disturbance. However, no grizzly bears have been observed or are known to exist in the watershed.

Status of Peregrine Falcon

Because of population declines of American peregrine falcons (*Falco peregrinus anatum*), the USFWS, in 1970, listed this subspecies as endangered under the Endangered Species Conservation Act of 1969 (P.L. 91-135, 83 Stat. 275). American peregrine falcons were included in the list of threatened and endangered foreign species on June 2, 1970 (Fed. Reg. Vol. 35, Pg. 8495), and were included in the United States list of endangered and threatened species on October 13, 1970 (Fed. Reg. Vol. 35, Pg. 16047). The subspecies was subsequently listed under the ESA of 1973, as amended (16 U.S.C. 1531 et seq.). The peregrine falcon was also listed as an endangered species by Washington State (WAC 232-12-014). Because of significant recovery in large parts of its range, the peregrine falcon was formally delisted under ESA on August 25, 1999 (Fed. Reg., Vol. 64, No. 164, page 46541).

Peregrine falcons occur year-round in Washington as either nesting or migratory individuals. Of the three subspecies that occur in the state (Allen 1991), *F. p. anatum* is the only one known to nest in Washington (Peregrine Falcon Recovery Team 1982; Johnsgard 1990). The other two subspecies are migrants and winter visitors that would be unlikely to utilize the Cedar River Watershed, as they depend on large concentrations of waterfowl and shorebirds in that season.

No comprehensive studies of peregrine falcon numbers or distribution have been conducted within the Cedar River Watershed. No peregrine falcons have been observed or are known to inhabit the Cedar River Watershed. However, the municipal watershed is within its potential range, and it contains some suitable nesting habitat, including rock outcrops and cliffs. Nesting of a pair of peregrines was documented in 1998 on nearby Mt. Si, to the north of the municipal watershed.

Conservation Objectives for Species Dependent Primarily on Special Habitats

Objectives for Gray Wolf

The objectives of the gray wolf conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of gray wolves, to provide a net benefit for the wolf, and to contribute to its recovery. These objectives will be pursued within the municipal watershed by protecting potential gray wolf breeding, denning, and foraging habitat.

Objectives for Grizzly Bear

The objectives of the grizzly bear conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of grizzly bears, to provide a net benefit for the grizzly bear, and to contribute to its recovery. These objectives will be pursued within the municipal watershed by protecting potential grizzly bear denning and foraging habitat.

Objectives for Peregrine Falcon

The objectives of the peregrine falcon conservation strategy are to avoid, minimize, or mitigate for impacts of any incidental take of peregrine falcons, to provide a net benefit for the peregrine falcon, and to contribute to its recovery. These objectives will be pursued for the peregrine falcon within the municipal watershed by protecting their nesting, foraging, and roosting habitat within the watershed.

Common Elements of Species Conservation Strategies for Species Dependent Primarily on Special Habitats

All of the Community-based Conservation Strategies have potential benefits for the gray wolf, grizzly bear, and peregrine falcon, should any of these species occur in the municipal watershed. These three species all use Special Habitats (Table 4.2-3), and all three forage widely in various open habitat types that are protected by the reserve status of watershed forests. Efforts to protect and restore wetland areas, natural meadows, and persistent shrub communities should contribute foraging habitat. Protection of old-growth forest and recruitment of additional mature and late-successional forest may also provide benefits for gray wolves and grizzly bears, to the extent these species may use such areas for foraging and denning. Although no forest openings will be created by commercial timber harvest under the HCP, natural disturbances such as fires and windstorms can be expected to create forest openings used by ungulates and other wildlife species that are prey for the three species.

In addition, the current closure of the municipal watershed to unsupervised public access, including watershed roads, should be of particular importance for gray wolves and grizzly bears, which are both sensitive to human disturbance (e.g., see USDI 1993). While some forest roads are reported in the scientific literature to create adverse conditions for wolves and grizzlies, the major problem is illegal hunting and other human disturbance, both of which should be greatly curtailed by the locked gates on the watershed and surveillance by watershed inspectors (Section 2.3.10). The planned removal (deconstruction) of about 38 percent of forest roads and the commitment not to harvest timber for commercial purposes will also reduce the potential for disturbance related to roads.

Additional Mitigation and Conservation Measures for Species Dependent Primarily on Special Habitats

<u>*Measures Benefiting the Gray Wolf*</u>

Protection of rock outcrops, meadows, and persistent shrub communities (Special Habitats) through designation of all forests outside developed areas, including forest adjacent to Special Habitats, for reserve status, and protection and restoration of riparian areas will protect and provide foraging habitat for the wolf. Potential den sites may also be available, particularly in the protected rocky areas and areas of old-growth forest, which include large hollow trees and logs. All of these habitat types are protected through the HCP. An increase in the area of mature and late-successional forest cover within the municipal watershed may also benefit the wolf to the extent that late seral forests provide adequate foraging opportunities or denning sites.

The commitment not to harvest timber for commercial purposes, meaning there will also be no log haul for a commercial program, will greatly limit the amount of potential disturbance to the wolf and its habitat. Minimal human contact is believed to be the second most important factor for the recovery of wolves (USFWS 1984, as cited in WDNR 1997). Potential disturbance to wolves during reproduction should be low as a result of restrictions on public entry into the watershed. Restriction of access on watershed roads will reduce potential mortality or injury from motor vehicle collisions and reduce the ability of poachers and trespassers to harass or harm wolves.

To protect wolves during denning, the City will avoid silvicultural activities, road construction, blasting, and helicopter operations within 1 mile of active gray wolf dens from March 1 to July 31 and within 0.25 mile during the rest of the year. Disturbance will also be limited near any rendezvous sites that are located within the municipal watershed. If wolves are documented in the municipal watershed, the City will consult with the Services concerning the most effective and feasible measures to minimize and mitigate impacts of watershed operations, and the City will develop a plan for such measures.

Funding for the gray wolf conservation strategy is incorporated into the funding established for other mitigation and conservation strategies.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the gray wolf achieves its conservation objectives and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Should wolves den within the watershed, wolf dens may be monitored, consistent with minimizing disturbance, in order to better understand the behavior of the animals so that strategies for future protection can be developed.

Measures Benefiting the Grizzly Bear

Protection of the grizzly bear will be accomplished by preserving and protecting non-forested habitats the bear uses such as wet meadows, ponds, and marshes. Denning habitat for the grizzly bear will be protected through the enhancement and protection of riparian areas and the logs and down wood associated with old-growth forests. The protection and absence of commercial harvest within the Northern Spotted Owl CHU, which provides habitat and connectivity to adjacent forest lands, will provide further benefits for the grizzly bear, should this species ever occur within the municipal watershed.

Potential disturbance to grizzly bears during reproduction should be low as a result of restrictions on public entry into the watershed. Restriction of access on watershed roads will reduce potential mortality or injury from motor vehicle collisions and reduce the ability of poachers and trespassers to harass or otherwise harm bears.

To protect grizzly bears during denning, the City will avoid harvest and road construction within 1 mile of active grizzly bear dens from October 1 to May 30 and within 0.25 mile during the rest of the year. If grizzly bears are documented in the municipal watershed, the City will consult with the Services concerning the most effective and feasible measures to minimize and mitigate impacts of watershed operations, and the City will develop a plan for such measures.

Funding for the grizzly bear conservation strategy is incorporated into the funding established for other mitigation and conservation strategies.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the grizzly bear achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Should grizzly bears den within the watershed, bear dens may be monitored, consistent with minimizing disturbance, in order to better understand the behavior of the animals so that strategies for future protection can be developed.

Measures Benefiting the Peregrine Falcon

Peregrine falcons will be protected primarily through the protection of open habitats by giving reserve status to all watershed forests outside developed areas, including forest adjacent to Special Habitats. All identified cliff habitat will be protected in this manner, thus protecting possible nesting habitat. Additionally, the forested reserve will protect wetlands, meadows, and riparian areas that could provide foraging opportunities for peregrine falcons in the municipal watershed.

To protect peregrine falcons during the nesting season, the City will avoid or minimize silvicultural activities or construct roads within 0.5 mile of a known active nest site between the dates of March 1 and July 31, or within 0.25 mile of a nest site at other times of the year.

Funding for the peregrine falcon conservation strategy is incorporated into the funding established for other mitigation and conservation strategies.

The monitoring and research program outlined in Section 4.5.5 will be used to determine if the conservation strategy for the peregrine falcon achieves its conservation objectives, and to support the adaptive management program (Section 4.5.7), which is designed to provide a means with which mitigation strategies can be altered to better meet conservation objectives. Should peregrines nest within the watershed, nests may be monitored, consistent with minimizing disturbance, in order to better understand the behavior of the animals so that strategies for future protection can be developed.

Biological Goals and Objectives for Other Species of Concern

Overall Objectives

Only seven species addressed in the HCP are currently listed under the federal ESA. All seven species were included in the group of 14 species of greatest concern, for which individual species conservation strategies are presented above. The 69 species addressed in the HCP that are not included in the group of 14 species of greatest concern are termed the *other species of concern* (Section 3.6).

Many of the general planning objectives for the HCP that are described in Section 2.4 apply to the other species of concern. The mitigation and conservation strategies for the 69 other species of concern are designed to avoid, minimize, or mitigate for the impacts of the equivalent of any taking during the term of the HCP. These strategies are also designed to provide a net benefit for the 69 species and contribute to their recovery, should any become listed under the ESA.

The mitigation and conservation strategies for the other species of concern are habitat-based and are primarily covered by the Community-based Conservation Strategies presented above, which are targeted at species dependent on Late-successional and Old-growth Forest Communities, the Aquatic and Riparian Ecosystem, and Special Habitats. The objectives of the Community-based Conservation Strategies relate to the *overall functioning* of the combination of all conservation and mitigation measures on a landscape level, as they can potentially affect the species addressed in this HCP.

Because of the commitment in the HCP not to harvest timber for commercial purposes, those species that depend primarily on the earliest seral forest habitats, such as the grass-forb-shrub stage of succession, will receive relatively less benefit from the HCP (see effects analyses in Section 4.6 for more complete discussion). These community-based strategies and related habitat-based objectives are described above. The biological goals and measurable objectives applicable to the 69 other species of concern are briefly described below.

Several of the other species of concern, all aquatic, now occur, or would be likely to occur if present in the Cedar River, primarily downstream of the Landsburg Diversion Dam. These species include the Pacific lamprey, river lamprey, and sea-run cutthroat trout. All of these species will be able to pass over the Landsburg Diversion Dam after the fish passage facilities are constructed (Section 4.3.2; Section 4.6.4) and will benefit by elements of the Community-based Conservation Strategies targeted at protection and restoration of aquatic and riparian habitats in the municipal watershed. They will also benefit by the downstream habitat protection and restoration that is part of the mitigation for instream flows and other elements of the Instream Flow Management strategy (Section 4.4.2) that will provide habitat, reduce the risk of stranding, and improve survival through the Ballard Locks. In short, these species will benefit by many of the conservation and mitigation measures included in the Species Conservation Strategies described above for the anadromous fish species that are included in the species of greatest concern, as well as in the Community-based Conservation Strategies.

Objectives for Habitat and Community Types

The primary objectives of the community-based conservation strategies are, over the term of the HCP, to protect or improve the quality and/or quantity of key habitats within the municipal watershed for all of the species addressed in the HCP (Table 4.2-3), and to preserve the biological communities that include those species. The specific biological objectives for the Community-based Conservation Strategies that are applicable to the 69 other species of concern are to:

- Contribute to sustaining populations of species dependent on *late-successional and old-growth forests* by:

  (1) Protecting all existing old growth in the municipal watershed;

  (2) Recruiting a significant amount of additional mature and late-successional forest over time from previously harvested second growth;

  (3) Improving forest structure and habitat quality through silviculture in areas of second-growth forest to accelerate development of characteristics similar to those of late-successional forests;

  (4) Restoring natural forest processes that create and maintain habitat for species dependent on late-successional and old-growth forests; and

  (5) Developing an overall spatial pattern of mature, late-successional, and old-growth forest in the municipal watershed that is capable of supporting the species addressed in the HCP and that provides landscape connectivity both within the watershed and with key areas outside the watershed in a manner that is an improvement over current conditions.

- Contribute to sustaining populations of species dependent on *aquatic and riparian habitats* by:

  (1) Protecting all aquatic habitats in the watershed;

(2) Improving aquatic and riparian habitats and water quality through restoration projects;

(3) Sustaining natural processes and functions that create and maintain habitats, and restoring to a more natural range of variation those processes that have been disturbed by past human activities; and

(4) Providing landscape connectivity within stream systems and among significant wetlands and associated riparian areas.

- Contribute to sustaining populations of species dependent on *Special Habitats* in the municipal watershed by:

  (1) Protecting Special Habitats from degradation;

  (2) Protecting other habitats needed by species dependent on Special Habitats for such uses as foraging and dispersal; and

  (3) Providing landscape connectivity through increases in proportion of older seral forest in intervening areas.

- Maintain natural biological diversity of species and communities within the municipal watershed, recognizing the important functional linkages among the major ecosystems, biological communities, and habitats present.

Some additional general, but relevant, conservation objectives pertinent to the other species of concern were also described in Section 4.2.1. These objectives are less measurable, but nonetheless important. They include:

- Develop an integrated, landscape approach that addresses the spatial relationship of habitats within the watershed and with regard to nearby areas to improve the ability of the watershed, over time, to support the species addressed by the HCP;
- Develop strategies to restore and sustain the natural processes that create and maintain key habitats for species addressed by the HCP and that foster natural biological diversity of native species and their communities;
- Pursue land management approaches that, as practicable, help avoid catastrophic events such as forest fires that would jeopardize drinking water or habitats for species addressed by the HCP; and
- Develop a forest management program that would sustain the forest ecosystem as a whole in the municipal watershed to better support the species addressed by the HCP over time.

Monitoring and Research Program Related to Other Species of Concern

The Monitoring and Research program for the HCP includes many elements that pertain to measuring progress with respect to achieving the above objectives for other species of concern. Performance of the HCP related to the objectives for species dependent on late-successional and old-growth forests in the municipal watershed will be monitored by:

- An inventory of terrestrial habitats, which includes an assessment of the forest inventory data, augmentation of inventory data by additional sampling, ecological classification of old-growth forest to better characterize habitat quality, field verification of the database, and a long-term habitat inventory program that will allow changes in forest habitat attributes to be tracked.

- Monitoring of forest restoration projects, including projects to redevelop forest structure and diversity in second growth, to allow tracking the success of individual projects in achieving their objectives.
- Surveys for spotted owls and marbled murrelets.
- Funding for optional surveys and studies targeted at individual species or sensitive habitats. These surveys can be prioritized as most appropriate to provide new information or track changes in populations or key habitats.
- Monitoring to evaluate the effectiveness of habitat restoration projects in aquatic, riparian, and upland habitats.
- Use of the Geographical Information System for tracking and mapping habitat changes over time.
- Development of a predictive model of forest growth, succession, and habitat development, and a basic model of species and habitat relationships, in both cases to facilitate adaptive management of restoration and forest management activities.

Performance of the HCP related to the objectives for species dependent on the Aquatic and Riparian Ecosystem will be monitored by:

- Instream flow and downramping compliance monitoring for those species dependent on regulated streamflows, with additional monitoring targeted at chinook and steelhead.
- Long-term stream and riparian monitoring and research in the municipal watershed, which includes monitoring based upon an index of biological integrity, or an alternative approach, for streams and water quality indicators that will allow tracking of changes in the quality of stream environments.
- Monitoring of stream and riparian restoration projects in the municipal watershed, which will allow tracking the success of individual projects in achieving their objectives.
- Evaluation of the permanent use of dead storage in Chester Morse Lake (Permanent Cedar Dead Storage Project), including an evaluation of impacts on vegetation on the deltas of the Rex and Cedar rivers. This evaluation will provide useful information for future decisions related to this project and in subsequent monitoring if the project is implemented, which would require a plan amendment.

Performance of the HCP related to the objectives for species dependent on Special Habitats in the municipal watershed will be monitored by:

- Tracking of habitat changes described above that will provide information on Special Habitats, including upland grass-forb meadows, upland persistent shrub communities, and vegetated talus and felsenmeer slopes.

- Elements of the above monitoring programs that provide information on habitats *adjacent to* Special Habitats, such as forests, and on other habitats that are used by any of the species dependent on Special Habitats, such as aquatic habitats and forests.

- Compliance monitoring of HCP activities related to Special Habitats.

Importance of Adaptive Management for Other Species of Concern

Information that will be collected in the above monitoring programs, as well as information on species addressed in the HCP that will be collected by federal and state agencies, will be used in the adaptive management program of the HCP (Section 4.5.7). The adaptive management program provides flexibility to alter mitigation *adaptively* in response to new information or understanding, including any change in status of the species addressed in the HCP, in order to most effectively meet the conservation objectives of the HCP. This flexibility includes the ability to shift and reprioritize funds for mitigation and conservation measures (Section 5.3.2).

The adaptive management program also provides for response to *changed circumstances* related to environmental events that can be reasonably anticipated and that could either impact species and habitats addressed by the HCP or undermine the effectiveness of particular conservation and mitigation measures. Such events include forest fires, windstorms, floods, and droughts.

Rational for Watershed Management Mitigation and Conservation Strategies

Introduction

The Watershed Management Conservation and Mitigation Strategies described in the preceding parts of this section are intended to minimize and mitigate for the impacts of any take of species addressed in the HCP as a result of City activities covered by this HCP (Section 1.3; Appendix 1). The strategies do so by guiding and constraining watershed management activities to protect and rehabilitate key habitat in the municipal watershed for fish and wildlife species addressed in the HCP, and by providing additional measures for the conservation of the species of greatest concern. The plan is based on the assumption that *ecosystem management*, in a broad and practical sense, must be integrated with any human uses of natural resources that are occurring (Grumbine 1994). In the case of the Watershed Management Mitigation and Conservation Strategies, the resource uses are the withdrawal of water for human use and the generation of electricity through operation of a hydroelectric plant. The City intends that such resource use be *sustainable* over the long term.

Within this overall context, the rationale for the Watershed Management Mitigation and Conservation Strategies has four components:

(1) A conservative approach to landscape management;

(2) Incorporation of both community-based and species-specific conservation strategies;

(3) Measures to sustain and restore those natural processes that create and maintain habitats; and

(4) Biological targets that should foster biodiversity and produce a net benefit for species addressed in the HCP.

Conservative Approach to Landscape Management

As discussed in Section 3.3.4, scientists at the two watershed conservation biology workshops did not agree on one single approach to watershed forest management. Some favored applying a long-rotation timber harvest approach to the entire watershed, arguing that late-seral forest could be developed that would have most of the functional value of late-successional and old-growth forests. Others scientists felt that this approach is as yet too experimental and needed to be combined with a commitment to ecological reserves, particularly to protect aquatic and riparian habitats. There was also a difference of opinion as to whether tree retention at harvest or silvicultural intervention during stand development would be the best way to produce late-seral forest that could have the structural and biological attributes of late-successional and old-growth forests of high-quality (Carey and Curtis 1996). As described above, the Seattle City Council made a policy decision to take the most conservative, low-risk approach and eliminate timber harvest for commercial purposes within the municipal watershed.

This conservative landscape approach is projected to result in an increase by nearly a factor of five in the acreage of mature, late-successional, and old-growth forest in the municipal watershed over the 50-year term of the HCP. Water quality and aquatic habitats are also projected to improve over time.

Incorporation of both Community-based and Species-specific Strategies

Introduction

The Watershed Management Mitigation and Conservation Strategies combine a "coarse-filtered" approach that focuses on whole biological communities (Community-based Conservation Strategies) with a "fine-filtered" approach that provides additional measures for a few target species (Species Conservation Strategies for the 14 species of greatest concern) (Marcot et al. 1994).

Community-based Conservation Strategies

The plan is also based on the premise that protection of species, and the ecosystems on which they depend, can best be accomplished by focusing on entire biological communities through a combination of: (1) *preserving relatively undisturbed habitats,* (2) *protecting other key habitats*, (3) actively *intervening to rehabilitate and restore degraded habitats* that are important to overall landscape function, and (4) *providing landscape connectivity* (Franklin and Forman 1987; Frissell 1993; Franklin 1992).

Scientists are in broad agreement that *protection of relatively undisturbed "refuge" habitat* is key to any long-term strategies to protect species (Franklin 1990; Sedell et al. 1990; FEMAT 1993; Moyle and Yoshiyama 1994; Frissell and Bayles 1996). Key undisturbed, or relatively undisturbed, habitats in the watershed include existing old-growth forest, many wetlands and streams, and other Special Habitats (e.g. natural meadows and rock formations) needed by some species. All these habitats are protected by placing all watershed forests outside developed areas in reserve status. Inclusion of all second-growth forest in a watershed reserve will provide much better landscape distribution of later seral forest across the watershed in the future than exists now.

Additional protection of key habitats is provided by the management guidelines for the watershed.

The HCP includes *active intervention to restore or rehabilitate streams and riparian forests* and *upland forests*, as well as commitments to improve and remove roads to reduce sediment loading to streams. These measures will collectively improve the quality of habitats over time and restore natural functionality of upland forests, riparian forests, and aquatic habitats.

Connectivity will be greatly improved for aquatic habitats by upgrading, replacement, or improvement of culverts that block fish passage (described above) and construction of the fish ladders and other passage facilities at Landsburg (Section 4.3). *Connectivity of riparian habitat will be improved* by the inclusion in reserve status of all riparian habitats and all other forest, interconnecting all these habitats both along the stream system and across the landscape. *Habitat connectivity will be greatly improved in upland habitats* for species dependent on mature, late-successional, and old-growth forest by the designation of all forest, including all old growth, as reserve, thereby recruiting over time a relatively large amount of mature and late-successional forest. Mature, late-successional, and old-growth forests, overall, will increase in acreage by a factor of nearly five over the term of the HCP, and the older forest will be much better distributed over the watershed than it is today. As second growth in the CHU matures, there will be better linkage with the federal late-successional reserves system in the Cascades.

Species-specific Conservation Strategies

Because the biology of the species addressed in the HCP differs among those species, and because the regional status of the species varies, the strategies for the 14 individual species also vary. Strategies for a number of species – the marbled murrelet, northern goshawk, northern spotted owl, bald eagle, common loon, gray wolf, grizzly bear, and peregrine falcon – include seasonal protection during sensitive periods, primarily breeding. For several species – the marbled murrelet, common loon, and bull trout – the strategies also include additional measures to protect habitat or provide other benefits beyond what is included in the Community-based Conservation Strategies. A significant monitoring and research effort is directed at bull trout, pygmy whitefish, and marbled murrelets, and monitoring directed at other species is included as well (see Section 4.5).

The Species Conservation Strategies for the four anadromous fish that are species of greatest concern are addressed in sections 4.3 and 4.4. Three of the four species will be allowed within the municipal watershed, for the first time in a century, when the fish ladders are constructed at Landsburg (Section 4.3). Emergency population supplementation may be used for any of these species, if needed, and a hatchery will be constructed to enhance the sockeye population (Section 4.3). A substantial commitment is made to monitoring and research for all four species. This monitoring and research will provide the basis for effective adaptive management and new, key information for fisheries managers that will contribute to better management of these stocks to sustain healthy, harvestable runs.

Sustaining and Restoring Natural Processes that Create and Maintain Habitats

The City believes it is appropriate to consider both *natural processes that create and maintain habitats* and *desired future conditions* in designing a landscape management plan (Franklin 1992; Oliver 1992; Grumbine 1994). There is emerging scientific agreement that habitats and communities, and the species that depend on them, can only be sustained over the long term if the natural processes that create and maintain those habitats and habitat elements are sustained or, if applied to disturbed systems, brought back within a relatively normal range of variation (Franklin 1992; Frissell and Bayles 1996).

The City's approach incorporates two elements:

(1) Short-term measures to *replace, by human intervention, key elements* of a natural system, such as adding large woody debris to stream and creating snags in forests, where such elements are lacking because natural ecological processes have been disturbed; and

(2) Long-term measures to *restore an ecological system's ability to provide key elements itself*, without human subsidy, through natural processes.

The desired future conditions are, in general, conditions characteristic of relatively undisturbed aquatic habitats and naturally maintained late-successional and old-growth forests. For streams used by salmonids, amphibians, and invertebrates, these conditions include riparian forests with large conifers to provide bank stability, shade, a source of nutrients for the stream community, and large woody debris so important to stream habitat quality, complexity, and function (discussed above). When riparian forests are completely removed during logging, this functionality is lost. While healthy streams need the sediment delivered by natural landslides and erosion, the intensified delivery rates from such anthropogenic sources as poorly constructed forest roads overload streams with sediment and degrade habitats. In older forests, complex forest structure, and associated biological diversity, is produced by such natural processes as disease, wind damage, and competition. These processes create the snags and logs, and the multiple canopy layers so important to many species, yet lacking in many intensively managed tree plantations.

In the *short term*, human intervention will be used to replace missing elements in aquatic and forest ecosystems (for example, placing logs in streams to recreate habitat complexity, revegetating banks to increase bank stability, topping or damaging trees to produce snags, and cutting trees to produce logs). In the short term, it is also important to *minimize impacts of further anthropogenic perturbations*. Avoidance, minimization, or mitigation of impacts is accomplished in this HCP by the commitment not to harvest timber for commercial purposes, by a variety of standards and guidelines for protecting habitats and species during watershed operations, and by improvements and substantial decommissioning (removal) of forest roads to reduce sediment loading to streams. The functional elements and protection provided by intervention in the short term will serve to *bridge the period of transition* to the time when the ecological systems have recovered and are self-sustaining.

In the *long term*, the goal is to have LWD recruited into a steam in normal amounts from a healthy, naturally functioning riparian forest, and snags and logs recruited into older forest by natural processes of tree mortality. To that end, silviculture will be used to accelerate development of the kind of forest structure and composition in watershed forests that generates those critical processes in riparian and upland areas, with patterns of growth, competition, and mortality typical of high quality, naturally regenerated stands.

The commitment not to harvest timber for commercial purposes, normal forest growth and maturation, and the commitments regarding silvicultural intervention will combine with natural processes such as windthrow, disease, and fire to develop, over time, the structure and diversity of naturally regenerated, older forests. These processes will result in development of large live trees, a multi-layered forest, and a diversity of plants, and the recruitment of such biological legacies as large snags and logs. The resulting landscape in the watershed will be characterized by a proportion of mature, late-successional, and old-growth forest more characteristic of the region prior to European settlement (Henderson 1990, 1993; Bolsinger and Waddell 1993).

In short, the Watershed Management Mitigation and Conservation Strategies were designed to restore the natural processes of forest development, riparian function, sediment loading to streams, and peak stream flows to within a more normal envelope of variability. The intent of the landscape interventions is to accelerate, to the extent possible, the development of mature habitat conditions and functionality, and redevelopment of the natural processes that create and maintain key habitat elements.

Biological Targets that Foster Biodiversity and Produce a Net Benefit

The HCP incorporates a number of general, and some specific, biological targets (desired conditions and outcomes) that will contribute to maintaining natural biological diversity and supporting the species addressed in the HCP. These include:

- Conditions characteristic of relatively undisturbed aquatic habitats, and naturally maintained late-successional and old-growth forests;
- Measures to provide for habitat patterns and connectivity across the watershed landscape that will support the full natural diversity of communities and species;
- Rates of disturbance (e.g., sediment production, forest removal, peak storm flows) that are within or close to within natural bounds of variation;
- A proportion of late seral forest more typical of landscapes prior to logging;
- Maintenance of the full range of habitats needed to support the species addressed in the HCP; and
- Measures that produce a net benefit for the species addressed in the HCP and that will contribute to their recovery, thus improving habitat conditions overall.

4.2.3 Monitoring and Research

The City will commit to a program of monitoring and research to accomplish the following:

- Determine whether HCP programs and elements are implemented as written (compliance monitoring);
- Track the results of efforts to protect and restore habitats for species of concern (effectiveness monitoring);
- Obtain more information on species of concern, to test critical assumptions in the plan and reduce uncertainty; and

- Gain understanding needed to refine management decisions to better meet plan objectives.

The program is described in detail in Section 4.5, Monitoring and Research.

Monitoring and research elements include short and long-term programs, cooperative research, habitat and species inventories, data management, and modeling. Each element will be developed after gathering information from agency biologists and other experts. Periodic reports detailing all activities and data will be submitted to the appropriate oversight subcommittee as detailed in Section 4.5, Monitoring and Research. Elements of the monitoring and research program directly related to the Watershed Management Mitigation and Conservation Strategies include:

- Experimental 2-year watershed stream monitoring and research program;
- Long-term watershed stream monitoring and research program;
- Aquatic habitat restoration monitoring;
- Species monitoring and research for several fish species;
- Terrestrial habitat inventories;
- Habitat restoration research and monitoring;
- Terrestrial species monitoring and research for several avian species;
- Optional species survey(s) in experimental and sensitive habitats;
- Data formats and geographic information system (GIS) compatibility;
- Forest growth/habitat development modeling program;
- Habitat/species relationship basic modeling program; and
- Studies related to the Cedar Permanent Dead Storage Project.

4.2.4 Summary of Effects of Watershed Management Mitigation and Conservation Strategies

Introduction

The objectives and the potential effects of the various watershed management mitigation and conservation measures were discussed in detail in preceding sections in conjunction with the discussion of the measures themselves. Monitoring to determine the effectiveness of the measures in meeting the stated conservation objectives is described briefly in Section 4.2.2 above and in detail in Section 4.5 below, along with additional studies and research to provide important information. This section (4.2.4) gives an overall summary of the effects of the Watershed Management Mitigation and Conservation Strategies, taken as a whole, on the species addressed in the HCP. The funding commitments for the measures included in Section 4.2 are summarized in Table 4.2-10, at the end of this section. Details of funding and costs are given above. Note that this section provides primarily a landscape-level discussion of the ecological effects of the Watershed Management Mitigation and Conservation Strategies; Section 4.6 provides an in-depth evaluation of the effects of the HCP on all species addressed in the HCP from the standpoint of potential take.

The watershed mitigation and conservation measures collectively entail:

- Changes in operations and activities within the municipal watershed that will alter the nature and intensity of ongoing impacts in the future;
- Impacts of past activities;
- Increase protection of habitats that should result in recovery from conditions of prior disturbance;
- Employ direct intervention to improve, rehabilitate, or restore habitats affected by past activities; and
- Provide additional protection specifically targeted at the species of greatest concern.

The major types of City land management operations in the municipal watershed that could adversely affect the species addressed in the HCP are related to silviculture (restoration thinning and ecological thinning), use and management of forest roads, and related activities. The potential impacts from these kinds of activities are discussed in detail above in the context of both regional practices and practices within the municipal watershed. Research in the Pacific Northwest has identified a number of general impacts from activities related to timber harvest and forest roads (Sidle et al. 1985; Franklin 1992; Curtis 1993). These types of potential impacts generally include:

- Impacts to water quality and aquatic habitat caused by increased delivery of sediment from slope failures or accelerated erosion associated with forest roads or clearcuts;
- Degradation of riparian and aquatic habitats associated with removal of riparian vegetation, and anthropogenic sediment and debris loading in streams;
- Forest fragmentation and loss of older seral forest habitat through clearcutting;
- Impacts to soils and vegetation from timber harvest activities; and
- Cumulative effects of timber harvest and forest roads on streams through increased peak runoff.

In addition to measures to avoid, minimize, or mitigate these kinds of impacts, the HCP includes measures to improve aquatic, riparian, and forest habitats through direct intervention. The City believes that these measures will, on the whole, produce significant improvements in habitat over time. However, the City acknowledges that current approaches and techniques for habitat improvement, rehabilitation, and restoration are experimental in nature. To respond to this uncertainty, the City will:

(1) Apply these measures conservatively;

(2) Monitor experimental projects for effectiveness and adequacy, and monitor overall trends in habitat quality (Section 4.5); and

(3) Operate under a paradigm of adaptive management, with provisions to abandon or alter restoration techniques that are unsuccessful or ineffective in favor of other forms of mitigation (section 4.5.7, 5.3, and 5.5).

This summary of effects includes a discussion of effects organized by (1) the ecosystems, communities, and habitats addressed, (2) the Species Conservation Strategies for the 14 species of greatest concern, and (3) a set of five overall objectives and four benchmarks for the measures to avoid, minimize, and mitigate impacts of potential take on the species addressed in the HCP.

Effects of Conservation and Mitigation Strategies

Expected Effects of Community-based Measures for Late-successional and Old-growth Forest Communities

The forest habitat projections presented below were modeled using the Forest Projection System (Section 3.3.7). Table 4.2-5 and Figure 4.2-6 show the expected change in forest seral stages within the municipal watershed over the term of the HCP, and Table 4.2-6 and Figure 4.2-7 show expected change in forest age classes. Table 4.2-7 gives the distribution of forest seral stages by 1,000-ft elevation zones for the same years.

Table 4.2-5. Acres and percent of the forested land in different seral stages within the watershed as existed in 1997 and as projected to occur in 2020 and 2050 under the HCP.

Forest Seral Stage (age)	1997	2020	2050
Early (0-29)	15,610 (18.3%)	1,165 (1.4%)	0 (0.0%)
Mid (30-79)	54,591 (63.9%)	34,008 (39.8%)	12,332 (14.4%)
Mature (80-119 years)	1,074 (1.3%)	35,819 (41.9%)	34,931 (40.9%)
Late-successional (120-189 years)	91 (0.1%)	190 (0.2%)	23,919 (28.0%)
Old-growth (190 – 850 years)	13,889 (16.2%)	13,889 (16.2%)	13,889 (16.2%)
No age or not modeled	222	406	406
Total	85,477	85,477	85,477

Figure 4.2-6. Forest seral stages in the municipal watershed, by acres, as existed in the year 1997 and as projected for years 2020 and 2050 under the HCP.

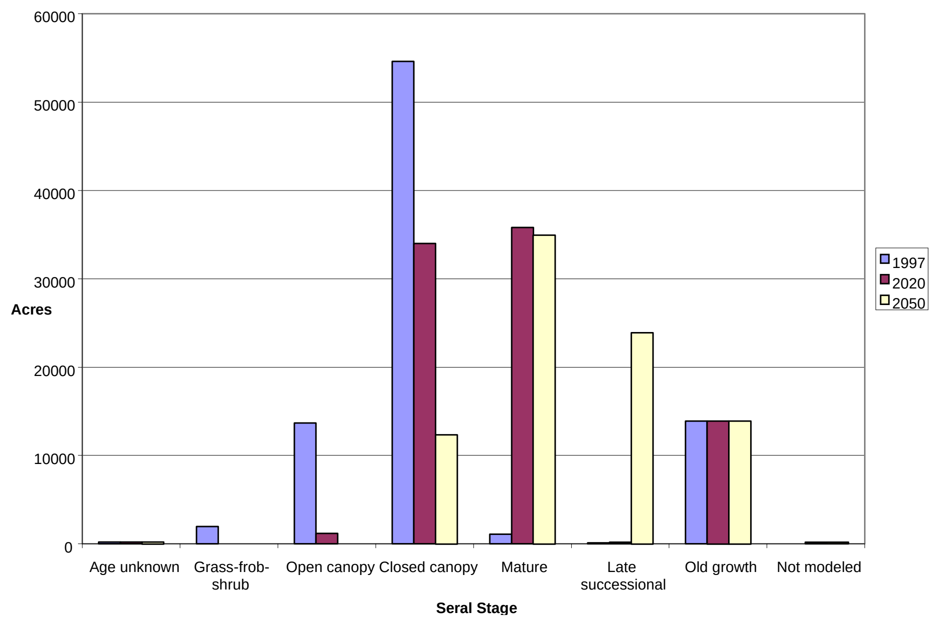


Table 4.2-6. Stand age distribution in the municipal watershed, by acres, as existed in 1997 and as projected to occur in 2020 and 2050 under the HCP.

		Projected	
Stand Age	**1997**	**2020**	**2050**
Age unknown	222	222	222
0-9	1,937	0	0
10-19	6,035	0	0
20-29	7,638	1,165	0
30-39	7,605	5,352	0
40-49	10,767	5,815	0
50-59	6,470	8,814	1,164
60-69	17,878	8,369	5,352
70-79	11,871	5,658	5,815
80-89	950	12,091	8,814
90-99	112	15,613	8,370
100-119	12	8,115	17,747
120-189	91	190	23,919
> 189	13,889	13,889	13,889
Not modeled	0	184	184
Total	85,477	85,477	85,477

Figure 4.2-7. Stand age distribution in the municipal watershed, by acres, as existed in year 1997 and as projected for years 2020 and 2050 under the HCP.

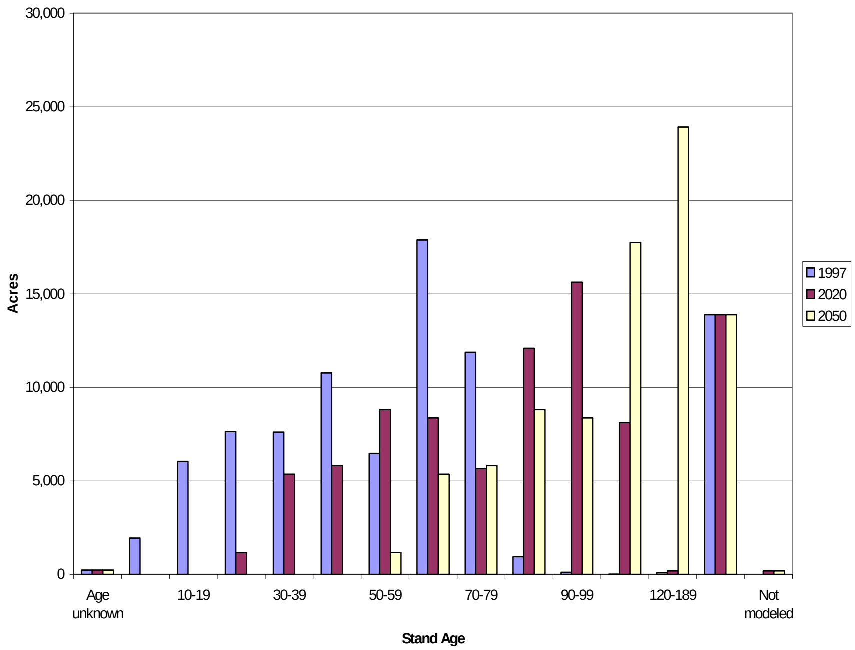


Table 4.2-7. Stand age distribution, by acres and by elevation zone, in the municipal watershed for year 1997 and projected for years 2020 and 2050 under the HCP.

			Projected	
Elevation (ft)	**Seral Stage**	**1997**	**2020**	**2050**
0-999	Early Seral: Grass-forb-shrub (0-9)	7	0	0
	Early Seral: Open canopy (10-29)	541	0	0
	Mid-seral: Closed canopy (30-79)	8,982	979	495
	Mature (80-119)	437	8,882	2,180
	Late-successional (120-189)	91	190	7,376
	Old-growth (190-850)	0	0	0
	Age unknown	0	0	0
	Not modeled	0	7	7
0-999 Total		**10,058**	**10,058**	**10,058**
1000-1999	Early Seral: Grass-forb-shrub (0-9)	793	0	0
	Early Seral: Open canopy (10-29)	221	749	0
	Mid-seral: Closed canopy (30-79)	18,118	1,730	919
	Mature (80-119)	456	17,064	7,164
	Late-successional (120-189)	0	0	11,460
	Old-growth (190-850)	150	150	150
	Age unknown	21	21	21
	Not modeled	0	45	45
1000-1999 Total		**19759**	**19759**	**19759**

2000-2999	Early Seral: Grass-forb-shrub (0-9)	516	0	0
	Early Seral: Open canopy (10-29)	3,322	299	0
	Mid-seral: Closed canopy (30-79)	18,555	12,553	2,743
	Mature (80-119)	181	9,708	14,764
	Late-successional (120-189)	0	0	5,053
	Old-growth (190-850)	2,415	2,415	2,415
	Age unknown	129	129	129
	Not modeled	0	14	14
2000-2999 Total		**25,118**	**25,118**	**25,118**
3000-3999	Early Seral: Grass-forb-shrub (0-9)	568	0	0
	Early Seral: Open canopy (10-29)	8,015	117	0
	Mid-seral: Closed canopy (30-79)	8,634	16,843	6,779
	Mature (80-119)	0	165	10,316
	Late-successional (120-189)	0	0	30
	Old-growth (190-850)	7,123	7,123	7,123
	Age unknown	47	47	47
	Not modeled	0	92	92
3000-3999 Total		**24387**	**24,387**	**24,387**
4000-4999	Early Seral: Grass-forb-shrub (0-9)	53	0	0
	Early Seral: Open canopy (10-29)	1,574	0	0
	Mid-seral: Closed canopy (30-79)	302	1,903	1,396
	Mature (80-119)	0	0	507
	Late-successional (120-189)	0	0	0
	Old-growth (190-850)	4,188	4,188	4,188
	Age unknown	25	25	25
	Not modeled	0	26	26
4000-4999 Total		**6,142**	**6,142**	**6,142**
5000+	Early Seral: grass-forb-shrub	0	0	0
	Old-growth (190-850)	13	13	13
	Age unknown	0	0	0
	Not modeled	0	0	0
5000+ Total		**13**	**13**	**13**
Grand Total		**85,477**	**85,477**	**85,477**

Barring a severe natural or anthropogenic disturbance such as a forest fire, all existing old-growth forest (13,889 acres) would be retained, and by the year 2050, a total of 72,739 acres (70 percent) of the known age forest would be between 80 and 850 years old, compared to about 15,054 acres (18 percent) of the forest in these older seral stages in 1997 (Table 4.2-5; Figure 4.2-6). This represents a nearly fivefold increase in older forest seral stages. All conifer forest within the watershed will be at least 50 years of age at year 2050. These changes should make a significant future contribution of habitat on a regional basis for species dependent on late-successional and old-growth forests, such as the northern spotted owl, marbled murrelet, northern goshawk, and forest bats (Table 4.2-3).

Protection of old growth and recruitment of mature forest in the CHU and the remainder of the watershed will establish a key link in the federal late-successional reserve system. The recruitment of older forest habitat under the HCP will serve to connect habitats for old-growth dependent species on either side of the I-90 corridor, make a valuable contribution to maintaining populations of those species in the long term, and generally increase the effectiveness of the federal late-successional and old-growth reserve system in an area of critical importance.

The inclusion in reserve status of forested lands that are currently in early seral stages will, as the forest matures, serve to make habitat types less fragmented and more contiguous, widen travel and dispersal corridors for most wildlife species, reduce edge effects, and more effectively connect forest elements within the watershed with similar key and sensitive habitats on lands in other ownerships adjacent to watershed boundaries.

As can be seen from Table 4.2-7, 50,562 acres (70 percent) of the 72,739 acres of the mature, late-successional, and old-growth forest in the year 2050 will be below 3,000 ft elevation, a thirteen-fold increase at this elevation from the acreage in 1997 (3,730 acres). Given both the current scarcity of older forest below 3,000 ft and the continued human development of forestlands in the Puget Sound region, these projected increases in older seral habitats below 3,000 ft elevation should make a significant future contribution of habitat for species dependent on late-successional and old-growth forests at lower elevations, such as the fisher.

This older forest habitat west of Cedar Falls will also provide an important link from the federal reserve system at higher elevations to the forests in Tiger Mountain State Park (managed by WDNR) to the northwest of the municipal watershed. The forest in the Rattlesnake Lake Recreational Area will similarly link to the Rattlesnake Ridge Natural Area (also managed by WDNR). The CHU and other forest land in the upper watershed will link to the federal late-successional reserve system and the Adaptive Management Areas managed by the USFS in the I-90 corridor, and hence to the nearby Alpine Lakes Wilderness.

Under a program of no timber harvest for commercial purposes, early forest seral stages (less than 30 years old) created by past commercial timber harvest will disappear through natural maturation by year 2027 under the HCP, but some early seral forest habitat likely will be created by natural events such as windstorms and fire. The expected pattern of forest seral stages likely would approach the pattern present before commercial timber harvest began in the watershed, and thus should be favorable for species dependent on late seral forests. This pattern of forest seral stages should greatly facilitate dispersal of forest species.

To the extent that any species addressed by the HCP use recently harvested areas for foraging, the elimination of early seral forest habitat created by commercial timber harvest will reduce the amount of such habitats compared to current, more extensively disturbed, conditions. However, future early seral forest habitats will be created by natural processes such as fires and windstorms, and thus provide a more natural pattern and quality of such habitats than what would be created by commercial timber harvest.

The projected combined total of 54 percent of the landscape in late-successional and old-growth forest (all at least 120 years old) in 2050, assuming no significant removal by fires, begins to compare reasonably to the average of 50 percent forest over 200 years old in landscapes in the Olympic and Mt. Baker-Snoqualmie national forests during the last millennium (Henderson 1990). However, Henderson (1993) reported an average rate of disturbance of 0.33 percent of forest per year from historic forest fires in the Mt. Baker-Snoqualmie National Forest, which would equate to about 282 acres per year in the municipal watershed.

Because of the episodic, rather than periodic, nature of forest fires in this region (Agee 1993), the above-mentioned average rate of disturbance is not useful in predicting the amount of early seral forest at any particular time, but it can be expected that some areas of early seral forest will be created during the term of the HCP by fire or windstorm, or possibly by disease or defoliating insects. The actual rate and magnitude of forest disturbances will be affected by regional climate change, chance events, changing environmental conditions, risk of fires caused by humans or lightning, and the City's policy of suppressing forest fires to prevent catastrophic damage and to protect water quality (described above).

Some penetration of light and wind at the edges of old-growth stands (edge effects) will occur, reducing the quality of interior habitat, and there is a risk of blowdown and edge creep (unraveling at forest edges exposed to winds from nearby cleared areas). However, both edge effects and edge creep should decrease over time as adjacent forest matures and both should become of minor concern. Removal of about 38 percent of forest roads will further serve to reduce forest fragmentation and reduce edge effects on interior forest habitats (see section above entitled "Measures Applicable Primarily to the Aquatic and Riparian Ecosystem Component").

Planned silvicultural interventions should also improve the quality of the developing forest for species dependent on late-successional and old-growth forests. Restoration and ecological thinning and restoration planting will be designed to accelerate development of characteristics of late-successional and old-growth forest, or to restore riparian function in streamside forests. As indicated in Table 4.2-8, the City expects to treat about 15,000 acres of forest in a manner that should improve forest structure and composition for species dependent on late-successional and old-growth forests. Thus, treatments will be applied over 20 percent of the total of more than 71,000 acres of second-growth forest in the watershed.

Table 4.2-8. Estimated acres expected to receive silvicultural treatments that should improve habitat conditions for species dependent on late-successional and old-growth forests.

Area of watershed	Restoration planting	Restoration thinning in young stands	Ecological thinning in older stands	Total
Upland Forest	1,000	10,480	2,000	13,500
Riparian Forest[1]	700	420	150	1,270
TOTAL	1,700	10,900	2,150	14,770

[1] Acreage breakdown only approximate for restoration and ecological thinning.

However, the City acknowledges that the restoration and rehabilitation measures and projects that will be employed in the upland, riparian, and aquatic habitats are experimental in nature. Consequently, the City will carefully monitor these projects and manage them within an adaptive management paradigm to improve their effectiveness over time (Section 4.5.7). Overall trends in habitat change will also be monitored, and techniques will be developed to better characterize habitat quality for both upland and aquatic habitats (Section 4.5).

Short-term, site-specific impacts from restoration and ecological thinning operations can be expected, but the long-term improvement in habitat development should more than offset those impacts, producing a net benefit to species addressed in the HCP (see Section 4.6). In addition, the City will develop and implement measures to avoid, minimize, or mitigate such short-term impacts.

Expected Effects of Effects of Community-based Measures for the Aquatic and Riparian Ecosystem

Virtually all elements of the Aquatic and Riparian Ecosystem are protected by the inclusion of all watershed forest in reserve status. The City expects that the combination described above of protection of habitats through reserve status, aquatic and riparian restoration activities over the term of the HCP, and management guidelines will result in significant improvement in water quality and the condition and quality of aquatic habitats (particularly stream habitats) and riparian habitats (particularly forested habitats near streams). All riparian forest and other forest near water bodies will be at least 50 years old at HCP year 50, and the majority of this forest will be much older.

In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft (on Type I-III waters), 150 ft (on Type IV waters), and 100 ft (on Type V waters) were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

Additional measures included in the HCP to improve or help restore riparian and aquatic habitats include placement of large woody debris in streams, bank stabilization and revegetation, conifer underplanting to restore native conifers, and replacement of stream crossing structures that impede or block fish passage, which will restore access to currently inaccessible stream habitats.

Over the term of the HCP, the City expects that the Community-based Strategies described above will achieve the stated conservation objectives and will:

- Improve the quality of stream and riparian habitats substantially;
- Protect other aquatic habitats;
- Restore accessibility to stream habitats where now blocked or impeded;
- Improve surface water quality; and
- Provide improved connectivity among aquatic habitats over the watershed landscape.

Expected Effects of Community-based Measures on Special Habitats

The City expects that the measures described above will serve to protect and maintain the long-term viability of the special habitats in the municipal watershed, and improve connectivity among these habitats through creation of a forest reserve. As long as the regional populations of the species dependent on these habitats remain viable, the combination of these measures with other measures included in the Watershed Management Mitigation and Conservation Strategies should serve to maintain these species in the municipal watershed.

Intensity of Activity and Associated Mitigation

With a commitment not to harvest timber for commercial purposes, general watershed management, silvicultural interventions, and restoration and management of roads are the primary land management activities that could produce impacts on the species addressed in the HCP or their habitats. The City intends that the watershed management mitigation and conservation measures as a whole, including the various management guidelines specified, serve as mitigation for the watershed management activities described above. These mitigation and conservation measures include:

(1) The commitment not to harvest timber for commercial purposes;

(2) Restoration activities included for roads, forests, and streams–activities that will reduce anthropogenic impacts over time and produce long-term habitat improvements;

(3) Management guidelines designed to avoid, minimize, and mitigate impacts of those activities;

(4) Additional measures for the 14 species of greatest concern; and

(5) Additional measures to be developed in the early stages of the HCP, in consultation with the Services, to minimize and mitigate those activities.

Estimates of the totals and rates for *silvicultural activities* over the term of the HCP are summarized below.

- Restoration thinning in young stands (typically less than 30 years old):

  Upland forest: about 10,500 acres (average 700 acres/year over the first 15 years)

  Riparian forest: 420 acres (average 28 acres/year over the first 15 years)

- Ecological thinning in older stands (typically between 30 and 60 years old):

  Upland forest: 2,000 acres (average 40 acres/year)

  Riparian forest: 150 acres (average 3 acres/year)

- Restoration planting:

  Upland forest: 1,000 acres (average 20 acres/year)

  Riparian areas: about 700 acres (average 14 acres/year)

Estimates of the totals and rates for *road management activities* over the term of the HCP are summarized below.

- Road maintenance (required on all active roads each year, varying by year and including inspection, grading, cleaning ditches, cleaning culverts, brushing, and minor repairs)

  Approximately 520 miles/year in HCP year 1, diminishing as roads are removed to about 384 miles/year at HCP year 20 and beyond

- Road construction:

  Approximately 5 miles total over 50 years

- Road improvements (reengineering and major repairs):

  Approximately 4-10 miles/year, potentially more in some years

- Road removal or deconstruction:

  Approximately 38 percent of road system (236 miles) (average about 10 miles/year over first 20 years, with possibly more roads removed after HCP year 20)

- Culvert upgrades for passage of peak flows at stream crossings:

  Approximately 700 culverts, possibly more or fewer, depending on need

- Road use (watershed administration and management):

  Normal watershed management and administrative operations

  Facility construction, upgrades, or repair

  Occasionally, to support sale of logs from ecological thinning or salvage, or to move logs to restoration sites

Estimates of the totals or rates for *stream restoration* over the term of the HCP are summarized below.

- Bank stabilization (armoring):

  Approximately 7,500 ft of bank, possibly more or less, depending on need

- Bank revegetation:

  Approximately 10,000 ft of bank, possibly more or less, depending on need

- Large woody debris placement:

  Approximately 50 projects, possibly more or fewer, depending on need and cost

- Culvert upgrades for fish passage at stream crossings:

  Approximately 30-60 culverts, possibly more or fewer, depending on need.

Restoration thinning, ecological thinning can be expected to produce some short-term impacts to the forest and harvest site, but these activities will be mitigated by the following measures, developed in consultation with the Services, to minimize and mitigate site-specific impacts:

- Guidelines to protect soils and vegetation during these activities;
- Improvements in forest structure and diversity produced by these activities; and
- Additional measures to be developed early in the HCP.

As discussed above, hauling timber is the major use of forest roads that can result in sediment loading to streams. Elimination of timber harvest for commercial purposes under the HCP thus eliminates the major source of sediment production from road use.

Forest roads will be used for watershed administration and management, for watershed surveillance and access, for research and monitoring, for habitat restoration activities, and for other uses, such as educational programs, scientific research, and facility construction.

Construction work related to roads can also produce short-term impacts, but these impacts will be minimized and mitigated through construction guidelines (Appendix 17). In the long run, sediment loading to water bodies will be substantially *reduced* by removal (deconstruction) of roads, road improvements, replacement or modification of stream crossing structures not properly designed to pass peak flood flows, improved road maintenance and repair standards, and programs designed to reduce surface erosion and road-related landslides that deliver sediment to streams. The result should be an improvement, over time, in both water quality and aquatic habitats.

Construction and operational activities related to mitigation for the blockage to anadromous fish at Landsburg are discussed in Section 4.3. Construction and operational activities related to management of instream flows within the municipal watershed are discussed in Section 4.4.

Summary of Expected Effects for Species of Concern

Habitat should be maintained or improved for all species addressed over the term of the HCP either through improvements in the amount, quality, or level of protection of habitat (e.g., for aquatic, riparian, and mature and late-successional forest habitats) *or* through the reestablishment of more natural patterns of habitat distribution. To the extent that any species uses recently harvested areas for foraging, the elimination of early seral forest habitat created by past commercial timber harvest will reduce the amount of such habitats compared to current, more extensively disturbed, conditions. However, future early seral forest habitats will be created by natural processes such and fires and windstorms, and thus provide a *more natural pattern and quality of such habitats* than what would be created by commercial timber harvest or what exists today.

The City expects that the Species Conservation Strategies described above for the 14 species of greatest concern will meet the stated conservation objectives, providing benefits and protections in addition to the benefits and protections associated with the Community-based Conservation Strategies. Habitat should be maintained or improved for all 14 species over the term of the HCP, and additional protection will be provided during sensitive periods of the life cycle of many of the species. Unless external factors intervene, the City expects that the population status of each of the species in the municipal watershed will be at least maintained, and, in most cases, improved under the Species Conservation Strategies described above.

The City also expects that the Community-based Conservation Strategies that apply to the 69 other species of concern will meet the conservation objectives described above for those species. Key habitat should be maintained or improved for all 69 species over the term of the HCP. Unless external factors intervene, the City expects that the population status of each of the species in the municipal watershed will be at least maintained, and in most cases improved, during the term of the HCP.

While several species that use early seral forest habitat are expected to experience a decrease in that habitat over the term of the HCP, the watershed landscape will, over time, approach a condition more similar to the natural pattern to which the species are adapted. Furthermore, the generally reduced level of human disturbance in the watershed under the HCP and the expected availability of clearcuts in areas adjacent to the municipal watershed should both serve to offset the effects of reduced early seral forest habitat within the municipal watershed. Finally, the 50-year commitment by the City to protect and restore the municipal watershed may be very important to many species in a region now experiencing and projected to experience high levels of population growth and development. This commitment may be especially important for species that occur primarily at elevations in the Puget Sound Region.

An evaluation of effects of the HCP to support a determination of allowable take and an ESA Section 7 determination of jeopardy by the Services is included in Section 4.6. This section includes more detailed discussion of effect by species or groups of species.

Evaluation of Effectiveness in Meeting Objectives

Along with the various specific conservation objectives presented in the preceding subsections of Section 4.2, the City has stated five overall objectives that can be directly related to a determination of the effects and effectiveness of the watershed management mitigation and conservation measures for species addressed in the HCP. These five objectives applicable to land management in the municipal watershed are to:

(1) Avoid, minimize, or mitigate the impacts of incidental taking of species listed under the ESA as threatened or endangered, to the maximum extent practicable, and the impacts of the equivalent of taking for unlisted species;

(2) Maintain, and restore to more natural ranges of variation, those natural processes that create and maintain habitats and important habitat elements in the municipal watershed;

(3) Provide habitat connectivity within the municipal watershed and with other significant areas of habitat in the region;

(4) Provide a net benefit to all the species and contribute to their recovery; and

(5) Manage the watershed in a manner that can sustain the forest ecosystem and the Aquatic and Riparian Ecosystem over the long term in a manner that can support native species and that fosters natural biodiversity.

The objectives related to anadromous fish are given in the Mitigation Strategies for the Anadromous Fish Barrier at Landsburg (Section 4.3) and the Instream Flow Management Strategy (Section 4.4). These two sets of mitigation and conservation strategies address the impacts of the water supply diversion and regulation of instream flows by the City, and the effects of the Landsburg Diversion Dam in blocking passage of anadromous fish. The Watershed Management Mitigation and Conservation Strategies complement these two sets of mitigation and conservation strategies, particularly for the three species (chinook and coho salmon, and steelhead trout) that will be passed over the Landsburg Diversion Dam when fish ladders and other fish passage and protection facilities are constructed (Section 4.3).

The evaluation of the Watershed Management Mitigation and Conservation Strategies with respect to meeting the objectives listed above are discussed below in the context of four types of *benchmarks*:

(1) Current habitat conditions;

(2) Current population status, largely as a function of current habitat capability;

(3) Current level of commitments for watershed land management; and

(4) Impacts of current and past operations and activities.

Based on the foregoing discussion of the expected effects of the combined mitigation and conservation measures, the City believes that the Watershed Management Mitigation and Conservation Strategies will meet the five overall objectives stated above, as well as the various conservation objectives presented in the preceding subsections of Section 4.2. The primary measures and effects of the HCP that contribute to that conclusion are summarized in Table 4.2-9 with respect to each of the five overall objectives. The following subsection briefly indicates the major criteria used for evaluating effectiveness in meeting each objective.

Predicted Effectiveness in Meeting Objectives

Objective: Avoid, Minimize, or Mitigate Impacts of Taking to Extent Practicable

In determining whether or not the Watershed Management Mitigation and Conservation Strategies can be expected to effectively avoid, minimize, or mitigate the impacts of the expected taking to the maximum extent practicable, the City considered the direction and magnitude of incremental impacts of changes in operations or facilities under the HCP, and the measures that would mitigate for those impacts. The following factors were considered to contribute to meeting this objective:

- Incremental impacts of operations or facilities that can be expected to be either small and effectively mitigated, if adverse, or positive in nature;
- Effectiveness of species-specific mitigation and conservation measures; and
- Additional programs that would create a benefit to counter any predicted negative impact.

Although road use and some tree-cutting will occur, the level of road use and tree-cutting will be relatively minor under the commitment not to harvest timber for commercial purposes, and these activities will be mitigated with the variety of measures described above. The City believes that it will achieve the standard of avoiding, minimizing, and mitigating the impacts of potential taking to the maximum extent practicable for four reasons: (1) the expected level of potential impacts of expected land management activities within the municipal watershed is relatively low; (2) conservative management guidelines designed to minimize and mitigate impacts will be implemented; (3) take of most species addressed in the HCP is expected to be very limited over the term of the HCP; (4) the HCP includes a substantial commitment to habitat restoration; and (5) the broad commitments to habitat protection, especially for forests, will lower the potential for take over large areas of the watershed.

With respect to the four benchmarks listed above:

(1) Habitat conditions for species addressed in the HCP will improve over time, even for species that use early seral forest habitats if the conclusion is made that a more natural pattern and quality of forest habitats, including early seral habitat produced by natural disturbances, will be more beneficial for those species than the quantity of such early seral habitat produced by timber harvest.

(2) Populations of nearly all species should be maintained or should increase, to the extent that habitat and conditions in the municipal watershed influence those populations and if external factors do not intervene. The only populations of species that might decrease as a result of the HCP are those populations for which the availability of early seral forest habitat in the watershed is limiting, which may not apply to any of the species addressed in the HCP.

(3) Commitments for watershed land management and restoration are legally binding under the HCP, and are thus stronger. Watershed management under the HCP is considerably more conservative than past commitments, particularly because the City is forgoing the opportunity to harvest timber for commercial purposes, and the commitment to watershed restoration is substantially greater than the present level of commitment.

(4) Compared to impacts of past levels of activity, impacts of ongoing operations and activities will be substantially reduced and/or mitigated by the measures included in the HCP, particularly because the City is eliminating harvest of timber for commercial purposes. Impacts of past activities that adversely affected habitats will be addressed by a substantial commitment to restoration and rehabilitation under the HCP.

Objective: Maintain and Restore Natural Processes

The Watershed Management Mitigation and Conservation Strategies include several programs and measures designed to sustain relatively undisturbed natural processes and to restore natural processes disrupted by past or current human activities to within more natural limits. These programs and measures include:

- Programs to reduce anthropogenic sediment loading to streams and other aquatic habitats by removal of a large part of the watershed road system, improved maintenance of roads, engineering improvements to roads and stream crossings, stabilization of streambanks, and minimization of impacts by elimination of timber harvest for commercial purposes;
- Projects to restore instream habitat functionality and complexity with placement of large woody debris, providing habitat complexity during the transition between current conditions and future conditions under which the riparian forests provide an adequate supply of large woody debris, on a sustained basis, without human intervention;
- Programs to accelerate restoration of the natural functions and complexity of riparian forest through protection and silvicultural intervention;
- Programs to accelerate the development of old-growth conditions in the previously harvested forest within the watershed through silvicultural intervention, with the ultimate objective of self-sustaining, natural recruitment of coarse woody debris and other features of late seral forests; and
- Development, over time, of a pattern of forest cover more similar to that which existed prior to commercial timber harvest in the watershed, with forest openings primarily created by natural processes.

Objective: Provide Local and Regional Habitat Connectivity

The Watershed Management Mitigation and Conservation Strategies include several measures and programs designed to restore disrupted connectivity among habitats within the watershed and with outside areas:

- For stream habitats:
  - + Replacement, modification, or removal of structures that block or impede passage of fish at stream crossings, restoring within-watershed connectivity for stream systems; and
  - + Construction of fish passage facilities at the Landsburg Diversion Dam (Section 4.3), improving regional connectivity in the Cedar River for all native species.
- For riparian habitats:
  - + Establishment of a continuous riparian corridor within the watershed, which connects all streams and associated water bodies and wetlands.
- For wetlands:
  - + Connectivity for dispersal among wetlands and other aquatic habitats through protection of all forest outside developed areas.
- For mature, late-successional, and old-growth forests:
  - + Development, over the 50-year term of the HCP, of an overall landscape within the municipal watershed that will have about 50 times the acreage of mature and late-successional forest than exists today, and early seral forest created primarily by natural processes, providing substantially improved conditions for breeding, wintering, and dispersal within the watershed;
  - + Improved linkages between high elevation forests near the Cascade Crest and low-elevation forests in the western portion of the municipal watershed; and
  - + As the second-growth forest matures in the municipal watershed over time, improved linkages between the spotted owl CHU and other elements of the federal late-successional reserve system and between the watershed and other key forest habitat in the region.
- For Special Habitats:
  - + Development of substantially more mature and late-successional forest between Special Habitats, facilitating dispersal among habitat patches.

Objective: Provide a Net Benefit to the Species and Contribute to Their Recovery

In determining whether the Watershed Management Mitigation and Conservation Strategies can be expected to provide a net benefit for species addressed in the HCP, and thus contribute to the recovery of any that are listed, the following factors were considered to contribute to a net benefit:

- Incremental impacts of changes in operations or facilities under the HCP that are expected to be either small and effectively mitigated, if adverse, or positive in nature;
- An increase in quantity of usable habitat for the species addressed;
- An increase in quality of habitat for the species addressed;
- Improved landscape connectivity among patches of similar habitat;
- An increased level of protection over prior levels; and
- Species-specific measures that provide any additional benefits to a species compared to current conditions.

As indicated in Table 4.2-9, the City believes that the Watershed Management Mitigation and Conservation Strategies should provide a net benefit to all species addressed in the HCP. However, discussion of benefits for a number of species is warranted.

Bull trout and pygmy whitefish are predicted to experience incremental impacts of changes in reservoir operations (with the new instream flow regime) that are negative. However, when compared to current operations, these impacts are expected to be extremely minor for bull trout and even less for pygmy whitefish (sections 4.5.6 and 4.6). Other programs, such as stream protection and restoration, will provide positive benefits for these species that should more than offset the minor negative effects of changed reservoir operation, particularly if rearing habitat is limiting rather than spawning habitat (see discussion of bull trout workshop in Section 3.3.4). Restoration activities begin in HCP year 1, and most road and streams restoration projects will be completed within the first decade of the HCP.

Because of recent changes in vegetation around the reservoir, impacts of recent reservoir operations on common loons are uncertain (sections 3.35 and 4.5.6). However, these impacts are not a consequence of changes in reservoir operations under the HCP's instream flow regime, which is not projected to differ measurably from the current regime with respect to impacts on loons (Section 4.5.6). Rather, these impacts are a consequence of changes in reservoir operations that began more than a decade ago, but for which effects on vegetation have lagged behind the changes in operations. However, the reproductive success of loons on the reservoir will be monitored to identify any problems and to develop solutions, if needed, through adaptive management (Section 4.5.7).

The Cedar Permanent Dead Storage Project would benefit anadromous fish but could have adverse impacts on bull trout, pygmy whitefish, and/or loons. However, construction of this project itself is not a Covered Activity under the HCP (Section 1.3), and implementation of the project will require a plan amendment. Before this project is implemented, impacts will be carefully evaluated over a period of 5 years, and mitigation will be developed (Section 4.5.6).

All anadromous species should receive a net benefit under the HCP immediately after implementation, because the proposed instream flow regime has significant benefits compared to the current regime. Not only are the instream flows superior in terms of providing habitat, but the risk of stranding will be reduced for all species by downramping constraints, better protection will be provided for redds, increased flows for outmigrating sockeye fry should increase fry survival compared to conditions under current flows, and the City will manage flows to more closely mimic those natural patterns that help sustain the riverine ecosystem (Section 4.4.2). Other measures will provide even greater benefits during the early part of the HCP, including construction of fish passage facilities at Landsburg, funding for improvements at the Ballard Locks to increase survival of smolts, and a contribution of about $5 million for habitat protection and restoration downstream of the Landsburg Diversion and in the Walsh Lake system (Section 4.4.2).

Habitat for the band-tailed pigeon may not improve, as the proportion of mixed coniferous and deciduous should not change much, and forest openings will decrease. Mineral springs, important to this species, will be protected if found, but none are known to exist in the municipal watershed currently. Nesting habitat for golden eagles will be protected. To the extent that this species uses recently harvested areas for foraging, foraging habitat will decrease over time, but the habitat should better represent more natural conditions than what exists today, in terms of both the acreage of forest openings and the quality of naturally open habitat.

Effects on species not known to be present in the watershed are speculative and would depend on their future presence in the municipal watershed as well as the habitats that they may use. The known naturally open-habitat types for grizzly bear, gray wolf, and wolverine will be protected, and habitat connectivity among habitat patches will be improved as the proportion of later seral forest increases over time. To the extent these species use only Special Habitats for foraging, the available habitat will not be increased in amount, but some should improve in quality as a result of the maturation and development of forest adjacent to them and better connectivity among them. If any of these species also use later seral forest, then habitat will be increased. In addition, dens of gray wolves and grizzly bears, if found, will be protected.

Objective: Manage for Sustainable Ecosystems

While the evaluation of the four overall objectives discussed above is relatively straightforward, the City acknowledges the difficulty of evaluating whether the proposed watershed management mitigation and conservation measures will result in *sustainable* forest, riparian, and aquatic ecosystems within the municipal watershed. Some potential future effects on the ecosystems, communities, and habitats - such as global climatic change (Franklin et al. 1991) or a drastic regional decline of many species that occur or could occur within the municipal watershed - are obviously outside the control of the City. Whether or not *any* approach to watershed management is sustainable may well depend on factors over which few in the region have any control. While acknowledging the difficulty of defining sustainability, as well as the difficulty of demonstrating its achievement or non-achievement over the term of the HCP, the City believes that sustainable management is an important goal that should be pursued.

One widely accepted requisite of sustainability is the maintenance of biological diversity and ecological integrity (Karr 1991; Covington and DeBano 1993). Studies have shown that biological diversity can buffer an ecosystem against extreme events (Tilman 1994), and Aldo Leopold has cautioned that the first step in intelligent tinkering is to keep all the “cogs and wheels” (Leopold 1949). Franklin et al. (1991) have argued that maintaining forest ecosystem diversity will require attention to not only reserves but also “commodity lands,” and that whole landscapes must be managed in an integrated manner to maintain diversity and to provide for movement and dispersal of organisms.

Marcot et al. (1994) argue that sustainable ecosystem management entails maintenance or restoration of biodiversity, maintenance of long-term site productivity, and sustainable natural resource production, and that objectives must be defined and pursued at several scales of space and time. Amaranthus et al. (1989) conclude that maintaining site productivity entails avoidance of severe disturbances to timber harvest sites, such as extensive soil compaction, broadcast burning, and erosion; preservation of organic matter; protection of natural soil communities; and rapid recolonization with indigenous plants and soil organisms. Franklin et al. (1989) add that maintaining long-term productivity goes beyond site management and requires maintaining natural diversity across the landscape.

Carey and Curtis (1996) have argued that much of the "ecological functionality" of late-successional forests can be achieved through proper silviculture and long harvest rotations. On the other hand, Franklin (1990) has argued that such new approaches to forest management, because they are still experimental, do not preclude the need for reserved areas.

A wide variety of natural processes and disturbances both create and maintain habitat important for species in any ecosystem. Broad agreement is developing that degradation of ecosystems occurs when such natural process or disturbance regimes are altered by anthropogenic factors so that these processes and disturbance regimes move outside of normal limits of behavior (FEMAT 1993). For example, increased sediment loading into streams from the increased rates of landslides and erosion associated with forest roads and clearcuts has long been recognized to have adverse impacts to fish habitats (Bisson and Sedell 1984). Controlling anthropogenic influences can bring a process or disturbance regime back within a normal range of variation, and serve to restore biological diversity. Because most modern landscapes - including the municipal watershed - have been disturbed or degraded by past human activities, ecosystem restoration should have a place in any program that aspires to be sustainable (Primack 1993).

To respond to the goal of achieving sustainable management of the watershed ecosystems, the City developed Watershed Management Mitigation and Conservation Strategies that:

- Take the highly conservative approach of eliminating the harvest of timber for commercial purposes, placing all watershed forest outside developed areas in reserve status and resulting in an expected fifty-fold increase in the amount of mature and late-successional forest by HCP year 50;
- Preserve long-term *site productivity* by limiting most activities that disturb soils and vegetation to restoration activities and by implementing various protective measures to protect soils and vegetation;
- Include measures to both *protect* riparian and aquatic habitats with measures to *restore or rehabilitate* previously disturbed areas; and
- Allow *rates of forest disturbance to be governed largely by natural factors*, with the exception of City efforts to control the risks and adverse impacts of forest fires.

Absent major external factors that may have severe impacts on the watershed, the City believes the combination of measures described above has a high likelihood of resulting in sustainable aquatic, riparian, and forest ecosystems in the watershed.

Funding Commitments for Watershed Management Mitigation and Conservation Strategies

Funding commitments for Watershed Management Mitigation and Conservation Strategies are described in preceding subsections of Section 4.2 and are summarized in Table 4.2-10 below and in Table 5.3-2 in Chapter 5.

Table 4.2-9. Summary of effects of Watershed Management Mitigation and Conservation Strategies in terms of meeting five overall conservation objectives over the 50-year term of the HCP.

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
1. Avoid, minimize, & mitigate take to maximum extent practicable	• All wetlands, streams, lakes, & ponds protected in reserve • Delivery of sediment to streams from roads reduced substantially from historic levels • Elimination of delivery of sediment from timber harvest • Strict constraints on road construction & management • Protection of nest sites in the breeding season (or longer) for two species of greatest concern • Improved passage for all native fish within the watershed & at Landsburg (Section 4.3) • Instream flows that provide improved anadromous fish habitat & downramping flow restrictions to reduce stranding of young fish (Section 4.4) ***Take avoided, minimized, or mitigated to maximum extent practicable***	• Elimination of timber harvest for commercial purposes, resulting in a fifty-fold increase in mature & late-successional forest • All old growth & entire CHU protected • Silvicultural intervention to accelerate development of late-successional forest characteristics • Protection of nesting sites in the breeding season (or longer) for all three species of greatest concern ***Take avoided, minimized, or mitigated to maximum extent practicable***	• All Special Habitats protected within forested reserve • Guidelines to minimize impacts of activities near Special Habitats • Protection of nests sites or dens for all three species of greatest concern ***Take avoided, minimized, or mitigated to maximum extent practicable***

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
2. Maintain & restore natural processes	• Natural riparian forest functions restored, including LWD recruitment to streams & bank stabilization • Anthropogenic sediment delivery rate reduced significantly through road removal, road improvements, better road maintenance, and elimination of timber harvest for commercial purposes • Stream continuity restored • More natural patterns of river flows than current (Section 4.4) ***Stream & riparian processes sustained & restored***	• Development of old-growth characteristics & processes, including recruitment of coarse woody debris through reserve status • Silvicultural intervention to accelerate development of late-successional forest characteristics and provide habitat during transition to development of natural processes that create and maintain habitat • Natural diversity of forest tree species increased through planting • Forest continuity restored ***Natural processes of forest development sustained & restored***	• Natural relationship with surrounding forest restored • Protection from impacts • Restore natural connectivity through older seral forest ***Natural relationships with other habitats protected & restored***

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
3. Provide habitat connectivity	• Restoration of access to inaccessible habitat for resident fish[3] • Protection of forest adjacent to all streams, ponds, lakes, & wetlands through reserve status • Protection of all riparian areas in reserve status • Protection of included forests in wetland complexes ***Connectivity provided & restored for wetlands, streams, & riparian areas***	• Development of continuous mature forest corridors in watershed • Development of larger and interconnected areas of older seral-stage forest • All forest in CHU protected through reserve status, linking to federal late-successional forest reserve • More natural spatial pattern of forest seral stages ***Significantly improved connectivity within watershed & regionally***	• Improved connectivity provided by commitment not to harvest timber for commercial purposes, protecting forest among Special Habitats • Increased connectivity with overall increase in late seral forests, & decrease in early seral forests ***Improved connectivity among Special Habitats & with other habitats needed by species that use Special Habitats***
4. Provide net benefit	• Increased protection over time as riparian forest matures • Recovery of degraded stream habitats over time through protection & restoration • Accessibility restored to habitat • Hatchery facility, downstream habitat restoration, and improved instream flows (sections 4.3 & 4.4) ***Net benefit for all species***[4]	• All old growth protected • Fifty-fold increase in mature & late-successional forest • Elimination of early seral forest created by timber harvest ***Net benefit for all species***	• Increased protection over time as adjacent forest matures • Increased connectivity with increase in older forest ***Net benefit for all species***[5]

Species Group[1] / Objective[2]	Species dependent on: Riparian & Aquatic Ecosystem	Species dependent on: Late-successional & Old-growth Forest Communities	Species dependent on: Special Habitats
5. Manage sustainably	• Protection of riparian & aquatic habitats from impacts • Recovery of aquatic habitat from past damage, and reestablishment of more natural levels of sediment loading • Reestablishment of stream continuity at road crossings • Reestablishment of forest connectivity in wetland complexes & with riparian corridors on streams ***Aquatic/riparian ecosystem should be sustained***	• Very conservative approach with elimination of timber harvest for commercial purposes • Amount of older seral-stage forest recovering to proportion similar to pre-logging conditions in region • Forest openings created primarily by natural disturbances • Improved landscape connectivity ***Forest ecosystem should be sustained***	• Protection of Special Habitats from impacts • Protection of adjacent forests through reserve status • Restoration of adjacent forest through silvicultural intervention • Improved connectivity among Special Habitats through commitment not to harvest timber for commercial purposes ***Special Habitats should be sustained***

1 See Table 4.2-3 for species groupings.

2 See description above.

3 Passage for anadromous chinook, steelhead, and coho, and other native species will be restored at Landsburg Diversion Dam as well (Section 4.3). In addition, the HCP includes funding to increase survival of smolts of all four species passing through the Ballard Locks (Section 4.4).

4 The effects on bull trout, pygmy whitefish, and common loons from reservoir operations related to the new instream flow regime (Section 4.4) are discussed in Section 4.5.6. The incremental effects of the change in reservoir management are expected to be minor.

5 See discussion in text above.

Table 4.2-10. Summary of funding commitments and schedule[1,2] for Watershed Management Mitigation and Conservation Strategies.

Projects	Average Cost per Year[3] During Phase 1 of Implementation	Average Cost per Year[3] During Phase 2 of Implementation	Average Cost Per Year[3] Throughout Rest of HCP	Total (for entire HCP)
Habitat Restoration	HCP years 1-8	HCP years 9-16	HCP years 17-50	Total
Culvert upgrades & replacement for fish passage	$120,000	$16,250	$3,824	$1,220,000
Culvert upgrades & replacements for sediment reduction	$15,625	$15,625	$17,647	$ 850,000
LWD placement	$12,500	$46,875	$14,706	$ 975,000
Bank armoring	$19,750	$19,750	$12,941	$ 756,000
Bank revegetation	$6,625	$6,625	$3,118	$ 212,000
Conifer under-planting & long-term maintenance	$6,250	$6,250	$3,294	$ 212,000
Restoration and ecological thinning in riparian areas	$5,625	$5,625	$2,647	$ 180,000
Restoration thinning in uplands [4]	$201,750	$125,750	$0	$2,620,000
Ecological thinning in uplands [4]	$31,250	$31,250	$14,706	$1,000,000
Restoration planting in uplands	$9,375	$9,375	$4,412	$ 300,000
Road Management & Improvement	HCP years 1-5	HCP years 6-10	HCP years 11-50	Total
Road stabilization [5]	$350,000	$200,000	$112,500	$7,250,000
Road decommissioning	$250,000	$250,000	$2,500 [6]	$5,000,000
Road Maintenance Program	$93,600	$80,000	$60,000	$3,268,000
Total for 50 years				**$15,518,000**

[1] All budget estimates are made in 1996 dollars and will be adjusted for inflation and deflation.
[2] Watershed management costs associated with the monitoring and research activities discussed in Section 4.5 are not reflected in this table. For more detail on these additional funding commitments for monitoring and research see Section 4.5.
[3] Actual costs per year will depend on the projects implemented during any period of the HCP, and will vary over time.
[4] Accelerates development of late-successional forest conditions.
[5] Some funds for stabilization may be used for deconstruction (decommissioning).
[6] For HCP years 11-20.

Section 4.3 Contents

4.3 Minimizing and Mitigating the Effects of the Anadromous Fish Migration Barrier at the Landsburg Diversion Dam

4.3.1 Introduction

BACKGROUND AND PLANNING CONTEXT

Although it has been substantially altered, the Cedar River/Lake Washington subbasin of the Lake Washington Basin (Map 2) offers many features that, if properly arrayed and protected, can form the basis for a robust aquatic ecosystem. To be effective, an anadromous salmonid rehabilitation program must provide a comprehensive set of solutions that address the life history and habitat requirements of the fish from the headwaters to the sea. The institutional complexities associated with such an effort are substantial (Stouder et al. 1997). However, creative approaches for addressing the complex amalgam of human activities that affect anadromous salmonids are beginning to emerge (National Research Council 1996; Lee 1997).

During the last decade, naturally reproducing populations of anadromous fish in the Lake Washington Basin have declined in abundance. Since 1990, record low adult returns have been reported in at least one year for each of the four anadromous species in the Cedar River: chinook, coho, and sockeye salmon, and steelhead trout. Cutthroat trout populations are thought to have increased in recent years; however, most cutthroat in the basin are believed to exhibit adfluvial and fluvial life history patterns, rather than an anadromous pattern. While there have been several isolated examples of relatively strong runs of salmon and steelhead (1996 sockeye and coho returns, 1997 steelhead returns), the population trend for the four strictly anadromous populations has been one of substantial decline (see Chapter 3).

There are a number of factors that can potentially reduce the survival of anadromous fish originating from the Cedar River at various stages of their life histories, including: habitat loss and degradation as a result of a variety of land and water management activities; injury to outmigrating smolts at the Ballard Locks; harvest in sport, Tribal, and commercial fisheries; inappropriate artificial propagation practices; predation by native and non-native fish; food supplies in Lake Washington; predation by marine mammals; droughts and floods; and unfavorable ocean conditions. As a municipal water and power utility and land manager, the City can affect anadromous fish during significant portions of their freshwater life histories.

During the last 100 years, the City has gradually acquired full ownership of the upper two-thirds of the Cedar River Basin. Ownership now includes the entire watershed upstream and east of the municipal water supply diversion facilities at the Landsburg Diversion Dam (see Figure 1.2-2 and Map 2). For reasons of convenience, this area will be referred to as the municipal watershed. The City's land management activities in the municipal watershed can have a significant impact on water quality and aquatic, riparian, and upland habitat within and, to a lesser degree, downstream of the City's ownership boundary (Section 4.2).

Through the operation of its water storage and diversion facilities, the City can influence stream flow, a clearly important component of fish habitat, throughout the entire 34.5 stream miles of naturally accessible mainstem habitat between Lower Cedar Falls and Lake Washington. However, only the mainstem of the Cedar River is subject to regulation from the reservoir storage facilities formed by Chester Morse Lake and the Masonry Pool, and the diversion at Landsburg. Stream flows and habitat below the reservoir are also strongly influenced by natural, unregulated inflows. On an annual basis, the Cedar River contributes approximately one-half of the total inflow to Lake Washington and is, therefore, important in maintaining water quality in the lake, and in managing lake levels, navigation, and fish passage at the Ballard Locks.

The Landsburg Diversion Dam is a low head, run-of-the-river facility at RM 21.8 from which the City draws water for municipal and industrial use. The dam has blocked anadromous fish migration to approximately 17 stream miles of formerly accessible habitat (mainstem plus tributaries) since the early part of the twentieth century. Two Washington State statutes, passed subsequent to the construction of the Landsburg Diversion Dam, stipulate the provision of fish passage facilities or, if passage facilities are not practical, fish cultural facilities, to address the effects of migration barriers such as the Landsburg Diversion Dam. In the past, the City has consistently held that construction of the Landsburg Diversion Dam predates these state laws and is therefore not bound by them (Section 2.3.7).

However, the City supports the intent of these state laws, and it is clear that restoration of this lost element of the ecosystem can provide substantial benefits to anadromous fish populations, and it is therefore a central component of the City's HCP. To resolve any potential issues concerning the Landsburg Diversion Dam and intake under state law, the City is entering into a Landsburg Mitigation Agreement with Washington State (Appendix 28), to which NMFS and USFWS are also signatory Parties.

An additional 3.4 miles of stream within the City's ownership boundary, in the Walsh Lake subbasin, were also accessible to anadromous fish prior to the construction of the diversion dam. In 1931, the outlet of Walsh Lake was diverted from upper Rock Creek into the Walsh Lake Diversion Ditch, which empties into the Cedar River below the Landsburg Diversion Dam. The degree to which anadromous fish can presently access this former habitat through the Walsh Lake Diversion Ditch is unclear. While there appears to be at least one partial fish migration barrier in the lower portion of the channel, juvenile coho salmon have been reported in Walsh Lake and its tributaries (Section 3.2.2).

In the last several years, a number of biophysical and institutional factors in the Lake Washington Basin have become aligned in a manner that can potentially lead to the rehabilitation of once-plentiful salmonid populations. Citizens and organizations concerned with the well being of aquatic resources in the basin are using salmon and steelhead as keystone species to help better understand potential pathways for protecting and restoring aquatic ecosystems. Table 4.3-1 portrays these efforts as five general areas of activity organized along a continuum from the crest of the Cascades to the marine environment.

Table 4.3-1. Summary of anadromous salmonid conservation efforts in the Lake Washington Basin.

LOCATION	ACTIVITY	PARTICIPANTS
1. Headwaters	**Cedar River Watershed HCP**: • Protect water quality, upland, riparian, and aquatic habitat • Provide improved instream flows throughout the entire river downstream of the reservoir • Restore fish passage into 17 stream miles of refuge habitat • Provide supplemental fish production	**City of Seattle** in collaboration with federal, state, and Muckleshoot Indian Tribal resource managers
2. Lower Cedar River	**Lower Cedar River Basin Plan:** • Protect water quality, upland, riparian, and aquatic habitat • Provide recommendations for land management prescriptions and habitat restoration projects to promote protection of water quality, upland, riparian, and aquatic habitat • Coordinate initiatives throughout the subbasin • Expand public involvement and education	**King County** in collaboration with City of Seattle, City of Renton, state and Muckleshoot Indian Tribal resource managers, and interested citizens
3. Lake Washington, Lake Sammamish, and associated lowland subbasins	**Lake Washington/Cedar River and Lake Sammamish Forums**: • Protect water quality and fish habitat in Lake Washington, Lake Sammamish, and their tributaries • Fund and administer the Lake Washington Ecological Studies to determine the causes of decline in juvenile sockeye survival • Improve regional cooperation and coordination	**King County** in collaboration with municipal governments in the watershed; state and Muckleshoot Indian Tribal resource managers; and the Army Corps of Engineers
4. Estuary	**Ballard Locks Fish Passage Improvements:** • Improve facilities and operations to reduce injury, mortality, and delay during upstream and downstream migrations *Note: All anadromous fish in the basin must pass through this facility twice during their lives.*	**U.S. Army Corps of Engineers** in collaboration with state, Tribal, and federal resource managers, and the Forums
5. Ocean	**Washington Wild Salmonid Policy** and other harvest management initiatives: • Improved harvest management to meet spawning goals	**State and Tribal harvest managers**

The importance of headwater areas in protecting water quality and the biophysical processes that form stream channels and aquatic and riparian habitat has been well documented (see Naiman et al. 1992; Sedell et al. 1997). As mentioned above, the City now owns the upper two-thirds of the Cedar River Basin. Protection and rehabilitation of the natural structure and function of the landscape in the municipal watershed offers a potential foundation upon which to build a comprehensive salmonid conservation program for the Lake Washington Basin as a whole.

The City has been working with state, federal, and Muckleshoot Indian Tribal resource managers since 1989 to develop mitigation measures for the fish migration barrier at the Landsburg Diversion Dam. These efforts form the basis for the mitigation strategies presented here. By agreement, the mitigation actions have been directed at four anadromous salmonid species, chinook, coho and sockeye salmon and steelhead trout. Mitigation measures for these species will have effects on other species as well. In developing the anadromous fish components of the Cedar River Watershed HCP, we have attempted to use the conceptual framework of *rehabilitation* as described by the authors of *Upstream: Salmon and Society in the Pacific Northwest* (National Research Council 1996). Where possible, this HCP attempts to protect remaining functional components of the ecosystem, reconnect habitats that have been fragmented by anthropogenic activities, and rely on the natural regenerative capacity of the system to foster natural reproduction and production. In some situations, such as several of the measures prescribed to minimize and mitigate the effects of the anadromous fish migration barrier at the Landsburg Diversion Dam, the HCP includes elements of *substitution*, such as fish passage facilities, stream channel restoration, and artificial propagation. However, substitution measures are offered only when it is not possible to rely solely on natural regenerative processes. Substitution measures are offered as elements in a comprehensive, ecosystem-based program that attempts to allow target resources to fully benefit from natural rehabilitative processes. Because substitution measures can entail significant elements of uncertainty and risk, they have been linked to substantial monitoring and research programs and a commitment to adaptive management with broad-based oversight (sections 4.5.3, 4.5.7, 5.4, and 5.5; Appendix 28).

The Landsburg Mitigation Agreement (Appendix 28), to which both Washington State and the Services are signatories, provides for oversight of the implementation of the mitigation described in Section 4.3. The Parties to the Landsburg Mitigation Agreement will make decisions regarding operating guidelines, facility designs, monitoring plans, changes to mitigation actions and related issues. The Cedar River Anadromous Fish Committee will be established to advise the City during implementation. It will include the Parties to the Landsburg Mitigation Agreement, the Muckleshoot Indian Tribe, and other stakeholders. King County will be a member if it agrees in writing to support the HCP.

OBJECTIVES

The use of the upper portion of the Cedar River Basin for municipal water supply offers challenges and opportunities for anadromous fish. The success of efforts to rehabilitate Cedar River salmon and steelhead will depend, in large part, on our ability to manage the challenges while implementing creative solutions that allow the opportunities to unfold for the fish. The objectives established for this element of the HCP support the goal of avoiding, minimizing, and mitigating the incidental take of species listed as threatened or endangered, and the HCP treats unlisted species of concern as if they were listed. However, the objectives go beyond this goal and, like the more comprehensive planning objectives presented in Section 2.4, call for a program that: (1) provides a net benefit to the species covered in the plan; and (2) substantially contributes to the recovery of species that are currently listed or that might be listed in the future. The specific objectives listed below were developed to help guide the City’s efforts to avoid, minimize, and mitigate the effects of the migration barrier at the Landsburg Diversion Dam in a manner that helps anadromous fish and their habitat thrive while preserving and protecting the municipal water supply. These objectives include:

(1) Implement biologically sound short- and long-term solutions that help provide for the recovery and persistence of well-adapted, genetically diverse, healthy, harvestable populations of sockeye, coho, and chinook salmon, and steelhead trout in the Cedar River;

(2) Provide fish passage over the Landsburg Diversion Dam, consistent with drinking water quality protection, and in a manner that is coordinated with run recovery, biological need, water supply operations, and facility maintenance requirements;

(3) Maintain a safe, high-quality drinking water supply;

(4) Implement solutions that have a high likelihood of success and that provide substantial value for target resources and the ecosystems upon which they depend;

(5) Coordinate with and support other compatible rehabilitation activities to help realize the full benefits offered by aquatic resource conservation efforts in the Lake Washington Basin; and

(6) Design and implement measures that satisfy any mitigation obligations the City may have for the fish migration blockage created by the Landsburg Diversion Dam as defined by state and federal law and pursuant to City ordinance and initiatives.

OVERVIEW OF ANADROMOUS FISH CONSERVATION MEASURES

To meet the above objectives, the City has developed interim and long-term conservation strategies that cover four anadromous salmonid species. Long-term measures for chinook, coho, and steelhead are based upon provisions to allow the fish to recolonize their formerly occupied habitat upstream of the Landsburg Diversion Dam. Recent analyses, completed as part of the development of the HCP, demonstrate that the presence of steelhead, coho, and chinook, if carefully monitored, is very unlikely to pose a risk to drinking water quality (Appendix 5; Section 3.3.5). The analyses also demonstrated that, because of the unique life history pattern of sockeye salmon that typically results in a much larger spawning population size, fish passage is not advisable as a mitigation solution for sockeye. Therefore, a separate, additional mitigation component, based on an artificial propagation program, is provided for sockeye salmon.

A significant period of time will be required to complete final design, permitting, and construction of long-term mitigation facilities. During this time, it is quite possible that Cedar River anadromous fish populations will continue to decline. Therefore, the City will begin providing interim conservation measures immediately in HCP year 1 (Section 4.3.2).

The City's interim and long-term commitments have been designed in a manner that attempts to assure that anadromous fish receive maximum benefit from the rehabilitative measures prescribed in the plan. The provisions to avoid, minimize, and mitigate the impacts of the anadromous fish migration barrier at the Landsburg Diversion Dam form one component of a more comprehensive anadromous fish conservation strategy embodied in the HCP as a whole. The measures described here are linked to and rely on two additional key components of the HCP: (1) the City's commitments to protect, restore, and reconnect upland, riparian, and aquatic habitat in the upper two-thirds of the basin, as described in Section 4.2; and (2) the City's commitments to provide beneficial instream flows, as described in Section 4.4, throughout the 34.5 mile reach of mainstem habitat historically accessible to anadromous fish. The hatchery will encourage the recovery of the naturally spawning sockeye population in the lower Cedar River by increasing the survival potential of returning sockeye through artificial propagation. As mentioned previously, the provisions of the HCP should themselves be viewed as one element in a broader, basin-wide restoration initiative in the Lake Washington system that addresses all life history stages of the four anadromous species (Table 4.3-1).

The following section, Section 4.3.2, first describes the specific approach and conservation measures applied to each of the two groups of anadromous fish, followed by a discussion of the underlying rationale used in the development of the respective conservation strategies. Next, Section 4.3.3 briefly discusses the objectives and major components of the monitoring and research program (which are fully detailed in Section 4.5). Finally, Section 4.3.4 summarizes the anticipated effects of the conservation strategies.

4.3.2 Conservation Strategies

BASIC APPROACH

Charged by the National Research Council with the task of developing options for improving the prospects for the long-term sustainability of salmon in the Pacific Northwest, the authors of *Upstream: Salmon and Society in the Pacific Northwest* (National Research Council 1996) recommend an approach they call "rehabilitation," which they define in the following manner:

> …a pragmatic approach that relies on natural regenerative process in the long term and selected use of technology and human effort [substitution] in the short term - rather than on attempts to restore the landscape to some pristine former state and rather than on a primary reliance on substitution, i.e., the use of technologies and energy inputs, such as hatcheries, artificial transportation and modification of stream channels. Rehabilitation would protect what remains in an ecosystem and encourage natural regenerative processes.

Wherever possible, the HCP provides anadromous fish conservation measures that employ the rehabilitative approach described above. However, this approach could not be used in all situations because the Cedar River is located near and partially within the largest metropolitan area in the state and provides two-thirds of the municipal water supply to 1.25 million people. Therefore, the plan also employs additional substitution measures in an effort to realize the full benefit of the program's rehabilitative features.

CONSERVATION STRATEGY FOR CHINOOK AND COHO SALMON AND STEELHEAD TROUT

Four facilities are prescribed to provide safe upstream and downstream passage of migrating chinook, coho, and steelhead into and out of the municipal watershed upstream of the Landsburg Diversion Dam: (1) a fish ladder at the Landsburg Diversion Dam; (2) a fish ladder and holding and sorting facilities at the partial migration barrier created by the City's water supply line crossing approximately 1/3 mile downstream from the Landsburg Diversion Dam; (3) downstream fish passage facilities at the Landsburg Diversion Dam; and (4) new screening facilities on the municipal water supply intake to minimize juvenile fish injury or migration delays. Once fish passage facilities are completed, all native fish species in the Cedar River, with the exception of sockeye salmon, will be allowed access to the municipal watershed through the fish passage facilities.

Several factors are likely to affect the schedule for the construction of fish passage and protection facilities for steelhead, chinook, and coho. These include the need to: upgrade the 65-year-old Landsburg Diversion Dam to support new facilities for fish; coordinate construction with other facility improvements that are necessary for continued compliance with drinking water regulations; provide for protection of the dam during floods; and provide the normal time required for environmental assessment, facility design, permitting, and construction. However, the City also understands the potential importance of providing 17 miles of protected refuge habitat for anadromous fish populations in the Lake Washington watershed. Therefore the City will make every effort to complete the planning design and construction of upstream and downstream fish passage facilities by the end of HCP year 3. Oversight of the design, construction and operation of the fish passage facilities will be provided by the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee.

Prior to the completion of fish passage facilities, the City will provide interim funding to mitigate for the effects of migration barrier. This funding will be allocated as agreed upon by the Parties to the Landsburg Mitigation Agreement, with advice from the interagency Cedar River Anadromous Fish Committee, to support studies required to fill key information gaps and/or provide interim artificial propagation for one or more of the populations.

Design and permitting for fish passage and protection facilities will commence immediately upon federal approval of the HCP. Initiation of construction will be subject to the City's ability to gain the necessary permits and complete the SEPA/NEPA review process. If construction is delayed, the City will continue to provide interim mitigation as directed by the Parties to the Landsburg Mitigation Agreement.

Interim Measures for Chinook, Coho, and Steelhead

With Lake Washington chinook and coho salmon populations in decline and steelhead trout showing only tentative signs of recovery after dropping to record low levels in the early 1990s, rehabilitation efforts should start immediately. Toward that end, the City will begin providing funds for interim mitigation measures in HCP year 1, immediately after the plan is approved.

Prior to the construction of fish passage, the City will implement interim restoration measures for steelhead, coho, and chinook based on the following primary objectives: (1) gather biological information that is critical in designing and managing effective, biologically sound short- and long-term conservation measures; and (2) if appropriate, design and implement broodstock augmentation programs to help preserve one or more of the populations. Appropriateness of augmentation measures will be determined jointly by agreement of the Parties to the Landsburg Mitigation Agreement (Appendix 28), which includes the USFWS and NMFS, with advice from the Cedar River Anadromous Fish Committee. The City will commit up to $90,000 per year until all fish passage facilities have been constructed to implement either one or a combination of the following two interim mitigation measures, as agreed upon by the Parties:

- Conduct studies of life history, genetics, or demographics of the populations to support the development of the most appropriate measures to protect and rehabilitate the runs over the long-term; and
- Develop and implement an emergency artificial propagation program to help preserve one or more of the runs and prevent extinction, loss of genetic diversity, or loss of adaptive capacity associated with extremely small population size.

Emergency supplementation of chinook, coho, or steelhead will only be used as interim mitigation if the Parties to the Landsburg Mitigation Agreement all agree that:

- Such intervention is needed for the purpose of population support;
- Supplementation can be conducted without significant risks to the population being supplemented;
- Risks of supplementation can be effectively monitored and managed adaptively to protect the long-term genetic integrity and demographic viability of the target population; and
- Risks of supplementation of the target population will not result in significant risks to non-target salmonid populations.

Long-term Measures for Chinook, Coho, and Steelhead

Introduction

The City considers the provision of suitable upstream and downstream fish passage facilities at the Landsburg Diversion Dam as full mitigation for chinook, coho, and steelhead during the period for which the passage facilities are in operation. The habitat protection and restoration measures described in Section 4.2 for the City-owned municipal watershed upstream of the Landsburg Diversion Dam and the instream flow protection measures described in Section 4.4 will provide additional benefits by maintaining and protecting a significant freshwater refuge habitat for these species. Conceptual designs and cost estimates have been developed for all fish passage and protection facilities in collaboration with federal, state, and Tribal fish resource managers and are summarized in Appendix 6. Final facility design and construction will be guided by federal and state fish passage criteria and overseen under the terms of the Landsburg Mitigation Agreement.

The City based its funding commitment for the design, permitting and construction of the fish passage and protection facilities on the designs and projected costs identified in Appendix 6 and believes that these funding levels are sufficient. However, against the possibility that the committed funding levels may not be adequate, a special design contingency fund of $583,000 will be established by the City that is outside the cost caps and funding amounts described elsewhere in this HCP. As described in the Landsburg Mitigation Agreement (Appendix 28), this fund can be used, if needed, for construction of passage and protection facilities to achieve the objectives of the agreement. Fish passage facility design will commence immediately in HCP year 1. The target completion date for construction of all fish passage facilities is the end of HCP year 3.

Upstream Fish Passage

The City will provide up to $965,000 for the design, permitting, and construction of an adult fish ladder at the Landsburg Diversion Dam. The City will also provide up to $1,046,000 for the design, permitting, and construction of a fish ladder and fish holding and sorting facilities at the partial fish barrier created by the SPU water supply line that crosses under the Cedar River at Landsburg Park, approximately 1/3 mile downstream of the Landsburg Diversion Dam.

Upstream fish passage facilities at both locations will be constructed according to federal and state criteria to minimize migration delay and provide safe and efficient passage upstream of the migration barriers. Fish sorting and holding facilities will be designed to allow safe and efficient sorting of coho and chinook from the more numerous sockeye and to provide for the safe and efficient return of sockeye to the river downstream of the passage facilities.

Downstream Fish Passage

With the present configuration at the Landsburg Diversion Dam, downstream migrating juvenile and adult fish must pass over the radial spill gates on the dam and may be injured as they strike suspended spill gate supports and the concrete apron below. To reduce this risk, an alternative downstream passage route will be provided. The City will provide up to $958,000 for the design, permitting, and construction of downstream fish passage facilities at the Landsburg Diversion Dam.

Facilities will be designed and constructed to ensure the safe passage of juvenile and adult fish past the dam and into the plunge pool downstream over a broad range of flows. The configuration of downstream passage facilities will be designed to complement entrance conditions at the downstream end of the fish ladder.

Fish Screening Facilities

The present screening facility at the municipal water supply intake on the Cedar River at the Landsburg Diversion Dam does not meet federal and state fish protection standards and poses a risk of mortality for under-yearling fish. To reduce this risk, the City will provide up to $2,859,000 for the design, permitting, and construction of fish screening facilities at the Landsburg Diversion Dam.

Fish screens will be designed to meet federal and state criteria for protecting young-of-the-year salmonids from injury at the intake facilities over the full range of flows that can be diverted into the water supply lines at Landsburg. In addition to screens, an appropriate bypass pathway will be provided for downstream movement of fish past the screen and diversion facilities. Appropriate screen cleaning facilities will be provided to ensure that screens will remain in operation continuously over a wide range of stream flows.

Fish Passage Facility Operations and Maintenance

Once fish passage facilities are constructed, the City will provide up to $50,000 per year for passage facility operation and maintenance for the term of the HCP.

Water Quality Monitoring

Once fish passage facilities are in operation, the City will provide up to $10,000 per year for up to 6 years to implement a water quality sampling program to monitor the effects of coho and chinook salmon spawning carcasses on drinking water quality (Section 4.3.3). Pending the results of this monitoring program, the number of adult salmon allowed to pass over the diversion dam may be adjusted either upward or downward from the allowable maximum target of 46,500 pounds of spawning carcasses, based on 1,000 chinook and 4,500 coho salmon. If, in the future, the number of fish allowed to pass upstream must be adjusted downward to protect drinking water quality, the City will provide up to $30,000 per species per year, prorated according to the deficit (based on the target) in the biomass of chinook and coho passed, for alternative mitigation as agreed upon by the Parties to the Landsburg Mitigation Agreement, with advice from the Cedar River Anadromous Fish Committee. If agreement on alternative mitigation cannot be reached by the Parties, then the City will spend the remaining funds for fish habitat acquisition, restoration, enhancement or monitoring in the Lake Washington Basin (Appendix 28). The City will also provide $60,000 in HCP year 1 to help fund collaborative studies with NMFS regarding recolonization of habitat within the municipal watershed by anadromous fish (Section 4.5.3).

Fish passage Facility Monitoring

The City will provide up to a total of $110,000 during the first 12 years after completion of upstream fish passage facilities to monitor adult fish passage and to better understand run timing, the rate of passage, and the rate at which the populations recolonize previously blocked habitat. Once fish screening facilities are constructed, the City will provide up to $15,000 to perform hydraulic analyses to refine flow characteristics of the screens to demonstrate conformity with hydraulic parameters established during the design of the facilities.

Land and Water Management Practices in the Municipal Watershed

Stream habitat throughout the Lake Washington Basin has been significantly degraded by human activities during the twentieth century. Productive spawning and rearing habitat is of vital importance for the recovery and persistence of salmonid resources. Much productive fish habitat has been lost in the basin, and that which remains is subject to increasing risk from development pressures. The reconnection of the Cedar River above the Landsburg Diversion Dam with the rest of the ecosystem that supports anadromous fish offers an opportunity to reverse this trend and provide a substantial increase in the quantity and quality of anadromous fish habitat available in the Lake Washington Basin.

The subbasin between Landsburg and Lower Cedar Falls, and the entire watershed above it, are wholly owned by the City of Seattle and will be managed according to the commitments described in section 4.2 of this HCP. The land management prescriptions in the HCP will effectively create a watershed ecological reserve consisting of the entire municipal watershed, because no timber harvest for commercial purposes will be allowed in the watershed. Land management practices in the municipal watershed will be designed exclusively to protect water quality, aquatic, riparian and upland habitat and the natural ecological processes that form and maintain habitat. Watershed management conservation and mitigation measures include a substantial road decommissioning and improvement program designed to reduce sediment loading to streams, culvert replacement at stream crossings to improve degraded habitat conditions and restore aquatic habitat connectivity throughout the entire municipal watershed, and silvicultural interventions to restore riparian and upland forests. These commitments will help protect, restore, and reconnect aquatic and riparian habitat and the processes that create and maintain habitat complexity and integrity throughout the natural range of anadromous fish upstream of the Landsburg Diversion Dam.

The instream flow protections described in Section 4.4 will further help protect the quality of aquatic habitat in this area by providing assurance that flows throughout the majority of the reach between Landsburg and Lower Cedar Falls will remain near or above the flows that provide maximum habitat availability (Maximum Weighted Usable Area) for key life history stages of all three anadromous species throughout the year. In addition, instream flow prescriptions ensure continuous delivery of rearing flows in the bypass reach between Masonry Dam and the Cedar Falls hydroelectric facility. Once anadromous fish are present in the river above Landsburg, downramping prescriptions will be implemented to moderate the rate at which City operations may reduce stream flows to decrease the risk of stranding juvenile fish. And finally, fish barriers will be installed at the tailrace of the Cedar Falls hydroelectric project to minimize injury to fish migrating upstream.

CONSERVATION STRATEGY FOR SOCKEYE SALMON

The City's short- and long-term mitigation commitments for sockeye salmon are derived from direction provided by Senate Bill 5156, passed in 1989 by the Washington State Legislature and codified in R.C.W. 75.52, and by the work of the formal interagency policy and technical committees established by this legislation. Senate Bill 5156 enables the City to receive full mitigation credit under state law for the effects of the migration barrier on sockeye salmon in exchange for funding the planning, design, construction, and operation of a facility to produce sockeye fry, "comparable in quality to those produced in the Cedar River and in equal number to what could be produced naturally by the estimated 262,000 adults that could have spawned upstream of the Landsburg diversion."

The City will provide funding for a comprehensive sockeye mitigation program with four primary components:

(1) Continuation of the Landsburg interim sockeye hatchery program for an additional 4 years;

(2) After HCP year 4, implementation of a long-term artificial propagation program that will be capable of meeting the mitigation goals described in the state legislation and help ensure that relatively large and robust populations of sockeye fry are recruited into Lake Washington each year;

(3) A monitoring and research program to provide the scientific foundation for adaptively managing the mitigation program to minimize risk and help ensure that a diverse, well-adapted sockeye population remains an integral component of a robust aquatic ecosystem in the future; and

(4) Restoration or protection, or both, of sockeye spawning habitat in the lower 21.8 miles of the Cedar River, downstream of the City's ownership boundary (see also Section 4.4.2).

Interim Measures for Sockeye Salmon

Introduction

Because of the complex and comprehensive nature of the long-term sockeye mitigation program, the City estimates that planning, design, permitting, and construction activities for artificial propagation facilities will require approximately 4 years to complete. Returns of Cedar River sockeye salmon have generally declined in recent years. The average return between 1989 and 1996 was 135,000, while it was nearly

243,000 between 1967 and 1988. The lowest return on record occurred in 1995. The City will implement interim measures prior to completion of long-term mitigation facilities in an effort to slow the rate of decline in the population and to gather additional information that will be useful in managing the long-term mitigation program.

In 1993, the Cedar River Sockeye Policy Committee decided to postpone construction of a proposed sockeye spawning channel and to initiate a 5-year, emergency sockeye recovery effort to reverse the precipitous decline of Lake Washington sockeye salmon populations and to gather the information required to develop and implement an effective long-term sockeye mitigation program. The emergency recovery effort is composed of two major components: the Landsburg Interim Sockeye Hatchery Program and the Lake Washington Ecological Studies (Section 2.3.8). The interim hatchery program, begun in 1991, has three primary objectives: (1) to slow the rate of decline in the sockeye population by augmenting fry production from the Cedar River; (2) to test the efficacy of recently developed sockeye salmon culture techniques in the Cedar River (McDaniel 1994); and (3) to provide a large number of differentially marked fish to support the second program component, the Lake Washington Ecological Studies. The primary objective of the Lake Washington Ecological Studies Program is to determine the factors contributing to reduced juvenile sockeye salmon survival in Lake Washington and to make recommendations for improving in-lake fry-to-smolt survival. Information gathered during the emergency recovery effort has been, and will continue to be, used to guide the development of the long-term mitigation program.

Extended Funding for the Landsburg Interim Sockeye Hatchery

Established as a prototype facility in 1991, the Landsburg interim sockeye hatchery has been operated by the WDFW under a series of cooperative funding agreements with the City (Appendix 2). It has successfully produced healthy, high-quality sockeye fry for release into the Cedar River every spring for the past 7 years. Since 1991, production has been gradually increased from 2,000,000 to 14,000,000 fry. All fry have been successfully marked while in the incubators using recently developed otolith (ear bone) marking techniques that use minor variations in incubation water temperature to create differential banding patterns on the developing otoliths of larval fish (Volk et al.1990). Prototype testing is considered well advanced at this time, and many of the functional elements and procedural insights developed during the testing will be used as the basis for final design of the long-term artificial propagation facility.

Operations at the interim sockeye hatchery have demonstrated that the incubation period in the hatchery is usually shorter than that of fry produced by natural spawning. Two potential causes are the slightly warmer winter temperature of spring-fed incubation water in the hatchery compared to water temperature in the river and the tendency toward shorter development periods in hatcheries. A slightly shorter incubation period could have ramifications on in-lake fry survival rates due to concomitant effects on the timing of fry emergence, release, and entry into Lake Washington. Also, egg take timing is closely associated with emergence timing, and the egg take schedule for the hatchery needs to match the timing of the run in so far as possible. Facilities will be designed to include the ability to chill incubation water, to allow volitional fry emergence and release, and to rear fry for up to two weeks in order to more closely simulate the condition of naturally produced fish (if determined to be appropriate after experimental testing; see next subsection). In an effort to promote a thoughtful, stepwise approach to the mitigation program, and to continue to provide support for the sockeye population, the City will extend its funding of the interim hatchery program. Under a current Memorandum of Agreement (Appendix 2), the City will fund the operation of the Landsburg interim hatchery. Beginning no later than HCP year 1, and continuing through HCP year 4, the City will provide up to $256,000 per year to cover the costs of producing up to 16 million fry at the Landsburg Interim Sockeye Hatchery. In addition, the City will initiate a comprehensive monitoring and research program to evaluate program effectiveness and manage risks (see Section 4.3.3).

Fry-rearing Evaluations

Results from the prototype hatchery suggest that the hatchery-produced fry tend to emerge and outmigrate to Lake Washington slightly earlier than naturally produced fry (Seiler and Kishimoto 1997). It has been hypothesized that by rearing artificially produced sockeye fry for a short period of approximately 2 weeks operators may be able to more closely simulate the condition and timing of naturally produced fry emerging from the Cedar River and will therefore enable hatchery fry to perform and behave in a manner more similar to naturally produced fry. To test this hypothesis, the City will provide up to $65,000 during a selected 4-year period between HCP years 1 and 8 to short-term rear specially marked sample groups of fry for approximately 10 days to 2 weeks prior to release into the system.

If the Parties to the Landsburg Mitigation Agreement agree, prior to its initiation, not to pursue this feeding program or to terminate the program before it is complete, then the Parties, in consultation with the Cedar River Anadromous Fish Committee, may agree to instruct hatchery operators to try other approaches to delay fry movement into the lake until food supplies might increase.

Long-term Measures for Sockeye Salmon

Introduction

The primary objective of long-term mitigation measures for sockeye is to implement an effective, comprehensive, and biologically sound artificial propagation program that has the capacity to produce up to 34 million sockeye fry annually. These fry must be comparable in quality to naturally produced fry and must be produced in a manner that preserves the long-term reproductive fitness and genetic diversity of the Cedar River sockeye population, while minimizing genetic, ecological, and demographic risks to other wild salmonid populations in the Lake Washington Basin.

To help meet these objectives, the City commits to a monitoring and adaptive management program with the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee. This program is summarized below and described in Sections 4.3.3 and 4.5.3. Decisions regarding long-term and annual facility production targets for sockeye fry are under the purview of the fisheries co-managers -- the WDFW and the Muckleshoot Indian Tribe, -- and the Parties to the Landsburg Mitigation Agreement

Artificial Propagation Facility

The City has agreed to follow the recommendation of the Cedar River Sockeye Technical and Policy Committees to construct a hatchery with the capacity to produce up to 34 million sockeye fry per year. As described in Appendix 26, the Cedar River Sockeye Technical Committee recommended that a hatchery, rather than the originally planned spawning channel, should be pursued. Committee members concluded that a spawning channel would pose relatively higher, less manageable risks. The committee also recommended that fry release be incrementally increased over time, and that habitat enhancement and protection efforts should also be a priority for all resource management agencies involved in the Cedar River Basin.

The hatchery program will employ recently developed sockeye culture techniques, as further refined during prototype testing at the Landsburg interim hatchery, to help ensure the production of robust, disease-free fish.

The City will provide up to $7,678,000 during HCP years 1-4 for planning, design, permitting, and construction of a sockeye salmon hatchery. Beginning in HCP year 5, the City will provide up to $300,000 per year to fund facility operations (see Appendix 28). The production facility will consist of five major components: (1) water collection and delivery facilities to provide up to 4 cfs of high-quality, disease-free fresh water; (2) an incubation facility with the capacity to successfully incubate approximately 37 million sockeye eggs and larval fish according to sockeye culture disinfection and isolation protocols; (3) emergent fry collection, short-term holding, and transport facilities for the release of 34 million fry; (4) broodstock trapping, collection, transport, and holding facilities capable of capturing up to 27,000 adult Cedar River sockeye per year from a representative sample of the run between mid-September and mid-December; and (5) various operations and staff support facilities. The Parties to the LMA will ensure that a comprehensive public involvement and environmental review process for the long-term hatchery program is carried out prior to the end of HCP year 3 when the Parties will make final decisions regarding the production capacity, design, operating guidelines, and adaptive management features for the hatchery program. If the total cost of hatchery facilities or their operation is less than the amount provided above, then any savings may be used to provide further benefits to any or all anadromous salmonid species, including chinook salmon, as directed by the Parties in consultation with the Cedar River Anadromous Fish Committee.

Habitat Restoration

Protection and restoration of naturally spawning sockeye salmon and their habitat is vital to successful long-term recovery of sockeye salmon in the Lake Washington Basin. The City will provide $1,637,000 to protect and restore fish habitat in the lower Cedar River downstream of the City's ownership boundary (see Section 4.4.2 for additional downstream habitat funding commitments). Projects will be designed in a manner that will benefit any or all anadromous salmonid species, especially chinook salmon, and enhance natural ecological processes that shape and maintain riparian and aquatic habitat. Projects may be selected from the many mainstem protection and rehabilitation opportunities identified in King County's Cedar River Basin Plan (King County 1993). The dispensation of these funds will be allocated at the discretion of the Parties to the Landsburg Mitigation Agreement, with advice from the Cedar River Anadromous Fish Committee, and may be directed into passive, rehabilitative approaches, such as riparian habitat acquisition, if the Parties agree. The funds for habitat restoration will become available in HCP years 2-4.

Managing the Risks: Program Guidelines, Research, and Monitoring

A number of sources have detailed the problems associated with the misapplication of artificial propagation in the past and have cautioned against the continued misuse of this approach in the future (Hard et al. 1992; Hilborn 1992; National Research Council 1996; Reisenbichler 1997; WDFW 1997b). In many years, the number of fry released from the hatchery will represent a significant portion of the total sockeye fry produced in the Lake Washington Basin. Clearly, the artificial propagation program should not be viewed in isolation from the many rehabilitative features of the HCP. Nor should the risks associated with a relatively high energy, technological approach be dismissed.

Prototype testing with the interim hatchery since 1991 indicates that it is quite feasible to consistently produce healthy, high-quality sockeye fry in a hatchery setting using recently developed protocol for managing the fish health risks associated with IHNV (McDaniels et al. 1994). Data from the 1997 adult returns are presently being analyzed by the WDFW and will provide the first substantial body of information on the rate at which hatchery fry survive to adulthood. This recently collected data set is still being analyzed and will require corroboration with data collected in subsequent years to adequately address a number of the uncertainties associated with the sockeye fry production program. The City recognizes that, while the sockeye fry production program offers potential benefits for the population, it also entails a level of uncertainty and risk.

Because the origin of the sockeye run in the Cedar River is believed to be the Baker River in northern Washington State, the NMFS does not consider the Cedar River stock to be part of a recognized Evolutionarily Significant Unit (ESU) under the ESA (Fed. Reg., Vol. 63, No. 46, pp. 11749-11771). Thus, potential adverse genetic changes in the Cedar River population potentially caused by artificial production are of concern for the well being of wild spawning sockeye, but are not an issue under ESA (Waples 1998).

However, the sockeye in Bear Creek, a tributary to the Sammamish River, could possibly be of natural origin and are at least *potentially* part of an ESU (Waples 1998). The Bear Creek population is not currently believed to be in danger of extinction nor likely to become endangered in the foreseeable future if present conditions continue (Fed. Reg., Vol. 63, No. 46, pp. 11749-11771).

There are a number of types of risk associated with operation of the proposed artificial propagation program (Waples 1998):

- Genetic risks to the Bear Creek population of sockeye (a provisional ESU) that could result from straying of Cedar River fish into Bear Creek, with particular concern for fish of hatchery origin;
- Genetic risks to the Cedar River population that could result from a large number of hatchery produced adults interbreeding with fish of natural origin, with potential for loss in reproductive fitness over time; and
- Ecological risks to other naturally reproducing salmonids in the Lake Washington Basin, such as spawning interactions and transfer of diseases.

Another risk associated with the sockeye mitigation program involves the collection of broodstock. The operation of traps in tributaries to the Columbia River to collect broodstock for supplementation efforts have sometimes failed to obtain a representative subset of the target population, delayed migration to target and non-target stocks, or resulted in the redistribution of the spawning population (Bugert 1998). During sockeye broodstock collection in the Cedar River, chinook salmon and early coho salmon will also be migrating upstream. Depending on the design and operation of broodstock collection facilities, the migration and spawning distribution of non-target species such chinook and coho can be affected to some extent. Annual facility installation and removal activities can also potentially affect migrating and spawning fish and their redds.

However, there are also demographic risks (risks of extinction) to the Cedar River/Lake Washington sockeye population if overall population size becomes very low. If the return per spawner ratio of the past ten years persists, and measures to reverse this trend are not implemented, the population could be reduced to extremely low levels within as little as two or three generations. It should also be noted that *any* measure that increases the production of sockeye from the Cedar River, or from any other streams in the Lake Washington Basin that may contain Baker River stock, could lead to more straying into Bear Creek and other north end creeks and to increased ecological interactions with other salmonids in the basin.

Kapuscinski (1997) suggests two guiding principles for the use of artificial propagation in rehabilitating Pacific salmon:

> …(1) use hatcheries only as part of a comprehensive rehabilitation strategy, with rigorous adherence to adaptive management and (2) ensure that all hatchery programs maintain genetic diversity between and within salmon populations and avoid disruption of all other levels of biodiversity in salmonid watersheds.

As part of the sockeye mitigation program, the City intends to implement these principles, first, through the development of rigorous pre-project planning, and, second, through implementation of an effective monitoring and adaptive management program (see Kapuscinski and Miller 1993; Kapuscinski 1997).

Prior to final design, construction, and operation of the hatchery facility, program guidelines will be developed to maximize the chances for long-term success and minimize potential negative impacts on naturally reproducing salmonids in the Cedar River and elsewhere in the basin. The City will provide up to $32,000 in HCP year 1 for the development of specific guidelines to support the design and management of the long-term sockeye fry production program to help ensure the long-term success of the program and minimize genetic and ecological risks.

The hatchery facility and operating budgets have been designed to meet the following initial guidelines:

- Broodstock will be taken only from sockeye returning to the Cedar River;
- Broodstock will be collected randomly from a representative sample of the entire spawning population continuously from mid-September through mid-December;
- The number of fish collected for broodstock may be as great as 27,000 fish per year, but will never be greater than 50 percent of the total number of fish returning to spawn in the Cedar River;
- Matings will be randomized and conducted at a ratio of one male to one female, unless other protocols can be developed to more closely simulate natural mating selection (Waples 1998);
- Fish culture and fish health management practices will strictly adhere to established sockeye culture protocol (McDaniel et al. 1994) to minimize the risks associated with the IHN virus and ensure the production of healthy fry;
- All hatchery fry will be marked by manipulating incubation temperatures to place an identifying series of bands on their otoliths (Volk et al. 1990);
- Emergent fry will be allowed to volitionally outmigrate from incubators;
- Fry will be released into the Cedar River and allowed to outmigrate to Lake Washington in a manner that approximates the timing of emergence and outmigration of naturally produced fry;
- Although it may be necessary to hold early emerging fry for a short period of up to 2 weeks to ensure that the developmental condition and timing of hatchery fry migration into Lake Washington corresponds with that of naturally produced fry, there will be no extended rearing of hatchery fry;
- Fry production will be increased gradually while monitoring forage conditions in Lake Washington and the performance of wild and hatchery produced fry;
- Fry production for any given year may be set at less than maximum facility capacity in response to information gained from the monitoring program or other considerations; and
- Fry production for any given period may be limited if monitoring indicates a level of straying of hatchery fish into Bear Creek that exceeds the threshold for acceptable straying rate as established by the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee.

Prior to beginning final design of the long-term fry production facility, the City will sponsor a process that will reexamine the potential genetic and ecological risks associated with the sockeye mitigation program. The results of this exercise will be used to refine facility design criteria and operating protocols in conjunction with the monitoring results from the interim hatchery program. Final approval of the hatchery design, capacity, operating guidelines, and adaptive management program by the Parties to the Landsburg Mitigation Agreement will be deferred until the end of HCP year 3 to allow sufficient time to complete the Lake Washington ecological studies, gather sufficient information on adult returns and other aspects of the interim hatchery program, develop operational guidelines, finalize the adaptive management program, determine the replacement hatchery capacity, and complete a project-specific environmental review.

The sockeye broodstock collection program has two primary objectives: (i) to capture an adequate number of adult sockeye salmon in a manner that provides a representative subset of the entire Cedar River sockeye population, and (ii) to avoid and minimize any impacts the program may have on naturally reproducing fish in the Cedar River. In 1999, the Cedar River Technical Committee developed and implemented interim operational guidelines for the existing broodstock collection weir that were designed to help meet these objectives. Beginning in HCP year 1, the City will provide up to $200,000 to evaluate alternative broodstock collection methodologies, analyze the potential effects of these methodologies, and develop solutions that will avoid and minimize potential negative impacts on naturally reproducing fish while effectively capturing sufficient sockeye broodstock to meet program goals. Additional considerations in the selection of broodstock collection facilities will be to minimize, insofar as possible, impacts on nutrient and substrate movement within the river and the risk of loss or damage to broodstock collection facilities or equipment during floods.

Specific aspects of the design and operation of interim and long-term sockeye broodstock collection facilities will be further refined during the development of program guidelines and long-term facility design by the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee. Prior to the end of HCP year 3, long-term broodstock collection facilities and practices will be described and reviewed as part of a project-specific environmental review for the long-term sockeye mitigation program. The City believes that the potential risks associated with installation, operation, and removal of interim and long-term broodstock collection facilities can be minimized and avoided through the development of a rigorous broodstock collection protocol and implementation of improved broodstock collection practices beginning in HCP year 1.

The City will provide up to $3,473,000 for monitoring and research (Section 4.5.3) to help ensure the success of the mitigation program and to reduce the risk of deleterious effects on naturally reproducing sockeye salmon. Monitoring and research activities will commence in year 1 of the HCP and will be overseen by the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee. Specifically, the monitoring program is focused on the following questions:

- Are hatchery-produced sockeye fry developmentally, morphologically, and behaviorally similar to naturally produced sockeye fry in the Cedar River?
- Are morphological and behavioral characteristics (such as adult body size, run timing, and spawning distribution) of hatchery-produced fish different from naturally produced fish in the Cedar River?
- Do hatchery fry survive at the same rate as naturally produced fry?
- Can the molecular genetic attributes of hatchery-produced fish be distinguished from those of naturally produced fish?
- Is the reproductive fitness of the Cedar River sockeye population changing over time as a result of the mitigation program?
- Is the mitigation program increasing the rate at which Cedar River sockeye stray into the north Lake Washington tributaries to levels that pose an unacceptable level of risk to the genetic diversity and adaptive character of the population as a whole?
- Is the carrying capacity of the lake sufficient to support the supplemental fry without negatively affecting naturally produced sockeye fry from the Cedar River and elsewhere in the basin?
- Does the artificial production program pose a significant health risk to naturally reproducing salmonids in the Lake Washington Basin?

The monitoring program will also be refined and reexamined prior to the construction of the long-term sockeye mitigation facility. Results from the monitoring program will be used by the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee, to manage the implementation of the sockeye mitigation program.

Program Oversight and Provisions for Adaptive Management

The interim and long-term mitigation and monitoring programs will be overseen by the Parties to the Landsburg Mitigation Agreement, in consultation with the Cedar River Anadromous Fish Committee. The Parties to the Landsburg Mitigation Agreement will use the results of the monitoring and research program (sections 4.3.3 and 4.5.3) to evaluate the performance of the program and agree on program alterations. The Parties will approve annual operating and monitoring plans, review annual operating and monitoring reports, and govern annual operating plans and procedures.

As specified in Appendix 28, the adaptive management program for the sockeye fry-production program will include a number of important provisions. First, key objectives will be established for the sockeye fry-production program as follows:

- The replacement sockeye hatchery should be designed with the capacity to produce up to 34 million fry;
- The program should be designed to produce fry that are similar in quality to those that are produced naturally;
- The program should avoid or minimize detrimental impacts on the reproductive fitness and genetic diversity of naturally reproducing sockeye salmon populations in the Cedar River and Bear Creek subbasins; and
- The program should avoid or minimize detrimental ecological impacts on native salmonids throughout the watershed.

Second, during HCP year 1, the Parties will develop guidelines to govern the design, construction, operation, and monitoring phases of the sockeye fry production program. These guidelines will include procedures for developing and modifying annual production targets.

Third, the Parties recognize that adaptive responses to emerging issues are desirable in management of the hatchery and the monitoring program. The Parties also recognize that circumstances might occur that could cause them to modify expected outcomes that could result in an inability to achieve production objectives, and that the City will not be responsible for such circumstances or results.

Fourth, to ensure that the program is successful, the City will provide up to $3,473,000 to monitor the performance and potential impacts of the sockeye fry production program. Decisions will be made by the Parties regarding interpretation of monitoring results, alterations in the monitoring program, and alterations in production program operations.

Fifth, if, based on the monitoring results, the Parties, in consultation with the Cedar River Anadromous Fish Committee, conclude that certain components of the program implementation are not meeting program objectives, then the Parties, by agreement, may alter the program to meet those objectives, provided such alterations do not result in expenditures earlier than scheduled nor change the total dollar amount allocated by the City to the sockeye salmon mitigation program.

Sixth, if the sockeye fry-production program is discontinued by agreement, or if the City is unable to complete construction of the replacement sockeye hatchery, then the City will commit remaining monitoring (as well as remaining operation and construction) funds, at a level not to exceed the total of its original commitments, to alternative mitigation or monitoring as directed by the Parties. If the Parties cannot agree on alternative mitigation or monitoring, then the City will spend the remaining funds for fish habitat acquisition, restoration, enhancement or monitoring in the Lake Washington Basin.

Managing the Risks: Expected Outcomes

The City believes that the risks of the hatchery program to wild-spawning sockeye salmon can be adequately managed for the following reasons:

- The program will be guided by measurable, relevant objectives to help control ecological and genetic risk;
- A monitoring program will be designed, developed, implemented, and adjusted to provide information necessary to evaluate performance of the production facility with respect to the objectives;
- In order to further assess and address incremental risks, production will be ramped up gradually. Program performance will be monitored to provide sufficient information to manage incremental risks. The Parties, in consultation with the Cedar River Anadromous Fish Committee, will make appropriate adjustments in production levels and other operational procedures to meet program objectives and minimize risk.
- An adaptive approach will be followed that includes provisions for altering the program if adverse impacts occur, including provisions to reduce production, alter hatchery operations, or develop alternative mitigation if established thresholds are exceeded.

Because harvests of sockeye will be managed by the fisheries co-managers, competition with naturally reproducing fish can also be managed and controlled. As noted above, any measures that increase sockeye production in the Lake Washington Basin might produce competitive effects, but harvest management to achieve escapement levels allows the level of competition as well as the harvest level to be managed as well. Because hatchery production will be increased gradually, and because otolith-marked fish can be tracked and monitored, the effects of such potential competition on naturally reproducing fish in the Basin can be monitored and managed. Funding for studies of the plankton food source in Lake Washington will provide information that will allow fisheries co-managers to adjust production from the hatchery, on both annual and long-term bases, to levels appropriate for the carrying capacity of the lake.

Besides the potential effects of sockeye on other species through competition for limited food resources, there is the potential for other ecological effects on other salmonids, including chinook salmon and steelhead trout. These include the potential for transmission of diseases such as IHN virus from sockeye to other species and interference with spawners of these species by spawning sockeye (Waples, 1998).

Again, it should be noted that increases in the production of sockeye salmon through the use of *any* measures (not just a hatchery) could increase the risk of disease transfer or adverse spawning interactions as well. As demonstrated by the interim hatchery program, the incidence of IHN in hatchery-produced fry is substantially reduced or eliminated by recently developed sockeye culture protocol. Therefore, the proposed hatchery program entails lower risks of IHN transmissions than many alternative approaches to sockeye mitigation. Potential competitive interactions between spawning sockeye and other species that spawn at the same time (coho and chinook) can be addressed through harvest management practices. Because coho, chinook and sockeye salmon have coexisted naturally in many watersheds, neither disease transmission nor spawning competition would be expected to be significant concerns associated with restored sockeye production. Spawning distribution outside the Cedar River will be monitored through spawner surveys in Bear Creek to determine the extent to which Cedar River hatchery sockeye stray within the Lake Washington basin. Threshold levels will be defined under the adaptive management program that triggers an appropriate response to avoid undue impact to this natural sockeye stock.

Little or no impact from spawning sockeye would be expected on spawning steelhead because steelhead spawn well after the sockeye spawning season is over. Effects on chinook should be minor for several reasons. Chinook are very aggressive to other species, most individuals spawn in considerably deeper water than do most sockeye, and chinook females typically place their eggs deeper in the gravel than do sockeye (Chambers et al. 1955). While there is potential for such interference between sockeye and coho, the majority of coho in the Cedar River spawn after most sockeye have completed spawning. Because coho, chinook and sockeye occur together naturally, they can be expected to have developed adaptations that tend to minimize the effects of interspecific competition during spawning.

RATIONALE

Past impacts to the freshwater habitat of anadromous fish in the Lake Washington Basin may be divided into three major categories: (1) structural alteration of the system's drainage pattern resulting from the construction of the Ballard Locks and rerouting the Cedar River into Lake Washington; (2) degradation of spawning, incubation, and rearing habitat due to a variety of land and water management activities such as land clearing and development and water storage and diversion; and (3) loss of habitat connectivity as a result of construction of dams and road crossings and other activities in and near stream channels. As a component of the larger regional framework for anadromous fish conservation outlined in Table 4.3-1, the HCP addresses the need to rehabilitate spawning, incubation, and rearing habitat, and restore connectivity in much of the Cedar River Basin by providing commitments to implement protective land and water management regimes and by avoiding, minimizing, and mitigating the effects of the migration blockage at the Landsburg Diversion Dam. Addressing the structural alterations in the drainage pattern of the Lake Washington Basin is beyond the scope of this HCP.

The measures described in this section of the HCP address a major source of lost habitat connectivity: the Landsburg Diversion Dam. These measures are closely linked to, and dependent upon, the land management and instream flow prescriptions described in sections 4.2 and 4.4.

Complete restoration of the Cedar River system would require: elimination of all water diversion and storage facilities in the Cedar, Green, and White rivers; reestablishing the Black River as the outlet of Lake Washington; rerouting the Cedar River into the Black River; rerouting the White River into the Duwamish; and removal of all anthropogenic structures and activities from the floodplains of the Cedar, Black, Green, White, and Duwamish rivers and the Duwamish estuary. Such actions would provide significant benefits for aquatic resources in the long term, and may serve as a planning model for comparison of alternative approaches to fish conservation. However, there is very little chance that the Cedar and Green rivers will cease to be a source of regional municipal water supply. Nor is it likely that the lower Cedar, Black, Green, White, and Duwamish river systems will be returned to a natural state during the 50-year term of the HCP.

Given this context, the City recognizes that methods of substitution such as construction of hatcheries and fish ladders, and alterations of stream channels, can play a role as components in a comprehensive conservation program that is guided by a rehabilitative conceptual framework. Because the use of some substitution measures can entail various levels of risk to naturally reproducing fish, they will be employed with caution, monitored closely, and adjusted based upon their measured performance and impacts.

Lost Buffering Capacity and Reduced Resiliency

Fish habitat in the Cedar River has been affected by human activities in several important ways. First, the Landsburg Diversion Dam excludes the populations from approximately 32 percent of their potential spawning, incubation, and rearing range in the Cedar River Basin. Second, much of the 21.8 miles of currently accessible stream channel downstream of the City's ownership boundary is now confined by levees and various forms of bank armoring. Thus, the river has lost much of its ability to spread into the former floodplain during high flow events. Consequently, high flows tend to be confined, which concentrates energy, increases bedload transport, and increases the frequency with which incubating eggs and alevins are scoured. Several studies suggest that redd scour during periods of high stream flow can markedly reduce the survival of incubating sockeye eggs and alevins in the Cedar River (Thorne and Ames 1987; Cascades Environmental Services 1991; Seiler and Kishimoto 1997).

In addition, channel confinement, riparian clearing, and other activities have reduced channel complexity and reduced the quality and quantity of rearing habitat for stream-dwelling juvenile salmonids in the river below Landsburg Diversion Dam. And finally, streamflow regulation through the operation of the City's water storage and diversion facilities and hydroelectric generating plant affects the quantity and quality of fish habitat. Streamflow regulation can affect a number of factors, including the amount and distribution of spawning and rearing habitat in the river at any given time, the risk of damaging incubating eggs or alevins by scour or desiccation, the risk of stranding fish during reductions in flow, the conditions for upstream and downstream migration, and the processes that shape stream channels.

The loss of 17 stream miles of spawning, incubation, and rearing habitat upstream of the Landsburg Diversion Dam and the effects of land use and water management activities throughout the lower subbasin have impaired the buffering capacity of the ecosystem and reduced the resiliency of the anadromous fish populations. The productive capacity of the system upstream of the Landsburg Diversion Dam is presently lost to all four anadromous species. Reductions in the quantity and quality of the habitat downstream of Landsburg have further reduced the productive capacity of the populations. As a result of this lost productive capacity, anadromous fish are less resilient to change and less able to sustain themselves during periods of environmental adversity, such as poor ocean conditions. In addition, the altered condition of the river downstream of Landsburg has created an environment that is less able to buffer the effects of floods, and, therefore, results in incubation habitat that is less stable and more vulnerable to damage during high flow events. The net result of all these activities for anadromous fish is a reduction in their capacity to sustain themselves under adverse environmental conditions, while simultaneously being subjected to an increasingly hostile incubation and rearing environment.

Chinook and Coho Salmon and Steelhead Trout

The status of coho, chinook, and steelhead populations in the Cedar River is, to some degree, reflective of the condition of their habitat. All three species spawn, incubate, and, unlike sockeye, rear as juveniles in the Cedar River and its tributaries. With the exception of some very recent hopeful signs for steelhead, all three populations have exhibited declines in the Lake Washington Basin during the last decade (Fresh 1994). Improvement in the condition of stream habitat is especially important to the recovery of these three species that must rear in streams for extended periods as juveniles.

In the past, strong concerns have been expressed by the City and by state and federal drinking water regulators about the human health risks associated with the passage of large numbers of salmon into the municipal water supply above the Landsburg Diversion Dam (SWD 1985, 1993). Spawning carcass biomass, and therefore relative run size, is an important factor when considering the impacts of anadromous fish reintroduction above the drinking water intake at the Landsburg Diversion Dam.

As part of the development of the Cedar River HCP, the City contracted CH2M HILL, Inc., to conduct an assessment of the public health risks posed by the passage of anadromous salmonids over the Landsburg Diversion Dam (see Appendix 5). The consultant concluded that, for the following three reasons, steelhead passage does not present a significant threat to drinking water: (1) most adult steelhead do not die on the spawning grounds after spawning; (2) steelhead typically spawn in much lower numbers than either of the other three anadromous species; and (3) steelhead spawn in the late winter and spring, and thus do not compound the effects from other anadromous runs.

The risk assessment also included an analysis of the potential effects of the return of 1,000 chinook and 4,500 coho salmon spawners to the river upstream of the Landsburg Diversion Dam, estimated to produce about 46,500 pounds of carcass biomass. Although chinook and coho escapement goals have not been established for this reach of river, methods used to establish target spawner returns in similar habitats suggest that the adult run sizes used in the water quality analysis are approximately equal to the number required to fully seed the habitat upstream of the dam. The analysis demonstrated that the passage of 1,000 adult chinook and 4,500 adult coho salmon was very unlikely to degrade water quality or pose a risk to public health.

The establishment of a watershed ecological reserve (Section 4.2.2), which will protect 17 stream miles of spawning and rearing habitat for coho, chinook, and steelhead (as well as upstream areas) within the municipal watershed, is a primary focus of the City's conservation program for anadromous salmonids affected by its facilities and operations on the Cedar River. The City views this component as a key application of the concept of rehabilitation. Although heavily logged early in the twentieth century, this portion of the watershed has largely become reforested with mid- seral conifer forests, largely between 60 and 80 years old (Section 3.2.2). The biophysical processes that form and maintain aquatic and riparian habitat have been largely reestablished and, with the protections and restoration activities provided by the HCP, will be sustained in the future. The quality of the aquatic habitat is generally very good today and is expected to improve in the future as a result of these processes.

However, additional substitution measures (fish passage facilities) are required to allow anadromous fish to receive the full benefits of the spawning and rearing habitat offered by the watershed ecological reserve. Fish passage facilities will substantially increase the present restricted freshwater range of coho, chinook, and steelhead. The reconnection of this habitat will significantly increase the system's buffering capacity with respect to anadromous fish and will improve the capacity of the populations to sustain themselves over a broad range of environmental conditions.

Sockeye Salmon

The most numerous anadromous salmonids in the eastern Pacific are pink, chum, and sockeye salmon. Their abundance is due, in large part, to their ability to live in lakes (sockeye) or near-shore marine areas (pink and chum) as very young fish, where they can take advantage of extensive rearing areas and relatively vast planktonic food resources. In contrast, young coho, chinook, and steelhead typically rear for variable, often extended, periods in streams and rivers, which, by comparison, offer far less area and a much smaller food base to support juvenile fish. Thus, the capacity of a stream to support large spawning populations of pink, chum, or sockeye is typically much greater than the capacity to support species for which juveniles must rear for extended periods in the stream environment.

As described in Section 3.4.7, the major drainage pattern alterations that occurred in the Lake Washington Basin in the early twentieth century allowed the previously rare sockeye to flourish. The expansion of the sockeye population was certainly enhanced by plantings of Baker River sockeye into the Cedar River and Issaquah Creek during the 1940s. However, the expansion of the sockeye population in the north Lake Washington tributaries, which is thought to be derived from a native Lake Washington stock (Hendry and Quinn 1996), suggests that sockeye populations could have expanded and perhaps colonized the Cedar River even without the plantings of Baker River fish. In spite of the benefits provided to sockeye by drainage pattern alterations in the basin, habitat loss and degradation resulting from land and water management activities during the latter half of the twentieth century have clearly limited the potential productivity of sockeye throughout the basin.

The presently impaired condition of the sockeye habitat in the Cedar River system is likely reflected in the status of the population. The opportunity to meet the full escapement goal for Cedar River sockeye of 350,000 spawning fish has occurred only twice in the last 10 years and only eight times since 1967. The average spawner return ratio (spawner/recruit ratio) for the most recent 10 complete brood years (1982-1991) has declined to 0.79 adult fish returning per fish that spawned in the previous generation (WDFW, 1997e). This number is well below the threshold value of 1.0 required to maintain the population over the long term and is much lower than ratios in excess of 2.0 reported for robust sockeye populations (Burgner et al. 1969). It is possible that, in the future, a strong return of spawners may sometimes serendipitously coincide with an unusually mild flood season. However, under existing conditions, sockeye fry recruitment from the Cedar River will likely continue to be suppressed by under-escapement or high incubation mortality, or both.

The sockeye salmon escapement goal for the habitat upstream of the Landsburg Diversion Dam has been established by the WDFW to be 262,000 adult fish (see Appendix 4). This is also the number established in Senate Bill 5256, passed in 1989 by the Washington State Legislature and codified in R.C.W. 75.52, as the basis for the mitigation requirement for the sockeye salmon migration barrier created by the Landsburg Diversion Dam. This number of adult sockeye, or a substantial portion of the number, would pose an unacceptable risk to public health if allowed to spawn naturally above the diversion and water intake at Landsburg. In recognition of this substantial risk, and in consideration of the City's central mission to protect public health, an alternative strategy has been developed to mitigate for the lost sockeye salmon production capacity upstream of the Landsburg Diversion Dam.

Sockeye in the lower 21.8 miles of river below the diversion will derive benefit from the watershed management prescriptions described in Section 4.2, primarily through the delivery of high quality water and the maintenance of a relatively stable sediment delivery regime. However, the lost spawning and incubation capacity for sockeye upstream of the Landsburg Diversion Dam is not addressed by the HCP's rehabilitative measures prescribed for coho, chinook, and steelhead. Here, the HCP will also employ substitution measures, including an artificial propagation program, and habitat enhancement projects in addition to further habitat protection in the lower river downstream of the City's ownership boundary. The allocation of funding between habitat enhancement projects and habitat protection projects will be determined by the Parties in consultation with the Cedar River Anadromous Fish Committee with the objective of protecting and restoring habitat for coho, chinook, sockeye, and steelhead.

The sockeye fry production program is offered as an alternative solution that can, as a component of a larger comprehensive, watershed-based rehabilitation program (Table 4.3-1), help restore some of the system's lost buffering capacity and resiliency by providing an incubation refuge for sockeye salmon. The construction of groundwater-fed side channels can potentially serve a similar function, although the potential risks and benefits of production from constructed groundwater-fed side channels and artificial production differ (Waples 1998). It should be recognized, however, that both measures substitute for, rather than restore, features of the natural system. The fry production program attempts to substitute for the lost production capacity upstream of Landsburg Diversion Dam. The groundwater-fed side channels attempt to substitute for the effects of increased scour in the main channel by providing newly created habitat elsewhere. When employed, substitution measures should be applied cautiously as part of a comprehensive rehabilitation program and with substantial provisions for monitoring and adaptive management (National Research Council 1996).

Although constructed side-channel projects pose little risk to the genetic integrity of the Cedar River sockeye population, relying on these experimental habitat-restoration projects may result in more demographic risk than reliance on artificial production. For example, the following factors may reduce or preclude the long-term production of sockeye fry for some of the potential side-channel projects: production in side-channels is more readily limited by the number of returning adults, which has been declining; the groundwater supply may be limited or lacking in some otherwise suitable areas; some property owners may not cooperate on specific projects; predation on emerging sockeye fry by coho presmolts and other species in the side-channels may be significant, there is risk of increased sedimentation over time in side-channels gravels not exposed to the higher storm flows of the river; there is a higher likelihood that eggs and fry will carry and be susceptible to IHN; and there is some risk of flood damage to channels in the floodplain.

Artificial production is more likely to provide demographic support under a broad range of population levels and will reduce the likelihood of negative impacts associated with IHN. However, this approach poses greater potential genetic risks for the Cedar River sockeye population and, through straying, for the Bear Creek sockeye population. If the risks of the artificial production can be managed, as argued above, the artificial production program and associated habitat enhancement and protection programs can be complementary strategies that combine to reduce the likelihood of population extinction and increase the chance of producing harvestable runs of sockeye. And together, the two programs increase the likelihood that the mitigation goals for sockeye can be met.

As originally conceived, the sockeye fry production program was slated to produce approximately 34 million fry per year, which was expected to result in an average return of approximately 260,000 adult fish (James M. Montgomery, Inc. 1990). More recent analyses that integrate the declining trend in spawner/recruit ratios during the last 10 years suggest that the fry production target will more likely result in an average annual return of approximately 225,000 adult fish (SPU, unpublished data). A total of 27,000 adult fish will be required each year to refill the hatchery, leaving an average of approximately 198,000 fish available to spawn naturally in the river. Thus, the majority of returning, supplementally produced fish will reproduce naturally in the river, thereby increasing the degree to which the system's natural regenerative capacity can contribute to maintaining the fitness and viability of the population.

The return of additional supplementally produced adult fish increases the likelihood that the natural spawning areas in the river will be fully seeded and will have an opportunity to significantly contribute to subsequent fry production. Incubation refuges offered by the hatchery and newly constructed groundwater-fed side channels reduce the risks associated with elevated incubation mortality during floods and poor recruitment of fry to the lake. This general conceptual approach, which manages Cedar River sockeye as a composite population derived both from naturally and hatchery produced fry, rests on a key assumption: fry produced in the hatchery will be similar enough to naturally produced fry to be considered their genetic and ecological equivalent. This assumption and a number of supporting assumptions are the focus of the sockeye research and monitoring program (Section 4.5.3).

The recently adopted Washington State Wild Salmonid Policy addresses programs such as the sockeye fry production program included in the City's HCP and proposes strict criteria for implementation. Quoting from page 13 of *Additional Policy Guidance on Deferred Issues Concerning Wild Salmonid Policy* (Washington Fish and Wildlife Commission 1997):

> Only fish whose parents spawned in the wild shall be counted toward meeting the spawner abundance goals. The exception to this guidance is where a formal supplementation program has been established (or where existing law requires otherwise and has not been changed by agreement or subsequent proceedings). Further, WDFW staff may count locally –adapted, hatchery-origin fish toward meeting natural spawning escapement objectives if there is empirical evidence that hatchery fish spawning in the wild had the same short- and long-term reproductive performance as wild fish. To count, fish must meet all of the following criteria:
>
> a) distribution throughout the watershed area normally used by the wild population;
>
> b) matching the genetic profile, size, age and run timing characteristics developed by the wild population in its evolutionary history; and

c) yielding progeny with survival rates and population dynamics comparable to the wild population.

In a footnote on the same page of the document, the Washington Fish and Wildlife Commission states:

> It is anticipated that only a few fish culture production projects (i.e., Lake Washington sockeye mitigation hatchery for the Landsburg Diversion Dam as it is designed) will be able to meet these criteria. Projects meeting these criteria will not be expected to meet the gene flow standards until it is technically feasible to mark fish externally and then selectively fish the resultant progeny. These situations would be the exception compared to the numbers of wild stocks of each species that do not have hatchery fish reproducing successfully in the wild.

The proposed sockeye mitigation program has been developed in close collaboration with technical and policy staff from the WDFW to meet the criteria established by the state's Wild Salmonid Policy. As part of its research and monitoring commitment, the City will fund a program to monitor the performance of the sockeye program, its adherence to the criteria stated above, and its success in meeting the objectives of the mitigation strategy.

4.3.3 Monitoring and Research

The City will implement a comprehensive monitoring and research program to ensure program compliance, evaluate the effectiveness of the conservation measures, and obtain the necessary information required to successfully implement an adaptive approach to managing uncertainty (sections 4.5.7 and 5.5). The monitoring and research program for anadromous fish conservation has the following primary objectives: (1) track program implementation and assure that actual activities comply with stated commitments in the HCP; (2) monitor the effectiveness of the conservation measures in meeting stated objectives; (3) track trends in the condition of habitats and key species populations; (4) test key assumptions; and (5) provide information to help refine future decision making and implementation of the conservation strategies.

Two mechanisms are provided to help ensure that program implementation complies with stated commitments. First, design, construction, and operation of conservation facilities will be overseen by the Parties to the Landsburg Mitigation Agreement, in consultation with the interagency Cedar River Anadromous Fish Committee. Second, the City will provide compliance reports to the Parties within 120 days after the end of HCP years 2, 5, 8, 11, 15, 25, 30, 35, 40, 45, and 50. These reports will contain summaries of all significant HCP-related activities and associated data, including program planning, facility design and construction, program operation, expenditures, adaptive management, and decisions of the HCP Oversight Committee.

The elements of the research and monitoring program for anadromous fish, and their associated funding levels, are given in Table 4.3-2. These elements are described in detail in Section 4.5.3, but several clarifications are warranted here. First, monitoring of chinook, steelhead, coho, and sockeye at the fish ladders to be constructed at Landsburg will provide valuable information on the timing and size of the runs that will be useful to both the fisheries co-managers (WDFW and Tribe) and the Cedar River Anadromous Fish Committee. Additional information on run timing and size for sockeye, chinook, and coho may be collected during operation of sockeye broodstock collection facilities in the lower Cedar River. The foregoing information will provide a valuable supplement to data collected by WDFW in their annual surveys on the Cedar River.

Second, because all hatchery fry will be otolith-marked, the reproductive fitness of wild-origin versus hatchery-origin sockeye in the Cedar River can be compared by a combination of measures of (1) physical and physiological condition of emergent fry and the timing of their outmigration; (2) spawner recruit ratios, derived from studies of fry-to-adult survival and spawning distribution (otolith recovery of adults); and (3) potential genetic differences and morphological changes in adults collected from the Cedar River.

Third, a portion of the funding for the otolith recovery and genetic analyses shown in Table 4.3-2 will be used to monitor the straying rate into Bear Creek and to evaluate its potential impact, so that hatchery operations can be modified, if necessary, to meet the straying rate standards established by the Parties to the Landsburg Mitigation Agreement.

Table 4.3-2. Summary of Anadromous Fish Research and Monitoring Program.

ELEMENT	HCP YEARS	ANNUAL AMOUNT	TOTAL AMOUNT	Key Issue
Chinook, Coho, and Steelhead				
Performance of upstream fish passage facilities	First 12 years after construction of upstream passage facilities	$50,000 in first year for fish counting equipment, then $5,000 per year to operate there after	$110,000	Rate of passage and behavior of adult fish during migration. Rate at which upstream habitat is recolonized
Evaluate and fine tune velocity profiles at fish screening facilities	As soon as fish screening facilities are constructed	$15,000	$15,000	Engineering analyses and previous experience predicts the need to make fine adjustments on facilities to optimize performance and meet state and federal fish passage criteria
Effects of salmon carcasses on drinking water quality[1]	Years 1, 6, 8, 13, 18, 23	$10,000	$60,000	Help ensure that full escapement of chinook, coho, and steelhead can be achieved with no significant decline in drinking water quality or risk to public health
Elements of the Watershed Aquatic and Terrestrial Monitoring and Research Program	See sections 4.5.4 and 4.5.5	See section s 4.5.4 and 4.5.5	See section s 4.5.4 and 4.5.5	Aquatic and riparian habitat conditions and responses to land management regime between Lower Cedar Falls and the Landsburg Diversion Dam
Sockeye Salmon				
Fry condition at release	5-50	$2,000	$92,000	Physiological, developmental and morphological similarity between artificial and naturally produced fry
Fry marking and mark evaluation	1-8, 24-27, 42-45	$20,000	$320,000	Fry to adult survival, spawning distribution
In-river fry trapping and counting	1-8, 24-27, 42-45	$35,000	$560,000	Outmigration timing and comparative fry to adult survival for naturally and artificially produced fry

ELEMENT	HCP YEARS	ANNUAL AMOUNT	TOTAL AMOUNT	Key Issue
Fish health	5-12, 24-27, 42-45 -------------- 13-23, 28-41, 46-50	$20,000 ------------- $10,000	$620,000	Risks associated w/IHN
Short term fry rearing	1 -------------- 2-4	$35,000 ------------- $10,000	$65,000	Similarity to naturally produced fry, fry to adult survival
Plankton abundance, distribution, periodicity	1-4, 24-27 42-45 -------------- 5-12	$40,000 ------------- $7,000	$536,000	Fry outmigration timing and in-lake carrying capacity
Otolith recovery from returning adults	1-12, 28-31, 46-49	$40,000	$800,000	Fry to adult survival, spawning distribution
Genetic analyses	1-4, 9-12, 28-31, 46-49	$30,000	$480,000	Preserving genetic diversity and adaptive character

[1] The City will also provide $60,000 in HCP year 1 to help fund collaborative studies with NMFS regarding recolonization of habitat within the municipal watershed by anadromous fish.

4.3.4 Effects of the Conservation Strategies

The City has attempted to approach anadromous fish conservation in a comprehensive, ecosystem-based context that, to the greatest extent practicable, relies on natural regenerative processes complemented by selected substitution elements in an effort to provide the full measure of potential benefits to aquatic resources. The City's activities on the Cedar River are important factors to be considered when developing a successful anadromous fish conservation program for the Lake Washington Basin. As discussed above, the provisions offered in the HCP should be viewed as one component in a larger and more comprehensive multi-jurisdictional conservation initiative that considers all aspects of the fish's life history from headwaters to and including the marine environment (Table 4.3-1).

The conservation strategies provided to minimize and mitigate the effects of the anadromous fish migration barrier formed by the Landsburg Diversion Dam will improve conditions for Cedar River salmon and steelhead in five primary ways:

(1) Chinook, coho, steelhead as well as other migratory species, such as river lamprey and Pacific lamprey, will regain access to 17 stream miles of reconnected, productive habitat that will be protected and restored as part of a watershed ecological reserve and that will serve as a refuge for spawning, incubation, and juvenile rearing.

(2) Immediate implementation of interim measures will help reduce the rate of decline in the chinook, coho and steelhead populations and provide key information that will be used to refine and manage long-term conservation measures.

(3) The artificial propagation program for sockeye salmon will provide an incubation refuge, increase fry recruitment from the river, help ensure that adequate numbers of adult fish return to spawn naturally in the river, and help restore the capacity of the population to sustain itself during periods of adverse environmental conditions, while avoiding and minimizing risks to naturally reproducing salmonids.

(4) The commitment to fund habitat protection and restoration in the lower river outside the City's ownership boundary will help restore natural stream structure and function and improve system buffering capacity by contributing to the protection and development of important riparian and stream channel features and functions and by providing high flow refuge areas for spawning, incubation, and rearing.

(5) The monitoring and research program will provide useful information on Lake Washington sockeye salmon. It will help ensure the effectiveness of the conservation strategies, and will provide information that may be used to refine conservation measures, adapt them to changing conditions, and avoid and minimize risk.

The City's commitments to habitat protection and restoration, fish passage, and instream flows will significantly increase the quantity and quality of spawning and rearing habitat available to Cedar River coho, chinook, steelhead and other migratory species/forms (except sockeye). Above Landsburg, these species will be provided the opportunity to regenerate themselves through the processes of natural reproduction and production in a protected environment where natural biophysical processes are allowed to shape the structure and function of riparian and aquatic habitat. Recolonization of the habitat upstream of the Landsburg Diversion Dam will increase the resiliency and productive capacity of the system for the species that are allowed to pass upstream. Sockeye, while excluded from the area above the Landsburg Diversion Dam, will benefit from improved water quality and habitat conditions as well as from artificial production.

The effects of anadromous fish recolonization on existing aquatic communities upstream of the Landsburg Diversion Dam are uncertain. Populations that serve as prey for juvenile salmonids and populations that prey upon juvenile salmonids may both be affected by recolonization. The presence of juvenile coho, chinook, and steelhead could increase competition for food and rearing space and could potentially have a negative effect on the resident rainbow trout population, for example. However, the potential negative effects of competitive pressures may be mitigated and offset, to some extent, by a number of factors, including the contribution of anadromous fish carcasses, eggs, and larval and juvenile fish to the aquatic food web, and an increase in the efficiency with which a given trophic level can exploit a given forage base due to an increase in the intensity of niche partitioning. Riparian communities are expected to benefit from the introduction of marine-derived nutrients as anadromous salmon colonize the upstream area. While all of the effects of recolonization are difficult to precisely predict, it is not unreasonable to expect that aquatic community assemblages will tend toward a condition similar to the state that existed in the watershed prior to the construction of the Landsburg Diversion Dam.

The majority of the spawning and incubation habitat for Lake Washington sockeye is provided by the Cedar River. As described earlier, spawning habitat loss and degradation have decreased the buffering capacity of the system and reduced the capacity of the sockeye population to sustain itself when faced with adverse environmental conditions. In the last 10 years, average spawner/recruit ratios have dropped sharply and the population trend is one of relatively steep decline. The sockeye fry production program provides an incubation refuge that will help ensure sufficient recruitment of fry into Lake Washington and, therefore, help ensure that sufficient numbers of adult fish return to spawn naturally in the river. This restored fry production capability will increase the capacity of the population to maintain itself when challenged with adverse environmental conditions. If habitat conditions in the rest of the Cedar River Basin can be maintained or improved, and if spawner/recruit ratios can be maintained at or above present levels, then we can expect significantly more opportunities to meet full escapement goals and provide more frequent opportunities for sport and Tribal sockeye harvests in Lake Washington.

Information collected during the operation of the prototype sockeye hatchery and the implementation of the emergency recovery program (sections 3.4.7 and 4.3.2) indicate that the program prescribed by the HCP has a high likelihood of success. The application of recently developed sockeye culture techniques has been successful in generating consistently high in-hatchery survival rates and producing IHN-free fry. In spite of a growing history of successful hatchery production of sockeye fry and the potential benefits associated with the long-term sockeye mitigation program, there are some remaining uncertainties and risks associated with artificial production of sockeye salmon fry. These concerns focus on the impacts that increased sockeye production might have on naturally spawning stocks in the Lake Washington basin, specifically on the chinook spawning in the Cedar River and the sockeye spawning in Bear Creek. Potential influences on these natural stocks include overharvest, competition and changes in predation rates.

It is important to differentiate the impacts that would occur through increasing sockeye returns and the impacts that occur as a result of artificial propagation. Historically, sockeye returns to the Cedar River have been much greater than they are at present, without hatchery production, and presumably the impacts of these larger sockeye returns have already been experienced by other species/stocks. The concerns that specifically relate to artificial propagation center on genetic effects and the influence that hatchery returns may have on the fitness of fish spawning in the wild. Overharvest of non-target species/stocks, interactions on the spawning grounds, influences on predation rates and competition during rearing are concerns that result from higher sockeye production, irrespective of the origin of fish. Overharvest of non-target species and stocks can be controlled through appropriate sockeye harvest management by WDFW and Tribal co-managers. The larger size of chinook and their spawning site preferences suggest little impact on chinook by sockeye. Predation impacts are difficult to predict, but larger numbers of sockeye fry may have a sparing effect on other, less abundant, species/stocks. Little competition is expected between sockeye and other species, due to differences in rearing strategies and distribution. The primary concerns over hatchery production of sockeye are the potential for adverse impacts on the fitness of naturally spawning sockeye and the impacts of broodstock collection procedures. Evaluation of both of these concerns is included in the HCP and the results will be used to inform program decisions. These risks and uncertainties will be managed through the implementation of operational guidelines, in association with a monitoring and research program and a commitment to adaptive management, all of which will be guided by an interagency oversight body (sections 4.5.3, 4.5.7, 5.4, and 5.5).

The HCP's adaptive management program will be developed to ensure that the monitoring program is focussed on the evaluation of results with respect to specific objectives and risks. The adaptive management program will direct the monitoring activities so that critical data are collected to assess impacts, both positive and negative. Adaptive management criteria will be established to identify thresholds when program adjustments will be considered to meet program objectives, either by reducing undesirable impacts or improving performance. Program adjustments could include provisions for modifying hatchery operations or even the development of alternative mitigation. Adaptive management is a critical element of the HCP program in that it provides the means of responding to the uncertainty associated with changing conditions and new information.

The monitoring and research program, in addition to informing the adaptive management process, will contribute to a broader understanding of salmon ecology. Information gained from the monitoring and research program will be used to refine the implementation of the mitigation program to help ensure that program objectives are being met. The monitoring and research program will be regularly reviewed by a multi-agency technical committee to ensure that the program is addressing both the need to document the achievement of performance objectives and the need to minimize and avoid undesirable impacts. Some of the information from monitoring and research activity is expected to have relevance beyond the boundaries of the Cedar River and Lake Washington and contribute to a better overall understanding of salmon throughout their range.

The general effect of the mitigation and minimization measures contained in the HCP is to promote sustainable populations of fish by one or more of the following measures: by providing the means for emergency propagation for selected species, if needed, or alternatively for species-oriented research; by improving habitat conditions through acquisition, protection and restoration actions; by providing watershed stewardship commitments that ensure a high quality water source; through instream flow measures; and by increasing returns of sockeye through artificial production to help restore the natural spawning population. Various monitoring activities will generate additional information on some species using the downstream area that will be useful to the City and to Tribal and state resource managers. If larger returns result from the measures included in the HCP, as expected, additional productivity would, through increased importation of marine nutrients, aid the growth and survival of species that rear in the Cedar River Basin. While the mitigation efforts described in the HCP are designed specifically to benefit four anadromous salmonid species -- sockeye, chinook and coho salmon and steelhead trout -- these efforts will likely have effects on other migratory and resident species using the Cedar River as well (see chapter 4.6 for detailed descriptions of effects on individual species). While impacts from the HCP program could be beneficial, harmful or neutral to these non-targeted species, the nature of the actions and the ecosystem scope of the HCP is generally likely to provide some benefit to other species in the Cedar River in ways that are similar in their effects on the targeted species. Perhaps more importantly, the focus of the HCP on protecting and restoring ecosystem capacity and key ecological processes should, over the long term, produce conditions in parts of the Cedar River Basin more similar to the conditions to which the species are adapted than the conditions that exist today.

Section 4.4 Contents

4.4 Instream Flow Management

4.4.1 Introduction

BACKGROUND AND PLANNING CONTEXT

The City of Seattle is a regional municipal water supplier providing drinking water to over 1.2 million customers in the Seattle metropolitan area. Approximately two-thirds of this water supply is provided from the Cedar River, with most of the remainder provided from the South Fork Tolt River in the Snoqualmie River basin. Protecting public health and safety by providing an adequate and reliable supply of safe, high-quality water is the City's core mission in managing its facilities and operations in the Cedar River basin. In fulfilling its water supply mission, environmental stewardship will remain a top priority for the City. The City recognizes and acknowledges the benefit of both instream and out-of-stream uses of water, as well as the relationship of land use to water quality and instream habitat (SWD 1993).

Stream flow volume, rate of change, and timing of delivery are important features of aquatic ecosystems that have been subject to significant influence from anthropogenic activities during the twentieth century in the Pacific Northwest (National Research Council 1996). Through its water storage and supply activities in the Cedar River basin, the City can exert considerable influence over stream flows in the lower 35.6 miles of the river downstream of Masonry Dam. Chester Morse Lake and the associated Masonry Pool, the City's water storage reservoir that was formed from ancient Cedar Lake with the construction of a crib dam on Cedar Lake in 1901 and the Masonry Dam in 1914, captures run-off from the upper 43 percent of the Cedar River basin. In addition, the City currently diverts approximately one-fifth of the total annual flow from the river for municipal water supply at river mile 21.8, 13.8 miles downstream from Masonry Dam (Map 2). Although inflows to the river from the lower 57 percent of the basin are unregulated, the City's releases from Chester Morse Lake and diversions at the Landsburg Dam have a significant influence on stream flows and the condition of aquatic habitat throughout the river below Masonry Dam.

Conservation of anadromous salmonids calls for broad-based, ecosystem approaches to the management of these species and their habitats (see National Research Council 1996; Gregory and Bisson 1997; Williams and Williams 1997). Because of their unique life history patterns and freshwater habitat requirements, anadromous salmonids force one to look broadly across the landscape to the many factors that influence the condition of the fish and their environment. The HCP treats salmon and steelhead as keystone species in the aquatic habitat that is formed by the Cedar River, and as such, these species form one of the central considerations for the City's HCP. As Gauvin (1997) illustrates, water management and its effects on instream flows must be a key consideration in effective, ecosystem-based approaches to salmonid conservation in the Pacific Northwest. Instream flow management is one of several central components that form the basis of the City's efforts to contribute to the conservation of anadromous salmonids in the Lake Washington basin through the implementation of the Cedar River HCP. The HCP should in turn be viewed as one component in a larger, multi-jurisdictional effort to implement a basin-wide anadromous fish conservation program (Table 4.3-1).

Prior to the construction of the Landsburg Dam early in the twentieth century, anadromous salmonids were present throughout the Cedar River from its confluence with the Black River, near the present-day site of the City of Renton, upstream to the natural barrier formed by Lower Cedar Falls, located 1.4 miles downstream from Masonry Dam (Section 3.2.5; Map 2). Today, sockeye, coho, and chinook salmon and steelhead trout are present in the 21.8 river miles between the Landsburg Diversion Dam and Lake Washington (Map 8). As part of the City's HCP, fish passage facilities will be installed at the Landsburg Diversion Dam to enable coho, chinook, and steelhead populations to reestablish themselves in their former habitat upstream (Section 4.3.2).

The majority of the steelhead and sockeye in the Lake Washington basin currently originate from the mainstem of the Cedar River. Substantial numbers of naturally reproducing chinook and coho are also present in the Cedar, although they compose a smaller fraction of the total Lake Washington population. Like many fish populations throughout the northwest, Cedar River salmon and steelhead have been experiencing a general trend of decline and are presently considered to be in a depressed condition (WDF et al. 1993). While there are many factors beyond the City's control that can affect the status of Cedar River anadromous fish populations, the City's reservoir management and water diversion activities can have a significant effect on the condition of freshwater habitat for these species. During any given season, at least two species of anadromous salmonids are present in the river. For much of the year, all four species are present simultaneously in more than one life history stage. Protective instream flow management practices can provide substantial benefits to anadromous fish in the Cedar River.

The relationship between fish habitat and instream flows on the Cedar River has been studied extensively for nearly 30 years. Most recently, a collaborative study program was initiated in 1986 with Tribal, state, and federal resource managers. The study program consisted of a comprehensive Instream Flow Incremental Methodology (IFIM) study and several ancillary investigations that addressed key biological factors not considered in standard IFIM studies (Section 3.3.2). The results of these investigations were published in 1991 and used as the basis for further analyses and negotiations with the study collaborators between 1993 and 1997. These further efforts culminated in the development of the instream flow management regime described in the March 17, 1997, Agreement in Principle for the Cedar River Habitat Conservation Plan (SPU 1997), signed by five cooperating state and federal agencies. The instream flow regime characterized in the Agreement in Principle is the basis for the instream flow management strategy presented in the City's HCP.

A formal Instream Flow Agreement (IFA), based on the Agreement in Principle, is part of this HCP (Appendix 27). The five signatories to the IFA are referred to in this section as Parties to the IFA (or "Parties"), and include NMFS, USFWS, WDFW, WDOE, and the City. The IFA establishes a Cedar River Instream Flow Oversight Commission, referred to below as “the Commission,” which includes all the Parties, as well as the Muckleshoot Indian Tribe.

OBJECTIVES

The operation of water storage and diversion facilities on the Cedar River can be both beneficial and detrimental to downstream aquatic resources. The HCP attempts to fully express potential benefits while limiting detrimental impacts. The objectives established for this element of the HCP treat unlisted species as if they were listed and support the goal of avoiding, minimizing, and mitigating the incidental take of species listed as threatened or endangered. However, the objectives go beyond this goal and call for a program that: (1) provides a net benefit to the species covered in the plan; and (2) substantially contributes to the recovery of species that are currently listed or that might be listed in the future. The specific objectives listed below were developed to help guide the City’s efforts to manage instream flows in a manner that protects anadromous fish and their habitat while preserving and protecting the municipal water supply.

(1) Implement a beneficial instream flow regime, based on the best current scientific information, that will help provide high quality fish habitat throughout the potential range of anadromous fish in the Cedar River from Lake Washington to the natural migration barrier formed by lower Cedar Falls;

(2) Reduce the risks of stranding juvenile salmonids and dewatering salmonid redds to levels that will help promote the full recovery and persistence of anadromous salmonid populations in the Cedar River;

(3) Provide an instream flow regime that significantly improves existing habitat conditions for all four species of anadromous salmonids in the Cedar River over existing conditions;

(4) Maintain the supply capacity from the municipal water system, including the Cedar River, as measured by average annual firm yield, protect drinking water quality and public health, and preserve the operational flexibility necessary to water supply operations;

(5) Help support measures that will contribute to improving downstream migration conditions for juvenile salmonids at the Hiram Chittenden (Ballard) Locks; and

(6) Preserve flexibility to meet water needs for people and fish that may be identified in the future.

OVERVIEW OF INSTREAM FLOW MANAGEMENT STRATEGY

To meet these objectives, the City has employed five broad categories of conservation measures.

(1) The HCP will provide a guaranteed flow regime consisting of minimum and supplemental flow commitments. The HCP minimum flow schedule is based upon the best available science and is designed to better mimic the natural hydrograph and provide beneficial conditions for fish while maintaining the City’s ability to meet its municipal water supply obligations. For example, recent investigations have revealed that, in years when spring flow levels are elevated, some steelhead spawn in areas near the stream margin that may become

dewatered later in the incubation season as flows drop to normal summer base levels in July; eggs deposited in these areas can experience significant mortality. To address this problem, the HCP provides higher minimum flows during the period when steelhead eggs and alevins are most vulnerable to dewatering in July and early August.

(2) The HCP flow regime will provide supplemental flows above minimum commitments as allowed by specific hydrologic conditions in the watershed and as warranted by the biological requirements of fish. For example, when hydrologic conditions are favorable in the fall, the HCP provides higher flows to recruit additional habitat along the margins of the stream, which is believed to increase potential sockeye production by placing more eggs in areas that are less vulnerable to scour during flood events (Section 3.2.2).

(3) Through the HCP, the City will commit to additional operational constraints to improve fish habitat and which may result in additional costs and organizational changes but will not have a direct effect on water supply. For example, the rate of stream flow reduction will be significantly constrained to reduce the risk of stranding juvenile fish.

(4) The HCP recognizes that a significant volume of water is often available above the guaranteed flow commitments and water supply needs of the City, and that future studies and developments may reveal beneficial instream or out-of-stream uses for some of this water. The HCP will provide for an interagency Commission that will serve as a forum for sharing of information and discussion concerning potential use of this water. In addition to the guaranteed flow regime, the City will reserve 100 mgd of its 300 mgd water claim for instream resources and is dedicated to managing water diversions from the Cedar for the next 5 to 10 years in the same range that water diversions have been for the last five years (98-105 mgd on an annual average basis).

(5) To compliment its commitments to instream flows, the City will make specific financial commitments to protect habitat conditions in the basin downstream of the municipal watershed. For example, as part of the instream flow management conservation strategies, the City will provide $3 million for habitat protection and restoration in the lower Cedar River basin downstream of Landsburg.

The specific instream flow management provisions presented in Section 4.4.2 may be grouped into one of the four categories described above. Section 4.4.2 first describes the specific instream flow conservation measures that collectively form the instream flow management regime. The descriptions are followed by a discussion of the underlying rationale used in the development of the respective conservation measures. Next, Section 4.4.3 briefly summarizes the major components of the research and monitoring program, which is more fully described in Section 4.5.2. Finally, Section 4.4.4 summarizes the anticipated effects of the conservation strategies. (See also Section 4.6 for a more detailed analysis of effects on particular species)

The instream flow management regime is one component of a more comprehensive anadromous fish conservation strategy embodied in the HCP as a whole. The provisions described here are linked to two additional central components of the HCP: (1) the City's commitments to protect, restore, and reconnect upland, riparian, and aquatic habitat in the upper two-thirds of the basin as described in Section 4.2; and (2) the commitments set forth in section 4.3 to minimize and mitigate the effects of the anadromous fish migration barrier at the Landsburg Diversion Dam.

The HCP can provide a cornerstone for a comprehensive and integrated anadromous fish conservation program in the Lake Washington basin. However, other factors - land management, ground water withdrawals, channel hardening, habitat protection, restoration in the Cedar River basin downstream of the City's ownership boundary, ocean conditions, fish harvest management practices, and other factors - will also play an important role in the effectiveness of the anadromous fish conservation measures provided by the HCP.

4.4.2 Conservation Strategies for Instream Flow Management

Stream flow regulation through the operation of the City's water storage and diversion facilities and hydroelectric generating plant can have very direct effects on the quantity and quality of fish habitat. Stream flow regulation can affect many environmental factors important to fish including: the amount and distribution of spawning and rearing habitat in the river at any given time; the risk of damaging incubating eggs or larval fish by scour or desiccation; the risk of stranding fish during reductions in flow; conditions for upstream and downstream migration; and the biophysical factors that form and maintain stream channels. The strategies described below have been developed in an effort to address all of these issues, while attempting to encourage measures that preserve the general features and patterns of the natural hydrograph in the Cedar River basin in a manner that is consistent with the City's responsibilities as a regional municipal water supplier (Section 2.2).

The HCP Instream Flow Management program includes a guaranteed flow regime that prescribes minimum instream flow requirements, and also includes adaptive provisions for the allocation of supplemental flows, when hydrologically available and biologically beneficial, through operation of a multi-agency Cedar River Instream Flow Oversight Commission (detailed in the IFA, Appendix 27 to the HCP). To provide further flexibility to adapt instream flow management as conditions change and new information becomes available, the City will commit, over and above the guaranteed flow regime, an additional 100 MGD of its 300 MGD water claim to the river for instream resources. In addition, the City will provide a number of additional financial and operating commitments (described later in this section) that will help protect aquatic habitat throughout the basin downstream of its water management facilities. Implementation of the instream flow management regime, including the adaptive features discussed above, will be guided by research and monitoring commitments and overseen by the interagency Cedar River Instream Flow Commission (Commission).

RELOCATED AND ENHANCED FLOW MEASUREMENT POINTS

The stream flow measurement point for the present non-binding IRPP instream flow regime is located at the existing United States Geological Survey (USGS) stream gage #12119000 in Renton, 1.6 miles upstream from Lake Washington (Map 2). The City will replace this single measurement point with several new instream flow measurement points in order to more closely align the City's accountability with its actual operations, to improve operating precision, and to provide better protection for fish habitat.

First, the measurement point for minimum and supplemental stream flows will be located at the existing USGS stream gage #12117600 at river mile 20.4, 1.4 miles downstream of the Landsburg Diversion Dam. This gage will also be used to monitor the compliance of all upstream City facility water management operations with downramping prescriptions (the rate at which stream flows may be reduced as a result of project operations) as provided below in this section.

To further reduce fish stranding risks associated with reductions in stream flow, the City will commit to a second measurement point for downramping prescriptions at the existing USGS stream gage #12116500 located at river mile 33.2, 0.5 miles downstream of the Cedar Falls hydroelectric project tailrace. This measurement point will become effective immediately after fish passage facilities are completed at the Landsburg Diversion Dam and anadromous fish are allowed to pass upstream into the reach between Lower Cedar Falls and Landsburg (Section 4.3.2).

And finally, a new USGS stream gage will be established near river mile 33.7 just upstream of the Cedar Falls hydroelectric facility tailrace. This gage will be installed to monitor compliance with the City's commitment to provide rearing flows for anadromous fish in the bypass reach between Lower Cedar Falls and the hydroelectric project once fish passage facilities are completed at the Landsburg Diversion Dam.

For the purpose of the accretion flow monitoring study discussed in Section 4.4.3, the City will monitor flows at the existing USGS stream gage # 12119000 at river mile 1.6 in Renton, or at a new USGS stream gage station located in the vicinity of this existing USGS stream gage. If a more suitable physical location is found near the site of the existing USGS stream gage # 12119000, the City will fund the installation and temporary operation of a new USGS stream gage. The existing stream gaging site at river mile 1.6 in Renton is located in a deposition zone that is subject to frequent scour and deposition events that result in a relatively unstable lateral streambed profile. The primary purpose for locating and installing a new stream gage would be to provide a more accurate and reliable data source for use in analyzing rates of natural inflow to the Cedar River between the Landsburg Diversion Dam and Lake Washington. In addition, the City will monitor flows at up to two additional locations between Renton and Landsburg. This would be for only a temporary period as part of the accretion flow study to help monitor accretion flows between Landsburg and Renton. Monitoring at these locations will begin when the accretion flow study is initiated and will terminate when the accretion flow study is completed by or before HCP year 13.

INSTREAM FLOW COMMITMENTS

The instream flow management regime provides a variety of protective elements including commitments to *minimum flows* and *supplemental flows*. The minimum instream flows described in this section represent *requirements* of the City and are referred to as "firm" flows or volumes, subject to the specific conditions and procedures set forth below for minimum flows. The term "minimum instream flow commitments" is not used here to indicate the lowest stream flow levels required to marginally protect fish habitat. Rather, the term is used here to indicate the levels below which the City will not allow stream flows to drop in the Cedar River. *The minimum instream flow commitments presented here have been collaboratively developed with the benefit of an extensive biological information base, and represent beneficial flows that will help ensure the continuous provision of high quality fish habitat throughout the Cedar River between Lower Cedar Falls and Lake Washington*.

Additional flows or volumes provided to supplement minimum flows, as described later in this section under the title, "Supplemental Flows", represent *goals* of the City and are referred to as "non-firm" flows or volumes, subject to the specific conditions and procedures described below for supplemental flows. For both requirements and goals, the City's commitments are to the *occurrence* of the specific flows under the conditions stated and not to a particular method of water management that causes those flows to occur. At times, the City will need to release water from storage in order to meet its requirements or goals downstream; at other times other flow management actions or natural hydrologic events may provide the necessary flows. The sum of the minimum flow commitments and the supplement flow commitments is referred to below as the *guaranteed flow*. As described in section 3.2, and Technical Appendix #36, actual stream flows experienced in the river during given periods of they year are often greater than the guaranteed flow commitments. These additional flows are referred to as *stream flows above the guaranteed levels,* or *expected flows*.

Minimum Flows

The City will operate its facilities on the Cedar River to ensure that stream flows remain above certain specified levels to protect fish habitat, as summarized in Table 4.4-1 and Figure 4.4-1, and as described below. The measurement point for these stream flow commitments will be the existing USGS stream gage #12117600 located at river mile 20.4, 1.4 miles downstream from the Landsburg Diversion Dam. Selections of the key species and life stages for which minimum flows were established during different periods of the year are summarized in Table 4.4.5. Detailed explanations of other elements of the flow regime are presented in the following sections.

The City will subscribe to a binding set of minimum instream flow commitments that will replace the current non-binding flow targets. The general shape of the curve for HCP minimum flow commitments over the year will follow the general shape of the natural annual hydrograph. Flows begin to trend upward in the early fall as rainfall and runoff typically increase. Flows reach relatively high levels by early to mid-October and continue at elevated levels until late spring when they begin to trend lower, reaching summer base flow levels in late July and early August. Flows remain at base levels until the start of the early fall ramp-up (Figure 4.4-1).

As with the existing IRPP regime, the HCP minimum instream flow commitments consist of normal flows and critical flows. However, the HCP minimum flows also include a number of additional features. Between October 8 and December 30, the minimum flow regime provides for either high normal or low normal flows depending upon actual hydrologic conditions. The HCP minimum flow commitments also provide a flexible block of 2500 acre feet of water which will be available in all normal years to provide added instream flow protection during the early summer. In addition, normal minimum flows include flow augmentations from September 16 through September 30, when the flashboards are in place on the overflow dike at the outlet of Chester Morse Lake. Similar provisions for augmentation also apply to critical minimum flows between September 2 and September 15. As described below under the section titled "Supplemental Flows," minimum flows are further augmented under specified conditions from February 11 to April 14 and from June 17 to August 2.

As described in the next section, critical flows would apply under adverse conditions in which specified hydrologic criteria have been met and public notification and water conservation measures specified in the City's water shortage contingency plan have been implemented (Appendix 10). Switches to critical flows would be expected at a frequency of approximately once in 10 years on the average and would be implemented according to very specific criteria and procedures described later in this section.

Table 4.4-1 summarizes the guaranteed flow regime and the frequency of occurrence of the various provisions at the stream gage below the Landsburg Diversion Dam. Low and high normal flows are included in the column titled "Normal Minimum." Normal minimums plus applicable supplements are listed in the column titled "Normal with Supplement." Critical flows are listed with and without the critical flow supplement.

Restoring access for chinook, coho, and steelhead into the habitat upstream of the Landsburg Diversion Dam is a central component of the HCP's conservation strategy for anadromous fish (Section 4.3). The provision of beneficial flows in the 12.4 stream miles of mainstem habitat between Lower Cedar Falls and the Landsburg Diversion Dam is key to the success of this strategy. Because of the need to deliver water via this stream reach for diversion into the municipal water supply intake at Landsburg, flows immediately upstream of Landsburg will always be higher than flows immediately downstream of Landsburg, except when diversion facilities are taken out of service. Interruptions in service at the diversion facilities are infrequent. Interruptions usually only occur when raw water turbidity thresholds are exceeded (typically during the ascending leg of freshet flow events in excess of 1000 cfs) or during infrequent maintenance and repair activities. Table 4.4-2 summarizes the expected minimum flow levels under the HCP normal minimum flow regime as measured near the center point of the upper Cedar River Study Area, *upstream* of the Landsburg Diversion Dam. The HCP minimum instream flow commitments as measured at the existing USGS stream gage #122117600 *downstream* of Landsburg, combined with the additional flows required for the City's municipal water supply diversion, ensure that flow levels in the river *upstream* of the Landsburg Dam will typically be near or above the levels required to provide maximum habitat availability for chinook, coho, and steelhead spawning and rearing.

Table 4.4-1. Minimum and Supplemental Flow Commitments.

		Minimum and Supplemental Flows at Landsburg			
Water Week	Calendar Week	Normal Minimum (cfs)	Normal with Supplement (cfs)	Critical Minimum (cfs)	Critical with Supplement (cfs)
49	Sep 2 - Sep 8	80		70	80[5]
50	Sep 9 - Sep 15	80		70	80[5]
51	Sep 16 - Sep 22	95	133[2]	80	
52	Sep 23 - Sep 30	95	210[2]	80	
1	Oct 1 - Oct 7	210		100	
2	Oct 8 - Oct 14	330/275[1]		130	
3	Oct 15 - Oct 21	330/275[1]		160	
4	Oct 22 - Oct 28	330/275[1]		180	
5	Oct 29 - Nov 4	330/275[1]		200	
6	Nov 5 - Nov 11	330/275[1]		200	
7	Nov 12 - Nov 18	330/275[1]		200	
8	Nov 19 - Nov 25	330/275[1]		200	
9	Nov 26 - Dec 2	330/275[1]		200	
10	Dec 3 - Dec 9	330/275[1]		200	
11	Dec 10 - Dec 16	330/275[1]		200	
12	Dec 17 - Dec 23	330/275[1]		200	
13	Dec 24 - Dec 30	330/275[1]		200	
14	Dec 31 - Jan 6	260		180	
15	Jan 7 - Jan 13	260		180	
16	Jan 14 - Jan 20	260		180	
17	Jan 21 - Jan 27	260		180	
18	Jan 28 - Feb 3	260		180	
19	Feb 4 - Feb 10	260		180	
20	Feb 11 - Feb 17	260	365[3]	180	
21	Feb 18 - Feb 24	260	365[3]	180	
22	Feb 25 - Mar 3	260	365[3]	180	
23	Mar 4 - Mar 10	260	365[3]	180	
24	Mar 11 - Mar 17	260	365[3]	180	
25	Mar 18 - Mar 24	260	365[3]	180	
26	Mar 25 - Mar 31	260	365[3]	180	
27	Apr 1 - Apr 7	260	365[3]	180	
28	Apr 8 - Apr 14	260	365[3]	180	
29	Apr 15 - Apr 21	260		180	
30	Apr 22 - Apr 28	260		190	
31	Apr 29 - May 5	260		190	
32	May 6 - May 12	260		195	
33	May 13 - May 19	260		200	
34	May 20 - May 26	250		210	
35	May 27 - Jun 2	250		210	
36	Jun 3 - Jun 9	250		200	
37	Jun 10 - Jun 16	225		200	
38	Jun 17 - Jun 23	225	[4]	160	
39	Jun 24 - Jun 30	225	[4]	100	
40	Jul 1 - Jul 7	170	[4]	80	
41	Jul 8 - Jul 14	105	[4]	80	
42	Jul 15 - Jul 21	80	[4]	80	
43	Jul 22 - Jul 28	80	[4]	80	
44	Jul 29 - Aug 4	80	[4]	70	
45	Aug 5 - Aug 11	80		70	
46	Aug 12 - Aug 18	80		70	
47	Aug 19 - Aug 25	80		70	
48	Aug 26 - Sep 1	80		70	

[1]Values shown represent High- and Low-Normal minimum flows weeks 2 - 13
[2]Guaranteed flow during normal years if flashboards in place
[3]Guaranteed flow provided approximately 70 percent of time in normal years
[4]Additional 2,500 acre-feet (for minimums) in all normal years 6/17 - 8/4; plus additional 3,500 acre-feet (supplemental) in 70 percent of normal years 6/17 - 8/4 as directed by Commission
[5]Guaranteed flow during critical years if flashboards in place

Figure 4.4-1. Minimum and Supplemental Flow Commitments.

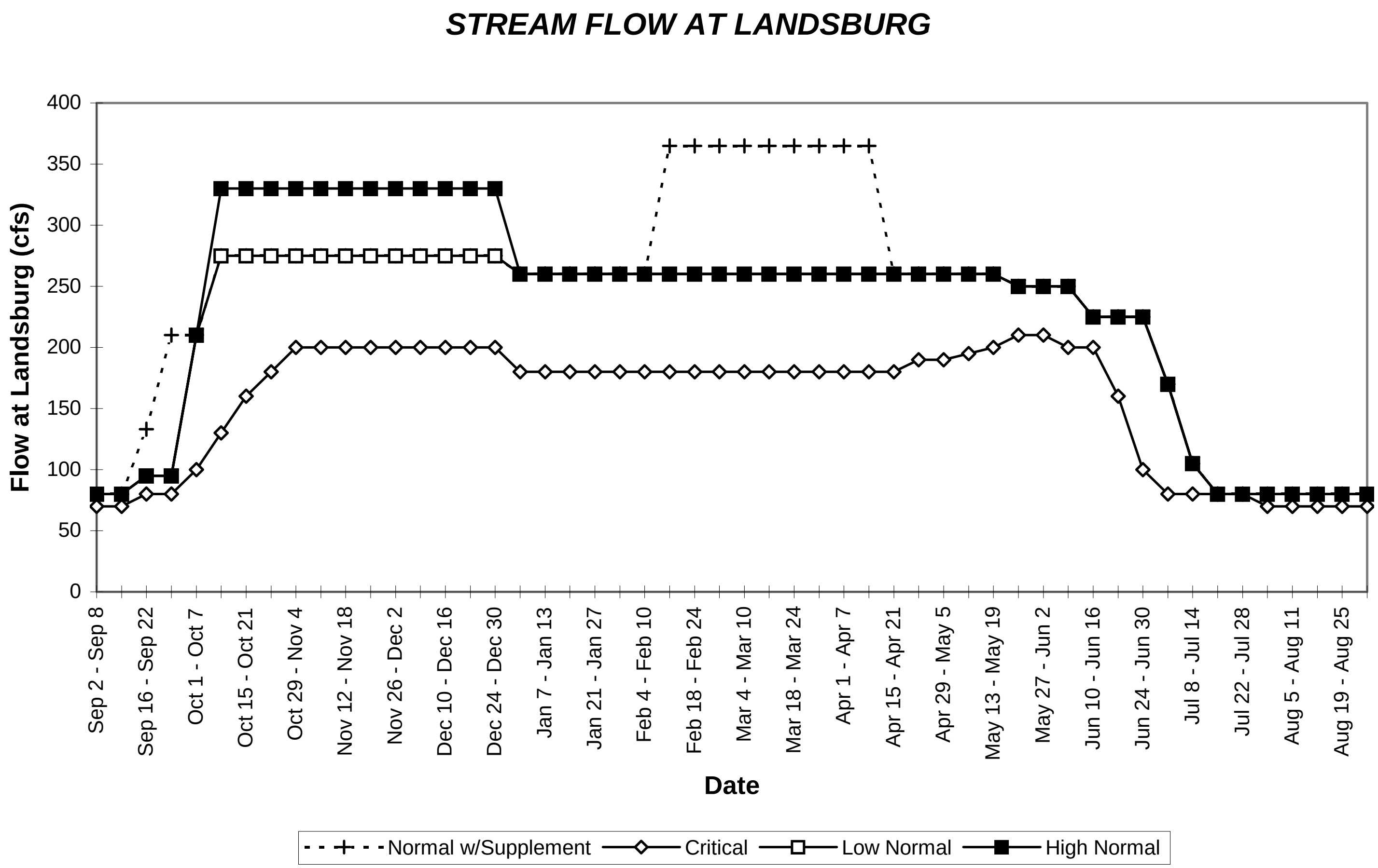


Table 4.4-2. Summary of expected minimum flows in the Upper Cedar River Study Area (upstream of Landsburg Diversion Dam).

Time period	Required HCP Minimum Plus Supplemental Flow at Landsburg (cfs)	Average Diversions Minus Inflow Flow Between Mid-Point of Upper Cedar Study Area and Landsburg (cfs)	Resultant Flow Adjusted to Mid-Point of Upper Cedar Study Area (cfs)	Key Species/Life History Stage	Percent of Maximum Weighted Usable Area Provided in the Upper Cedar Study Reach
Sept. 2 - Sept. 15	80	152	232	steelhead rearing	100
Sept. 16 - Sept. 22	133	131	264	chinook spawning	82
Sept. 23- Sept. 30	210	132	342	chinook spawning	93
Oct. 1- Oct. 7	210	118	328	chinook spawning	92
Oct. 8 - Oct. 14	330	118	448	chinook spawning	99
Oct. 15 - Oct 28	330	116	446	chinook spawning	99
Oct. 29 - Nov. 4	330	102	432	chinook spawning	99
Nov. 5 - Nov. 18	330	105	435	chinook spawning	99
Nov. 19 - Dec. 2	330	117	447*	coho spawning	85
Dec. 3 - Dec. 30	330	147	477*	coho spawning	81
Dec. 31 - Feb. 3	260	134	394*	coho spawning	92
Feb. 4 - Feb. 10	260	142	402*	coho spawning	91
Feb. 11 - Mar. 3	365	142	507*	coho spawning	78
Mar. 4 - Mar. 31	365	142	507*	steelhead spawning	100
April 1- April 14	365	143	508*	steelhead spawning	100
April 15 - May 5	260	160	420	steelhead spawning	97
May 6 - May 19	260	155	415	steelhead spawning	97
May 20 - June 2	250	155	405	steelhead spawning	97
June 3 - June 9	250	148	398	steelhead spawning	96
June 10 - June 16	225	151	376*	steelhead rearing	96
June 17 - June 30	225	186	411*	steelhead rearing	96
July 1- July 7	197	204	401*	steelhead rearing	96
July 8- July 14	186	205	391*	steelhead rearing	96
July 15 - Aug. 4	188	219	407*	steelhead rearing	96
Aug. 5 - Sept. 1	80	211	291*	steelhead rearing	99

*Flows exceed the level required to provide maximum weighted usable area.

Augmented Normal Flows in Late September for Spawning Chinook Salmon

The City's Overflow Dike located at the outlet of Chester Morse Lake has the capability to be fitted with temporary flashboards that increase the City's capability to control the flow of water from Chester Morse Lake into Masonry Pool. By retaining water in Chester Morse Lake during the dry season, seepage losses through the glacial moraine that forms the northeast bank of Masonry Pool can be reduced. This reduction in seepage loss results in a small but significant increase in water available for delivery to the Cedar River. These water savings will be entirely allocated to augmenting stream flows to provide increased spawning habitat for early arriving chinook salmon in the Cedar River. In any year in which the temporary flashboards, as they presently exist in the City's Overflow Dike or may hereafter be reconstructed (provided that such reconstruction does not result in greater impacts to Covered Species), are in place throughout the period of June 1 through September 30, the normal minimum flows will be increased by the amount of 38 cfs between September 15 and 22, and by the amount of 115 cfs between September 23 and 30.

Increased flow during this time will provide increased habitat availability for early spawning chinook. Available sockeye spawning habitat is reduced during this period as flows exceed the level required to provide maximum WUA for sockeye. However, the reduction in static sockeye spawning habitat will be somewhat offset by the potential increase in cumulative sockeye spawning habitat and by recruitment of new edge habitat that may be to some extent less vulnerable to subsequent scour during flood events.

Augmented Critical Flows in Early September

In dry years, inflows to the river between the Landsburg Dam and Renton typically remain at very low levels in early September. Additional flow during early September in drought years will improve conditions for early returning adult chinook and sockeye and improve rearing conditions for juvenile steelhead and coho. In any year in which the temporary flashboards, as they presently exist in the City's Overflow Dike or may hereafter be reconstructed (provided that such reconstruction does not result in greater impacts to Covered Species), are in place throughout the period of June 1 through September 30, the critical minimum flows will be increased by the amount of 10 cfs throughout the period between September 1 and 15.

High-Normal Flows for Sockeye Salmon Spawning

As described previously, flows in excess of those required to provide maximum WUA for spawning are thought to provide additional benefits for sockeye by recruiting spawning and incubation habitat in less scour-prone areas nearer the margins of the stream. In order to provide the potential benefits of higher spawning flows for sockeye, the City will provide a high-normal flow regime when hydrologic conditions are favorable in the fall. Note that low-normal flows are equal to the flow level that creates maximum WUA for chinook spawning and are well above the level that creates maximum WUA for sockeye spawning.

Between October 8 and December 31, the City will provide either high-normal flows of 330 cfs or low-normal flows of 275 cfs, except when flows are reduced to critical flows according to the procedures described below. More specifically, the City, beginning on October 8, will meet the high-normal and low-normal flow regimes with the following long-term average frequencies assuming that the critical minimum flow regime will be in effect at a long-term average frequency of 1 in 10 years:

- The City will follow the high-normal flow regime in 6 of 10 years, provided that it may switch down to low-normal in one of those years when and if actual or forecasted water availability conditions worsen significantly from those projected and understood at the time of the decision to provide high-normal flows; and

- The City may follow the low-normal flows in 3 of 10 years, provided that it will switch up to high-normal at such time after October 8 if the City determines that improving conditions allow, or when criteria for high-normal levels are met, whichever comes first.

Between October 1 and October 7, the City will convene a meeting of the Commission by phone or in person. The City will present information on water supply conditions and forecasts, water conservation measures taken during the spring and summer, and such other information as may be useful in assessing the situation. The WDFW and/or other Parties to the IFA will present information on the chinook and sockeye salmon run size and timing and such other information as may be useful in assessing the situation. Following discussion and consideration of the information exchanged, the City will follow either the high-normal or low-normal flow regime, provided, however, that in order to implement the high-normal flow regime, the following minimum criteria must be met:

- On October 8 the elevation of Chester Morse Lake is, or is reasonably forecasted to be, greater than elevation 1541.5 ft; and

- The average inflow to Chester Morse Lake for the antecedent 30-day period is greater than 31 cfs; and

- The average inflow for the antecedent 15-day period is greater than 32 cfs.

If the City elects to implement the low-normal flow regime, the City must show that during the peak water consumption season it has provided to its water customers, through paid or unpaid advertising or general news coverage, at least two water conservation messages that emphasize the importance of stream flows to fish habitat.

Table 4.4-3 shows expected frequencies of high- and low-normal curves, on average, throughout the period following October 8, assuming off-ramping (from high to low) and up-ramping (from low to high) decisions using modeled historical hydrologic information.

Table 4.4-7. Long-term average number of years in 10 years during which high-normal and low-normal minimum flow regimes are in effect (assuming critical flows in 1 of 10 years).

Week Period	High-Normal	Low-Normal
Oct 8 - Oct 14	6.0	3.0
Oct 15 - Oct 21	6.0	3.0
Oct 22 - Oct 28	6.0	3.0
Oct 29 - Nov 4	5.0	4.0
Nov 5 - Nov 11	5.5	3.5
Nov 12 - Nov 18	6.5	2.5
Nov 19 - Nov 25	6.5	2.5
Nov 26 - Dec 2	7.0	2.0
Dec 3 - Dec 9	7.5	1.5
Dec 10 - Dec 16	7.5	1.5
Dec 17 - Dec 23	8.0	1.0
Dec 24 - Dec 31	8.0	1.0

Additional Water in Early Summer for Incubating Steelhead

Collaborative studies conducted by the City and WDFW indicate that is some years, incubating steelhead eggs and alevins can be vulnerable to dewatering from late June through early August as stream flows recede to natural base flow conditions. The timing and magnitude of vulnerability during this period varies from year to year and is partially dependent upon stream flows during the last half of the steelhead spawning season. Vulnerability to redd dewatering increases with increased spawning flow (Burton and Little 1997). To address this issue, minimum flow requirements provide a 2500 acre-foot block of water which can be applied as directed by the Commission to protect incubating steelhead between June 17 and August 4. To support decision making by the Commission, the City will fund an in-season steelhead monitoring program to provide real-time information on the degree to which redds are vulnerable to dewatering (Section 4.4.3).

Reductions to Critical Flows

During conditions of severe drought, the City will be allowed to reduce stream flows to levels described by the critical flow regime (Table 4.4-1 and Figure 4.4-1) according to the switching criteria and conditions described below. It is expected that actual reductions to critical levels would occur only under conditions that occur during a 1-in-10 year drought event. The HCP critical flow regime has been designed around the IRPP critical flow regime but differs in several ways (Figures 4.4-4 and 4.4-5). HCP critical flows will be slightly higher than IRPP flows during the fall, winter, and most of the spring and slightly lower than IRPP flows during the summer.

Switching Criteria and Procedures

The City may reduce flows to the critical minimum flow regime whenever the following conditions are met:

(1) The surface elevation in Chester Morse Lake reservoir is less than the elevations shown by date, or linearly interpolated between the dates shown in Table 4.4-4. The

measuring point for determining reservoir elevation will be the existing staff gage on the Overflow Dike.

(2) The average inflow to Chester Morse Lake for the antecedent eight -week (56-day) period is less than the flow shown by date or the flow linearly interpolated between the dates shown in Table 4.4-3. The measuring point for determining reservoir inflow will be the existing USGS stream gage #12115000, located at river mile 43.5, which serves as an index for total reservoir inflow.

(3) The City has implemented demand reduction measures, including public information programs, as described in its Water Shortage Contingency Plan adopted in 1993 by City Ordinance #116869 and has achieved water usage reductions that are significant for the season in which the shortage has occurred. The Commission shall have the opportunity to review and comment on any proposed revisions to the Water Shortage Contingency Plan in advance of any submission of such proposals for legislative action by the Seattle City Council, as well as the opportunity to comment formally during the decision-making process.

(4) The City has completed the following consultation process: Not less than five working days before it anticipates making a reduction to critical flows, the City will convene, by phone or in person, a meeting of the Commission. The City shall present information related to the switching criteria specified in Table 4.4-4, and discuss with the Commission any suggested options or alternatives to such reduction, such as alternative timing, intermediate flows, and other options. This consultation process may be repeated at the request of any member, but at a minimum, the City shall reconvene the Commission approximately 14 and 35 days after instituting reduced flows to evaluate the situation. If the City returns to normal flows before the end of the interval, the City need not reconvene the Commission, but shall simply notify it of the resumption of normal flows.

The criteria described in conditions 1 and 2 above are hydrologic and reservoir conditions that indicate a degree of drought that triggers an “alert phase” in which the City will initiate consultations with the other Parties to the IFA in order to assess overall supply and fishery conditions, demand management, and forecasts. Based on the hydrologic record, these alert phase conditions are anticipated to occur more frequently than one year in ten, but some will not result in switching to critical flows. The criteria described in conditions 3 and 4 above are other procedures and requirements that must be met before the City may reduce flows from normal to critical. It is projected and intended that actual reductions would occur approximately one year in ten over the long term.

A stabilized flow regime may be more beneficial than a flow that cycles up and down between normal and critical. Therefore the Commission may agree to extend the period of reduced flow during periods when conditions described in Table 4.4-4 are not being met, in order to protect a specific life stage.

Switching criteria will be considered interim until such time as those criteria may be modified as described later in this section under “Technical Studies and Adaptive Management.”

Table 4.4-4. Index Reservoir Inflow and reservoir condition thresholds establishing Alert Phase and potential reduction to critical flows. Flows shown in this table are based on approximately the 10th percentile of the average weekly inflow measured at the existing USGS stream gage # 12115000, for the previous eight weeks.

Water Week	Calendar Date	Average Antecedent 8-week Inflow to Chester Morse Lake (cfs)	Calendar Date	Water Elevation in Chester Morse Lake (ft)
49	September 5	40	January 1	1,539
50	September 12	37	February 1	1,539
51	September 19	36	March 1	1,540
52	September 26	31	April 1	1,548
1	October 4	37	May 1	1,552.5
2	October 11	37	June 1	1,559
3	October 18	37	July 1	1,555
4	October 25	38	August 1	1,552
5	November 1	48	September 1	1,550
6	November 8	66	October 1	1,540
7	November 15	65	November 1	1,540
8	November 22	66	December 1	1,539
9	November 29	81		
10	December 6	101		
11	December 13	114		
12	December 20	127		
13	December 27	147		
14	January 3	158		
15	January 10	156		
16	January 17	152		
17	January 24	169		
18	January 31	160		
19	February 7	139		
20	February 14	148		
21	February 21	151		
22	February 28	146		
23	March 7	133		
24	March 14	141		
25	March 21	142		
26	March 28	142		
27	April 4	149		
28	April 11	157		
29	April 18	169		
30	April 25	185		
31	May 2	203		
32	May 9	227		
33	May 16	233		
34	May 23	263		
35	May 30	289		
36	June 6	283		
37	June 13	285		
38	June 20	274		
39	June 27	249		
40	July 4	221		
41	July 11	194		
42	July 18	167		
43	July 25	133		
44	August 1	110		
45	August 8	87		
46	August 15	69		
47	August 22	55		
48	August 29	45		

Supplemental Flows

In addition to the minimum flow commitments proposed above, the City will provide supplemental flows to meet biological objectives under specific conditions that reflect actual and forecasted water availability. Although the HCP minimum flow commitments are typically well above the levels required to provide maximum WUA, ancillary investigations conducted during the collaborative study program indicate that additional biological benefits for other important aspects of salmonid life history may be obtained at still higher flows during certain times of the year. Committing to provide these additional higher flows at the same frequency as the normal minimum flows discussed would result in an unacceptable loss of firm yield from the drinking water supply. However, in many years, hydrologic conditions are such that these additional flows can be provided. Through the HCP, the City is committing to frequency goals for providing these higher supplemental flows.

The goals for these "non-firm" supplemental flows are derived from analysis and modeling of weather and hydrologic data over the 64.5-year period of record. The frequencies that are projected for achieving these goals are based on the assumption that similar hydrologic conditions will occur in the future. The goals for "non-firm" flows will be incorporated into the City's estimates and actions regarding the water supply capacity of the Cedar River system, which are part of the City's water supply planning process. Neither the volume of water provided to meet the non-firm flow goals, nor the frequency of the City's achievement of those flows will be decreased throughout the term of the HCP, whether or not the City contracts to supply water from the Cedar River to customers or service territories not currently supplied.

Higher Spring Flows for Emigrating Sockeye Fry

Between February 4 and May 12, HCP normal minimum flow commitments are increased above present IRPP levels to provide improved conditions for outmigrating sockeye fry. To provide further benefits for emigrating sockeye fry between February 11 and April 14, the City will, as a goal, supplement the normal minimum instream flows listed in Table 4.4-1 by 105 cfs at least 70 percent of the time throughout said period in any year in which normal flows are in effect throughout said period.

Hydrologic conditions during this period of the year are naturally volatile. The City's water management operations must consider flood control objectives, steelhead spawning conditions, juvenile chinook rearing conditions, water quality, reservoir refill, and facility maintenance, in addition to sockeye outmigration needs. Not later than April 30 of each year, the City will provide a report to the Commission on average daily flows during the period between February 11 and April 14. The report will explain the considerations that prevailed in any case in which the 105 cfs supplement to normal minimum flow commitments was not provided at least 70 percent of the time throughout said period.

Additional Water in Early Summer for Incubating Steelhead

In some years, high stream flows during the late spring can force steelhead to spawn in areas where their redds will subsequently experience increased risks of dewatering. To address these situations, the City will provide a block of water, in addition to minimum flows, to be allocated, as directed by the Commission, in normal years when the need exists for increased steelhead incubation protection and if specific hydrologic conditions and risk sharing mechanisms provide the flexibility to do so.

Between June 17 and August 4, in addition to the normal minimum flow commitments, (including the 2500 acre foot block of water described above), the City will, as a goal and under the conditions set forth below, expect to further supplement normal minimum flows by 3,500 acre-feet of water in 63 percent of all years. The Parties to the IFA recognize that supplementation of minimum instream flows early in the dry season increases the overall risk of shortage in meeting both water supply needs and guaranteed flow commitments as actual conditions unfold throughout the summer and fall. Therefore, the IFA prescribes a decision-making process that will be implemented to balance those risks with the benefits available from such supplementation of flows (see Appendix 27).

The options to address the increased risk of shortage that were identified by the Parties to IFA included use of the Chester Morse Lake pumping plants under modified water right permit conditions, modifications to the use of the low-normal flow curve, or such other options as may be defined by the Commission. The HCP provides that the State shall issue a new water right permit for the pumping plants, as they presently exist or may hereafter be reconstructed at substantially the same capacity. Such new permit shall reestablish the terms and conditions of the present permit, issued on October 30, 1992, except for the following three changes:

(1) The duration of the permit shall be at least as long as the term of the HCP; and

(2) The City shall be entitled to use the pumping plants to recover volumes of water released above minimum flows when authorized through the decision process described above, provided that, in such case, the permit requirement to implement the Water Shortage Contingency Plan shall not apply; and

(3) The permit shall be subject to minimum instream flow requirements as provided in the HCP

COMPARING THE HCP GUARANTEED FLOWS WITH THE EXISTING IRPP TARGET MINIMUM FLOWS

When considering the HCP flow regime, it is helpful to compare it with the existing IRPP flow management regime and various other reference points. The City has presented several comparisons in Table 4.4-5, Figures 4.4-2, 4.4-3, 4.4-4, and 4.4-5 to help clarify the basis and content of its flow regime. These comparisons are quite useful, but require further explanation and description of the manner in which they were derived.

The present flow regime for the Cedar River was adopted by the Department of Ecology in 1979, through the IRPP. The City has consistently asserted that this regime is not binding on its senior right to store and divert water on the Cedar River (Section 3.2.4). While the City uses the IRPP flow regime as an operating target and as a water supply planning assumption, it has had difficulty meeting these levels during dry periods in the past. Therefore, from the City’s viewpoint, the use of the non-binding IRPP flow regime as a reference point tends to overstate current conditions and somewhat complicates comparisons with the proposed binding flow commitments. In comparing the numerical aspects of the two flow regimes, the City has presented them as if they were equal in their level of commitment and enforceability, even though the HCP regime, unlike the IRPP regime, will obligate the City to operate according to a set of binding prescriptions.

The HCP flow regime moves the flow measurement point from Renton to Landsburg for the reasons described previously. In order to compare the stream flow commitments in the HCP, as measured at river mile 20.4 near Landsburg, with the existing IRPP regime, as measured at river mile 1.6 in Renton, it is necessary to account for the effect of tributary and groundwater inputs to the river between Landsburg and Renton. These inflows vary depending upon hydrologic conditions. An extensive investigation of inflows between the two points was conducted as part of the Cedar River Instream Flow and Salmonid Habitat Utilization Study (Cascades Environmental Services 1991) and refined in subsequent discussions and analyses. The investigations resulted in the production of a model providing mean weekly inflows for the full range of hydrologic conditions experienced between water year 1929 and 1988 and later extended to mid-water year 1993 (Appendix 8). The accretion flow model developed during the instream flow study program has been used to make the appropriate adjustments to facilitate comparisons of the HCP and IRPP flow regimes.

The IRPP and HCP regimes are similar in that each provides a normal flow schedule and a critical flow schedule that is implemented during periods of severe drought. However, the IRPP normal regime is static; that is, it does not vary based upon actual or forecasted hydrologic conditions. In contrast, the HCP regime provides opportunities for increased stream flow commitments during periods of key importance to anadromous fish. The precise timing and distribution of these flows will vary from year to year depending on hydrologic conditions, biological need, and direction from the Commission. Comparisons of HCP guaranteed flows with IRPP flows, therefore, require an assumption about the pattern according to which supplemental water is distributed.

And finally, the HCP regime offers two different normal flow curves during the fall in an effort to provide additional benefits for spawning salmon. The frequency with which each of the HCP fall flow curves will be applied must be integrated into a comparison with the single normal curve provided by the IRPP regime.

Table 4.4-5. Comparison of HCP and IRPP Instream Flow Schedules

	HCP Instream Flow Schedule								*IRPP Instream Flow Schedule*			
	Requirements at Landsburg				Expected Minimum at Renton				Expected Minimum at Landsburg		Renton Target Flow	
	Minimums											
Calendar Week	High Normal (cfs)	Low Normal (cfs)	Critical (cfs)	Total With Supplemental Flow (cfs)	High Normal (+50%tile accretion) (cfs)	Low Normal (+50%tile accretion) (cfs)	Critical (+6%tile accretion) (cfs)	Total Expected With Supplemental Flow (cfs)	Normal (-50%tile accretion) (cfs)	Critical (-6%tile accretion) (cfs)	Normal (cfs)	Critical (cfs)
Sep 2 - Sep 8	80	80	70	80[1/]	137	137	97	107[1/]	73	83	130	110
Sep 9 - Sep 15	80	80	70	80[1/]	138	138	99	109[1/]	87	81	145	110
Sep 16 - Sep 22	95	95	80	133[2/]	152	152	108	190[2/]	133	82	190	110
Sep 23 - Sep 30	95	95	80	210[2/]	155	155	109	270[2/]	140	81	200	110
Oct 1 - Oct 7	210	210	100		273	273	126		205	98	268	124
Oct 8 - Oct 14	330	275	130		392	337	157		301	128	363	155
Oct 15 - Oct 21	330	275	160		402	347	186		298	161	370	187
Oct 22 - Oct 28	330	275	180		416	361	222		284	176	370	218
Oct 29 - Nov 4	330	275	200		420	365	246		280	200	370	246
Nov 5 - Nov 11	330	275	200		419	364	243		281	207	370	250
Nov 12 - Nov 18	330	275	200		459	404	253		241	197	370	250
Nov 19 - Nov 25	330	275	200		486	431	262		214	188	370	250
Nov 26 - Dec 2	330	275	200		497	442	256		203	194	370	250
Dec 3 - Dec 9	330	275	200		540	485	254		160	196	370	250
Dec 10 - Dec 16	330	275	200		513	458	271		187	179	370	250
Dec 17 - Dec 23	330	275	200		529	474	267		171	183	370	250
Dec 24 - Dec 30	330	275	200		541	486	279		159	171	370	250
Dec 31 - Jan 6	260	260	180		447	447	260		183	170	370	250
Jan 7 - Jan 13	260	260	180		450	450	263		180	167	370	250
Jan 14 - Jan 20	260	260	180		480	480	264		150	166	370	250
Jan 21 - Jan 27	260	260	180		465	465	262		165	168	370	250
Jan 28 - Feb 3	260	260	180		442	442	259		188	171	370	250
Feb 4 - Feb 10	260	260	180		468	468	256		162	174	370	250
Feb 11 - Feb 17	260	260	180	365[3/]	473	473	258	578[3/]	157	172	370	250
Feb 18 - Feb 24	260	260	180	365[3/]	473	473	277	578[3/]	157	153	370	250
Feb 25 - Mar 3	260	260	180	365[3/]	473	473	261	578[3/]	157	169	370	250
Mar 4 - Mar 10	260	260	180	365[3/]	469	469	259	574[3/]	161	171	370	250
Mar 11 - Mar 17	260	260	180	365[3/]	451	451	246	556[3/]	179	184	370	250

Table 4.4-5. Comparison of HCP and IRPP Instream Flow Schedules (continued)

	HCP Instream Flow Schedule								*IRPP Instream Flow Schedule*			
	Requirements at Landsburg				Expected Minimum at Renton				Expected Minimum at Landsburg		Renton Target Flow	
	Minimums											
Calendar Week	High Normal (cfs)	Low Normal (cfs)	Critical (cfs)	Total With Supplemental Flow (cfs)	High Normal (+50%tile accretion) (cfs)	Low Normal (+50%tile accretion) (cfs)	Critical (+6%tile accretion) (cfs)	Total Expected With Supplemental Flow (cfs)	Normal (-50%tile accretion) (cfs)	Critical (-6%tile accretion) (cfs)	Normal (cfs)	Critical (cfs)
Mar 18 - Mar 24	260	260	180	365[3/]	435	435	259	540[3/]	195	171	370	250
Mar 25 - Mar 31	260	260	180	365[3/]	442	442	278	547[3/]	188	152	370	250
Apr 1 - Apr 7	260	260	180	365[3/]	439	439	264	544[3/]	191	166	370	250
Apr 8 - Apr 14	260	260	180	365[3/]	426	426	248	531[3/]	204	182	370	250
Apr 15 - Apr 21	260	260	180		403	403	253		227	177	370	250
Apr 22 - Apr 28	260	260	190		393	393	249		237	191	370	250
Apr 29 - May 5	260	260	190		386	386	251		244	189	370	250
May 6 - May 12	260	260	195		375	375	249		255	196	370	250
May 13 - May 19	260	260	200		363	363	249		267	201	370	250
May 20 - May 26	250	250	210		350	350	250		270	210	370	250
May 27 - Jun 2	250	250	210		348	348	251		272	209	370	250
Jun 3 - Jun 9	250	250	200		345	345	249		275	201	370	250
Jun 10 - Jun 16	225	225	200		313	313	249		282	200	370	249
Jun 17 - Jun 23	225	225	160	[4/]	309	309	204	[4/]	278	162	362	206
Jun 24 - Jun 30	225	225	100	[4/]	298	298	143	[4/]	230	102	303	145
Jul 1 - Jul 7	170	170	80	[4/]	243	243	110	[4/]	163	80	236	110
Jul 8 - Jul 14	105	105	80	[4/]	174	174	113	[4/]	99	77	168	110
Jul 15 - Jul 21	80	80	80	[4/]	147	147	113	[4/]	63	77	130	110
Jul 22 - Jul 28	80	80	80	[4/]	142	142	107	[4/]	68	83	130	110
Jul 29 - Aug 4	80	80	70	[4/]	138	138	102	[4/]	72	78	130	110
Aug 5 - Aug 11	80	80	70		133	133	105		77	75	130	110
Aug 12 - Aug 18	80	80	70		133	133	103		77	77	130	110
Aug 19 - Aug 25	80	80	70		132	132	102		78	78	130	110
Aug 26 - Sep 1	80	80	70		131	131	101		79	79	130	110

[1/] Minimum flow during critical years if flashboards in place

[2/] Minimum flow during normal years if flashboards in place

[3/] Guaranteed flow provided approximately 70% of time in normal years

[4/] Additional 2,500 ac ft in all normal years 6/17 - 8/4, & additional 3,500 ac ft in 70% of normal years 6/17-8/4

Figure 4.4-2. Comparison at Renton of existing, non-binding IRPP flows, HCP flows, and flows required to create maximum weighted usable area (WUA) as defined by IFIM study for key species and life stages.

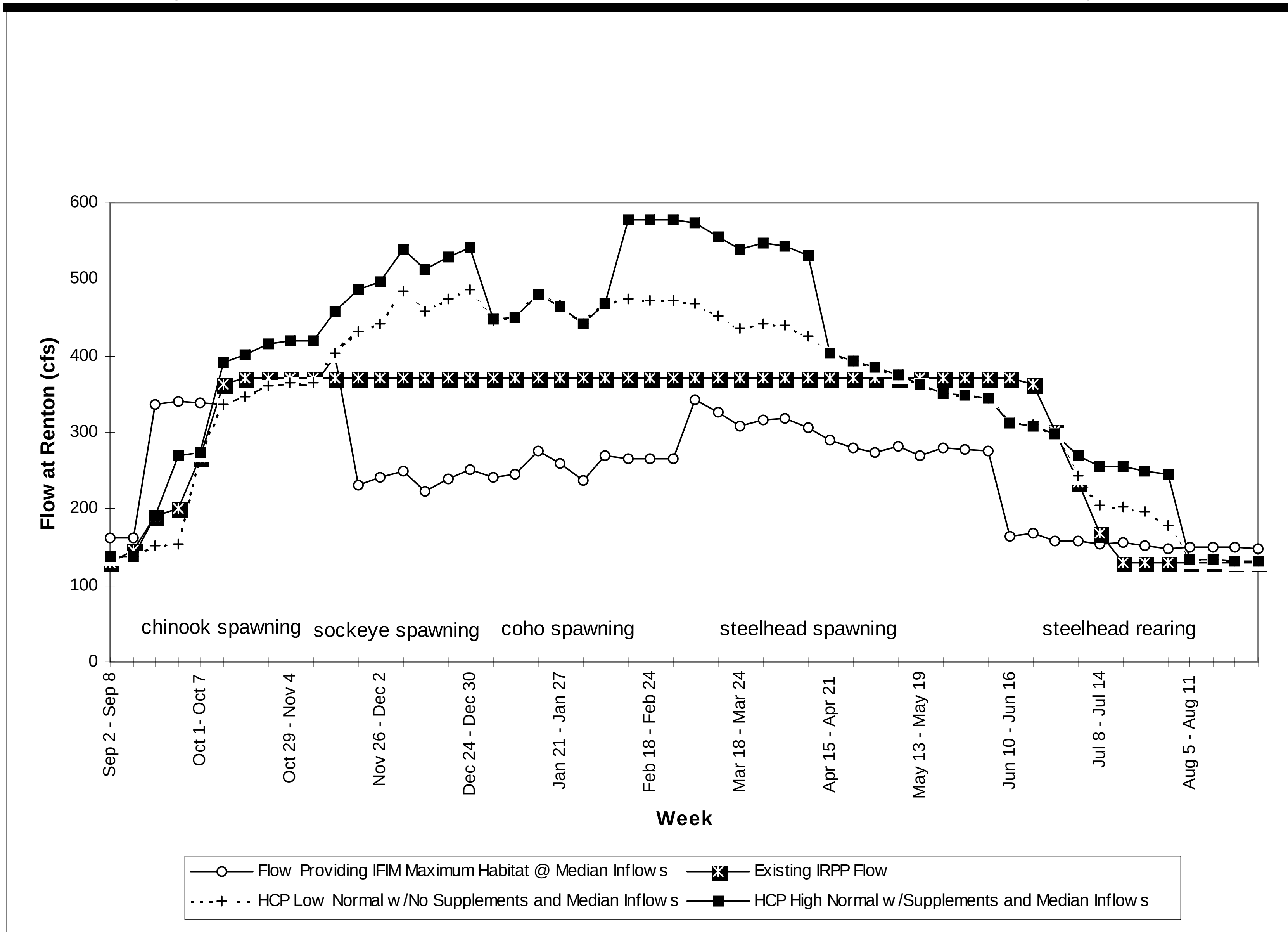


Figure 4.4-3. Comparison at Landsburg of existing, non-binding IRPP flows, HCP flows, and flows required to create maximum weighted usable area (WUA) as defined by IFIM study for key species and life stages.

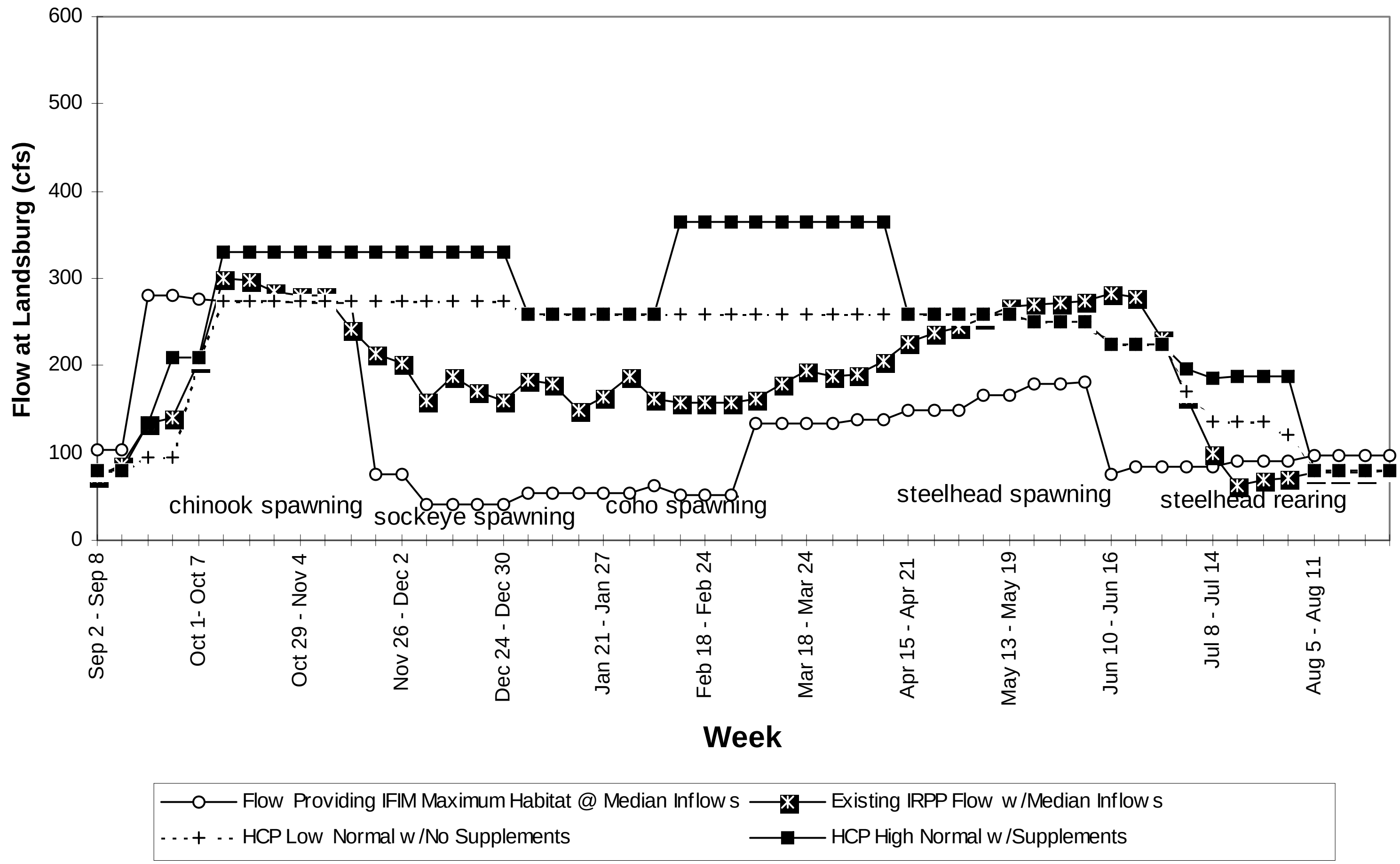


Figure 4.4-4. Comparison at Renton of existing, non-binding IRPP critical flows, HCP critical flows, and flows required to create maximum WUA as defined by IFIM study for key species and life stages.

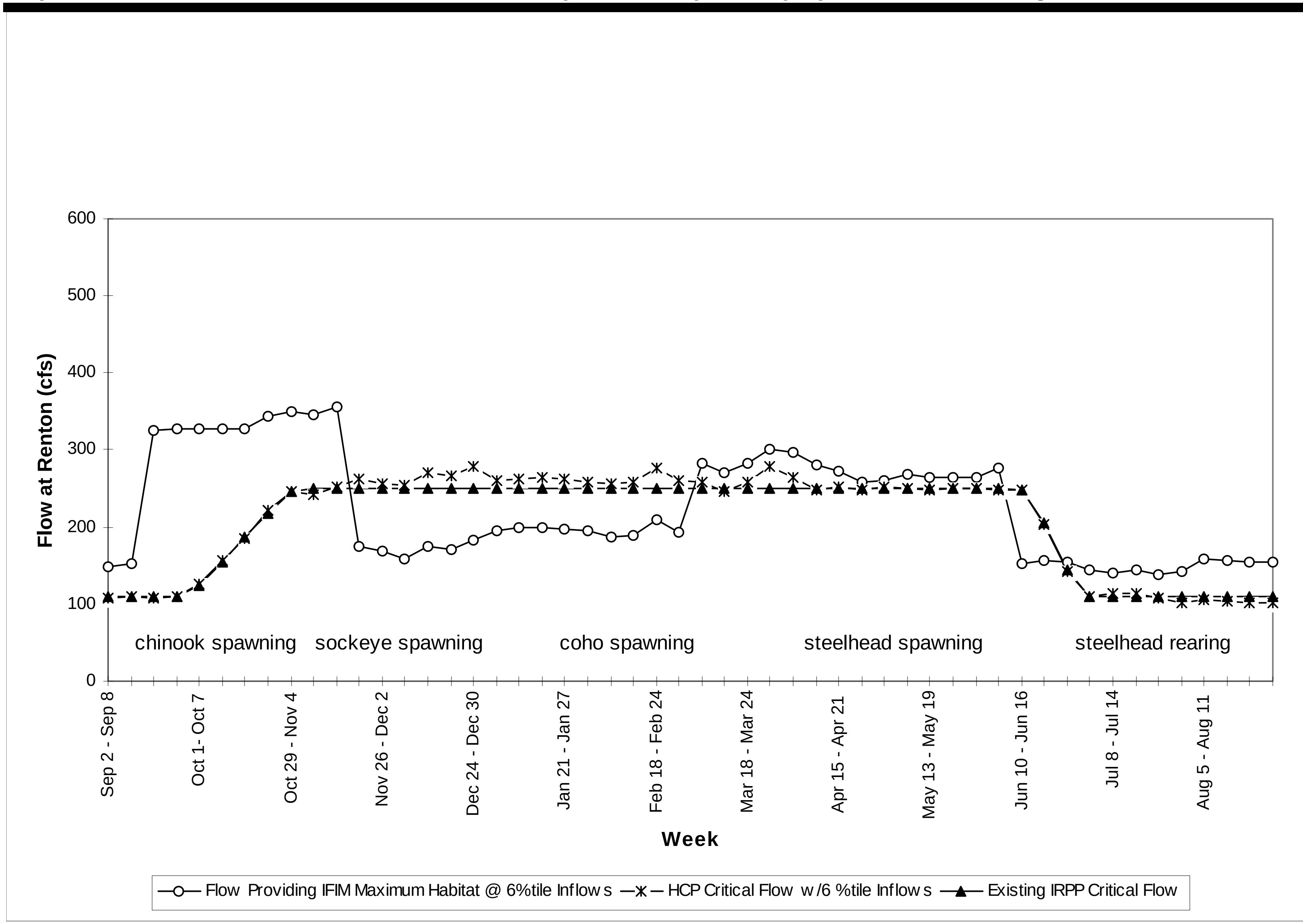
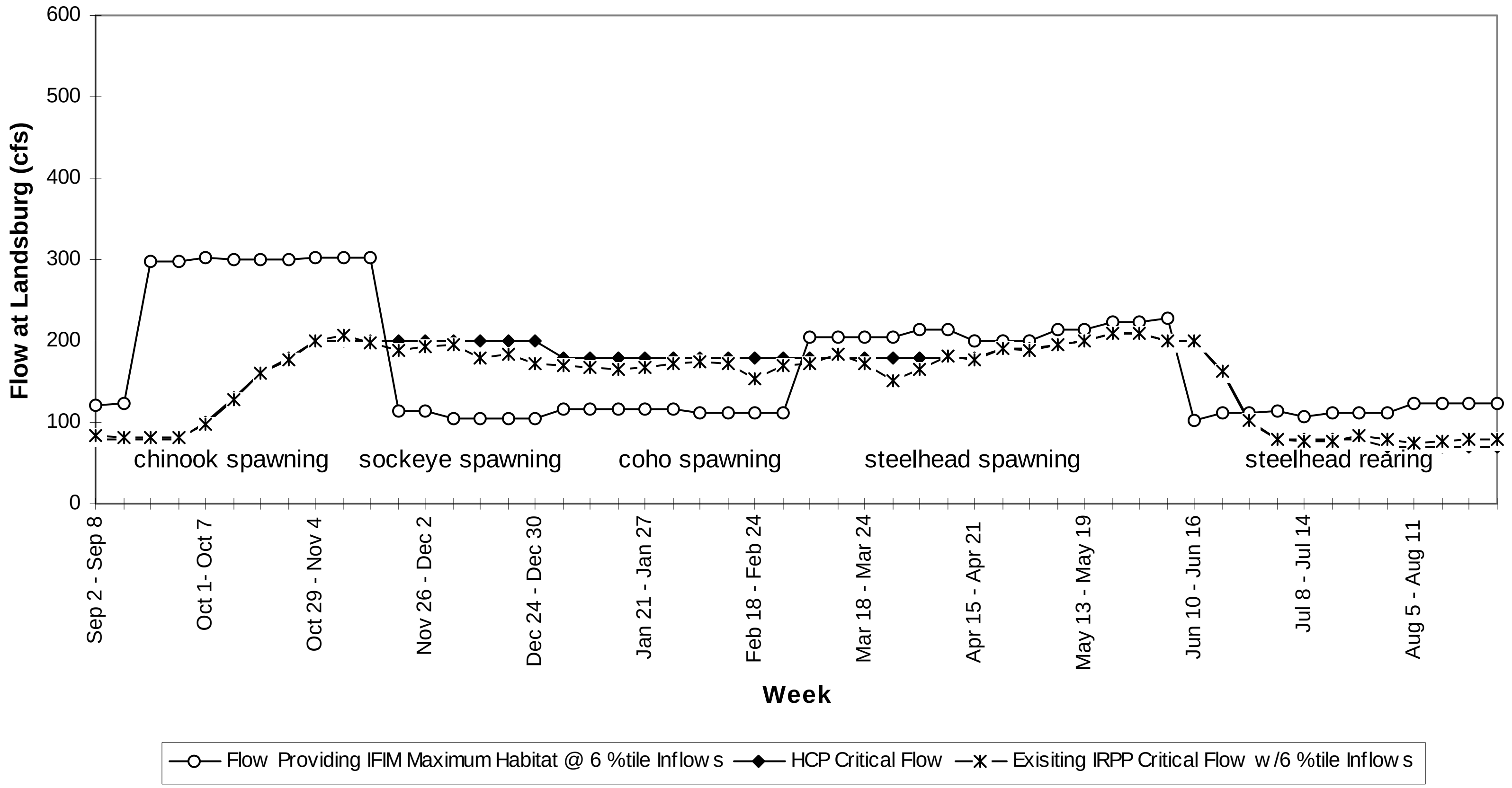


Figure 4.4-5. Comparison at Landsburg of existing, non-binding IRPP critical flows, HCP critical flows, and flows required to create maximum WUA as defined by IFIM study for key species and life stages.



BIOLOGICAL BASIS FOR THE GUARANTEED FLOWS

Biotic communities in freshwater ecosystems of the Pacific Northwest have evolved and developed over an approximate 10,000-year period since the recession of the continental glaciers at the end of the last ice age. A key feature to which these communities have adapted during this period is the general hydrologic pattern in the watershed they inhabit. Therefore, it seems prudent to consider general natural hydrologic patterns when developing an instream flow management regime for regulated rivers.

Several features of the instream flow management regime help reflect the natural hydrologic patterns in the basin. In particular, the minimum instream flow requirements follow the general shape of the natural annual hydrograph. The provision of supplemental flows linked to actual hydrologic conditions will help link instream flow management to naturally changing hydrologic conditions. In addition, by relocating the instream flow measurement point to Landsburg, the guaranteed flow regime will promote more natural short-term hydrologic patterns of variation throughout the river.

While the instream flow conservation strategy considers natural hydrologic patterns, simply attempting to mimic general natural hydrologic patterns is perhaps overly simplistic and insufficient to provide high quality salmonid habitat in a highly altered environment. This rather broad, high-level approach is important and informative, but can miss much of the complexity inherent in the relationships between stream flow and habitat quality. This added complexity can be partitioned into three general categories, as described below.

First, as an example, salmon and steelhead display a tendency to adapt to specific and unique conditions in particular watersheds, but they also display considerable plasticity. For example, robust anadromous salmonid populations are found in systems with a rather broad range of hydrologic conditions, from systems that exhibit quite sudden and dramatic flow fluctuations in response to phenomena such as rain-on-snow events, to very stable, spring fed systems in which flow variations are quite limited. Secondly, the specific micro-habitat preferences of various species and life stages of anadromous fish are complex, somewhat variable, and can be found in a relatively broad range of geomorphic conditions and stream channel types. Third, as discussed in section 3.2.5 and 4.3, the aquatic habitat for anadromous fish in the Cedar River Basin has been rather dramatically altered by anthropogenic activities during the twentieth century. The relationships between aquatic habitat characteristics and stream flow in the present channel, which is highly constrained, much narrower, shorter, and higher gradient than the original channel, are far different than the relationships that existed when the channel was in a natural condition. To further complicate matters, the changes in the drainage patterns of the Lake Washington basin that occurred with the construction of the Ballard Locks and re-routing of the Cedar River into Lake Washington resulted in rather dramatic ecological changes in the system and a shift in fish species composition (Section 4.3.2). In the Cedar River, these alterations likely resulted in the extinction of pink and chum salmon and have created challenging conditions for ocean-type chinook salmon (Section 3.5.10), but have provided conditions under which sockeye salmon were able to flourish (Section 3.5.8).

Therefore, in addition to considering natural hydrologic patterns, the instream flow conservation strategy also makes use of an extensive body of scientific information developed during 10 years of collaborative study and analysis (Sections 3.3.2 and 4.4.1). This body of knowledge provides detailed information on the habitat preferences of the anadromous fish species in the Cedar River and on many of the complex relationships between the quantity and quality of fish habitat and stream flow.

Supporting Studies and Analyses

The effects of stream flow on fish and fish habitat in the Cedar River have been the subjects of substantial study for the past 30 years. Early work conducted by the United States Geological Survey and Washington Department of Fisheries (Collings et al. 1970; Collings 1974) was used by the Washington Department of Ecology to establish minimum instream flow recommendations for the Cedar River in 1971 (WWRA 1971). Using this early work, coupled with additional studies conducted by the University of Washington (Stober and Greybill 1974; Stober et al. 1976; Stober et al. 1978; Stober and Hamalainen 1979; Stober and Hamalainen 1980; Miller 1976), the Washington Department of Ecology established a new set of minimum instream flows recommendations for the Cedar River in 1979 (Washington Department of Ecology 1979).

In 1986, the Cedar River Instream Flow Committee (CRIFC) was formed with the goal of using the best available science to conduct additional, collaborative investigations of the instream flow needs of aquatic resources in the Cedar River. The CRIFC was composed of representatives from the Washington Department of Fisheries, the Washington Department of Wildlife, the Washington Department of Ecology, the Muckleshoot Indian Tribe, the National Marine Fisheries Service, the United States Fish and Wildlife Service, the United States Army Corps of Engineers and the City of Seattle. The CRIFC called for and directed all aspects of a new set of studies conducted around a core approach provided by the Instream Flow Incremental Methodology (IFIM). IFIM "…is a decision- support system designed to help natural resource managers and their constituencies determine the benefits or consequences of different water management alternatives" (Bovee et al. 1998). The methodology is a broad-based approach that includes a library of linked analytical procedures that is grounded in ecological principles and is continuing to evolve. It provides a framework within which a number of different analytical tools can be developed to investigate the effects of stream flow on aquatic resources. IFIM can be used to help integrate the effects of natural and managed hydrology, instream and out-of-stream uses, and conflicting institutional interests with the biological requirements of aquatic species.

The CRIFC selected a contractor to perform selected studies and oversaw all aspects of the study planning, design, implementation, interpretation, and reporting of results. These studies were completed between 1986 and 1991 and published as the Cedar River Instream Flow and Habitat Utilization Studies in late 1991 (Cascades Environmental Services 1991) (see Section 3.3.2 of the proposed HCP). The studies included extensive Physical Habitat Simulation (PHABSIM) analyses (Bovee 1982, 1986) and a number of additional biological investigations. The CRIFC used this information, coupled with a number of additional hydrologic and biological analyses conducted jointly and independently by members of the committee as a primary information base during discussion and development of the HCP instream flow management regime from 1993 through 1997.

During the collaborative instream flow studies and development of the HCP instream flow management regime, the interagency CRIFC viewed the extensive PHABSIM analyses conducted on the Cedar River as a foundation for an instream flow management regime rather than as a prescriptive tool for determining preferred flows at any give time during the year. While the CRIFC agreed that PHABSIM analyses are an important tool in developing effective instream flow management practices, the members of the committee recognized that anadromous salmonid biology is complex and habitat requirements for these species are not completely described by standard PHABSIM analyses. Additional information is helpful in prioritizing species and life stages during particular times of the year; addressing aspects of their biology not typically analyzed in standard PHABSIM investigations; and understanding the complex relationships between hydrologic variation and natural ecological processes in the aquatic environment. During the course of collaborative studies and subsequent development of the HCP instream flow regime, a broad array of information was used in an effort to establish management provisions that would provide comprehensive protection for all life stages of anadromous fish and the habitat upon which they depend. These management provisions address key biological considerations determined to be of particular importance to Cedar River anadromous fish by the CRIFC and include:

- Limits on the rate at which stream flows can be reduced as a result of City's water management activities, established to reduce the risk of fish stranding and better reflect natural rates of stream flow recession;
- Increased guaranteed flows during the fall for increased cumulative sockeye spawning habitat and to recruit additional sockeye spawning habitat along the margins of the stream, which may potentially reduce the vulnerability of sockeye redds to scour during subsequent winter peak flow events;
- Increased guaranteed flows during the chinook and sockeye incubation season in the fall, winter, and spring to reduce the risk of redd dewatering;
- Increased guaranteed flows during the late winter and early spring to provide improved emigration conditions for sockeye fry;
- Steelhead redd monitoring program and flexible blocks of guaranteed and supplemental water during the summer for increased flows to reduce the risk of steelhead redd dewatering;
- Higher guaranteed flows into Lake Washington for more flexibility to provide beneficial fish passage conditions at the Ballard Locks; and
- A number of commitments that will result in stream flows that better reflect natural hydrologic patterns including: 1) relocation of the flow compliance point from Renton 20 miles upstream to Landsburg; 2) supplemental flows linked to real time hydrologic conditions; and 3) flexibility to collaborative manage flows above the guaranteed levels to support important natural ecological processes and provide benefits to fish

Species and Life History Considerations

The CRIFC identified all life stages of chinook, coho, sockeye and steelhead as the primary focus of the studies. Theses species were considered keystone species in subsequent discussion and negotiations. Life history periodicity information for the four species is provided in Figure 4.4-6. A summary of key considerations for the various species and life stages throughout the year is presented in Table 4.4-6.

A basic understanding of the life history of the salmon and steelhead is important for recognizing and understanding the likely impacts associated with different flow regimes. Differences in the timing of life stages mean that flows most advantageous for a particular life stage of one species may not be effective for another. Because each species and life stage has different habitat preferences, it is not possible to optimize habitat conditions for all species and life stages at a single river discharge level when multiple species and life stages are simultaneously present in the river. When habitat preferences for particular species and life stages do not overlap, prioritization decisions must be made. One approach is essentially an “averaging” approach that attempts to establish a combined aggregate measure of habitat condition for all species and life stages present. The other solution is to prioritize key species and life stages and to attempt to optimize conditions accordingly while minimizing potential detrimental impacts on other species and life stages. The CRIFC selected the latter approach.

Coastal cutthroat trout were not included in the studies because their smaller size and preference for small size streams and tributaries indicated they are much less influenced by Cedar River instream flows than other salmonids. Instream flows that meet the needs for the four studied species are expected to also provide adequately for cutthroat.

During the development of the HCP, the Services agreed that the Cedar River downstream of Cedar Falls does not presently support a viable population of bull trout, nor was such a population present in this area historically. If future information suggests that this is not the case and a viable population of bull trout is present in the Cedar River downstream of Cedar Falls, the City believes that the HCP instream flow management regime, which is designed to provide for the protection and recovery of chinook, coho, sockeye and steelhead, will protect and preserve bull trout also.

Stream flow commitments have been patterned to meet the habitat requirements of the various life stages for the four anadromous fish species in the Cedar River as summarized in Figure 4.4-6. A significant amount of information has been compiled on the run timing of adult chinook, sockeye, and steelhead and on the incubation and emergence timing of sockeye and steelhead in the Cedar River. Less information is available on adult coho run timing, coho and chinook emergence, and juvenile migration. Therefore life history periodicity descriptions for these life stages should be considered tentative.

Physical Habitat Simulation (PHABSIM) Analyses

Within the IFIM approach, Physical Habitat Simulation (PHABSIM) analyses provide an important tool for investigating the effects of stream flow on the physical components of fluvial fish habitat. PHABSIM analyses are based on the premise that habitat conditions preferred by different species and life stages of stream-dwelling fish vary within the channel as a function of flow. Or, stated more precisely, stream-dwelling fishes prefer specified ranges of depth, velocity, substrate, and cover type, and the availability of these preferred habitat conditions varies with stream flow. PHABSIM analyses use a set of computer models developed by the USFWS to integrate the life stage habitat preferences of individual species with measured, river-specific stream depth, velocity, substrate, and cover type to generate an index of habitat availability for particular species and life stages over a range of stream flow levels. This index of habitat availability is termed Weighted Usable Area (WUA) and is measured in square feet of habitat for a defined species and life stage per linear length of stream (Bovee 1982, 1986). The available habitat is weighted by its suitability in calculating WUA.

For example, chinook salmon have a preference for a certain range of water depths, velocities and substrate size for spawning. For the Cedar River, the CRIFC determined that preferred spawning depth for chinook ranged from 0.75 feet to 3.4 feet, preferred spawning velocity ranged from 1.0 feet per second to 3.5 feet per second and preferred substrate particle size ranged from 0.5 inches to 6.0 inches. The river discharge that provides the greatest area of these combined habitat preferences is commonly referred to as the flow that provides maximum WUA for chinook spawning and would be represented by the peak of the chinook spawning WUA curve (Figure 4.4-7). WUA is generally curvilinear. WUA typically increases as river discharge increases up to a certain level, and then WUA decreases as river discharge reaches a level that produces depths and velocities that are beyond the fish's habitat preference. The fact that WUA decreases to the right of the peak (as discharge increases) is an important aspect of the WUA function and is integral to discussions throughout this section.

By integrating the output from PHABSIM analyses for a particular species and life stage (such as spawning chinook salmon) with expected stream flows over a specified season (such as the fall chinook spawning season), habitat duration analyses may be generated to compare aggregate habitat availability for different potential flow regimes over a long period of time (in this case, the term of the HCP). In Appendix 36, the City presents analyses that describe and compare historic Cedar River stream flows, flows expected to occur over the next 50 years under the HCP flow regime, and flows that would be expected to occur under future conditions without the HCP flow regime, both based on the assumption that hydrologic conditions over the next 50 years will be similar to conditions over the 64.5-year period of record (Appendix 27, Exhibit A). This information on expected flows, coupled with modeled unregulated flows for the same period, was then used to generate the series of habitat duration analyses provided in Appendix 37 for various life stages of chinook, coho, sockeye and steelhead.

Habitat duration analyses allow investigators to compare total WUA and WUA distribution for given species and life stages for different stream flow regimes over specified time periods. For example, these analyses compare total aggregate chinook spawning WUA during the fall chinook spawning season as whole for three different stream flow regimes: flows expected under the HCP regime; flows that occurred historically under the IRPP regime; and predicted flows that would occur under natural conditions without regulation by the City's water management facilities. The results presented in Appendix 37 demonstrate that under nearly all hydrologic conditions that might occur, the HCP instream flow regime will provide more WUA for chinook spawning during the fall spawning season than either historical flows or predicted natural unregulated flows.

Because each species and life stage has different habitat preferences, it is not possible to achieve maximum WUA for all species and life stages at a single river discharge when timing of species and life stage in the river overlap. For example, Figure 4.4-7 illustrates that maximum WUA in Study Reach #1 for spawning sockeye is achieved at 125 cfs whereas maximum WUA for spawning chinook is achieved at 350 cfs. When the WUA/discharge function of two different species or life stages do not overlap but timing does, species prioritization decisions must be made.

Figure 4.4-6. Cedar River salmon and steelhead freshwater life stages.

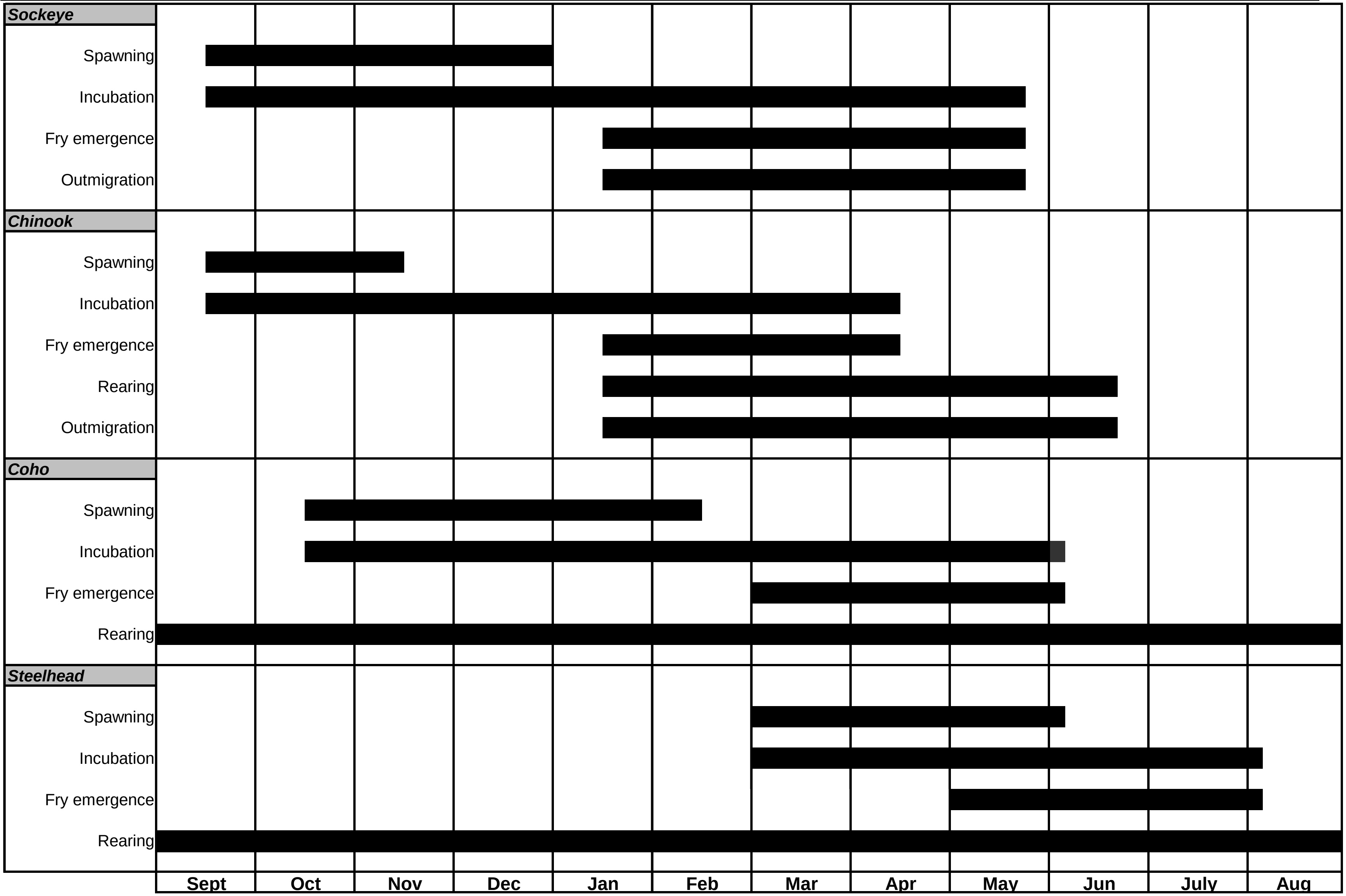
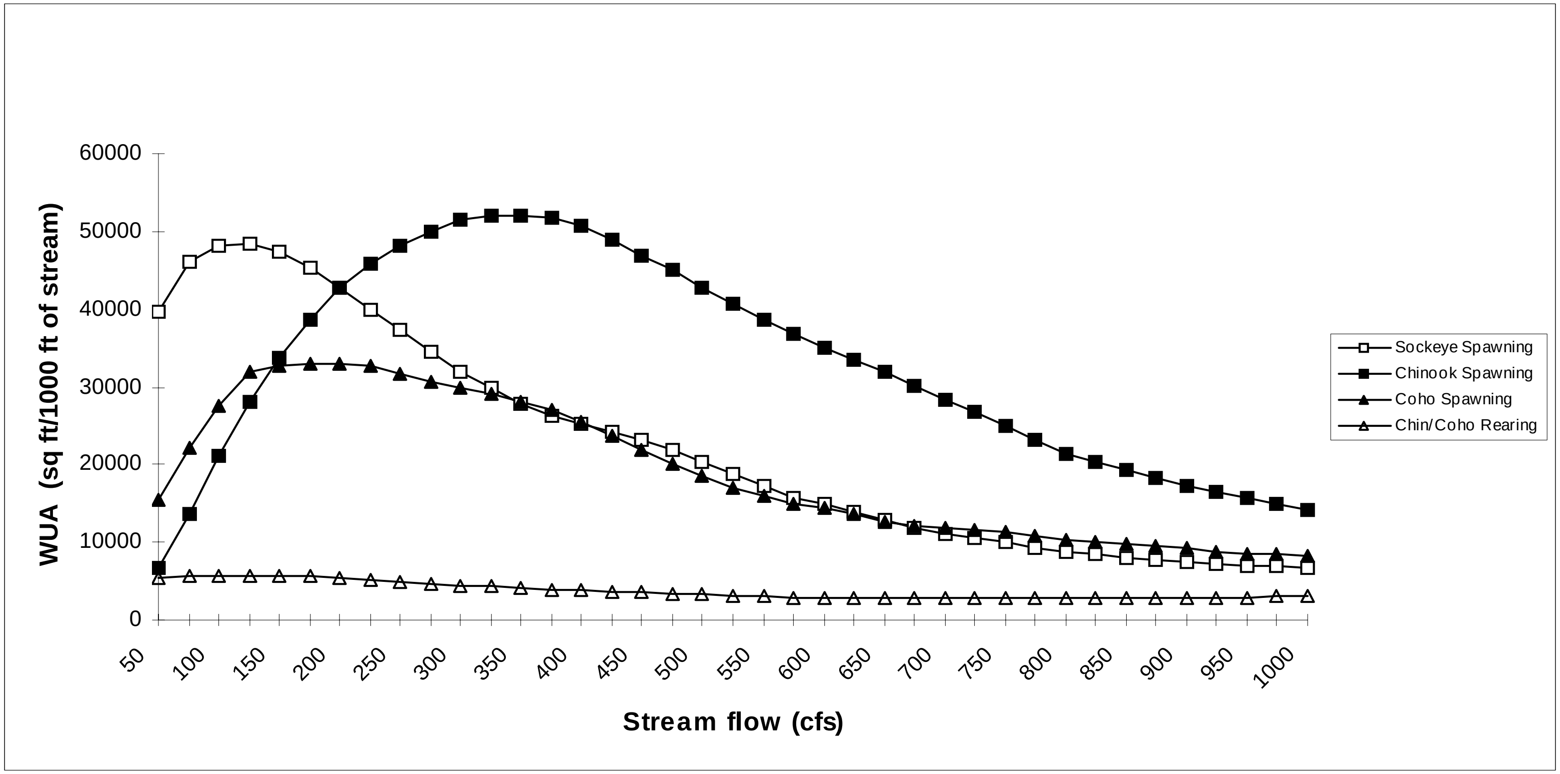


Table 4.4-6. Key instream flow considerations for anadromous fish in the lower Cedar River.

Time Period	Primary Species and Life History Stage Considerations	Additional Important Considerations
Mid-Sept. to Mid-Nov.	Quantity of chinook spawning habitat	• Cumulative habitat and edge habitat for spawning sockeye • Protecting incubating salmon • Quantity of juvenile rearing habitat
Mid-Nov. to End Dec.	Edge habitat for spawning sockeye	• Protecting incubating salmon • Quantity of coho spawning habitat
End Dec. to Early Feb.	Salmon incubation protection	• Quantity of coho spawning habitat • Protecting incubating salmon?
Early Feb. to mid-April	Outmigrating sockeye fry	• Protecting incubating salmon • Quantity of steelhead spawning habitat • Avoiding excessively high sustained flows that force steelhead to spawn in areas where redds will be vulnerable to later dewatering
Mid-April to early June	Avoid excessively high sustained flows that force steelhead to spawn in areas where redds will be vulnerable to dewatering	• Outmigrating sockeye fry • Quantity of steelhead spawning habitat • Quantity of juvenile rearing habitat • Protecting incubating salmon
Early June to early Aug.	Protecting incubating steelhead	• Quantity of juvenile rearing habitat
Early Aug. to Mid-Sept.	Quantity of juvenile rearing habitat	

Figure 4.4-7. Example of the relationship between stream flow and habitat, or Weighted Usable Area (WUA), for salmon spawning and rearing in Lower Cedar River Study Reach number 1.



The first consideration in designing the HCP flow regime has been to attempt to provide flows that meet or exceed the flows required to provide maximum WUA as defined by the PHABSIM analyses for key species and life stages throughout the year. PHABSIM is a powerful tool that is helpful in describing the relationship between stream flow and fish habitat and is a generally accepted methodology used to establish instream flow requirements for fish. However, the methodology entails some uncertainty and does not address all aspects of the biological requirements of fish (Castleberry et al. 1996). Recognizing that the PHABSIM analyses would not provide all the necessary information for establishing the appropriate instream flow regime, the CRIFC requested many additional studies be conducted to complement the PHABSIM information base (see Section 3.3.2). The flows required to provide maximum WUA have been used here as a foundation upon which additional flow is added to better address uncertainty and help meet ancillary biological requirements of anadromous fish as described by the companion investigations conducted during the collaborative study program.

Figures 4.4-2 and 4.4-3 are presented as the basis for discussing the needs of the fish and how they are addressed by the HCP normal minimum flow regime. To adjust the respective flow regimes to alternative measurement points, we have assumed median levels (50^{th} percentile) of inflow between Landsburg and Renton. For most of the year, the expected median HCP flows are not only greater than the existing IRPP flows, but are also greater than flows required to provide maximum WUA for key species and life stages as determined by the PHABSIM analyses. Although these increases in flow can result in significant decreases in the availability of spawning and rearing habitat, they provide additional overriding benefits that result in a net gain for target species and life stages.

Flows in the river between the Landsburg Dam and Renton are significantly influenced by natural local inflows. Under the provisions of the HCP, the flow measurement point will be moved upstream to Landsburg. As a result, stream flows throughout the river will exhibit a more natural pattern than under the existing regime. Because of this natural variation in inflows, HCP minimum flow commitments, as measured at Renton, may at times be somewhat higher or lower than the median flows displayed in Figure 4.4-2. Figure 4.4-3 compares the two flow regimes at Landsburg and demonstrates another important distinction between the two flow regimes. Under the present IRPP regime, the City can reduce flows in the upper river significantly during much of the year while still meeting the IRPP stream flow targets at Renton. Even relatively short-term reductions in flow to levels allowed by the IRPP regime as measured at Renton could pose a significant risk to incubating salmon and steelhead in the upper portions of the river.

Application of PHABSIM Analyses and Additional Studies

The HCP guaranteed flow regime is summarized in Table 4.4-1. The relationships between guaranteed flows, the existing non-binding IRPP minimum flows and the flows that provide maximum WUA for key species and life stages as determined by collaborative PHABSIM analyses are summarized in Figures 4.4-2 through 4.4-5. Expected flows will often exceed guaranteed flows during the fall, winter and spring because: (1) inflows to the basin often exceed amounts required to meet the guaranteed flows and municipal water supply demands; (2) surface runoff in the lower 57% of the basin enters the Cedar River naturally and is not influenced by the water storage reservoir; and (3) flood storage capacity in the reservoir is relatively limited. Expected flows under the HCP instream flow management regime, under the existing IRPP regime, and under natural unregulated conditions are summarized in HCP Appendix 36. Appendix 37 provides habitat duration analyses for expected flows under the HCP, IRPP and natural flow regimes using PHABSIM output for target species and life stages.

As described in the previous section, the HCP guaranteed flows are designed to be substantially greater than the flows required to provide maximum WUA for key species and life stages for the majority of the year. As flows increase above the levels required to provide maximum weighted usable area, water depths and velocities increase and the total amount of suitable habitat in the river generally decreases. Within this general pattern, spawning and rearing habitat availability vary independently and in different ways as flows change. For example, WUA for steelhead spawning increases as flows increase to a level of approximately 150 cfs as measured at Landsburg. When flows increase above this level, the amount of spawning habitat decreases rather markedly as depths and velocities in much of the channel increase beyond suitable ranges. In contrast, juvenile steelhead rearing habitat continues to increase as flows increase to a level of approximately 75 cfs, then decreases only slightly as flows increase further, because new low velocity habitat along the edges of the channel is recruited nearly as rapidly as low velocity habitat is lost in the rest of the channel.

For the three studied anadromous species that rear in the river (i.e., chinook, coho and steelhead), PHABSIM analyses demonstrate that WUA for juvenile rearing is less sensitive to changes in flows than is WUA for spawning. That is, for a given incremental flow change, the change in WUA for juvenile rearing is typically much smaller than the change in WUA for spawning. The analyses also demonstrate that the flows required to provide maximum WUA for spawning are much higher than the flows required to provide maximum WUA for juvenile rearing. For these reasons, and because WUA for juvenile rearing during the fall, winter and spring base flow conditions is not believed to be a major concern, spawning habitat and other considerations have generally been given higher priority in the Cedar River than rearing habitat availability.

There is one period during the year when there are no other overriding concerns and juvenile rearing is the primary focus of instream flow management. After the completion of steelhead incubation in early August and prior to the beginning of substantial chinook and sockeye spawning in mid-September, steelhead juvenile rearing is the key life history stage of concern. Juvenile coho salmon are also present at this time. However, the flows required to maximize WUA for juvenile steelhead are slightly greater than flows required to provide maximum WUA for either juvenile coho or juvenile chinook. Therefore, steelhead was selected as the key species of concern. During this time of year, instream flow considerations are typically important in determining the amount and quality of habitat available when juvenile fish are well dispersed and actively feeding and growing. Insufficient habitat availability at this time of year can potentially create a bottleneck for salmonids that rear in the river as juveniles. From August 4 through September 15, the HCP guaranteed flows are slightly below the levels required to provide maximum WUA for juvenile steelhead rearing, but still provide 98 to 99 percent of maximum WUA for this species and life stage. Habitat duration analyses summarized in Appendix 37 of the proposed HCP demonstrate that, for this period as a whole, expected flows under the HCP regime provide more WUA for juvenile steelhead rearing than expected flows under the existing IRPP regime or expected flows that would occur under natural conditions without the presence of water storage and diversion facilities. For the remainder of the year, from late September through the end of July, HCP guaranteed flows remain well above the levels required to provide maximum WUA for juvenile steelhead rearing.

During this period, HCP normal flows provide between 65 and 93 percent of maximum WUA for juvenile steelhead rearing.

In the fall, spawning conditions for salmon become a key biological consideration. By mid-September, substantial numbers of adult chinook salmon begin entering the river and maximizing chinook spawning habitat becomes a primary concern. With approximately 6 percent of the chinook salmon run typically in the river by September 16, the HCP guaranteed normal flows provide 77 percent of maximum WUA for chinook spawning. By September 23 with approximately 16 percent of the chinook run typically in the river, the HCP guaranteed flows provide 95 percent of maximum WUA. By October 8, with 50% of the run typically in the river, the HCP guaranteed low-normal flow provides 100 percent of maximum WUA, and the high-normal flow is greater than required to provide maximum WUA for chinook spawning. HCP low-normal and high-normal flows both remain equal to or greater than the flows that provide maximum WUA through the end of the chinook spawning season. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the chinook spawning period as a whole, expected flows under the HCP regime will provide more WUA for chinook spawning than expected flows under either the existing IRPP regime or the natural flow regime.

By mid-October, the HCP low normal flows have increased to a level that is approximately three and one half times the level required to provide maximum WUA for juvenile steelhead rearing. However, because of the relative insensitivity of WUA for juvenile rearing to flow in the Cedar River, these elevated flows still provide approximately 83 percent of maximum WUA for steelhead rearing.

The provision of cumulative spawning habitat is incrementally adding spawning habitat at the river margins, based on the assumptions that fish will fully occupy mid-channel habitat at lower flows and that increasing flows will recruit more unoccupied habitat at the river edge. A potential additional benefit of such edge habitat for fish that spawn there is a decreased risk of scour from high flows relative to redds nearer the thalweg. Efforts to provide additional cumulative spawning habitat and potential added protection from subsequent redd scour for sockeye take precedence over WUA for sockeye spawning in the fall. With approximately 11 percent of the sockeye run typically in the river by September 16, the HCP low-normal flows already exceed the flows required to provide maximum WUA for sockeye spawning. By the approximate mid-point of the run in mid-October, the HCP low-normal flows are more than two and one-half times the level required to provide maximum WUA for sockeye spawning. Water depth and velocity increase throughout much of the channel at these elevated flows, and the amount of total sockeye spawning habitat decreases. From October 8 through December 30, low-normal flows provide between 56% and 71 % of maximum WUA for sockeye spawning. High-normal flows provide between 51% and 61% of maximum WUA during this same period. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the sockeye spawning period as a whole, expected flows under the HCP regime will provide less WUA for sockeye spawning than expected flows under the existing IRPP regime, but more WUA than expected flows under the natural flow regime. Although significant amounts of sockeye spawning habitat become unavailable at these higher flows, the losses in static habitat are partially offset by cumulative increases in potential sockeye spawning habitat. That is, if we assume that significant numbers of sockeye have spawned during the earlier part of September, then flow increases in October will tend to force newly entering fish away from already seeded habitat and towards new, previously unsuitable habitat nearer the stream margins. This newly recruited sockeye spawning habitat nearer the stream margins is believed to provide further benefits to sockeye because this new habitat is believed to be somewhat less vulnerable to scour during subsequent flood events.

To reduce the risks associated with subsequent redd dewatering, minimum flows remain well above the levels required to provide maximum WUA for coho spawning throughout the winter. Because coho tend to spawn primarily in tributaries, reductions in available mainstem spawning habitat at this time are believed to be of less concern than providing added incubation protection for chinook and sockeye.

Preliminary analyses by WDFW suggest that emigrating sockeye fry can benefit from elevated flows during the late winter and spring (Seiler and Kishimoto 1997b). Therefore, HCP minimum flows remain elevated at elevated levels throughout the period of juvenile sockeye emigration from early February through the middle of May. Steelhead spawn in the mainstem from early March through early June and are also a consideration during this period. Higher flows for emigrating sockeye fry result in a moderate reduction in available spawning habitat for steelhead. Between mid-March and the end of May, the HCP guaranteed normal flows provide between 78 and 98 percent of maximum WUA for steelhead spawning. Habitat duration analyses demonstrate that, for the steelhead spawning period as a whole, expected flows under the HCP regime provide more WUA for steelhead spawning than expected flows under natural flow conditions or expected flows under the IRPP regime.

Higher flows during the period of steelhead spawning may also encourage fish to spawn in areas where their redds will be at greater risk of dewatering as flows drop naturally to base flow levels during the summer (Burton and Little 1997). The redds of late-spawning steelhead are most susceptible to this risk, because alevins may remain in these redds until early August. The risks associated with elevated spawning flows are offset in two ways. First, as sockeye emigration approaches completion in May, minimum flows decline to levels that are still above, but nearer the levels that create maximum WUA for steelhead spawning and thus provide more available spawning habitat. More moderate flows also reduce the risk that redds will be constructed in areas that will subsequently be dewatered. Second, the City will commit in the HCP to a real-time steelhead redd monitoring program and will provide a flexible block of water to be used by the Commission to provide added protection for any potentially vulnerable redds.

Upstream Fish Passage

Shallow depths across a riffle or gravel bar can create a low-flow blockage that limits a fish's ability to swim upstream. The shallowest and widest riffle in the Cedar River downstream of Landsburg was identified during the collaborative instream flow studies. Using the field data from the cross section measurements and hydraulic information developed for the PHABSIM analyses, the studies investigated the flow required to allow adult chinook to pass over the low-flow passage barrier. Although the absolute lowest minimum flow that would allow passage was not determined, the study demonstrated that passage of adult chinook would not be impeded at flows of 94 cfs or more as measured at the low flow blockage located approximately 0.5 miles upstream of the confluence with Rock Creek. HCP minimum flows are substantially greater than 94 cfs at this location from September 15 throughout the entire salmon and steelhead spawning seasons.

Delivery of Water to Lake Washington

On an annual basis, the Cedar River provides approximately one-half the total inflow to Lake Washington. The total volume of inflow to Lake Washington during the dry season is especially important for protecting water quality, for managing water levels in Lake Washington, and for providing suitable conditions for fish passage and vessel traffic at the Ballard Locks. Therefore, it is helpful to include consideration of factors beyond the river itself when developing a comprehensive approach to managing Cedar River instream flows. As a result of all the provisions listed above, the HCP guaranteed instream flow regime provides higher flows into Lake Washington than the existing IRPP minimum flow regime. Guaranteed flow volumes into Lake Washington (minimums plus supplemental flows) are summarized in Table 4.4-6 for different flow exceedance levels during the typically dry period of the year between June 17 and September 16. As can be seen from Table 4.4-7, the HCP guaranteed flow regime provides from 5 to 39 percent more flow volume into Lake Washington, than the existing IRPP minimum flow regime.

Table 4.4-7. Compared total Cedar River flow volume at Renton for the period June 17 through September 30.

City of Seattle HCP Minimum Normal Flow Exceedance Level at Renton	*Total Flow Volume Passing Renton with HCP Minimum Normal Flows Plus Supplemental Flows at Specified Accretion Flow Exceedance Levels (acre-feet)*	*Total Flow Volume Passing Renton with IRPP Minimum Normal Flows (acre-feet)*	*Difference Between IRPP and HCP Flow Regimes Minimums at Specified Exceedance Levels (acre-feet)*	*% Difference Between IRPP and HCP Flow Regimes at Specified Exceedance Levels*
10%	50,850	36,628	14,222	39%
30%	45,614	36,628	8,986	25%
50%	43,592	36,628	6,964	19%
70%	41,541	36,628	4,913	13%
90%	38,493	36,628	1,865	5%

MANAGEMENT OF STREAM FLOWS ABOVE THE GUARANTEED LEVELS

As described previously, stream flows in the Cedar River can often exceed the levels required to meet HCP guaranteed flow commitments and municipal water supply demands; especially during the wet periods of the year. These higher flows can be both beneficial and detrimental to aquatic resources. For example, high flow in the early spring may improve emigration conditions for sockeye fry. High flows also support many features and processes that help create and maintain favorable habitat characteristics in the stream channel and in riparian areas. However, higher flows can also have negative effects, such as displacing rearing juvenile fish into less favorable habitat and inducing bedload movement, which can cause mortality to incubating salmonids.

Scientists' understanding of the ecological benefits of natural patterns of river flows has increased in the last decade, and we can expect it to change more in the future (Poff et al. 1997; Richter et al. 1996). It is the City's intent not to over-exploit the Cedar River and to preserve ample flexibility to manage instream flows in the manner most beneficial to fish and the ecosystems upon which they depend. The City will use information gained in the many studies to be performed under the HCP, and by others, to attempt to manage instream flows in a manner that, where biologically appropriate, more closely mimics natural hydrologic patterns and that encourages natural ecological and regenerative processes throughout the lower river. These efforts must necessarily also consider the altered conditions of the lower river, flood control needs, and water customer needs.

Biotic communities in freshwater ecosystems of the Pacific Northwest have evolved and developed over an approximate 10,000-year period since the recession of the continental glaciers at the end of the last ice age. A key feature to which these communities have adapted during this period is the general hydrologic pattern in the watershed they inhabit. Therefore, it seems prudent to consider general natural hydrologic patterns when developing an instream flow management regime for regulated rivers.

The relationships between hydrology and aquatic habitat in fluvial systems are very complex. Attempting to precisely mimic general natural hydrologic patterns can result in both beneficial and detrimental effects to aquatic resources, especially in altered stream channels. A broad, high-level approach that is informed by natural hydrologic patterns can be helpful and informative. However, such an approach but can potentially miss much of the complexity inherent in the relationships between stream flow and specific habitat conditions. This added complexity can be partitioned into three general categories.

First, as an example, salmon and steelhead display a tendency to adapt to specific and unique conditions in particular watersheds, but they also display considerable plasticity. For example, robust anadromous salmonid populations are found in systems with a rather broad range of hydrologic conditions, from systems that exhibit quite sudden and dramatic flow fluctuations in response to phenomena such as rain-on-snow events to very stable, spring-fed systems in which flow variations are quite limited. Secondly, the specific micro-habitat preferences of various species and life stages of anadromous fish are complex, somewhat variable, and can be found in a relatively broad range of geomorphic conditions and stream channel types. Third, as discussed in sections 3.2.5 and 4.3, the anadromous aquatic habitat in the Cedar River Basin has been rather dramatically altered by anthropogenic activities during the twentieth century. The relationships between aquatic habitat characteristics and stream flow in the present channel, which is highly constrained and much narrower than the original channel, are far different than the relationships that existed when the channel was in a natural condition. To further complicate matters, the changes in the drainage patterns of the Lake Washington basin that occurred with the construction of the Ballard Locks and re-routing of the Cedar River into Lake Washington resulted in rather dramatic ecological changes in the system and a shift in fish species composition (Section 4.3.2).

Therefore, in addition to considering natural hydrologic patterns, the City has also committed to fund additional studies associated with the effects of stream flow on the early life history of chinook salmon and other salmonids and to further explore the effects of stream flow in altered fluvial environments. This information will be developed in consultation with the Instream Flow Commission and will be used by the Commission and the City in managing stream flows above the guaranteed levels provided by the HCP.

Adaptive Features of the Instream Flow Management Regime

Although a substantial amount of information was assembled over the last 10 years to guide the development of the HCP instream flow regime, the City anticipates that additional information will become available as the science of fluvial systems and strategies for managing stream flows in altered channels continue to evolve. In addition to well defined, guaranteed instream flow management commitments, the City acknowledges the need to provide sufficient flexibility to adapt and improve instream flow management strategies, as new information becomes available. Therefore, the HCP provides substantial commitments to manage the City's future diversions from the Cedar River with sufficient flexibility to meet additional needs for instream resources should such needs arise. In addition, the HCP provides over $ 3.4 million for further studies to: 1) monitor natural and regulated stream flows throughout the basin; 2) better quantify the effects of natural local inflows on stream flow in the Cedar river downstream of municipal watershed; 3) improve the ability of stream flow switching criteria to accurately reflect natural hydrologic conditions; 4) to improve our understanding of key aspects of the biology of chinook salmon and other salmonids in the Cedar River; and 5) better understand the effects of natural hydrologic patterns and stream flow management on fish habitat in altered fluvial systems (see Section 4.5.2). Finally, the HCP establishes an Instream Flow Commission (below and Appendix 27) that will make use of the information gathered during future studies to help guide the management of stream flows over and above the guaranteed levels to provide additional benefits for instream resources.

The use of this adaptive approach is particularly important in addressing the early life history of Cedar River chinook. Ocean-type juvenile chinook, such as those found in the Cedar River, typically express a tendency toward two early life history patterns. In one pattern, newly emerged juvenile chinook migrate directly downstream to the estuary where they rear for up to several months before moving into continental shelf waters. In the second pattern, juvenile chinook emerge from their redds and rear for up to three months in their natal stream before moving downstream to the estuary where they rear for shorter periods of time before moving into continental shelf waters (Healey 1991).

Preliminary investigations conducted by WDFW suggest that substantial portions of the juvenile chinook population in the Cedar River display both of these early life history patterns (WDFW 1999, unpublished data). However, in the case of the Cedar River fish, young chinook no longer have ready access to an estuary. Because the Cedar River was rerouted into Lake Washington during the early 1900s, all juvenile chinook that migrate from the Cedar River to the marine environment must now swim through approximately 19 miles of lacustrine habitat that supports a wide variety of native and introduced predators. As they enter the marine environment, juvenile chinook must pass through the Ballard locks and cope with a highly modified marine/freshwater interface that has relatively little resemblance to a natural estuary. This hydrologic configuration is very atypical for ocean-type chinook in general. There are few, if any, examples of newly emerged, ocean-type chinook fry rearing and migrating through a large natural lake system en route to the marine environment. In particular, this configuration is foreign to native Cedar River chinook that historically migrated only a very short distance in the Duwamish River between the Cedar River and the Duwamish Estuary. The degree to which Cedar River chinook have been able to adapt to this rather dramatic alteration of their environment is unclear.

The degree to which either of the two chinook early life history patterns contributes to the production of returning adults and overall survival of the population is also unclear. If, for example, juvenile chinook that migrate immediately out of the Cedar River contribute to the majority of the smolt production in the system, then spring juvenile rearing conditions in the river are less of a concern, and spring in-river emigration conditions become a greater concern. Alternatively, if young chinook that rear in the river for three months before migrating through the lake survive better than fish that enter the lake as newly emerged fry, then juvenile rearing conditions in the river during the spring are a very important consideration.

Much of the Cedar River downstream of the Landsburg Dam is confined by levees, with approximately 64 percent of the length of the river hardened on at least one bank (King County 1993). The average width of the active channel is now estimated to be approximately one half the width of the active channel in the mid-1800s prior to the impacts of development (King County 1998). During periods of high stream flow, the availability of suitable fry rearing and refuge habitat in this confined and narrowed channel can be substantially reduced. Preliminary studies conducted by WDFW indicate that large numbers of chinook fry emigrate from the river during high flow events in the spring. If high spring flows induce chinook fry to migrate to the lake, and these fish survive at a significantly lower rate than fish that rear in the river, then high spring flows could reduce overall smolt production. However, if fry that rear in the lake survive at a greater rate than fry in the river, then high spring flows may increase overall smolt production. The Cedar River constitutes one of the best opportunities in the region to protect and rehabilitate juvenile rearing habitat for chinook. Given that Lake Washington is completely surrounded by urban development, caution is advisable regarding changes to river flows during the chinook spring emigration period, particularly when other species are also considered.

Water management decisions on the Cedar River are very complex during the spring. Managers must consider the needs of (1) incubating salmon and steelhead, (2) spawning steelhead, (3) rearing juvenile steelhead, coho, and chinook, (4) emigrating sockeye and chinook fry, and (5) emigrating chinook, coho and steelhead smolts. In addition to protection of anadromous fish, decision-makers must also consider (1) flood management, (2) refilling Chester Morse Lake in a manner that protects nesting loons and incubating bull trout, and (3) continuing to provide a safe and reliable municipal water supply.

To make good instream flow management decisions, managers must be supplied with accurate and reliable information. As mentioned above, such information on the early life history of chinook salmon is presently limited. To address this information gap and support instream flow management decisions, the HCP provides $1 million specifically earmarked for studies that address the early life history of chinook salmon and other key life stages of anadromous salmonids in the Cedar River (Section 4.5.2). The City expects that these study results, along with results from other key studies, will be used by the Cedar River Instream Flow Commission to help make well informed and balanced instream flow management decisions during the spring and other key periods of the year.

In summary, the adaptive approach to instream flow management provided by the HCP is expected to improve our understanding of the complex biological requirements of anadromous salmonids in altered fluvial systems. This improved understanding, combined with the flexibility provided by the HCP, will support a more robust management framework that is expected to improve conditions for aquatic resources and help protect and restore ecological processes that shape and maintain aquatic habitat in the lower Cedar River.

Future Uses of the Cedar River

The City of Seattle influences river flows in the Cedar River through its water supply and hydroelectric operations within the municipal watershed. Water from the Cedar River is used by two-thirds of the City's 1.3 million customers in King and Snohomish Counties. While the daily and average river flows in the Cedar River vary substantially, the river has an average annual total flow of about 550 million gallons per day (mgd). The City has a water right claim for annual average water withdrawals, or diversions, of 300 mgd from the Cedar River, where an annual average diversion for a given year is the average of the daily diversions over that year. Over the past 50 years, the City has withdrawn an average of about 118 mgd annually from the river, with a peak annual diversion of 144 mgd during 1991. In recent years, aggressive conservation has reduced annual withdrawals to between 98 and 105 mgd, even though the region's population has grown substantially. Annual withdrawals and the total volume of river flow vary year to year, but an average annual withdrawal of 118 mgd constitutes about 22 percent of the average annual total river flow. This withdrawal also represents about 12 percent of the water that the entire Lake Washington basin produces.

The technical basis of the instream flow regime in this HCP is the habitat needs of anadromous fish, however, not the pattern of water withdrawals. The HCP's instream flow regime is based on the best available science. It was developed collaboratively with experts in many agencies, the methods used have been standard throughout the U.S. for decades, and these standard methods were extended in significant ways to address issues specific to the Cedar River. Potential future river flows are expected to be substantially better for fish than past river flows due to improved and higher guaranteed flows coupled with the wide range of additional instream flow protection measures described elsewhere in Section 4.4. For additional information on expected flows in the Cedar River under the HCP, please refer to Technical Appendix 36.

The IFA includes the following statement of intent: "All Parties recognize that the Cedar River provides stream flows which are essential to the needs of people as well as to the survival and recovery of fish. It is the intent of the Parties to protect instream flows for fish and navigation and to minimize use of the Cedar River to serve future regional growth, while recognizing that conjunctive use of the Cedar may be important to achieving regional water supply efficiencies. All Parties recognize that there are innovative opportunities for use of the Cedar River, which may benefit both fish and people. The City will continue to actively pursue other water sources, innovative projects (such as the Cedar Dead Storage Project described herein), and water reuse options to address future growth. WDOE is not, by signing this agreement, approving or permitting any intertie project, water transfer, and/or future permits."

Through the HCP, the City is making a 50-year commitment to a binding set of minimum instream flow requirements, to replace the current non-binding flow targets, in order to contribute to the protection of aquatic resources above and below the Landsburg Diversion Dam. In addition, the City will provide "non-firm" water to supplement minimum instream flows under specified conditions. The goals for "non-firm" flows will be incorporated into the City's estimates and actions regarding the water supply capacity of the Cedar River system, which are part of the City's water supply planning process. Neither the volume of water provided to meet the non-firm flow goals nor the frequency of the City's achievement of those flows will be decreased throughout the term of the IFA.

The City also recognizes that a significant volume of water is often available above the instream commitments and current water supply needs of the City, and that in the future beneficial instream, downstream, or out-of-stream uses may be proposed for some of this water. The HCP allows the flexibility for future decisions regarding uses for this water. The HCP provides for a Commission that will serve as a forum for sharing of information and discussion of such issues.

An example of "innovative opportunities for use of the Cedar River which may benefit both fish and people" (from intent statement, above) is the Cedar Permanent Dead Storage Project described in this HCP. This project, if implemented, could provide greater water supply reliability and yield, while also making more water available for higher flows to provide additional biological benefits for some important aspects of salmonid life history during certain times of the year. The planned Tacoma-Seattle Intertie and Tolt Treatment Facility are examples of new projects that have been designed to work in conjunction with the City's existing Cedar and Tolt sources to meet future demand. As these two projects approach full utilization, they will use small additional increments of Cedar River water. When these projects are first brought online, use of Cedar River water will be decreased.

The City is dedicated to managing water diversions from the Cedar River for the next 5-10 years, except under emergency or very unusual situations (e.g., natural disasters, pipeline failures, water quality events, extreme drought, and system failures), in the same range that water diversions have been for the last five years (98-105 mgd on an annual average basis). The City is confident that this can be achieved because of significant capital investments in 1) current conservation programs; 2) the Tolt Treatment Facility (projected to come online in late year 2000), which will increase the capability and reliability of the Tolt system; 3) the Regional 1% Water Conservation Initiative (see subsection below for further description), which will be expanded to include participation by the City's wholesale customers in addition to current participation by the City's direct service area; and 4) potentially, the Tacoma-Seattle Intertie (project in planning) which, when developed, would enable the City to import Green River source water. The effect of the conservation programs will be to keep year-round and summer demand peaks lower. Availability of additional water through the Tolt Treatment Facility and, later, through the Tacoma-Seattle Intertie will, in that they will add water supplies from outside the Cedar River, also defer the overall need for Cedar River diversions, particularly during the peak demand season. Because increases in regional water demand over the next 5-10 years are expected to be offset through the mechanisms identified above, the within-year diversion patterns will be largely a function of hydrology and demand response to variable weather conditions. Therefore, within-year diversion patterns are expected to continue to vary and fluctuate as they have over past years.

Over the 50-year term of the HCP, the City currently projects that future annual water withdrawals from the Cedar River will continue to vary within a wide range, and as referenced in Technical Appendix 36 of the HCP, the City expects that annual diversions will average approximately 118 mgd over the next 50 years. Past experience makes it clear that swings in weather and the realities of operating a complex water supply system require that the City retain the ability to use more water in some years than in others. The public has access to the City's Cedar River water diversion data by making a request for such data from the City of Seattle Public Utilities. The City's annual average diversions are also reported to and published by the U. S. Geological Survey in their public annual reports that document hydrologic data for the State of Washington. Additionally, in the future, the City may develop the capability to provide public access to near real-time Cedar River water diversion data via the Internet and the World Wide Web.

While the purpose and function of the HCP is not to authorize or establish limits on the City's water diversions or to address the City's water supply planning process, there has nevertheless been citizen comment seeking to have the City allow some of the water which it may be entitled to withdraw under its water right to be left in the river for the benefit of fish over the term of the HCP, and that the City continue to develop and implement long-term water conservation measures for the region. Therefore, it is the City's intent to develop and implement a legal mechanism, such as a trust or other arrangement, by which it can reserve, for the length of the HCP, one-third or 100 mgd of its water right claim (on an annual average basis) for the benefit of fish, subject to the following conditions: 1) that the water so reserved is available to the City for emergency situations (natural disasters, pipeline failures, water quality events, extreme drought, and system failures); and 2) that the reserved water is protected from appropriation by third parties. It is also the City's intent to reserve an additional one-sixth or 50 mgd of its water right claim (on an annual average basis) through the same mechanism and subject to the same conditions described above, and subject to the additional condition that the City resolves some outstanding issues with the Muckleshoot Indian Tribe.

Near-term Demand Management

One method that will assist the City in managing diversions from the Cedar River within the specified range over the next five to ten years is demand management, or conservation. Towards that end the City has conducted a Conservation Potential Assessment (Appendix 31), which profiles the range of water conservation opportunities available to the City's retail and wholesale customers at differing levels of investments and over differing time periods. As a result of that Assessment, the City has created a long-term water conservation program that it will implement in both its direct retail and wholesale service areas. The goal of the program is to reduce average per capita consumption by 10% within a 10-year time frame. From an administrative standpoint, the program will consist of expansion of current conservation programs and development of new conservation programs to achieve the desired savings.

FLOW DOWNRAMPING PRESCRIPTIONS

Background

Resident and anadromous salmonids, particularly juvenile life stages, are vulnerable to sudden flow reductions in regulated rivers. Fish can be killed by stranding on open gravel bars or by isolation in potholes or side channels that subsequently dry up. Juvenile fish, especially newly emerged fry in their first growing season, are vulnerable to sudden flow reductions. Downramping guidelines prescribe the rates at which flows can be reduced in regulated rivers without causing significant detrimental impacts on aquatic resources.

Through its operations on the Cedar River, the City of Seattle can alter instream flows at three locations on the river that can create significant downramping events. The three locations and mechanisms are:

(1) Masonry Dam: low level outlet valve.

(2) Cedar Falls powerhouse: two turbines.

(3) Landsburg Diversion Dam: municipal water supply intake valve and/or diversion dam radial gates.

A recent analysis of the frequency and magnitude of instream flow changes on the Cedar River suggests that significant downramping events can occur quite frequently due to the need to make flow changes for many different reasons during normal operations. Presently, no formal downramping criteria are used to guide flow control operations at any of the three flow control points on the river.

Implementation of formal downramping rates that limit impacts on juvenile salmonids will provide a significant benefit to fisheries resources in the Cedar River basin below Masonry Dam. The City will commit to the implementation of downramping prescriptions for each of the three locations within the constraints posed by the biological needs of the resource and reasonable considerations for facility operations.

Points of Measurement

The City proposes that stream flow gages positioned downstream of flow control points be used to monitor and regulate ramping rates. Ramping rates below the Masonry Dam will be measured at a new gage immediately upstream of Seattle City Light's Cedar Falls

Hydroelectric Project at RM 33.7. Ramping of discharge from the Cedar Falls Hydroelectric Project will be measured at the existing USGS station at Cedar Falls (gage #12116500) located downstream from the powerhouse at RM 33.2. The downramping measurement point for operation of the diversion facilities and radial gates at the Landsburg Dam will be the existing USGS station below Landsburg (gage #12117600) at RM 20.4.

Definition of Critical Flow Ranges

The critical flow range may be defined as the range of flows within which significant exposure of streambed can occur. Information from the collaborative IFIM study was used to define the critical flow ranges for various locations on the river. In each case, transects exhibiting the greatest degree of stage sensitivity over the broadest range of flows were used to establish the flows above which the effects of flow reductions have relatively minor impact on potential fish stranding. Table 4.4-8 describes the critical flow ranges within which downramping prescriptions will apply at various locations on the river.

Table 4.4-8. Critical flow ranges for Seattle City Light and Seattle Public Utilities ramping operations at three locations on the Cedar River.

Measurement Location	Flow Range (cfs)	Downramping Prescription Classification
New USGS gage immediately above the Cedar Falls Powerhouse to be located near river mile 33.7	0-80	Critical
	>80	No ramping restrictions
Existing USGS Gage # 12116500 immediately below the Cedar Falls Powerhouse, located at river mile 33.2	0 - 300	Critical
	>300	No ramping restrictions
Existing USGS Gage # 12117600 immediately below the Landsburg Diversion Dam, located at river mile 20.4	0 - 850	Critical
	>850	No ramping restrictions

Downramping Prescriptions for Operations at the Landsburg Dam

Downramping at each of the three flow control locations poses a unique set of operational challenges. Because of these challenges and the need to better understand operational fine points, the City will phase in downramping prescriptions gradually over a 2-year trial period. Downramping prescriptions for the Landsburg Diversion Dam facilities are summarized in Table 4.4-9.

Table 4.4-9. Landsburg Diversion downramping prescriptions.

Operation Mode	Approximate Frequency of Occurrence	Period	Flow Range (cfs)	Maximum Downramping Rate
Normal Operation	Normal operations are considered to be in effect at all times except as noted below	February 1 to October 31	0 - 850	1 inch /hour
			>850	no ramping restrictions
		November 1 to January 31	0 - 850	2 inches /hour
			>850	no ramping restrictions
Full System Start-up	approx. 1 - 3 times per year for maint. and repair--approx. 2 hours per event	January 1 to December 31	0 - 850	60 cfs /hour
	approx. 5 - 10 times per year, depending upon the frequency of turbidity events--approx. 3 hours per event	January 1 to December 31	> 850	no ramping restrictions
Radial Gate Operations	One day per year for forebay cleaning	January 1 to December 31	0 - 850	Develop collaboratively with WDOE and WDFW as part of Forebay Cleaning Improvement Project
	As required to pass high flows during freshets and floods	January 1 to December 31	> 850	no ramping restrictions

Downramping rates and procedures will become effective not later than the end of HCP year 2. Not later than the end of HCP year 2, the City will install equipment to monitor the USGS compliance gage #12117600 at RM 20.4 on a real-time basis. Ramping rates will be calculated from provisional real time data measured at USGS gage #12117600. For compliance purposes, gage error, as determined by the USGS, shall be factored into the actual ramping rate calculation.

Normal Operations at Landsburg

Flow control capabilities at the Landsburg diversion facilities are quite refined and are capable of meeting quite conservative ramping rate prescriptions. However, at high flows, existing facilities are inundated if the radial gates are not opened to maintain a forebay elevation below 540 feet msl. The radial gates and their controls are not designed to operate in a manner required to meet the prescribed ramping rates.

Substantial modification of the gates and their controls would be required to meter the small increments of flow necessary to meet a ramping rate of 1 inch per hour. To avoid ramping with the radial gates, the City will maintain the radial gates in a closed position during normal operations at flows equal to or less than 850 cfs as measured at the existing USGS stream gage #112117600 below Landsburg at river mile 20.4. Below 850 cfs, ramping will be controlled by the water supply valve in combination with Cedar Falls Hydroelectric Facility operations. Between February 1 and October 31, the maximum downramping rate will be 1 inch per hour as a result of normal operations of the water supply intake valves. Between November 1 and January 31, the maximum downramping rate will be 2 inches per hour. The radial gates will be down and closed during normal operations

Full System Start-up at Landsburg

Full shutdown and subsequent start-up of the water diversion system occurs relatively infrequently. The system is shut down at least once per year during forebay cleaning in early March and normally once or twice per year for both scheduled and unscheduled maintenance. In addition, the diversion is shut down when influent turbidity approaches Washington State Department of Health specifications for raw drinking water supplies. Shutdowns due to high turbidity occur approximately 5 - 10 times per year, and these events almost always coincide with periods when stream flows exceed 1000 cfs.

When reinstating diversion operations (start-up) following a system shut-down, initial water supply valve adjustments are constrained by structural integrity concerns that in turn will limit the minimum extent of incremental flow control for short periods of time. In order to avoid cavitation and resulting mechanical damage to the two primary supply valves and pipelines, the supply valves on each of the supply lines at the Landsburg Dam must initially be opened to at least 25 percent of the fully open position during the first hour of reopening. This results in a flow increase in the water delivery system (decrease in stream flow) during the first 2 hours of the operation of approximately 60 cfs per hour. Cavitation and mechanical damage concerns do not constrain subsequent incremental openings. Therefore, during the first 2 hours following full system start-up, downramping will occur at a maximum rate of 60 cfs per hour when flows at Landsburg are 850 cfs or less. Continued increases in diversions after the first 2 hours are not constrained by mechanical concerns and will therefore proceed at the rates prescribed in Table 4.4-9.

Forebay-cleaning Procedures at Landsburg

In order to protect the quality of the municipal water supply, the forebay immediately upstream of the intake at the Landsburg Dam must be cleaned annually. To facilitate cleaning, the forebay is drained for 1 or 2 days each spring. Forebay draining requires opening the five radial gates on the dam. Opening and closing the radial gates can cause sudden reductions in stream flow below the diversion dam. For the past 2 years the City, in collaboration with WDFW, has been developing and implementing improved operating procedures to reduce the magnitude of downramping events when opening and closing the radial gates during the annual forebay-cleaning project. Significant operational improvements are being implemented and will continue to be refined.

By no later than the end of HCP year 2 and as part of the collaborative effort by the City and WDFW to improve forebay-cleaning procedures, the City will propose downramping rates and procedures for operation of the radial gates. After consideration of the City's proposal, the Commission will adopt final ramping prescriptions. Such prescriptions must be capable of implementation with existing equipment.

Downramping Provisions for Facilities Upstream of Landsburg

Downramping Below Masonry Dam

Water is periodically released directly into the Cedar River from Masonry Pool by way of the lower level outlet valve, the emergency spill gates, or the service spillway on Masonry Dam. Not later than the end of HCP year 1, the City will propose ramping rates, criteria, and procedures for operation of equipment at Masonry Dam at flows below 80 cfs. The Commission will adopt, with or without modification, the City's proposal, provided that the adopted ramping rates, criteria, and procedures will be limited to operations that can be accomplished with existing equipment. Ramping rates that are part of the final ramping requirements will be calculated from provisional real time data measured at a new USGS stream gage to be installed near RM 33.7, just upstream of the Cedar Falls Hydroelectric Facility. For compliance purposes, gage error, as determined by the USGS, shall be factored into the actual ramping rate calculation. Adopted ramping rates, criteria, and procedures will become effective only after construction of a fish ladder at Landsburg Dam and upstream passage of anadromous fish.

Downramping Below Cedar Falls Powerhouse

During much of the year water is delivered from Masonry Pool to the Cedar River at Cedar Falls via the Cedar Falls Hydroelectric Facility. Reductions in flows through the Hydroelectric Facility have the potential to cause significant reductions in flow and stage in downstream reaches of the river.

Not later than the end of HCP year 1, the City will propose ramping rates, criteria, and procedures for operation of equipment and reducing powerhouse discharge at flows below 300 cfs. Based on previous tests, ramping rates can be expected to be 2 inches or less per hour. The Commission will adopt, with or without modification, the City's proposal, provided that the adopted ramping rates, criteria and procedures will be limited to operations that can be accomplished with existing equipment. Ramping rates that are part of the final ramping requirements will be calculated from provisional real-time data measured at the existing USGS stream gage located at river mile 33.2. For compliance purposes, gage error, as determined by the USGS, shall be factored into the actual ramping rate calculation. Adopted ramping rates, criteria, and procedures will become effective only after construction of a fish ladder at the Landsburg Dam and upstream passage of anadromous fish.

ADDITIONAL MEASURES

Rearing Flows in the Bypass Reach Upstream of the Cedar Falls Hydroelectric Project

Approximately 0.5 miles of potential anadromous fish habitat is present in "Canyon Reach" of the Cedar River between the tailrace of the Cedar Falls Hydroelectric Project at RM 33.7 and the natural migration barrier formed by Lower Cedar Falls at RM 34.2.

This 0.5 mile bypass reach is located upstream of the influence of water delivered from Masonry Pool to the Cedar River via Cedar Falls Hydroelectric Project.

After construction of a fish ladder at Landsburg Diversion Dam and subsequent upstream passage of selected species of anadromous fish, the City will provide a minimum flow of 30 cfs on a continuous basis to protect rearing habitat in the Cedar River "Canyon Reach," measured by a new USGS stream gage to be installed near river mile 33.7 and funded by the City.

Emergency Bypass Capability at the Cedar Falls Hydroelectric Project

In its original configuration, the Cedar Falls Hydroelectric Project was not equipped with facilities to prevent an interruption in water delivery to the river during emergency shutdown of electrical generating equipment. To remedy this situation, in early 1999, the City installed, tested, and implemented operating procedures for new equipment to provide bypass flows around its hydroelectric turbines during most emergency plant shutdowns to protect against stranding fish and dewatering redds as a result of such events. The City committed up to a maximum of $350,000 for emergency bypass equipment.

Tailrace Protection at Cedar Falls Hydroelectric Project

With the present configuration of the tailrace at the Cedar Falls Hydroelectric Project, upstream migrating adult fish can enter the turbine effluent pipes where they are subject to injury or mortality. Upon construction of a fish ladder at the Landsburg Diversion Dam, and subsequent upstream passage of selected species of anadromous fish, the City will install a tailrace rack at the Cedar Falls Powerhouse to protect fish from injury or mortality. The City will commit up to a maximum of $250,000 for tailrace protection.

Downstream Habitat Protection and Restoration

Protection and restoration of aquatic and riparian habitat in the lowlands of the Lake Washington basin constitute a critical element in regional salmonid recovery efforts. The quality of fluvial habitat is strongly influenced by basin hydrology and the structure of the stream channels. Stream channel structure can in turn be strongly influenced by land management activities in floodplains and upland areas. In recognition of the value of complimenting beneficial instream flow management with beneficial land management, the City will provide up to $3 million dollars to protect and restore aquatic, riparian and floodplain habitat in the lower Cedar River downstream of the municipal watershed. Protection and restoration projects may include habitat acquisition and will be directed toward habitat for any and/or all species of naturally reproducing salmonids in the lower Cedar basin.

In its Lower Cedar River Basin and Nonpoint Pollution Action Plan, King County identified restoration of the Walsh Lake system within and just outside the municipal watershed as a high priority. The City proposes to provide up to $270,000 in funding for restoration of the Walsh Lake system and connecting areas within the municipal watershed, provided that King County agrees to contribute an equal amount for restoration of the this system. These funds will be provided in addition to the $3 million described above and the $1.6 million provided for lower river habitat as part of the mitigation program for the migration blockage at the Landsburg Dam (Section 4.3.2).

Funding for downstream habitat under the provisions of this section will be available in HCP years 2 through 4. City funding of projects that will ultimately be owned or managed by jurisdictions other than the City will be contingent upon a dollar for dollar match by the receiving jurisdiction.

Improvement of Long-term Water Use Efficiency and Smolt Passage at the Ballard Locks

The Ballard Locks form the outlet of Lake Washington. Water flow at the locks must be shared between vessel traffic and upstream and downstream migrating fish. All anadromous fish in Lake Washington must pass through the locks twice during their life. Recent investigations suggest that opportunities may exist to improve the efficiency with which freshwater is used at the locks (ACOE 1991) and provide better conditions for downstream migrating anadromous fish (Goetz et al. 1997).

The City will commit local sponsorship, up to a maximum expenditure of $1,250,000, for purposes of funding a feasibility study and implementation of long-term water efficiency improvements at the Ballard Locks provided that analyses show that the project will meet its intended purposes in a cost-effective manner. It is the City's understanding, based on information provided by the ACOE, that preliminary estimates for fresh water savings from these improvements would be about 30 cfs from June 1 through September 30. Thus, more than 6,000 acre-feet each year would be available for use in improving fish passage conditions at the Ballard Locks.

The City will also commit funding, up to a maximum expenditure of $625,000, for smolt passage improvements at the Ballard Locks in co-sponsorship with King County and the Muckleshoot Indian Tribe

Funding for Conservation Messages

Educating consumers about the linkage between water use and salmon habitat will help reduce diversions and keep more water in the river. The City will fund and publish or broadcast water conservation messages every summer that emphasize the importance of water conservation to protect fish habitat, at a cost of up to $30,000 per year.

Supplemental Stream Flows Resulting from the Cedar Permanent Dead Storage Project

Potential benefits exist for augmentation of both stream flows and water supply through the development of permanent non-emergency access to water stored below the natural gravity outlet of Chester Morse Lake (i.e., dead storage). The City will sponsor the evaluation of the Cedar Permanent Dead Storage Project, including necessary environmental, engineering, and financial studies. Engineering studies will address design options, siting, water quality, geology and hydrology, yield analysis, costs and economics, constructability, reliability, and other factors. Environmental studies will address potential effects of the project on resident fish and wildlife populations and wetlands, and will evaluate alternative mitigation measures. This feasibility study will commence not later than the end of HCP year 1 and will require not more than five years to complete. Total costs for HCP years 1 through 5 will not exceed $700,000 for the engineering, water quality, and economic studies and $745,000 for the environmental studies.

Representatives of the Commission, as well as other agencies, public groups, and individuals who are not Parties to the IFA, will participate in all stages of this analysis and will receive materials generated in support of this effort. The City will seriously consider suggestions by the Commission, as well as all other participants, throughout the analysis. The Parties are not, through the IFA, making resource commitments to this analytic effort.

Following this evaluation, the City will decide through its water supply planning processes whether and when to proceed with development of this source option, after comparing it with other source options in terms of its yield, reliability, cost, environmental impacts, timing, infrastructure and treatment requirements to deliver the water, likelihood and cost of securing necessary permits, and other factors. By agreement to this evaluation and process, WDOE is not validating in any way the City's claim or use of the dead-storage water.

If the City decides to proceed with the project, the Parties to the IFA agree to work collaboratively to evaluate whether the environmental impacts can be reasonably and cost-effectively mitigated. If environmental studies indicate that such mitigation is feasible, the Parties agree to negotiate in good faith amendments to the IFA to apportion between instream flows and municipal water supply the additional water benefits made available by the project, including consideration of additional water that may be needed to improve survival of fish at the Ballard Locks. Such amendments to the IFA shall not take effect unless and until the project is constructed and becomes operational. The Parties are not, through this IFA, addressing or resolving any questions relating to whether or not new permits or changes to water rights documentation will be required. By agreeing to negotiate any amendment regarding use of dead storage water for instream flows and water supply, WDOE is not in any way validating the City's claim or use of the water.

Gage Operation and Maintenance

The City will bear any expense not borne by the United States Geological Survey (USGS) and other cooperating agencies for flow and elevation measurements at all compliance and hydrologic monitoring locations required for implementation of the instream flow regime, including installation, real-time telemetry, relocation, rehabilitation, and maintenance of the measurement devices and related equipment. One or more of these devices may continue to be owned and operated by the USGS or other parties. If measurement instruments at one or more of the locations are not operational when the flow commitments set forth in the IFA become effective, the Commission, after consultation with the USGS, shall determine a reasonable temporary method of determining compliance with the requirements contained herein based upon available data. After consultation with the City and the USGS, the Commission will propose to USGS a reasonable schedule for installation of a permanent gage.

PROVISIONS FOR OVERSIGHT AND ADAPTIVE MANAGEMENT

Cedar River Instream Flow Oversight Commission

There will be established a Cedar River Instream Flow Oversight Commission (Commission) consisting of one member representing each of the signatories to the IFA. The purpose of the Commission will be to provide general oversight, coordination, and, where specifically authorized, direction regarding the implementation of the IFA. The Commission will serve as a forum for:

- Communication and coordination among the Parties to the IFA of technical information on hydrologic conditions, facility and system operations (water supply, hydropower, and Ballard Locks); fish biology and ecology; and such other subjects as may be beneficial in implementing the IFA;
- Allocation of the 2,500 acre-foot block of water in all normal years between June 17 and August 4;
- Allocation of an additional 3,500 acre-feet of water that is supplemental to minimum stream flow between June 17 and August 4 when available; and, if the need should arise, developing risk-sharing mechanisms to recover this additional water later in the same calendar year;
- Switching between high-normal and low-normal instream flow commitments;
- Switching between normal and critical minimum instream flow commitments;
- Review of supplemental flows provided between February 11 and April 14;
- Sharing of information and discussion concerning potential uses of unallocated non-firm Cedar River water; and
- Administering the responsibilities of the Parties to the IFA in support of technical studies and adaptive management.

In addition, the Commission will provide a forum for the Parties' exercise of rights, responsibilities, and decision-making authority, as further specified in the IFA. The Commission's authority is limited to that which is expressly granted by terms of the IFA. No action by the Commission shall abrogate WDOE's authority to manage the state's water resources, including regulation of diversion and use of the waters of the state.

Reporting

The City will provide to the Commission, on an annual basis, the record of measurements from all compliance and monitoring gage locations. Average daily flows and reservoir elevations will be provided to indicate compliance with guaranteed instream flow commitments. A table will be provided to show flows at the measuring points compared to the critical, low-normal, high-normal, and non-firm flow levels. For periods affected by downramping operations, flow data will be provided in one-hour increments to indicate compliance with downramping prescriptions.

The reports will include an explanation of circumstances involved in decisions concerning instream flows, including an analysis of cumulative progress toward achieving the goals for supplemental flows identified in Section B of the IFA. The reports will also include tables of precipitation levels, reservoir inflow, reservoir outflow, and Chester Morse Lake levels and usage. The reporting year is based on January 1 through December 31. For the first year, the City will make best efforts to submit its annual report within 90 days of the end of the annual reporting period, and advise the

Commission as to whether report preparation can be accelerated in succeeding years. The Parties may then agree to a shorter report preparation period. The Commission may modify the frequency and detail of flow and reservoir elevation reports.

As soon as reasonably feasible, but in any event not later than 30 days following discovery, the City will notify the Commission of any case, including emergency conditions, in which recorded flows are significantly below those specified in the IFA. Such nonconformance as may occur as a result of gage malfunction or retroactive USGS flow corrections to the record shall not constitute noncompliance by the City.

Supporting Technical Studies

The maintenance of the instream flow regime and other commitments contained in the IFA will benefit the fishery resources of the Cedar River by protecting, improving and increasing available habitat. The Parties recognize the importance of monitoring the condition of the habitat to assure that the purposes of the IFA are met. The Parties also acknowledge that available information on certain complex ecological and hydrologic processes is not complete. Therefore, the City, in cooperation with the other Parties, will sponsor and conduct certain studies and act on the results as indicated.

Except as otherwise provided, including the established cost caps, all major aspects of study planning, implementation, and coordination with other related studies shall be subject to the approval of the Commission, which shall meet as frequently as study requirements dictate. The Commission shall have the opportunity to review and comment on drafts of any final study reports. The City shall make every effort to complete final study reports no later than 1 year after completion of the respective studies.

Accretion Flow Analyses in the Lower Cedar River

The measurement point for the City's instream flows below Landsburg is located at the existing USGS gage at river mile 20.4. Accretion flow estimates developed in jointly overseen technical studies and further refined by the Cedar River Instream Flow Committee were used to represent the local inflows between Landsburg and Renton. Since accretion flow patterns can have a significant effect on fish habitat, and since future accretion flow patterns may vary somewhat from those calculated from historical data, the City will sponsor a long-term monitoring study to develop a better understanding of inflow patterns throughout the lower river.

The accretion flow study will: (1) specify the inflow assumptions to be evaluated; (2) establish and implement a long-term monitoring protocol; (3) establish analytical objectives; (4) identify any apparent long-term differences from the assumptions; and (5) perform additional investigations and analyses, if needed, to identify causes. The study will begin not later than the end of HCP year 3 and will continue for not less than 10 years. Total costs for monitoring and analysis will not exceed $400,000.

If the conclusions of the long term monitoring study show that actual local inflow patterns (after allowance for gage error) are clearly more or less than the previously assumed patterns for causes that cannot be reasonably attributed to factors such as land development and water withdrawals downstream of Landsburg, the Commission may agree to a procedure for adjusting the agreed-upon minimum flow commitments upward or downward by limited amounts. The Commission shall act through a majority vote (at least 51 percent) of the members participating in the decision, but only if that majority includes the City.

Development of Improved Switching Criteria

The switching criteria established to guide reductions to critical flows and selection of the high- and low-normal flows in the fall shall be considered interim. The City will provide up to $200,000 to sponsor a collaborative analysis of alternatives to these criteria. Revised switching criteria will incorporate advancements in modeling and forecasting, and will be necessary to accommodate potentially significant changes to the operation of the water supply system arising from planned development of a new supply source and water treatment facilities. Improved switching criteria can have a significant effect on the water manager’s ability to manage the water resource efficiently and can benefit fish by ensuring that decisions are appropriate to conditions of concern. The purpose of this study is to develop new criteria that are more comprehensive, timely, and reliable representations of key conditions.

The analyses will involve evaluation of various switching criteria, including measured stream flows and reservoir conditions, forecasted stream flows and reservoir conditions, refill success, system-wide (beyond only the Cedar River) conditions, biological conditions, and watershed conditions, such as soil moisture, snowpack, and groundwater. Adaptive management techniques will also be investigated. It will be the goal of the analyses to develop switching criteria that are measurable, independently verifiable, robust, and representative of the system’s ability to meet future diversion and instream flow needs. It is the intent of the Parties to the IFA to complete the study, and develop and implement revised criteria no later than the end of HCP year 4.

Revised switching criteria will replace the interim, provided, however, that implementation of the revised criteria will still result in the same predicted average frequencies for critical flow (one in ten years) and high-normal flow (six of nine normal years on October 8, and approximately the weekly frequencies as shown in the Table 4.4-3) as the interim switching criteria. In the event that the Commission is unable to reach unanimous agreement on revised switching criteria following completion of this analysis, the matter shall be resolved following the procedure set forth in Section F.4 of the IFA. If the matter cannot be resolved through the informal dispute resolution process, the interim criteria shall be retained. Nothing precludes a result in which one or more of the existing criteria are retained.

Monitoring Steelhead Incubation

The HCP provides for a “firm” and a “non-firm” block of water to supplement base flow commitments during the steelhead incubation period. In order to support decision-making regarding the use of this water and to minimize dewatering of steelhead redds, the City will sponsor annual monitoring of redds for a period of time until prospective flow guidelines and objectives can be established.

The monitoring program will locate, characterize and monitor steelhead redds from the time of their construction through the completion of fry emergence. The City will monitor steelhead redds for up to eight spawning seasons beginning in HCP year 1. Total costs of the study will not exceed $240,000.

Supplemental Biological and Physical Studies

In addition to the monitoring research efforts mentioned elsewhere in this and other sections of the HCP, the City will provide an additional $1,000,000 to support further study of the effects of certain aspects of instream flow management on anadromous salmonids; with special emphasis on additional information about chinook salmon and other salmonids originating from the Cedar River. The City recognizes the key role of Tribal, state, and federal fisheries resource managers in the development and implementation of future studies. Therefore, all major aspects of study planning, implementation, and coordination with other related studies shall be subject to the approval of the Commission through a majority vote of it members as specified in Section F.3 of the IFA (Appendix 27). The Commission shall have the opportunity to review and comment on drafts of all final study reports.

To enhance present understanding of the biology of aquatic resources in the Cedar River and the complex relationships between stream flow and fish habitat, the City proposes the following list potential supplemental study topics:

- The effects of stream flow on the migratory response of recently emerged chinook and sockeye fry, and chinook fingerlings;
- The effects of size of juvenile chinook and timing of entry into Lake Washington on survival to smolt and/or adult;
- Distribution, abundance and habitat preferences of rearing juvenile chinook in the mainstem Cedar River, with emphasis on the interaction of these factors with stream flow;
- Behavioral response of adult chinook salmon to changes in stream flow and the operation of sockeye broodstock collection facilities;
- Modeling analysis of the potential impacts of stream flow at Landsburg on water temperature at the mouth of the river and in Lake Washington;
- Modeling analysis of the potential impacts of spring and early summer stream flows at Landsburg on water velocity vectors and water residence time in Lake Washington;
- Vulnerability of chinook salmon and sockeye salmon to redd scour;
- The potential effects of redd superimposition on the survival of sockeye and chinook eggs and alevins; and
- Further investigations of the relationship between hydrologic features and the structure and function of instream and riparian habitat in altered stream channels.

The Commission will prioritize the study topics and may add or delete topics with the consent of the City. As descried above, all major aspects of study planning, implementation and coordination with other related studies shall be subject to the approval of the Commission.

Funding for the studies will be available over a period of up to 9 years, which would be sufficient time to encompass the complete life cycle of 4 brood years of chinook salmon. A schedule for dispensation of the supplemental study funds will be developed in consultation with the Commission by the midpoint of HCP year 1, with initial funding to occur after that date.

This study effort is expected to help generally advance the scientific basis for managing altered fluvial systems. The results of the studies can potentially be used by a variety of entities involved in the management of aquatic, riparian and upland habitat. Natural hydrology in the Cedar River basin is quite variable and stream flows in the Cedar River can often exceed the levels provided by the guaranteed flow regime. The results of the supplemental biological studies will provide an enhanced biological and physical information base that the Commission may use to advise the City in its management of stream flows at levels over and above those included in the guaranteed regime described in Section 4.4.2.

The Lake Washington ecosystem is very complex. Many of the factors that can affect the proposed Cedar River supplemental study topics and the successful implementation of appropriate investigations are outside the jurisdiction of the City. Successful implementation of the supplemental study program will require coordination with a number of other interested parties in the basin. Tribal, state and federal resource managers, King County and many of the municipalities in the Lake Washington watershed are developing a broad array of study programs to support basin-wide salmon conservation efforts. The City supports these programs and wishes to cooperate with other jurisdictions in promoting sound understanding of the ecosystem that supports Lake Washington salmon and steelhead.

RATIONALE

The primary purpose of the instream flow conservation strategy is to provide stream flows in the Cedar River downstream of Chester Morse Lake that will help ensure the presence of high quality aquatic habitat throughout 34.2 miles of the mainstem river between Lower Cedar Falls and Lake Washington. This reach of river constitutes the entire natural historic range of anadromous fish in the Cedar River. Four anadromous salmonid species, chinook, coho, and sockeye salmon and steelhead trout presently occupy the lower 21.8 miles of the mainstem. The HCP provides for the reintroduction of chinook, coho, and steelhead into the additional 12.4 miles of mainstem and associated tributary habitat upstream of the Landsburg Diversion Dam.

Water quality and quantity are both important components of aquatic habitat. The instream flow conservation strategy deals primarily with water quantity. The HCP addresses water quality protection through the watershed management prescriptions described in Section 4.2. Water quality is generally excellent in the 12.5-mile reach of the mainstem within the City’s ownership boundary due to relatively large inputs of high quality groundwater and because much of this portion of the basin has recovered substantially after being intensively logged early in the twentieth century. Although many factors downstream of the City’s ownership boundary pose threats to water quality in the lower reaches of the river, these threats are partially offset by the relatively large inputs of high quality water from the municipal watershed. In addition, the factors that threaten water quality are being addressed to various degrees through the implementation of King County’s Lower Cedar River Basin and Nonpoint Pollution Action Plan (King County 1998).

The HCP views the four anadromous fish species as keystone species for the aquatic habitat in the Cedar River downstream of Chester Morse Lake. These species have relatively stringent freshwater habitat requirements and are present in at least one, and typically more, life stages throughout the year. Biophysical processes and anthropogenic activities throughout the area encompassed by the natural hydrographic boundary of the Cedar River Basin directly affect the quantity and quality of anadromous fish habitat in the Cedar River. The City does not have control over activities in the basin outside its ownership boundary, nor on conditions in the marine environment that can have very significant effects on anadromous fish. However, the City does have the ability to: shape land management practices in the upper two-thirds of the basin; address the effects of the migration barrier formed by the Landsburg Diversion Dam; exercise some level of control over stream flows in the mainstem throughout the historic range of Cedar River salmon and steelhead; and contribute funding for habitat protection and restoration outside the municipal watershed.

The general approach to instream flow management in the HCP rests on a foundation of three primary features: 1) Provision of a guaranteed instream flow management regime based on the best available science to protect aquatic resources on the Cedar River; 2) identification of remaining information gaps and commitment of resources to address these gaps through additional collaborative study; and 3) providing sufficient flexibility in the future to work collaboratively with resource managers to adapt and further improve the management practices as conditions change and new information becomes available. Additional conservation measures include funding contributions to protect and restore habitats downstream of the municipal watershed and to improve survival of smolts leaving the Lake Washington Basin.

Natural Hydrologic Patterns and Basis for the Conservation Strategies

During the last 10,000 years, salmon and steelhead in the northwest radiated into an array of habitats and have adapted to the general environmental conditions that were present in specific watersheds throughout the region as the continental glaciers receded at the end of the last ice age (National Research Council 1996). One of the key factors to which these species have adapted during this period is the general hydrologic pattern in the watershed to which they home as adults and in which they incubate as eggs and alevins, and rear as juveniles. Therefore, it seems prudent to consider general natural hydrologic patterns when developing an instream flow management regime for regulated rivers.

Scientists' understanding of the ecological benefits of natural patterns of river flows has increased in the last decade, and we can expect it to change more in the future (Poff et al. 1997, Richter et al. 1996). It is the City's intent to manage instream flows in a manner that is beneficial to fish and the ecosystems upon which they depend. The City will use information gained in the many studies to be performed under the HCP, and by others, to attempt to manage instream flows in a manner that, where biologically appropriate, more closely mimics natural hydrologic patterns and that encourages natural ecological and regenerative processes throughout the lower river. These efforts must necessarily also consider the altered conditions of the lower river, flood control needs and water customer needs.

In addition to this commitment to future flexibility, several features of the proposed instream flow conservation strategy attempt to reflect the natural hydrologic patterns of the Cedar River. The guaranteed flow regime has been shaped to mimic the general pattern of the annual hydrologic regime in the Cedar River basin. In addition, the relocation of the instream flow measurement point to Landsburg will promote a more natural short-term hydrologic pattern throughout the river and especially in the 21.8 stream miles downstream of Landsburg. Constraints on the rates at which City facilities can allow stream flows to drop (downramping rates) will help keep short term flow fluctuations more similar to rates and magnitudes of natural short-term fluctuations. The provision of supplemental flows when hydrologic conditions are appropriate will result in seasonal flows that tend to fluctuate in a more natural manner than the present relatively static IRPP minimum flow regime. And finally, the City will fund additional physical and biological studies to support collaborative management of stream flows above the guaranteed levels to more closely mimic natural hydrologic patterns where biologically appropriate, protect important ecological processes and provide additional benefits to fish.

While the instream flow conservation strategy considers natural hydrologic patterns, simply attempting to mimic general natural hydrologic patterns is perhaps overly simplistic and insufficient to provide high quality salmonid habitat in a highly altered environment. This rather broad, high-level approach is important and informative, but misses much of the complexity inherent in the relationships between stream flow and habitat quality. This added complexity can be partitioned into three general categories.

First, as an example, salmon and steelhead display a tendency to adapt to specific and unique conditions in particular watersheds, but they also display considerable plasticity. For example, robust anadromous salmonid populations are found in systems with a rather broad range of hydrologic conditions, from systems that exhibit quite sudden and dramatic flow fluctuations in response to phenomena such as rain-on-snow events, to very stable, spring fed systems in which flow variations are quite limited. Secondly, the specific micro-habitat preferences of various species and life stages of anadromous fish are complex, somewhat variable, and can be found in a relatively broad range of geomorphic conditions and stream channel types. And third, as discussed in section 3.2.5 and 4.3, the anadromous aquatic habitat in the Cedar River Basin has been rather dramatically altered by anthropogenic activities during the twentieth century. The relationships between aquatic habitat characteristics and stream flow in the present channel, which is highly constrained, much narrower, shorter and higher gradient than the original channel, are far different than the relationships that existed when the channel was in a natural condition. To further complicate matters, the changes in the drainage patterns of the Lake Washington basin that occurred with the construction of the Ballard Locks and re-routing of the Cedar River into Lake Washington resulted in rather dramatic ecological changes in the system and a shift in fish species composition (Section 4.3.2). In the Cedar River, these alterations likely resulted in the extinction of pink and chum salmon, have created challenging conditions for ocean-type chinook salmon (Section 3.5.10) but have provided conditions under which sockeye salmon were able to flourish (Section 3.5.8).

Therefore, in addition to considering natural hydrologic patterns, the instream flow conservation strategy also makes use of an extensive body of scientific information developed during 10 years of collaborative study and analysis (Sections 3.3.2 and 4.4.1). This information provides detailed information on the habitat preferences of the anadromous fish species in the Cedar River and on many of the complex relationships between the quantity and quality of fish habitat and stream flow.

Prioritizing Species and Life stages

Various species and life stages have varying stream flow requirements that can, at times, be in conflict. Table 4.4-6 summarizes the primary species and life stages that the collaborative studies indicate should be carefully considered in the development of the HCP instream flow regime.

The CRIFC identified all life stages of chinook, coho, sockeye and steelhead as the primary focus of the studies. Theses species were considered keystone species in subsequent discussion and negotiations. An understanding of life history and periodicity of the various life stages is essential to understanding the habitat requirements of fish during the course of a year. Life history periodicity information for the four species is provided in Figure 4.4-6. A summary of key considerations for the various species and life stages throughout the year is presented in Table 4.4-6. The HCP instream flow regime attempts to address key species and life history requirements while minimizing conflicts between species.

Coastal cutthroat trout were not included in the studies because their smaller size and preference for small size streams and tributaries indicated they are much less influenced by Cedar River instream flows than other salmonids. Instream flows that meet the needs for the four studied species are expected to also provide adequately for cutthroat.

During the development of the HCP, the Services agreed that the Cedar River downstream of Cedar Falls does not presently support a viable population of bull trout, nor was such a population present in this area historically. If future information suggests that this is not the case and a viable population of bull trout is present in the Cedar River downstream of Cedar Falls, the City believes that the HCP instream flow management regime, which is designed to provide for the protection and recovery of chinook, coho, sockeye and steelhead, will also provide sufficient protection for bull trout.

Habitat Availability

Within the IFIM approach, Physical Habitat Simulation (PHABSIM) analyses provide an important tool for investigating the effects of stream flow on the physical components of fluvial fish habitat. PHABSIM analyses are based on the premise that habitat conditions preferred by different species and life stages of stream-dwelling fish vary within the channel as a function of flow. Or, stated more precisely, stream-dwelling fishes prefer specified ranges of depth, velocity, substrate, and cover type and the availability of these preferred habitat conditions varies with stream flow. PHABSIM analyses use a set of computer models developed by the USFWS to integrate individual species and life stage habitat preferences with measured, river specific stream depth, velocity, substrate, and cover type to generate an index of habitat availability for particular species and life stages over a range of stream flow levels. This index of habitat availability is termed Weighted Usable Area (WUA) and is measured in square feet of habitat for a defined species and life stage per linear length of stream (Bovee 1982, 1986).

From the strict standpoint of WUA, the primary species and life stages of interest are spawning and rearing chinook, coho, and steelhead and spawning sockeye (sockeye fry migrate immediately to Lake Washington after emergence and therefore do not rear in the river). For most of the year, HCP normal minimum flow commitments are equal to or greater than the flows required to provide maximum WUA for all life stages of the four anadromous fish species.

As flows increase above the levels required to provide maximum weighted usable area, water depths and velocities increase and the total amount of available habitat in the river generally decreases. Within this general pattern, spawning and rearing habitat availability vary independently and in different ways as flows change. For example, steelhead spawning WUA increases as flows increase to a level of approximately 150 cfs as measured at Landsburg. When flows increase above this level, the amount of spawning WUA decreases as depths and velocities in much of the channel increase beyond suitable ranges. In contrast, juvenile steelhead rearing WUA continues to increase as flows increase to a level of approximately 75 cfs, then decreases slightly as flows increase further (Figure 4.4-8).

By integrating the output from PHABSIM analyses for a particular species and life stage (such as spawning chinook salmon) with expected stream flows over a specified period of time (such as the fall chinook spawning season), habitat duration analyses may be generated to compare aggregate habitat availability for different potential flow regimes. In Appendix 36, the City presents analyses that describe and compare historic Cedar River stream flows, flows expected to occur over the next 50 years under the HCP flow regime, and flows expected to occur under future conditions without the HCP flow regime. This information, coupled with modeled unregulated flows, was then used to generate the series of habitat duration analyses provided in Appendix 37 for various life stages of chinook, coho, sockeye and steelhead. Habitat duration analyses allow investigators to compare total WUA and WUA distribution for given species and life stages for different stream flow regimes over specified time periods and at different seasons. For example, these analyses compare total aggregate chinook spawning WUA during the fall chinook spawning season as whole for three different stream flow regimes: flows expected under the HCP regime; flows that occurred historically under the IRPP regime; and predicted flows that would occur under natural conditions without regulation by the City’s water management facilities. The results presented in Appendix 37 demonstrate that under nearly all hydrologic conditions that might occur, the HCP instream flow regime will provide more WUA for chinook spawning during the fall spawning season than either historical flows or predicted natural unregulated flows.

For the three anadromous species that rear in the river, the Cedar River PHABSIM analyses demonstrate that WUA for juvenile rearing is generally much less sensitive to changes in flows than is WUA for spawning. That is, for a given incremental flow change, the change in WUA for juvenile rearing is typically much smaller than the change in WUA for spawning. The study also demonstrates that the flows required to provide maximum WUA for spawning are typically much higher than the flows required to provide maximum WUA for juvenile rearing. For these reasons, and because WUA for juvenile rearing during fall, winter and spring base flow conditions is not believed to be a major concern, spawning habitat and other considerations have generally been given higher priority in the Cedar River than availability of juvenile rearing habitat

There is one period during the year when there are no other overriding concerns and juvenile rearing is the primary focus of instream flow management. After the completion of steelhead incubation in early August and prior to the beginning of substantial chinook and sockeye spawning in mid-September, steelhead juvenile rearing is the key life history stage of concern. Juvenile coho salmon are also present at this time. However, the flows required to maximize WUA for juvenile steelhead are slightly greater than flows required to provide maximum WUA for either juvenile coho or juvenile chinook. Therefore, steelhead was selected as the key species of concern. During this time of year, instream flow considerations are typically important in determining the amount and quality of habitat available when juvenile fish are well dispersed and actively feeding and growing. Insufficient habitat availability at this time of year can potentially create a bottleneck for salmonids that rear in the river as juveniles. From August 4 through September 15, the HCP guaranteed flows are slightly below the levels required to provide maximum WUA for juvenile steelhead rearing, but still provide 98 to 99 percent of maximum WUA for this species and life stage. Habitat duration analyses summarized in Appendix 37 of the proposed HCP demonstrate that, for this period as a whole, expected flows under the HCP regime provide more WUA for juvenile steelhead rearing than expected flows under the existing IRPP regime or expected flows that would occur under natural conditions without the presence of water storage and diversion facilities. For the remainder of the year, from late September through the end of July, HCP guaranteed normal flows remain well above the levels required to provide maximum WUA for juvenile steelhead rearing. During this period, HCP normal flows provide between 65 and 93 percent of maximum WUA for juvenile steelhead rearing.

In the fall, spawning conditions for salmon become a key biological consideration. By mid-September, significant numbers of chinook and sockeye begin entering the river and maximizing chinook spawning habitat availability becomes a primary concern. HCP minimum flows in late September and early October rise well above the levels that provide maximum WUA for sockeye spawning, and are designed to rise to the level equal to the flow that provides maximum WUA for chinook spawning by the peak of the chinook spawning season in early to mid-October. After October 8, low-normal flows are set at the level that provides maximum WUA for chinook spawning for the remainder of the chinook spawning season. High-normal flows are greater than the level required to provide maximum WUA for chinook spawning. From late September through mid- to late October, HCP guaranteed flows are typically greater than would be provided under natural, unregulated conditions. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the chinook spawning period as a whole, expected flows under the HCP regime will provide more WUA for chinook spawning than expected flows under either the existing IRPP regime or the natural flow regime.

With approximately 11 percent of the sockeye run typically in the river by September 16, the HCP normal flows already exceed the flows required to provide maximum WUA for sockeye spawning. By the approximate mid-point of the run in mid-October, the HCP low-normal flows are more than two and one-half times the level required to provide maximum WUA for sockeye spawning. Water depth and velocity increase throughout much of the channel at these elevated flows and the amount of total sockeye spawning habitat decreases. HCP low-normal flows provide approximately 70 percent of maximum WUA and the high-normal flows provide approximately 60 percent of maximum WUA for sockeye spawning. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the sockeye spawning period as a whole, expected flows under the HCP regime will provide less WUA for sockeye spawning than expected flows under the existing IRPP regime, but more WUA than expected flows under the natural flow regime.

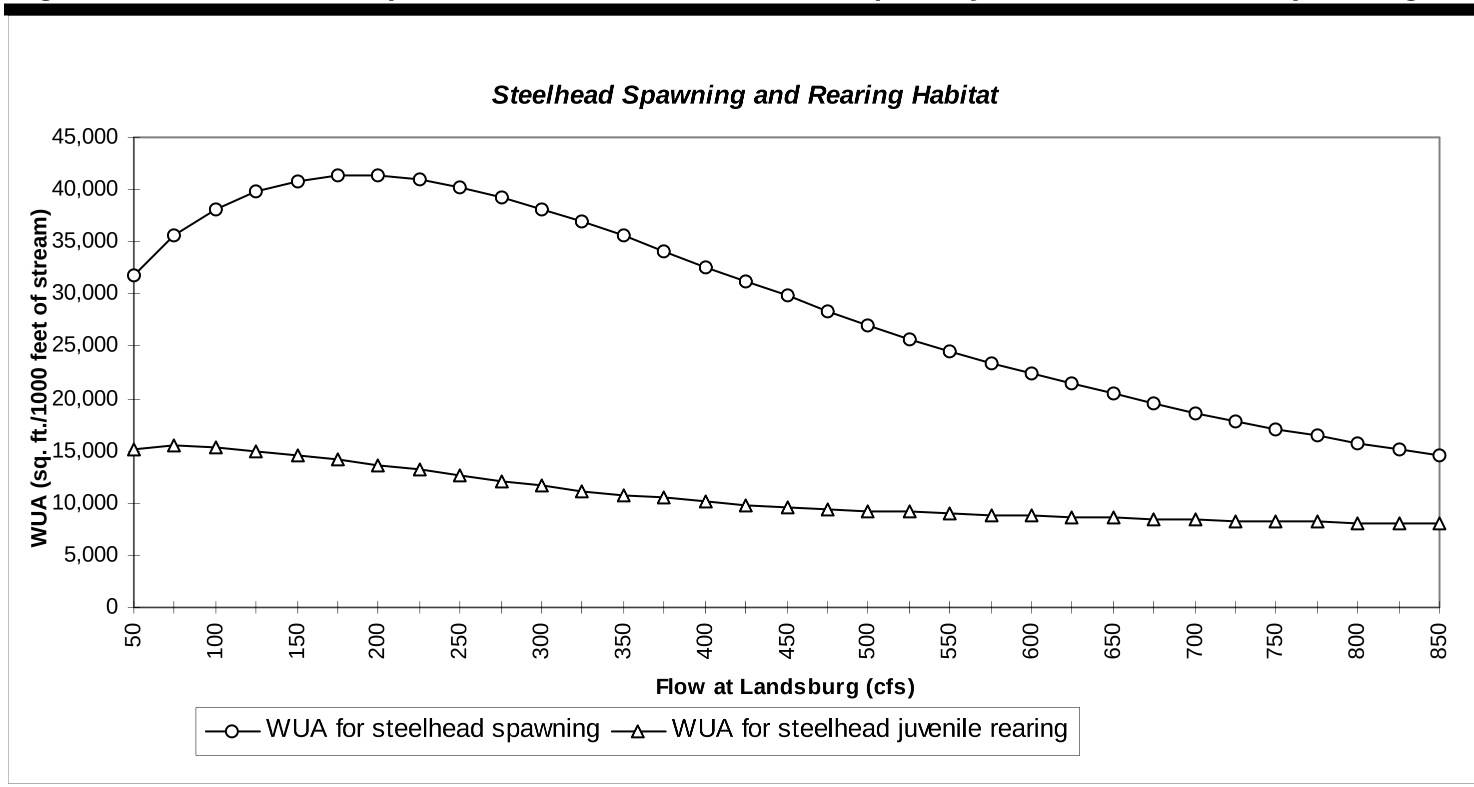
The HCP normal flows remain equal to or greater than the levels required to provide maximum WUA for chinook, sockeye, and coho spawning from October 8 throughout the rest of the salmon spawning season. Flows throughout the period of steelhead spawning in the spring also remain well above the level required to provide maximum WUA for steelhead spawning. Again, these higher flows result in a moderate reduction of the total amount of steelhead spawning habitat. Between mid-March and the end of May, the HCP flows provide between 78 and 98 percent of maximum WUA for steelhead spawning. Habitat duration analyses demonstrate that, for the steelhead spawning period as a whole, expected flows under the HCP regime provide more WUA for steelhead spawning than expected flows under natural flow conditions or expected flows under the IRPP regime.

HCP normal flows are also well above the level required to provide maximum WUA for juvenile steelhead rearing for the entire period from late September through the end of July. During this period, HCP normal flows provide between 65 and 93 percent maximum WUA of juvenile steelhead rearing.

Additional Habitat Quality Considerations

The first consideration in designing the HCP flow regime has been to provide flows that meet or exceed the flows required to provide maximum WUA as defined by the PHABSIM analyses for key species and life stages throughout the year. PHABSIM is a powerful tool that is helpful in describing the relationship between stream flow and fish habitat and is a generally accepted methodology used to establish instream flow requirements for fish. However, the methodology entails some uncertainty and does not address all aspects of the biological requirements of fish in the Cedar River (Castleberry et al. 1996; Seiler and Kishimoto 1996; Thorne and Ames 1987). Recognizing that the PHABSIM would not provide all the necessary information for establishing the appropriate instream flow regime, the CRIFC requested many additional studies be conducted to complement the PHABSIM information base (see Section 3.3.2). The flows required to provide maximum WUA have been used here as a foundation upon which additional flow is added to better address uncertainty and help meet ancillary biological requirements of anadromous fish as described by the companion investigations conducted during the collaborative study program.

Figure 4.4-8. Relationship between stream flow and the quantity of steelhead trout spawning and rearing habitat.



Fish Passage

Shallow depths across a riffle or gravel bar can create a low flow blockage that limits a fish's ability to swim upstream. The shallowest and widest riffle in the Cedar River downstream of Landsburg was identified during the collaborative instream flow studies. Using the field data from the cross section measurements and hydraulic information developed for the PHABSIM analyses, the studies investigated the flow required to allow adult chinook to pass over the low-flow passage barrier. Although the absolute lowest minimum flow that would allow passage was not determined, the study demonstrated that passage of adult chinook would not be impeded at flows of 94 cfs or more as measured at the low flow blockage located approximately 0.5 miles upstream of the confluence with Rock Creek. HCP minimum flows are substantially greater than 94 cfs at this location from September 15 throughout the entire salmon and steelhead spawning seasons.

Salmon Spawning Habitat in the Fall

In addition to providing adequate spawning habitat availability for chinook and sockeye, the guaranteed flows in the fall have been designed to provide additional benefits for sockeye in two ways. First, the flows employ the potential benefits of a cumulative approach to providing sockeye spawning habitat in contrast to a static approach. The regime attempts to increase available sockeye habitat over and above the amount provided by the static flow providing maximum WUA by incrementally increasing flows to recruit new habitat after habitat recruited at lower flows has been previously seeded. As flows increase, depths and velocities over previously seeded habitat exceed suitable levels for spawning and fish are forced to spawn in other areas including new habitat recruited by the increasing flows. As flows increase, the rate of habitat loss is greater than the rate at which new habitat is acquired. If, however, this lost habitat was previously seeded when flows were lower, then it still contributes to the total productive cumulative sockeye spawning habitat. Flows at the beginning of the sockeye spawning season have been established at, or slightly above, the value providing maximum WUA. Flows are then gradually stepped up over the next 3 weeks of the spawning season to recruit additional new habitat. After 3 weeks of flow increases, significant amounts of sockeye spawning habitat have been lost. However, if this lost habitat was previously seeded, it remains productive and is now less vulnerable to damage from the activities of subsequent spawning fish.

Secondly, the increasing flow levels recruit new spawning habitat along the margins of the streams that is believed to be less vulnerable to scour than areas of the mid-channel. Thus, the loss in WUA for sockeye spawning during flow increases in the fall can be offset by an increase in cumulative spawning habitat and recruitment of sockeye spawning habitat that is less vulnerable to scour. By spreading the eggs throughout the channel, incubation habitat is diversified and, over the long-term, can be more resilient and less vulnerable to variations in environmental conditions.

Because chinook tend to spawn in deeper, faster water, use larger substrate, and bury their eggs deeper than sockeye, the flow increases early in the fall actually increase WUA for chinook spawning. Thus both chinook and sockeye can potentially benefit from the gradual flow increases in the fall that generally follow the shape of the natural hydrograph.

Incubation Protection

Incubating alevins can experience significant mortality during short periods of dewatering. By providing guaranteed flows at appropriate levels, risks to incubating salmon and steelhead can be greatly reduced. In the Cedar River, incubating salmonids are present in substantial numbers from approximately mid-September until the end of July. Minimum-flow commitments during this time have been designed to help reduce the risk of short-term redd dewatering.

Because steelhead incubate during the period of a naturally declining hydrograph in the Cedar River, they can be especially vulnerable to dewatering under certain circumstances. In addition to increased minimum flows during the latter portion of the incubation season, the HCP also provides real-time monitoring coupled with supplemental blocks of water that may be applied by the Commission in a manner that will minimize risk to incubating steelhead.

Outmigration Conditions for Sockeye

Sockeye fry emerge from the gravel during the late winter and spring and migrate directly downstream to Lake Washington where they rear for a year prior to migrating to sea. Preliminary studies conducted independently by WDFW suggest that most fry arrive at Lake Washington within 48 hours of emergence and that their survival during their downstream migration is positively correlated with stream flow (Seiler and Kishimoto 1996).

Spring is a challenging time for water management on the Cedar River. Management strategies are attempting to meet multiple objectives, including: refilling the Chester Morse Lake Reservoir; providing suitable flows for sockeye outmigration; preventing sustained high flows to avoid inducing steelhead to spawn in areas that are at high risk of being dewatered; flood management; and minimizing the impact of reservoir level fluctuations on nesting loons, incubating bull trout and shoreline wetlands. In an effort to benefit outmigrating sockeye, minimum flow commitments have been set higher than the non-binding IRPP regime during this period. The HCP regime also provides even higher supplemental flows 70 percent of the time in a manner that attempts to minimize subsequent risks to incubating steelhead.

Protection from Stranding

Many of the benefits of the previously described conservation measures can be negated by excessive and frequent flow fluctuations that strand juvenile fish. Therefore, to help secure all the benefits provided by the various components of the instream flow conservation strategy, the City will commit to a set of downramping prescriptions that are very similar to downramping guidelines established by the State of Washington (Hunter 1992).

Contributions to Fish Passage at the Ballard Locks

On an annual basis, the Cedar River provides approximately one-half the total inflow to Lake Washington. The total volume of inflow to Lake Washington during the dry season is especially important for protecting water quality, for managing water levels in Lake Washington and providing suitable conditions for fish passage and vessel traffic at the Ballard Locks. Therefore, a comprehensive approach to managing Cedar River instream flows must also address factors beyond the river itself. As a result of all the provisions listed above, the HCP instream flow regime will ensure that, under conditions of minimum flow, more water will flow down the Cedar River into Lake Washington than under the existing IRPP regime. Anticipated dry season inflows to Lake Washington under IRPP and HCP minimum flow conditions are summarized in Table 4.4-7.

Recognizing the importance of providing safe fish passage conditions for anadromous fish migrating to and from Lake Washington, the City will also provide $1.85 million to help support enhanced water conservation and the construction of improved downstream fish passage facilities at the Ballard Locks.

Funding for Habitat Protection and Restoration in the Lower Cedar River

Protection and restoration of aquatic and riparian habitat in the lowlands of the Lake Washington basin represent a critical element in regional salmonid recovery efforts. As discussed in Section 4.3 and shown in Table 4.3-1, these efforts will require cooperation of many jurisdictions and agencies if they are to be successful. To contribute to the protection and restoration of habitat in the Cedar River downstream of the municipal watershed and within the Walsh Lake subbasin, the City will contribute over $3 million dollars. Projects in the lower river may include habitat acquisition and will be directed toward habitat for any and/or all species of naturally reproducing salmonids. These funds are in addition to the $1.6 million provided for lower river habitat as part of the mitigation program for the migration blockage at the Landsburg Dam (Section 4.3.2). The HCP's nearly $5 million in contributions to habitat outside the municipal watershed will increase the probability that the potential benefits of the instream flow regime can be realized for anadromous fish.

4.4.3 Monitoring and Research

The City will commit to a program of monitoring and research to determine whether the instream flow management program elements are implemented as written (compliance), to track the results of efforts to protect and restore species of concern and their habitats (effectiveness), to obtain more information on species of concern, to test critical assumptions and reduce uncertainty, and to gain understanding needed to refine management decisions to better meet plan objectives. The instream flow monitoring and research program is described in detail in Section 4.5; the adaptive management program is described in Section 4.5.7 .

Monitoring and research elements are summarized in Table 4.4-10 and include real-time and longer-term programs to monitor and investigate hydrologic and biological factors influencing fish and their habitat in Chester Morse Lake in the river downstream of the lake. All monitoring and research activities will be conducted in collaboration with the Parties to the IFA and the Cedar River Instream Flow Commission. Periodic reports detailing all activities and data will be submitted to the Parties and the Commission as detailed in the IFA and Section 4.5 of the HCP.

Elements of the monitoring and research program directly related to Instream Flow Management Strategies include:

- Funding to support measurement of regulated and unregulated stream flow at key locations throughout the basin;
- Steelhead incubation and redd monitoring program;

- Additional biological and physical studies to gather additional information on key life stages of fish in the Cedar River with special emphasis on juvenile chinook and to further explore the effects of stream flow on aquatic habitat in altered stream channels;

- Studies to support the development of potentially improved criteria to govern switching between normal and critical flows and high-normal and low-normal flows;

- Further investigations of accretion inflows into the river between Landsburg and Renton;

- Further evaluation of the potential effects of ongoing reservoir management on bull trout and common loons;

- Investigation of the feasibility of tapping Chester Morse Lake dead storage to provide more water for downstream aquatic resources, and potential improvements in municipal water supply and reliability;

- Investigation of the possible effects of the potential Chester Morse Lake Dead Storage project dynamics of river delta fans in the reservoir and potential impacts on aquatic resources;

- Evaluation of the effects of the Dead Storage Project on bull trout spawning migration and the potential need for and feasibility of providing migration assistance; and

- Evaluation of the potential effects of the Dead Storage Project on pygmy whitefish and rainbow trout in Chester Morse Lake.

Table 4.4-10. Summarized Cedar River instream flow monitoring and research program.

Elements	HCP Years	Costs	Notes
Stream Flow Measurement	1-50		The City will bear any expense not borne by the USGS and other cooperating agencies for installation, telemetry, relocation, rehabilitation and maintenance of gages at all measuring points specified in IFA
Steelhead Redd Monitoring	1-8	$240,000	
Supplemental Biological and Physical Studies	1-9	$1,000,000	Additional information on key aspects of life history of fish in the Cedar River with special emphasis on chinook early life history and relationships between hydrologic characteristics and fish habitat in altered systems.
Monitor Downramping Rates	1-50	Included in other costs	Use same gages as above
Flow Switching Criteria Study	Completed by the end of year 4	$200,000	
Lower Cedar River Accretion Flow Monitoring Study	For an estimated 10 continuous years within 1-13	$400,000	Study may be extended or shortened by agreement between Parties and City
Reservoir Elevation Management			
Bull trout redd inundation studies	1 or more years within 1-8	$110,000	$55,000/year
Common Loon Monitoring	1-50	$125,000	Up to $25,000/interval: years 1-10, 11-20, 21-30, 31-40, 41-50
Cedar Permanent Dead Storage Project Evaluation			
Engineering studies	1-5	$700,000	Project feasibility, concept design, costs
Delta fans geomorphologic investigations and modeling; plant studies	1-3	$370,000	Includes plant community studies
Loon habitat studies		$30,000	
Bull trout passage assistance plan	Completed by the end of year 5	$65,000	
Pygmy whitefish and rainbow trout impact investigations	Begin in 3 or 4	$280,000	

4.4.4 Effects of Instream Flow Conservation Strategies on Anadromous Fish

GENERAL EFFECTS

The HCP Instream Flow Management Strategies are expected to provide a substantial improvement over existing conditions for aquatic resources in the Cedar River. The management regime is expected to avoid, minimize and mitigate for the effects of the City's water supply and hydroelectric operations on aquatic resources in the Cedar River basin. Further, the proposed management practices are expected to contribute substantially to the recovery and persistence of species currently listed under the federal Endangered Species Act and to those that might reasonably be expected to listed in the future.

The HCP guaranteed flow regime and associated protective provisions attempt to reflect natural hydrologic patterns in several ways. First, the minimum flow regime has been designed to follow the general shape of the natural annual hydrograph in the Cedar River Basin. Flows begin to increase between mid-September and mid-October when fall rains typically begin to arrive, soil moisture increases, and surface runoff begins to increase. Flows remain elevated for the duration of the normal wet period of the year. In late spring, flows begin to decrease as runoff from rainfall and snowmelt in the relatively low-elevation Cedar River basin begins to decline. Flows continue to recede throughout the summer, reach dry season base flow levels by early August, and remain at that level until the return of the wet season in the fall.

Second, the primary instream flow measurement point will be relocated from its present location near the mouth of the river at Lake Washington, to the vicinity of the City's water supply diversion facilities approximately 20 miles upstream. The relocated measurement point will encourage more natural short-term variations in flow throughout the river and especially in the 21.8 miles downstream of the Landsburg Dam.

Third, constraints on the rates at which City facilities can allow stream flows to drop (downramping rates) will help keep short term flow fluctuations more similar to rates and magnitudes of natural short-term fluctuations.

Fourth, the provision of additional supplemental flows when conditions allow will encourage a trend toward more natural fluctuations in the annual hydrologic patterns than under the current, relatively static regime.

Finally, through the HCP, the City commits to manage stream flows above the guaranteed levels in a manner that, where biologically appropriate, more closely mimics natural hydrologic patterns to protect important ecological processes and provide additional benefits to fish.

In addition to providing a regime that is more similar to the natural hydrologic regime, the HCP instream flow strategy will provide many specific prescriptions, safeguards, operating constraints, and financial commitments, none of which exist under the present management regime, to improve conditions for Cedar River anadromous fish. These measures have been developed with an extensive information base that has been developed collaboratively with state, federal, and Tribal resource managers over the last

10 years. The primary improvements provided by the HCP instream flow regime over existing conditions are summarized below.

- Binding minimum flow commitments, where none presently exist, that provide more water and better habitat conditions throughout the river between the natural anadromous fish migration barrier at Lower Cedar Falls and Lake Washington;

- Supplemental flows that provide additional water above minimums, as conditions allow, to further improve anadromous fish habitat;

- Downramping prescriptions to constrain the rate at which flows may be reduced in the Cedar River and, therefore, limit the risks of stranding juvenile fish;

- Relocation of the flow measurement point to Landsburg for increased operating precision, better protection of habitat in the upper reaches of the lower river, and a more natural hydrologic pattern;

- The provision of rearing flows in the bypass reach between Lower Cedar Falls and the Cedar Falls hydroelectric facility;

- Higher guaranteed flows from the Cedar River into Lake Washington, especially during the dry season;

- Funds to support improvements in downstream fish passage and water use efficiency at the Ballard Locks;

- Funds for protection and restoration of aquatic and riparian habitat in the lower Cedar River Basin;

- Funds for additional studies to enhance existing information on key life stages of anadromous salmonids, with special emphasis on juvenile chinook salmon;

- Preservation of sufficient flexibility to adapt and improve instream flow management practices, by reservation of 1/3 of the City's water claim for instream resources and by dedication to manage diversions from the Cedar River at existing levels for the next 5 to 10 years.

- Collaborative management of flows above guaranteed levels to protect important ecological benefits and provide benefits to fish.

SUMMARY OF SPECIFIC EFFECTS

The discussion of the specific effects of the HCP flow regime will center on the key life stages for the four anadromous salmonids as described in Figure 4.4-6 and Table 4.4-6. Coastal cutthroat trout were not included in the studies because their smaller size and preference for small size streams and tributaries indicated they are much less influenced by Cedar River instream flows than other salmonids. Instream flows that meet the needs for chinook, coho, sockeye and steelhead are expected to also provide adequately for cutthroat. During the development of the HCP, the Services agreed that the Cedar River downstream of Cedar Falls does not presently support a viable population of bull trout, nor was such a population present in this area historically. If future information suggests that this is not the case and a viable population of bull trout is present in the Cedar River downstream of Cedar Falls, the City believes that the HCP instream flow management regime, which is designed to provide for the protection and recovery of chinook, coho, sockeye and steelhead, will also provide sufficient protection for bull trout. A detailed analysis of effects on particular species can be found in Section 4.6, which includes a discussion of potential effects on cutthroat trout and bull trout.

From September 23 through May 12, the HCP guaranteed flows will, on average, be significantly greater than the existing non-binding IRPP minimum flow regime and are typically well above the flow levels that provide maximum WUA for key life stages of all four anadromous fish species as determined by the collaborative PHABSIM analyses (Figure 4.4-2). As flows increase above the level required to provide maximum WUA, water depths and velocities in much of the stream channel increase beyond suitable levels and the total amount of spawning and rearing habitat generally decreases (Figure 4.4-7). However, the increased flows will provide a variety of significant benefits that improve habitat quality for salmon spawning, incubation, and outmigration.

From May 13 through June 16, the HCP guaranteed flow commitments slowly decline in a pattern that follows the shape of the natural hydrograph and will, on average, be slightly lower than IRPP flows. These lower flows provide more WUA for steelhead spawning and juvenile steelhead, coho, and chinook rearing than the existing IRPP regime.

From late June to August 4, the HCP guaranteed flow commitments will generally be greater than the existing IRPP flows. The actual flows during this period will vary from year to year as prescribed by the Commission to provide protection of incubating steelhead. However, throughout this period, the elevated flows will be greater than the flows required to provide maximum WUA for steelhead, coho, and chinook rearing and will generally result in a small reduction in juvenile rearing habitat. From August 5 to September 15, the HCP guaranteed flow commitments are essentially equal to the existing IRPP flows. Both sets of flows are slightly below the levels required to provide maximum WUA for juvenile salmonid rearing. However, both regimes provide quantities of juvenile salmonid rearing habitat that are very near maximum WUA.

Fall Flows

As significant numbers of adult chinook and sockeye salmon begin to enter the Cedar River by mid-September, considerations for juvenile rearing conditions become secondary to considerations for sockeye and chinook spawning. By mid-September guaranteed flow commitments increase beyond the levels that provide maximum WUA for coho and steelhead juvenile rearing. However, the resultant losses in rearing habitat associated with these increased flows are moderate and are not believed to pose a threat to the populations. By the middle of September, the HCP flows are greater than required to provide maximum WUA for sockeye spawning, but are still less than the flows required to provide maximum WUA for chinook spawning. After October 7, HCP flows are equal to or greater than the level required to provide maximum WUA for chinook spawning. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the chinook spawning period as a whole, expected flows under the HCP regime will provide more WUA for chinook spawning than expected flows under either the existing IRPP regime or the natural flow regime. Habitat duration analyses also demonstrate that the HCP provides more WUA for sockeye spawning than expected flows under the natural flow regime, but less WUA for sockeye spawning that expected flows under the existing IRPP regime.

The HCP flow regime attempts to balance three sometimes competing spawning habitat considerations during the fall: (1) maximizing WUA for chinook and sockeye spawning t at any given time; (2) further increasing the cumulative amount of sockeye spawning habitat available during the spawning season by gradually increasing flows above the level that provides maximum WUA; and (3) increasing flows above the level required to create maximum WUA for spawning to recruit additional sockeye spawning habitat along the stream margins in an effort to reduce the risk of redd scour during subsequent flood events.

During the third week in September and first week of October, the HCP guaranteed flow commitments are equal to the existing IRPP minimum flows. During the fourth week of September, HCP flows are significantly greater than existing IRPP flows and provide significantly greater WUA for chinook spawning. These increased flows result in a reduction in WUA for sockeye spawning and reduced capacity to provide additional cumulative spawning habitat for sockeye. However, these losses in sockeye spawning habitat are believed to be offset by the benefits provided to chinook salmon that tend to spawn slightly earlier than sockeye.

From October 8 through mid-November the HCP low-normal flows are approximately equal to the flows that provide maximum WUA for chinook spawning, are lower than IRPP flows, and provide more chinook spawning habitat than IRPP flows. HCP high-normal flows during this period are greater than the flows that provide maximum WUA for chinook spawning, are greater than IRPP flows, and provide slightly less chinook spawning habitat than IRPP flows. Although the elevated high-normal flows reduce WUA for chinook spawning, these losses are very small (less than 3.5 percent) and are offset by benefits of providing additional incubation protection for all salmon species, increased cumulative sockeye spawning habitat, and increased sockeye spawning habitat along the stream margins where redd scour is believed to be less frequent and less severe.

Winter Flows

Chinook spawning is complete by mid-November, but sockeye continue to spawn in the mainstem through the end of December, and coho continue to spawn until mid-February. Sockeye spawning remains the primary focus through December, but salmon incubation protection is also important during this period. By January, protection of incubating salmon becomes the primary consideration for instream flows. Flows remain elevated well above the level that provides maximum WUA for coho spawning and above the levels provided by IRPP to reduce the risk of redd dewatering. Although the elevated flows reduce WUA for coho spawning, most coho are thought to spawn in tributaries to the mainstem and chinook and sockeye incubation protection is considered a higher priority for mainstem flow considerations.

By early February, significant numbers of sockeye fry are emerging and migrating downstream to Lake Washington. Fry emergence and migration peaks in late March, continues through mid- to late May, and is the primary concern for instream flows through mid-April. From February 11 through April 14, HCP flows are elevated further to improve conditions for outmigrating sockeye fry. Steelhead begin to spawn in early March and continue through early June. HCP guaranteed flow commitments remain well above the levels that provide maximum WUA for steelhead spawning, resulting in a moderate loss of steelhead spawning habitat during this entire period. Although important, WUA for steelhead spawning is considered to be of secondary importance to sockeye outmigration conditions and salmon incubation protection during this period.

Spring Flows

After April 14, steelhead spawning flows become increasingly important. Incubating steelhead that are spawned after April 14 will remain in the gravel through the period during which flows begin to drop to summer base flow levels and are therefore more vulnerable to dewatering than the offspring of early spawners. If stream flows remain significantly elevated for extended periods of time after April 14, significant numbers of steelhead may be forced to spawn in areas that are at significant risk of being dewatered prior to the completion of fry emergence. Therefore, HCP guaranteed flow commitments between April 14 and May 12 trend downward. However, to provide continued protection for incubating salmon, HCP guaranteed flow remain well above the levels required to provide maximum WUA for steelhead spawning and remain higher than existing IRPP flows.

After May 12, flows are allowed to drop slightly closer to the levels that create maximum WUA for steelhead spawning to coincide with peak steelhead spawning activity in early to mid-May. Water temperatures begin to warm during this time of year and juvenile rearing becomes increasingly important as young steelhead, coho, and chinook enter a period of active feeding and rapid growth. After May 12, flows begin to drop slightly below existing IRPP flows to provide increased WUA for steelhead spawning and juvenile salmonid rearing. However, to protect incubating steelhead, flows remain well above levels that provide maximum WUA for steelhead spawning and rearing. Although these higher flows result in a loss of habitat, they provide more steelhead spawning and juvenile rearing habitat than the existing IRPP flows. Habitat duration analyses demonstrate that, for the steelhead spawning period as a whole, expected flows under the HCP regime provide more WUA for steelhead spawning than expected flows under natural flow conditions or expected flows under the IRPP regime.

Summer Flows

From early June through early August, steelhead incubation protection is the primary focus of instream flow management. Flows during this period remain well above the level required to provide maximum WUA for juvenile steelhead, coho, and chinook and therefore result in a loss in rearing habitat. However, these habitat losses are quite small and are not believed to pose a threat to the populations. The amount of water available for instream flows from June 17 through August 4 is greater than the amount available under the existing IRPP regime. The actual flow levels during this period will be determined each year by the Commission based upon needs for steelhead incubation protection as demonstrated by in-season redd monitoring studies, water supply conditions, and other factors deemed appropriate.

After the completion of steelhead incubation in early August and prior to the start of salmon spawning in mid-September, juvenile coho and steelhead rearing are the primary concerns for instream flow management. This is a period of active feeding and growth for juvenile salmonids. The HCP and the existing IRPP flows are essentially equivalent during this time period. Although the flows are slightly lower than the flows required to provide maximum WUA, they are sufficient to provide 98 - 99 percent of maximum WUA for juvenile steelhead and coho rearing.

Management of Flows Above the Guaranteed Levels

As described above, the HCP commitments provide funding to enhance our understanding of key life history stages of anadromous fish and to further explore the relationships between basin hydrology and fish habitat in altered systems. Further, the HCP commitments preserve future flexibility to work with the Commission to adapt and enhance the management of stream flows above the guaranteed levels as new information is gathered and conditions change. This adaptive approach is expected to help protect important ecological processes and preserve options to provide additional benefits to fish should such opportunities arise in the future.

Downramping Prescriptions

The City's small hydroelectric facilities at Cedar Falls and water supply facilities at Landsburg operate at relatively constant levels and are not operated in a manner that provides for daily peaking and associated flow oscillations. Therefore, downramping is perhaps less of a concern on the Cedar River than in other regulated rivers with large hydroelectric facilities that vary flows to meet varying electrical demands during the course of a day. Nevertheless, adjustments to the City's water supply and hydroelectric facilities do result in a significant number of stream flow reductions during the course of a year.

At present, there are no downramping prescriptions on the Cedar River. The HCP provides downramping prescriptions that are patterned after WDFW downramping prescriptions (Hunter 1992). Downramping prescriptions will significantly reduce the risks of stranding salmonids and other species of fish throughout the river downstream of the Landsburg Dam beginning in HCP year 1. These protections will be extended to the river above the Landsburg Dam once anadromous fish are allowed to pass upstream.

Relocated and Enhanced Measurement Points

The stream flow measurement point for the present non-binding IRPP instream flow regime is located at the existing USGS stream gage #12119000 in Renton, 1.6 miles upstream from Lake Washington (Map 2). The new configuration of measurement points will provide improved conditions for anadromous fish in several ways. First, measurement at Landsburg provides added protection for the upper portions of the lower river below Landsburg. Under the current measurement regime, actual flows at Landsburg can be varied in a quite unnatural manner to meet target flows 22 miles downstream at Renton (Figure 4.4-3). In fact, there are times when releases from Landsburg can approach zero while still meeting IRPP target flows at Renton. By moving the measurement point to Landsburg, the upper reaches of the lower river will be better protected and flows downstream of the diversion dam will vary in a much more natural manner according to changes in natural inflows to the lower river. Secondly, the establishment of downramping measurement points at Landsburg and Cedar Falls will significantly reduce the risk of stranding juvenile fish during operational reductions in stream flow. Finally, the establishment of a stream flow measurement point upstream of the Cedar Falls powerhouse will provide added protection for the bypass reach and upper portions of middle Cedar River downstream from the powerhouse.

Funding for Improvements at the Ballard Locks

All anadromous fish in Lake Washington must pass through the locks twice during their lives. Recent investigations suggest that opportunities may exist to improve the efficiency with which freshwater is used at the locks (ACOE 1991) and provide better conditions for downstream migrating anadromous fish (Goetz et al. 1997). Water flow at the locks must be shared between vessel traffic and upstream and downstream migrating fish. Between June 15 and September 30, the typical dry season, the HCP guaranteed flow regime ensures that, under minimum flow conditions, significantly more water will flow into Lake Washington than under the existing IRPP minimum flow regime (Table 4.4-7).

In addition, the City will help fund measures at the Locks to improve fish passage conditions and improve water use efficiency in an effort to make even more water available for fish passage. These measures are expected to help improve the survival of juvenile anadromous salmonids as they migrate downstream through the facilities to saltwater.

Conditions in the River Upstream of the Landsburg Dam

The construction of emergency flow bypass facilities at the City's Hydroelectric Facility will help reduce the risks of fish stranding throughout the Cedar River downstream of Cedar Falls. The construction of a tailrace barrier at the facility will reduce hazards to upstream migrating fish. The provision of flows in the bypass reach upstream of the hydroelectric facility will improve conditions for juvenile salmon rearing and adult spawning.

Flows in the river immediately upstream of the Landsburg Dam will be significantly greater than flows immediately downstream of the dam except during relatively infrequent shut down of the municipal water supply intake. The HCP guaranteed stream flows coupled with the relocation of the measurement point to Landsburg ensures that flows in the Cedar River upstream of the Landsburg Dam will typically be near or greater than the flows required to provide maximum WUA for key species and life stages once anadromous fish are allowed to pass upstream of the Landsburg Dam (Table 4.4-2).

Contributions to Aquatic and Riparian Habitat Downstream of Landsburg

Many elements of the HCP are expected to provide benefits for water quality and fish habitat downstream of Landsburg. In addition to benefits discussed elsewhere, the City will provide $3.27 million to protect and restore habitat in the Walsh Lake system and in the mainstem of the Cedar River downstream of the Landsburg Diversion Dam as part of the proposed instream flow management program. This commitment is expected to contribute to improved habitat conditions in stream channels and riparian areas in the lower Cedar River. Habitat improvements are expected to provide substantial benefits for aquatic resources, including all salmonid species, in the lower river downstream of the municipal watershed boundary.

Conditions in Chester Morse Lake

The HCP flow regime generally ensures that, under minimum flow conditions, more water is provided for instream flows during the dry season than in the past. Therefore, it is possible that, in some years, water levels in Chester Morse Lake will be slightly lower during the summer and fall than under existing conditions. The differences in water level are expected to be relatively minor and the effects of these lower water levels on the aquatic community in Chester Morse Lake are also expected to be minor. These potential effects are analyzed in the section Environmental Evaluation of the New HCP Flow Regime (contained in Section 4.5.6) and in Section 4.6.

Section 4.5 Contents

4.5 Monitoring and Research

4.5.1 Introduction and Objectives to Monitoring and Research

BACKGROUND

A program of monitoring and research is essential to assess the impact of the management activities and conservation strategies included in this HCP. Monitoring and research are especially important for a long-term management plan such as the City's HCP, which includes a broad range of long-term conservation, mitigation, and restoration objectives. The monitoring and research program will allow the City to ensure compliance with the plan, to determine effectiveness of mitigation, to track trends in habitats and key species populations, to test critical assumptions in the plan, and to provide for flexible, adaptive management of the conservation strategies.

The City will commit to a monitoring and research program that will be conducted in the Cedar River Municipal Watershed and the larger Lake Washington Basin as an integral part of the HCP. The monitoring and research program will be the primary means to assess if the HCP is working as intended, and the results and experience gained from the program will enable the City to make better management decisions over time.

DEVELOPMENT OF THE MONITORING AND RESEARCH PROGRAM

The monitoring and research program was developed to support the multiple programs and objectives established for this HCP, which are discussed throughout this document. The monitoring and research program was designed to support these programs by providing information needed to achieve their stated objectives. Important features of the monitoring and research program include: commitments to long-term funding and data collection; commitments to improve the quality and quantity of baseline information; commitments to track key species and habitats; and commitments to use the results of this program to provide feedback to the other management components of the HCP through the adaptive management approach (sections 4.5.7 and 5.5).

The monitoring and research program was developed and designed to use a broad range of methods. This was necessary to encompass the monitoring and research needs of the various HCP conservation and management strategies, and to provide a means to fill the gaps and uncertainties in information that were identified during the development of the HCP strategies.

IMPLEMENTATION PLANNING

Unless otherwise specified, the City intends that HCP years 1-3 will be used primarily to plan and further develop the methods and sampling plans to be used for the individual studies, and that full-scale implementation will occur afterwards. The design of individual monitoring and research studies will be developed in cooperation with agency biologists, consultants, and other experts through individual consultations, workshops, and on-site field trips. The overall program design will rely on an ecosystem-level integration of data collection and study results to support adaptive management decisions associated with implementation of this HCP.

OBJECTIVES

The primary objectives of the HCP monitoring and research program are:

(1) To determine whether HCP programs and elements are implemented as written (compliance monitoring);

(2) To determine whether HCP programs and elements result in anticipated changes in habitat or other conditions for the species of concern (effectiveness monitoring);

(3) To assist the adaptive management process by providing information on the species of concern or their habitats, testing critical assumptions in the plan, and by providing a learning experience to refine management decisions in order to better meet plan objectives;

(4) To assess and promote the recovery and maintenance of watershed fish and wildlife populations; and

(5) To help ensure a continued supply of high quality drinking water by providing data on management activities that could potentially affect water quality.

MONITORING AND RESEARCH PROGRAM ELEMENTS

This HCP's Monitoring and Research Program contains a comprehensive suite of studies that are designed to help achieve the above objectives. These include project-specific monitoring, baseline monitoring, experimental research projects, and cooperative studies.

The major elements of the City's Monitoring and Research Program include the following:

Section	*Element of Conservation, Management, or Mitigation Strategy*
4.5.2	Instream Flow Monitoring and Research: Consisting of monitoring the strategy for instream flow management (Section 4.4), including instream flow and downramping compliance and technical studies and adaptive management regarding flow switching criteria, accretion flows, monitoring of steelhead redds, and supplemental studies.
4.5.3	Anadromous Fish Monitoring and Research: Consisting of monitoring the strategy for anadromous fish (Section 4.3), including technical studies and adaptive management regarding fish passage at Landsburg

Dam, sockeye salmon mitigation measures, and interim mitigation measures for steelhead, chinook, and coho.

4.5.4 Watershed Aquatic Monitoring and Research: Consisting of monitoring the strategies for watershed management (Section 4.2) related to aquatic and riparian species, including short- and long-term stream and riparian monitoring and research programs; monitoring of stream and riparian restoration projects; and monitoring, experimental research, and adaptive management for bull trout and common loons.

4.5.5 Watershed Terrestrial Monitoring and Research: Consisting of monitoring the strategies for watershed management (Section 4.2) related to upland species, including habitat monitoring and research; monitoring, research, and adaptive management related to marbled murrelets and spotted owls; and development of a basic predictive model for the relationships among forest growth, habitat characteristics, and selected watershed species.

4.5.6 Future Reservoir Management: Consisting of an evaluation of the potential environmental impacts of current reservoir operations on several species and an evaluation of the potential environmental impacts that may be associated with the Cedar Permanent Dead Storage Project.

4.5.7 Adaptive Management: Consisting of a commitment to an adaptive approach with two variations: (1) contingent responses for changed circumstances related to environmental events, and a formal approach with predefined criteria and decision thresholds for specific activities where considerable uncertainty exists; and (2) a second, less formal and more flexible approach that will be used as a simple tool or mechanism for responding to new information and experience that can be used to make conservation, management, and mitigation strategies more effective.

Within these specific programs, there are a number of projects that are identified as either experimental or research projects. The City regards the implementation of these projects as learning experiments for which monitoring results will aid in subsequent improvement in management decisions and restoration project designs. The City will encourage the cooperation and participation of outside agencies, educational institutions, research institutions, and independent researchers in the design, implementation, analysis, and funding of cooperative research investigations. If additional funding is provided, the City will consider extending the scopes and goals of the types of studies funded under the HCP.

HCP SCHEDULE CONVENTION AND HCP REPORTING

The effective date of the HCP is defined as the date that the Services issue the Incidental Take Permit (Appendix 1). HCP year 1 is defined as the period from the effective date of the HCP until the end of the first full calendar year following that date.

HCP compliance reports, unless otherwise specifically noted, will be submitted to the Services within 120 days following the end of HCP calendar years 2, 5, 8, 11, 15, 20, 25, 30, 35, 40, 45, and 50. For example, assuming the effective date of the HCP is in 2000, year 1 of the HCP will end December 31, 2001. The first report would then be submitted to the Services no later than 120 days after December 31, 2002. Instream flow compliance reports will be completed annually. The first instream flow compliance report will be submitted within 120 days of the end of HCP year 1. HCP compliance reports will contain summaries of all significant HCP-related activities and associated data and information. These activities and data include: planning, implementation, monitoring, research, compliance, expenditures, adaptive management, and the advice of the HCP Oversight Committee. For more details, see Appendix 30.

4.5.2 Instream Flow Monitoring and Research

BACKGROUND

Volume, changes in distribution, and the rate of change are important features of stream flows in aquatic ecosystems that have been subject to significant influence from anthropogenic activities during the twentieth century in the Pacific Northwest (National Research Council 1996). Through its water storage and supply activities in the Cedar River Basin, the City can exert considerable influence over stream flows in the 35.6 miles of the river downstream of Masonry Dam.

Stream flow regulation through the operation of the City's water storage and diversion facilities and hydroelectric generating plant can have very direct effects on the quantity and quality of fish habitat. Stream flow regulation can affect a number of environmental factors important to fish, including: the amount and distribution of spawning and rearing habitat in the river at any given time; the risk of damaging incubating eggs or larval fish by scour or desiccation; the risk of stranding fish during reductions in flow; conditions for upstream and downstream migration; and the biophysical factors that form and maintain stream channels.

The City will implement an instream flow monitoring and research program to: (1) ensure program and flow compliance; (2) verify accretion flows in the subbasin between the Landsburg Dam and Lake Washington; (3) improve flow-switching criteria; (4) develop better understanding of the relationship between river flows and the biology of anadromous fish; and (4) ultimately make better decisions about real-time flow management by learning from monitoring results.

A Cedar River Instream Flow Oversight Commission (the Commission) will be established to provide general oversight, coordination, and, where specifically authorized, direction regarding the implementation of the Instream Flow Agreement (Appendix 27).

Instream Flow Compliance

The City will monitor Cedar River instream flow compliance at the following locations:

(1) The existing USGS Gaging Station #12117600, Cedar River below Landsburg Dam, near RM 20.4. Monitoring at this location will begin on the effective date of the HCP.

(2) The existing USGS Gaging Station #12116500, Cedar River at Cedar Falls, near RM 33.2. Monitoring at this location will be initiated after construction of a fish ladder at Landsburg Dam and subsequent upstream passage of selected species of anadromous fish.

(3) A new site near RM 33.7 immediately above the Cedar Falls Powerhouse. Monitoring at this location will be initiated after construction of a fish ladder at Landsburg Diversion Dam and subsequent upstream passage of selected species of anadromous fish.

(4) The existing USGS Gaging Station #12119000, near Renton, or at a new gaging location nearby. Monitoring at this location will begin on the effective date of the HCP, and will terminate when the accretion flow study is completed (by or before HCP year 13).

(5) Up to two additional locations between Renton and Landsburg Dam. Monitoring at these locations would be for only a temporary period as a part of the accretion flow study (see "Accretion Flow Monitoring Study in the Lower Cedar River" below) to help monitor accretion flows between Landsburg Dam and Renton. Monitoring at these locations will begin when the accretion flow study is initiated and will terminate when the accretion flow study is completed (by or before HCP year 13).

The City will pay up to $30,000 for installation of a new USGS gage near RM 33.7 immediately above the Cedar Falls Powerhouse. The City will pay up to $11,000 per year for the maintenance of this gage. For the purpose of the accretion flow study, the City will pay up to $30,000 to install a new USGS gage in the vicinity of the current USGS Renton Gage, but at a better cross-sectional measuring site. As it has in the past, but only for the duration of the accretion flow study, the City will pay a portion ($9,100) of the annual maintenance for the gage in this vicinity. At the end of the accretion flow study, the City is willing to discuss and consider continuing to partially fund annual maintenance with other interested agencies on a cost-share basis, commensurate with the City's interests and the information provided. The City will pay for installation of new temporary gages between Landsburg Dam and Renton and their annual maintenance. The City will pay a gage installation cost of up to $15,000 per new temporary gage, and an annual maintenance cost of up to $5,000 per new temporary gage (see Table 4.5-7).

Instream flow compliance will be summarized annually in a written report, which will be submitted within 120 days of the end of the calendar year. The first instream flow compliance report will be submitted within 120 days of the end of HCP year 1.

Average daily flows and reservoir elevations will be provided to indicate compliance with minimum instream flow commitments and goals. The reports will include an explanation of decisions concerning provision of supplemental flows, including an analysis of cumulative progress toward achieving the goals for such flows. The frequency and detail of flow and reservoir elevation reports may be modified by the Instream Flow Commission.

As soon as reasonably feasible, but in any event not later than 30 days following discovery, the City will notify the Commission of any case, including emergency conditions, in which recorded flows are significantly below those specified in the HCP. Such non-conformance as may occur as a result of gage malfunction or retroactive USGS flow corrections to the record shall not constitute noncompliance by the City.

Flow Downramping Compliance

Anadromous and resident fish are vulnerable to sudden flow reductions in the Cedar River downstream of the reservoir. Fish can be killed by stranding on open gravel bars or by isolation in potholes or side channels that subsequently dry up. Newly emerged fry that have just absorbed the yolk sac and have recently emerged from the gravel are by far the most vulnerable (Hunter 1992). They are relatively poor swimmers and use the shallow margins of rivers (Phinney 1974; Woodin 1984). Downramping guidelines prescribe the rates at which flows can be reduced in regulated rivers without causing significant detrimental impacts on aquatic resources.

Through its operations on the Cedar River, the City of Seattle can alter instream flows at three locations on the river that can create significant downramping events. The three locations and mechanisms are:

(1) Masonry Dam: low-level outlet valve.

(2) Cedar Falls powerhouse: two turbines.

(3) Landsburg Diversion Dam: municipal water supply intake valve and/or diversion dam radial gates.

Presently, no formal downramping criteria are used to guide flow control operations at any of the three flow control points on the river.

Implementation of formal downramping rates that limit impacts on juvenile salmonids will provide a benefit to fisheries resources in the Cedar River Basin below Chester Morse Reservoir. The City will commit to the implementation of downramping prescriptions for each of the three locations within the constraints posed by the biological needs of the resource and reasonable considerations for facility operations. For periods affected by downramping operations, flow data will be provided in 1-hour increments to indicate compliance with downramping prescriptions. For downramping compliance report purposes, any USGS determination of gage error shall be factored into the actual ramping rate calculation.

The City will monitor Cedar River instream flow downramping according to the following:

(1) The downramping measurement point for operation of the diversion facilities and radial gates at the Landsburg Dam will be the existing USGS Gaging Station #12117600, Cedar River below Landsburg Dam near RM 20.4. Monitoring at this location will begin on the effective date of the HCP.

(2) Ramping of discharge from the Cedar Falls Hydroelectric Project will be measured at the existing USGS Gaging Station #12116500, Cedar River at Cedar Falls near RM 33.2. Monitoring at this location will be initiated after construction of a fish ladder at Landsburg Dam and subsequent upstream passage of selected species of anadromous fish.

(3) Ramping rates below the Masonry Dam will be measured at a new gage to be installed near RM 33.7, immediately above the Cedar Falls Powerhouse. Monitoring at this location will be initiated after construction of a fish ladder at Landsburg Dam and subsequent upstream passage of selected species of anadromous fish.

Downramping compliance will be summarized annually in the same written report as instream flow compliance, which will be submitted within 120 days of the end of the calendar year. The first downramping compliance report will be submitted within 120 days of the end of HCP year 1.

Technical Studies and Adaptive Management

The maintenance of the instream flow regime and other commitments contained in this HCP will benefit the fish populations of the Cedar River by protecting, improving, and increasing available habitat. The City recognizes the importance of monitoring the condition of the habitat to assure that the purposes of the HCP are met. The City also acknowledges that available information on certain complex ecological and hydrologic processes is not complete. Therefore, the City, in cooperation with the Instream Flow Commission, will sponsor and conduct certain studies and act on the results as indicated.

Except as otherwise provided, including the established cost caps, all major aspects of study planning, implementation, and coordination with other related studies shall be subject to the approval of the Commission, which shall meet as frequently as study requirements dictate. The Commission shall have the opportunity to review and comment on drafts of any final study reports. The City shall make every effort to complete final study reports no later than 1 year after completion of the respective studies.

Accretion Flow Monitoring Study in the Lower Cedar River

The City will conduct a long-term (10 or more year) monitoring study of accretion flows in the lower Cedar River between Landsburg Dam and Renton. The purpose of this study is to verify the accretion flow assumptions developed in past technical studies and further refined by the Cedar River Instream Flow Committee. This is important because these accretion flow assumptions at times can have a significant effect on fish habitat, and future accretion flow patterns also may vary somewhat from those calculated from historical data.

The accretion flow monitoring study will: (1) specify the precise inflow assumptions to be evaluated; (2) establish and implement a long-term monitoring protocol; (3) establish analytical objectives; (4) identify any apparent long-term differences from the assumptions; and (5) perform additional investigations and analyses, if needed, to identify causes of any differences from the assumptions.

If the conclusions of the long-term monitoring study show that actual local inflow patterns (after allowance for gage error) are clearly more or less than the previously assumed patterns for causes that cannot be reasonably attributed to factors such as land development and water withdrawals downstream of Landsburg, the Instream Flow Commission may agree to a procedure for adjusting the agreed-upon minimum flow commitments upward or downward by limited amounts. The Commission shall act through a majority vote (at least 51 percent) of the members participating in the decision, but only if that majority includes the City.

The study will begin not later than the end of HCP year 3 and will continue for not less than 10 years. Total costs for monitoring and analysis will not exceed $400,000. More details of the Accretion Flow Study are contained Section 4.4.2.

Improved Flow-switching Criteria Study

The objective of this study is to develop robust, measurable, reliable, and independently verifiable criteria that will allow a timely switch from normal to critical instream flows approximately 1 year in 10, and between high-normal flows and low-normal flows as described in Section 4.4.2

The current switching criteria established to guide reductions to critical flows and selection of the high- and low-normal flows in the fall are considered interim criteria. The City will sponsor and the parties to the IFA will support a collaborative analysis of alternatives to these criteria. The City and the parties to the IFA anticipate that revised switching criteria will be able to incorporate advancements in modeling and forecasting, and will be necessary to accommodate potentially significant changes to the operation of the water supply system arising from planned development of a new supply source and water treatment facilities. The City and the parties to the IFA further anticipate that improved switching criteria can have a significant effect on the water manager's ability to manage the water resource efficiently and can benefit fish by ensuring that decisions are appropriate to conditions of concern.

The analyses will involve evaluation of various switching criteria, including measured stream flows and reservoir conditions, forecasted stream flows and reservoir conditions, refill success, system-wide conditions (including other SPU water resources beyond the Cedar River), biological conditions, and watershed conditions, such as soil moisture, snowpack, and groundwater. Adaptive management techniques will also be investigated. The study may result in the retention of one or more of the existing criteria if such action is deemed appropriate in light of the additional analyses.

The study may cost up to $200,000 (see Table 4.5-7) and will be completed by the end of HCP year 4. More details on the Improved Flow-switching Criteria Study are contained in Section 4.4.2.

Cedar River Steelhead Redd and Incubation Monitoring

The HCP provides for a 2,500 acre-foot block of water in all normal years and an additional 3,500 acre-foot block of water in 63 percent of all years to supplement minimum flow commitments during the steelhead incubation period. In order to make better decisions regarding the provision of this water and to minimize dewatering of steelhead redds, the City will conduct and the parties to the Instream Flow Agreement will support annual monitoring of steelhead redds in HCP years 1-8 at a cost of $30,000 per year for a total cost of up to $240,000 (Table 4.5-7).

The monitoring program will: (1) locate and monitor steelhead redds from the time of their construction through the completion of fry emergence; and (2) trap emerging fry from a subsample of redds in order to determine total elapsed time between spawning and the completion of emergence.

The results of the study and the flow management experience gained during this period will be used to develop analytical tools that may be used to support subsequent decision making after HCP year 8. More details of the Cedar River Steelhead Redd and Incubation Monitoring Study are contained in Section 4.4.2.

Supplemental Studies

During the formal public review process for the Draft HCP, a number of parties raised several issues regarding persistent areas of uncertainty about the effects of instream flow management on aquatic resources. Some commenters indicated considerable interest in the City sponsoring further study of a number of topics, particularly focusing on obtaining enhanced information about chinook salmon, which were listed under the Endangered Species Act as "threatened" during the final year of preparing the HCP. In response this input, the City will provide an additional $1,000,000 to support further study of the effects of certain aspects of instream flow management on anadromous salmonids, with special emphasis on additional information about chinook salmon originating from the Cedar River. The City recognizes the key role of Tribal, state, and federal fisheries resource managers in the development and implementation of future studies. Therefore, all major aspects of study planning, implementation, and coordination with other related studies shall be subject to the approval of the Cedar River Instream Flow Oversight Commission (Commission) through a majority vote of its members as specified in paragraph F.3 of the Instream Flow Agreement (Appendix 27). The Commission shall have the opportunity to review and comment on drafts of all final study reports.

To enhance present understanding of the biology of aquatic resources in the Cedar River and the complex relationships between stream flow and fish habitat, the City proposes the following list potential supplemental study topics:

- The effects of stream flow on the migratory response of recently emerged chinook and sockeye fry and chinook fingerlings
- The effects of size of juvenile chinook and timing of entry into Lake Washington on survival to smolt and/or adult
- Distribution, abundance and habitat preferences of rearing juvenile chinook in the mainstem Cedar River, with emphasis on the interaction of these factors with stream flow.
- Behavioral response of adult chinook salmon to changes in stream flow and the operation of sockeye broodstock collection facilities
- Modeling analysis of the potential impacts of stream flow at Landsburg on water temperature at the mouth of the river and in Lake Washington
- Modeling analysis of the potential impacts of spring and early summer stream flows at Landsburg on water velocity vectors and water residence time in Lake Washington
- Vulnerability of chinook and sockeye salmon to redd scour
- The potential effects of redd superimposition on the survival of sockeye and chinook eggs and alevins
- Further investigations of the relationship between hydrologic features and the structure and function of instream and riparian habitat in altered stream channels.

The Commission will prioritize the study topics and may add or delete topics with the consent of the City.

Funding for the studies will be available over a period of up to 9 years, which would be sufficient time to encompass the complete life cycle of 4 brood years of Chinook salmon. A schedule for dispensation of the supplemental study funds will be developed in consultation with the Commission by the midpoint of HCP year 1, with initial funding to occur after that date.

This study effort is expected to help generally advance the scientific basis for managing altered fluvial systems. The results of the studies can potentially be used by a variety of entities involved in the management of aquatic, riparian and upland habitat. Natural hydrology in the Cedar River basin is quite variable and stream flows in the Cedar River can often exceed the levels provided by the guaranteed flow regime. The results of the supplemental biological studies will provide an enhanced biological and physical information base that the Commission may use to advise the City in its management of stream flows at levels over and above those included in the guaranteed regime described in Section 4.4.2.

The Lake Washington ecosystem is very complex. Many of the factors that can affect the proposed Cedar River supplemental study topics and the successful implementation of appropriate investigations are outside the jurisdiction of the City. Successful implementation of the supplemental study program will require coordination with a number of other interested parties in the basin. Tribal, state and federal resource managers, King County and many of the municipalities in the Lake Washington watershed are developing a broad array of study programs to support basin-wide salmon conservation efforts. The City supports these programs and wishes to cooperate with other jurisdictions in promoting sound understanding of the ecosystem that supports Lake Washington salmon and steelhead.

4.5.3 Anadromous Fish Monitoring And Research

BACKGROUND

The City will implement a comprehensive monitoring and research program to ensure program compliance, evaluate the effectiveness of the conservation measures, and obtain the necessary information required to successfully implement an adaptive approach to managing uncertainty (sections 4.5.7 and 5.5). The monitoring and research program for anadromous fish conservation has the following primary objectives: (1) track program implementation and assure that actual activities comply with stated commitments in the HCP; (2) monitor the effectiveness of the conservation measures in meeting stated objectives; (3) track trends in the condition of habitats and key species populations; (4) test key assumptions; and (5) provide information to help refine future decision-making regarding implementation of the conservation strategies.

Two mechanisms are provided to help ensure that program implementation complies with stated commitments. First, design, construction, and operation of mitigation facilities will be overseen by the parties to the Landsburg Mitigation Agreement, in consultation with the interagency Cedar River Anadromous Fish Committee (Section 4.3.2). Second, the City will provide compliance reports to the parties to the LMA 120 days after the end of HCP years 2, 5, 8, 11, 15, 25, 30, 35, 40, 45, and 50. These reports will contain summaries of all significant HCP-related activities and associated data, including program planning, facility design and construction, program operation, expenditures, and adaptive management.

FISH PASSAGE MONITORING AT LANDSBURG DAM

Fish Ladder Counts

The objective of this task is to enumerate the number of adult anadromous fish migrating upstream past the Landsburg Diversion Dam in order to better understand run timing, rate of upstream passage, and the rate at which the upstream habitat is recolonized, and to monitor upstream fish passage facility performance. The City will purchase, install, and operate an electronic fish counter at the Landsburg Dam to count adult anadromous salmonids. The cost of purchase and installation of the fish counter may be up to $50,000. Annual operating and maintenance costs may be up to $5,000 per year (Table 4.5-7). The electronic fish counter will be installed and operated for 12 years after construction of a fish ladder at Landsburg Dam and subsequent upstream passage of selected species of anadromous fish. The City may operate this counter after HCP year 12 if adequate funding can be arranged.

Intake Screening Evaluation and Monitoring

The new fish screens to be installed at Landsburg Dam will meet all federal (NMFS) and state (WDFW) screening criteria. Designs will be provided for agency and Tribal review at the preliminary and final design stages. If there is a request, meetings will be held at the preliminary or final design phase, or both, to discuss facility layout, design, and operation. Following construction of the screens, a site visit will be held for the parties to the Landsburg Mitigation Agreement and the members of the Cedar River Anadromous Fish Committee.

After the site visit, a hydraulic evaluation of the facility will be performed to determine compliance with physical fish screening criteria. This evaluation will include measurement of approach and sweeping water velocity components at the face of the screen, water velocity at the entrance to the fish bypass, and effectiveness of the screen cleaning mechanism. Velocity measurements will be taken near the surface, at mid-depth, and near the panel floor. All measurements will be obtained while the rate of diversion into the municipal water supply system is near maximum operating levels. If areas are identified where the approach velocity vector exceeds design criteria, baffling (solid steel plates) will be installed on the downstream side (inside) of the fish screen. Measurements will be retaken until all screen areas come within 5 percent of approach velocity criteria. Field measurements of approach and sweeping velocity vectors and identification of areas that have been baffled will be provided for review to the parties to the Landsburg Mitigation Agreement and the members of the Cedar River Anadromous Fish Committee. Cost of the screening evaluation is estimated to be up to $15,000 (Table 4.5-7). Reevaluation of screen hydraulics will be performed if facility modifications are made as a result of maintenance or repair.

Monitoring Fish Carcass Impacts on Drinking Water Quality

The City will monitor the effects on drinking water quality of allowing upstream passage of selected species of anadromous fish after construction of a fish ladder at Landsburg Dam. To achieve this objective, the City will supplement its regular water quality monitoring program by adding several new water quality parameters and increasing the current sampling frequency. One year of baseline data will be obtained prior to the introduction of anadromous fish, then data will be collected during 5 subsequent years after fish passage facilities have been completed and adult fish are passing above the

Landsburg Dam. The estimated cost for this program is $60,000 (Table 4.5-7). Any cost overruns for this study will be funded solely by the City. The City will also provide $60,000 in HCP year 1 to help fund collaborative studies with NMFS regarding recolonization of habitat within the municipal watershed by anadromous fish.

SOCKEYE SALMON MONITORING

In order to protect drinking water quality, the City proposes to fund alternative mitigation for sockeye salmon in lieu of fish passage at the Landsburg Diversion Dam. After many years of discussion, analyses, and prototype testing, the interagency Cedar River Sockeye Technical and Policy Committees recommended that, as mitigation for the migration blockage at the Landsburg Dam, the City fund the construction and operation of a sockeye hatchery capable of producing 34 million fry annually and provide $1,637,000 to fund downstream habitat protection or restoration in the lower Cedar River downstream of the municipal watershed (Section 4.3). The City recognizes that, in order to fulfill the intent of the established sockeye mitigation goals for the hatchery, facility operators must have the resources to evaluate the number, condition, and performance of fry released from the hatchery. In addition, the fry production program must be managed in a manner that avoids or minimizes the risk of potential negative impacts to naturally reproducing sockeye populations and populations of other salmonids. Therefore, the City proposes to support a 50-year monitoring program at a total cost of $3,473,000 to ensure that program objectives are being met and to avoid potential negative effects on naturally reproducing sockeye and other salmonids.

The sockeye monitoring program (Table 4.5-1) has been designed to address the following key questions:

(1) Are sockeye fry released from the hatchery similar to naturally produced sockeye fry in the Cedar River?

- Are hatchery-produced sockeye fry developmentally, morphologically, and behaviorally similar to naturally produced sockeye fry?
- Is the development rate and emergence timing of incubating hatchery-produced fry similar to naturally produced fry?
- Do hatchery-produced sockeye fry survive to adulthood at same rate as naturally produced sockeye?
- What is the effect of short-term rearing (up to 2 weeks) on the condition and performance of hatchery-produced fry?

(2) Are returning adult sockeye originating from the hatchery similar to naturally produced adult sockeye?

- Are morphological and behavioral characteristics (such as age at return, adult body size, run timing, and spawning distribution) of adult fish originating from the hatchery different from naturally produced fish in the Cedar River?
- Can the molecular genetic attributes of hatchery-produced sockeye be distinguished from those of naturally produced Cedar River sockeye?

- Is the overall reproductive fitness of the Cedar River sockeye population changing over time as a result of the program?

(3) Is the program detrimental to sockeye in the north Lake Washington tributaries?

- Is the program increasing the rate at which adult Cedar River sockeye stray into the north Lake Washington tributaries? If so, is it significantly impacting the genetic character and diversity of the population as a whole?

- Are the molecular and phenotypic characteristics of the north Lake Washington sockeye population changing over time as a result of the program?

- If straying is a problem, are there ways to minimize the straying of adult sockeye originating from the hatchery?

(4) Is the carrying capacity of Lake Washington sufficient to support the proposed supplemental sockeye fry production, and what is the most appropriate manner and time of year to release supplemental fry into the system?

- What are the suitable zooplankton food sources available to sockeye fry in the lake and how does this change during the year?

- Is the abundance and temporal distribution of the zooplankton forage base in Lake Washington sufficient to support supplemental sockeye fry production?

- How does the abundance of the zooplankton forage base for sockeye fry vary during the course of the year and from year to year?

- How much food do juvenile sockeye require at different times of the year?

(5) Do the hatchery-produced fry pose a significant health risk to naturally reproducing salmonids?

The quality and condition of newly emerged hatchery fry will be evaluated every year during the operation of the long-term facility. In an effort to implement a comprehensive monitoring program that will provide meaningful long-term information and provide support for ongoing program refinement for the duration of the HCP, the remainder of the sockeye monitoring program has been subdivided into three time intervals: initial period (HCP years 1-12), intermediate period (HCP years 24-31), and final period (HCP years 42-49). Each of the three monitoring intervals is further subdivided into two phases as follows:

Phase 1: Fry marking, mark evaluation, enumeration, and in-lake forage condition assessment; and

Phase 2: Evaluation of survival, behavior, and phenotypic and molecular genetic characteristics of marked fish when they return as adults.

Table 4.5-1. Summary of the sockeye salmon monitoring program.

ELEMENT	HCP YEARS	ANNUAL AMOUNT	TOTAL AMOUNT
PHASE 1 ACTIVITIES:			
Fry condition at release	5-50	$2,000	$92,000
Fry marking and mark evaluation	1-8, 24-27, 42-45	$20,000	$320,000
Wild and supplemental fry trapping/counting	1-8, 24-27, 42-45	$35,000	$560,000
Fish health	5-12, 24-27, 42-45 13-23, 28-41, 46-50	$20,000 $10,000	$620,000
Short-term fry rearing	1 2-4	$35,000 $10,000	$65,000
Plankton abundance, distribution, periodicity	1-4, 24-27, 42-45 5-12	$40,000 $7,000	$536,000
PHASE 2 ACTIVITIES			
Adult survival, distribution, and homing	1-12, 28-31, 46-49	$40,000	$800,000
Genetic analyses	1-4, 9-12, 28-31, 46-49	$30,000	$480,000
TOTAL			**$3,473,000**

MONITORING THE CONDITION OF NEWLY EMERGED SUPPLEMENTAL SOCKEYE FRY

As part of the compliance monitoring to ensure that supplemental fry are equivalent in quality to wild fry from the Cedar River, the City will provide up to $2,000 per year in HCP years 5-50 to measure fry condition factor, developmental stage, and other appropriate parameters to assess the relative physiological status of fry released from the hatchery.

Results from the prototype sockeye hatchery suggest that the hatchery-produced fry tend to emerge and outmigrate to Lake Washington slightly earlier than naturally produced fry (Seilor and Kishimoto 1997). It has been hypothesized that, by rearing artificially produced sockeye fry for a short period of approximately 2 weeks, operators will more closely simulate the condition and timing of naturally produced fry emerging from the Cedar River and will therefore enable hatchery fry to perform and behave in a manner more similar to naturally produced fry. To test this hypothesis, the City will provide up to an additional $65,000 during a selected 4-year period between HCP years 1 and 8 to short-term rear specially marked sample groups of fry for approximately 7-14 days prior to release into the system.

Phase 1: Monitoring Sockeye Fry and Juveniles, and the Lake Washington Forage Conditions

Fry Marking and Mark Evaluation

To monitor the performance of supplemental fry and their behavior after release, and to support the collection of general life history information on Lake Washington sockeye salmon, the City will provide up to $320,000 to support otolith banding or other appropriate means of marking all, or a significant portion of, the fry released from the proposed hatchery. These funds will also support the evaluation of the success of the marking protocol by examining the otoliths of a representative sample of fry from each mark group collected prior to release. Funds will be provided at a rate of $20,000 per year in HCP years 1-8, 24-27, and 42-45 (Table 4.5-1).

Naturally Produced and Supplemental Fry Trapping and Counting

An accurate estimation of the number of hatchery-produced and naturally produced fry is important in assessing the relative performance of each group. Hatchery inventories can provide an accurate assessment of the number of hatchery fish released into the system, but an intensive fry trapping program at the mouth of the river is required to obtain an accurate estimate of the number of naturally produced fry that migrate from the system each year. These estimates will provide the basis for estimating a number of important parameters for naturally reproducing sockeye including: incubation survival; total fry production; the timing of fry emergence and migration; and in-lake, fry-to-smolt survival. The City will provide up to $560,000 to partially fund the ongoing sockeye fry trapping and enumeration program at the mouth of the Cedar River. Results from this program provide important information on naturally produced and hatchery fry recruitment to Lake Washington, naturally produced fry emergence timing, and naturally produced sockeye reproductive success. Funds will be provided at a rate of $35,000 per year in HCP years 1-8, 24-27, and 42-45 (Table 4.5-1).

Fish-Health Monitoring

Because of the presence of the viral fish pathogen, IHNV, in all populations of sockeye salmon, vigilant fish culture protocol and reinforced fish-health monitoring are essential for a successful sockeye supplementation program. To help ensure the success of the supplementation program and effectively manage the risks associated with the IHN virus, the City will provide a total of up to $620,000 in HCP years 5-50 for an enhanced fish-health monitoring program for Cedar River sockeye salmon.

Lake Washington Plankton Studies

Juvenile sockeye rear in the offshore areas of Lake Washington for 1 year prior to migrating to the ocean. During this time, they are actively feeding and growing at a rapid rate. Lake Washington is generally more productive than most lakes that support sockeye. In addition, the sockeye smolts that leave Lake Washington are among the largest sockeye smolts in the world. Nevertheless, the ability of Lake Washington to support juvenile sockeye is finite. It is not presently clear what sockeye stocking rate the lake can support. However, recent information suggests that, in years of high juvenile sockeye abundance and low plankton abundance, food supplies may limit sockeye growth and/or survival for short periods during the winter months.

In order to gain a better understanding of the capabilities of the lake to support large numbers of juvenile sockeye and to better understand the within-year and between-year dynamics of the zooplankton forage base, the City will provide up to $536,000 to the University of Washington to support a study program that will monitor zooplankton composition, abundance, and distribution in Lake Washington. This will provide information on the trophic factors that control the growth and survival of juvenile sockeye salmon in the lake and will help improve our understanding of the lake's carrying capacity. The program will also provide information that will help guide the timing of fry releases from the hatchery. Up to $40,000 per year will be made available in HCP years 1-4, 24-27, and 42-54 (Table 4.5-1).

Results from the initial 4-year investigation will be used to design and implement a smaller, real-time spring plankton monitoring program that will be used to determine the most appropriate time to release supplemental fry each spring. This more narrowly focused monitoring program will be conducted in HCP years 5-12 at a cost of up to $7,000 per year (Table 4.5-1).

Phase 2: Monitoring Survival and Characteristics of Returning Adult Sockeye

Adult Survival and Distribution Studies

The purpose of these investigations is to measure the fry-to-adult survival of the hatchery-produced fish, to monitor their spawning distribution in the lower Cedar River, and to assess the rate at which supplemental fish might stray into the Bear Creek system. Data from these studies will be used to evaluate and modify fry release strategies and other appropriate aspects of the supplementation program to improve performance and minimize the risks of deleterious effects on sockeye reproducing in the wild. These studies would be conducted during HCP years 1-12, 28-31, and 46-49 and may cost up to $40,000 per year to fund the following: (1) a two-person survey crew to collect otolith samples from spawned carcasses in the Cedar River and Bear Creek; and (2) processing of the otoliths collected by the survey crew and from the hatchery broodstock (Table 4.5-1).

Phenotypic and Molecular Genetic Study of Wild and Supplemental Fish

The City will provide up to $30,000 per year to the University of Washington in HCP years 1-4, 9-12, 28-31, and 46-49 to characterize and monitor changes in phenotypic and molecular genetic traits in Lake Washington sockeye salmon populations in the Cedar River and north Lake Washington tributaries.

Minimizing Impacts of Sockeye Broodstock Collection

As described in detail in Section 4.3.2, beginning in HCP year 1, the City will provide up to $200,000 to evaluate alternative broodstock collection methodologies, analyze the potential effects of these methodologies, and develop solutions that will avoid and minimize potential negative impacts on naturally reproducing fish, while effectively capturing sufficient sockeye broodstock to meet program goals. Additional considerations in the selection of broodstock collection facilities will be to minimize, insofar as possible, impacts on nutrient and substrate movement within the river and the risk of loss or damage to broodstock collection facilities or equipment during floods.

INTERIM STEELHEAD, CHINOOK, AND COHO SUPPLEMENTATION AND/OR MONITORING AND RESTORATION STUDIES

Prior to the construction of fish passage facilities at Landsburg Diversion Dam, the City proposes to implement interim restoration measures for steelhead, chinook, and coho. The purpose of these efforts is to gather needed life history and genetic information that will aid in developing recovery plans and/or to artificially supplement one or more of the populations if needed (see Section 4.3.2), or to use funds for other interim measures as agreed by the parties to the Landsburg Mitigation Agreement (Appendix 28).

Assuming that the City of Seattle funds an interim supplementation program for steelhead, chinook, and coho, the City will capture, culture, and produce the fish and then monitor the health and vigor of non-wild progeny prior to release. The City will do this monitoring by recording the length, weight, condition factor, color, and other pertinent morphological characteristics of the fish. If the City does not fund a supplementation program, the City instead will fund restoration studies for the three species. Examples of restoration studies would be life history, genetic investigations, or demographic studies. The City will fund: (1) fish production and monitoring; or (2) restoration studies, or both, up to a total cost of $540,000 for HCP years 1-6. For more details on these programs, see Section 4.3.2.

CEDAR RIVER STEELHEAD REDD AND INCUBATION MONITORING

See "Instream Flow Monitoring," Section 4.5.2 above.

4.5.4 Watershed Aquatic Monitoring and Research

BACKGROUND

A program of aquatic monitoring and research in the municipal watershed is essential to assess the impact of the management activities and conservation strategies implemented by this HCP. Assessments of stream and riparian conditions will be used to provide feedback on whether the objectives of the Watershed Management Mitigation and Conservation Strategies (Section 4.2.2) for the Aquatic and Riparian Ecosystem are being met. The condition of the aquatic and riparian ecosystem is a key index of the overall condition of the watershed, because aquatic and riparian ecosystem functions are influenced by activities that occur throughout the landscape, including management of forests and roads, watershed restoration projects, and water management activities.

The Watershed Aquatic Monitoring and Research program contains elements specific to compliance and effectiveness monitoring, as well as specific research elements designed to improve understanding of ecological conditions and processes within the watershed. These elements are discussed below.

SHORT-TERM EXPERIMENTAL WATERSHED STREAM MONITORING AND RESEARCH PROGRAM

The City recently completed an experimental stream monitoring pilot program (Section 3.3.6). The goals of the program were to collect and analyze information on the condition of a broad range of streams in the watershed, and to use this information to develop a long-term stream-monitoring program. The objectives of the pilot study were to assess the condition of streams, determine possible explanations for their current condition, and to predict future trends. The study design involved three main components. These components include data on: (1) hydrology; (2) water quality; and (3) benthic macroinvertebrate communities. In order to collect this information, the City set up a total of 88 sampling sites. These included 30 stream flow monitoring stations, 7 channel-stability monitoring stations, 12 water quality monitoring stations, and 46 benthic macroinvertebrate monitoring stations. The pilot study was completed in 1999.

As part of the short-term experimental program described above, the use of benthic macroinvertebrate data as a monitoring tool is being evaluated through the development and use of a calibrated Benthic Index of Biological Integrity (BIBI) (Kerans and Karr 1994; Karr and Kerans 1992; Karr et al. 1986). The objective of a BIBI is to attempt to use the macroinvertebrate community and its structure as indicators and reflectors of natural and anthropogenic disturbances in the environment. Most BIBI work in the Pacific Northwest has been conducted on low-elevation streams. In those streams, the BIBI has been demonstrated to be a useful measure of overall stream health (Kleindl 1995). Because streams in the municipal watershed traverse a wide range of elevations, a BIBI is being custom-built specifically for the Cedar River Watershed based on the macroinvertebrate data collected in the experimental program. If it is determined that a Cedar River-specific BIBI can be a useful monitoring tool for the watershed, implementation of a long-term BIBI monitoring study will be considered as part of the long-term stream monitoring program in the HCP (see below).

Because the short-term stream monitoring and research pilot program was relatively successful, the City will consider using the results to assess the applicability of specific monitoring techniques, with appropriate modifications, for long-term monitoring, to develop a snapshot in time of baseline watershed conditions, and to provide an overview of stream conditions throughout the watershed that will help identify and prioritize sites for stream restoration efforts (Section 4.2.2). The total cost of the completed data collection and analysis was more than $280,000 (Table 4.5-7). The Short-term Experimental Watershed Stream Monitoring and Research Program is detailed in Section 3.3.6.

LONG-TERM STREAM AND RIPARIAN MONITORING AND RESEARCH PROGRAM

A long-term stream and riparian monitoring and research program will be implemented to measure the overall ecological response of the watershed to HCP management activities. Long-term monitoring is critical to provide the temporal context needed for adaptive management (Bisson 1996). This program will monitor stream health, document recovery from past water supply and land management operations, and evaluate the success of stream habitat restoration projects, as well as helping to identify any impacts of the City's operations on stream ecosystems during the term of the HCP.

Three long-term, integrated monitoring studies have been developed that may be used to provide an account of how stream ecosystems in the watershed respond to various management components of the HCP. These studies include measurements of stream temperature, channel morphology and stream habitat, and biotic integrity over a period of many years during the HCP. The results of the short-term experimental stream monitoring and research pilot program described above will be used to fine-tune or revise as necessary the long-term stream and riparian monitoring and research program.

The long-term stream and riparian monitoring and research program will implement studies to measure ecologically significant attributes that are affected by watershed activities. Stream temperature is an important attribute to track because altered thermal regimes can affect fish survival, growth, metabolism, reproduction, behavior, competition, and predation (McCullough, in preparation). Similarly, monitoring stream channel morphology is critical because alteration of stream channel structure is one of the most profound changes in habitat that can be associated with past and current forest practices (Gregory and Bisson 1997). Channel structure may be affected by sedimentation, mass failure, changes in rooting and vegetative cover, changes in hydrologic regime, and loss of in-channel wood (Cedarholm et al. 1981; Chamberlain et al. 1991). Stream habitat surveys are a useful tool for tracking changes in the condition of a stream and its suitability for fish. For example, a study in western Washington documented significant changes in pool habitat and amounts of large wood in streams draining old-growth forests, forests with moderate harvest (< 50 percent harvested within the last 40 years), and forests with intensive harvest (> 50 percent harvested within the last 40 years) (Ralph et al. 1994). Pool areas and depths were significantly greater in streams in old-growth forests than in harvested basins, and pools > 1 meter in depth were almost eliminated in harvested basins. The study also showed that a reduction in the abundance of large pieces of wood was also related to past logging. Finally, it has been clearly demonstrated that macroinvertebrate community assemblages can provide a biological index that is sensitive to both natural disturbances and many kinds of human-caused disturbances in the environment (Kerans and Karr 1994).

Although the stream temperature study, the channel stability and stream habitat study, and the BIBI study each focuses on measuring specific attributes at specific locations, the interpretation of collected data will concentrate on analyzing how these attributes contribute to ecological processes throughout the watershed. Additionally, the watershed-wide spatial design of the long-term monitoring program will provide baseline data necessary for evaluating future changes caused by modifications of management activities.

The City will conduct long-term stream and riparian monitoring studies that may include the following specific studies or other studies with similar objectives:

(1) A stream temperature study may be conducted to measure water temperatures in up to 10 stream segments per year during the period July 15 to September 15. Temperature studies will be conducted in HCP years 4, 5, 6, and 7. Additional temperature studies may be considered after HCP year 7, if the study indicates additional monitoring would be appropriate.

(2) A channel stability and stream habitat study may be conducted to assess up to 10 stream segments per year for HCP years 4, 7, 10, 15, 20, and 25. Stream channel characteristics (MacDonald et al. 1991) and various measures of ecological

response will be used. The data may be collected concurrently or as appropriate. Surveys may include the following:

- Establishment of permanent response survey reaches with lengths approximately 20 - 30 times the channel widths;
- Measurement of cross-sectional and longitudinal channel profiles with width and depth measurements at regular intervals;
- Determination of substrate composition by methods such as the Wolman pebble count (Wolman 1954) or other similar methods;
- Counts, volumes, and channel influence of large woody debris;
- Assessment of instream habitat features, such as pools and riffles;
- Documentation of general riparian vegetation community structure and size composition; and
- Establishment of permanent photographic record points to document changes over time.

(3) A BIBI study may be conducted that will rely on benthic macroinvertebrate sampling from up to 10 locations per year. Initiation of this study is dependent on the successful development of an index specific to the Cedar River Watershed as discussed in the above section. If a useful BIBI is developed, BIBI sampling will be conducted in HCP years 4-8, 10, 12, 15, 20, 25, 30, 40, and 50. Sampling may be terminated earlier if results do not warrant continuation, in which case another approach would be developed.

Other long-term monitoring studies may be considered if it is demonstrated that alternative study designs or measurements of other attributes are needed to evaluate long-term changes in ecosystem functioning. The importance and purpose of this flexibility, which is built in to the long-term monitoring and research program, is discussed in Section 4.5.7 (Adaptive Management). HCP years 1-3 will be used to plan the long-term monitoring program based, in part, on the results of the short-term experimental stream monitoring and research pilot program discussed above. Results from the short-term program will help guide the use of monitoring methods appropriate for the long-term monitoring program.

The cost per year of the long-term stream monitoring and research program will be up to $50,000 per year in years of intensive data collection. In most years this would not be the case, and the cost would be proportionally less. The cost of the entire program over the term of the HCP may be up to $459,000 (Table 4.5-7).

MONITORING OF AQUATIC AND RIPARIAN PROJECTS

Monitoring will be used to track compliance with and the success of specific projects implemented through the conservation strategies for the aquatic and riparian ecosystem (Section 4.2.2. The monitoring program is designed to record the efforts and results of these conservation and mitigation measures, to assess their effectiveness in improving affected aquatic and riparian functions, and to provide information for adaptive management and project modification. In general, aquatic habitat restoration programs are excellent candidates for adaptive management (Bisson 1997).

The frequency and intensity of aquatic and riparian conservation project monitoring may vary over time in order to assess the long- and short-term success of projects throughout a broad range of environmental conditions. For example, observations of stream channel morphology may be scheduled to occur following completion of specific projects and after high flow events.

Specific project monitoring components may include:

- Monitoring of changes in fish distribution, relative abundance, or species composition associated with stream and riparian projects;
- Monitoring of stream channel changes in substrate composition, streambed, or streambank configuration associated with stream and riparian projects;
- Assessment of plant survival and vigor and the relative degree of streambank erosion associated with riparian revegetation, conifer under-planting, restoration thinning, and bank bio-stabilization projects;
- Assessment of water passage through replaced and/or upgraded culverts, and at stream crossings after culverts have been removed;
- Determination of fish migration through replaced and/or upgraded culverts, and at stream crossings after culverts have been removed; and
- Documentation of road miles constructed, improved, maintained, and deconstructed within the municipal watershed.

Other monitoring studies will be considered if it is demonstrated that alternative study designs or measurements of other attributes are needed to evaluate the success of aquatic and riparian projects.

The City will conduct and fund monitoring of aquatic and riparian projects in HCP years 4-16, 18, 20, 25, 30, 40, and 50. This monitoring program may cost up to $25,000 per year in HCP years 4-6 and up to $50,000 per year in HCP years 7-16, 18, 20, 25, 30, 40, and 50 (Table 4.5-7).

WATERSHED AQUATIC SPECIES MONITORING AND RESEARCH

Bull Trout Monitoring and Research

R2 Research Consultants (in preparation) estimated that Chester Morse Lake contains a population of at least 3,000 bull trout (Section 3.5.6). This is undoubtedly an underestimate, as it was based on hydroacoustic analysis, which is generally accepted to regularly underestimate numbers of fish near the bottom of a lake. This viable population of over 3,000 bull trout has persisted throughout the City’s continued use of the Cedar River for water supply for almost 100 years. According to a 1998 inventory published by WDFW, the status of the bull trout stock in Chester Morse Lake and its tributaries is officially classified as unknown. However, the report states that “there are no data suggesting a chronically low condition, or short term decline" in population (WDFW 1998; also see Section 3.5.6).

The primary goal of the bull trout conservation strategy is to avoid, minimize, or mitigate for any incidental take of bull trout. The objectives of the bull trout monitoring and research program are to track the relative status of the Cedar River Watershed population, to examine factors associated with its relative health and viability, and to determine the effectiveness of the bull trout conservation strategy. Adaptive management will be a key component of all aspects of the bull trout monitoring and research program, and funds can be shifted among elements of the bull trout investigations, as needed. Additional studies concerning monitoring and research of bull trout are discussed in the subsection entitled "Environmental Evaluation of the Cedar Permanent Dead Storage Project" contained in Section 4.5.6.

Bull Trout Surveys and Relative Population Indices

A variety of methods have been used to monitor bull trout populations (Bonar et al. 1997). Range and distribution of this species have been examined using general stream fisheries survey methodologies, such as angling and streamside foot surveys (Johnson and Schrier 1989), electrofishing (Fraley and Shepard 1989; Schill 1991; Rieman and McIntyre 1995), and snorkeling (Hillman and Platts 1993; Bonneau et al. 1995; Rieman and McIntyre1995). Bull trout abundance has been determined using redd counts (Fraley and Shepard 1989; Brown 1992), trap counts (Fraley and Shepard 1989), snorkeling counts (Goetz 1991; Sexauer and James 1993), creel surveys (Fraley and Shepard 1989), and mark and recapture estimates (Faler 1995).

In order to monitor the health and viability of the Cedar River bull trout stock, the City will use a variety of survey methods to attempt to establish several relative population indices for bull trout. No one survey method or index is likely to be adequate by itself. But by using several survey methods in combination, the City hopes to obtain a more realistic assessment of the bull trout population than would otherwise be possible or practical. The types, frequencies, locations, and intensities of surveys may vary from year to year depending on results and environmental conditions.

Adult Surveys

Experimental Fish Weir and Live-Box Trap Counts

Traps are generally regarded as the most accurate technique available for enumerating the escapement of migrating fish (Cousens et al. 1982). However, traps are quite labor intensive and require constant maintenance (Bonar et al. 1997).

The City will design, construct, install, and operate an experimental fish weir and live-box trap on the upper Cedar River above Chester Morse Lake. The objectives of this project are to:

- Determine relative abundance of the Chester Morse Lake bull trout population over time;
- Determine migration timing;
- Determine the length, weight, and condition factor of the migrating bull trout; and

- If feasible, develop an index ratio of the number of adult upstream migrants trapped to the number of bull trout redds observed (see subsection entitled "Spawning Surveys" below). This index would be applied to the Rex River and other selected tributary streams on which spawning surveys will be conducted, but in which live trapping will not be employed.

Seasonal operation of the weir will be attempted annually during HCP years 1- 4. The feasibility and need for operation during additional years will be evaluated based on results from years 1- 4. If high flows or other negative factors make the operation of the weir impractical, the City will substitute other relative measures of the population's health and viability.

Experimental fish weir design, construction, installation, and operation over 4 years may cost up to $200,000. Continued operation in HCP years 5, 6, 10, 15, 20, and 30 is estimated to cost $25,000 per year (Table 4.5-7). If the Cedar Permanent Dead Storage Project (contained in Section 4.5.6) is implemented, the weir or alternative measures may be employed to monitor the project's impact on the bull trout population.

Spawning Surveys

In a recent comprehensive survey report comparing different techniques for sampling the distribution and abundance of bull trout/Dolly Varden, Bonar et al. (1997) state that redd surveys are one of the preferred methods (along with traps) for estimating adult abundance and escapement. The authors conclude that spawning redd surveys are suitable for both migrating and resident populations, while traps are best restricted to monitoring migrating fish.

The City will conduct bull trout spawning surveys in selected tributaries of Chester Morse Lake. The surveys will be performed annually in HCP years 1-8 and may cost up to $35,000 per year (Table 4.5-7). The frequency, location, and intensity of surveys may vary from year to year, depending on the previous years' results and the success and results from other survey methods, as well as prevailing environmental conditions.

Other Adult Surveys

Other adult survey methods might include day or night snorkel surveys, hydroacoustic surveys of staged adults, or other methods.

Juvenile and Emergent Fry Studies

A serious loss to a year class at the juvenile or fry life stages might not be discovered with an adult-only bull trout monitoring study until several years after the occurrence. Therefore, juvenile and fry surveys will be conducted in selected tributary streams. Alternative survey methods that may be implemented include: outmigrant netting, screw traps, minnow traps, electrofishing, day and night snorkeling, night spotlighting, and daylight counts timed to coincide with emergence. The surveys will be performed annually in HCP years 1-8 and may cost up to $35,000 per year (Table 4.5-7).

Bull Trout Distribution Studies

Telemetry Studies

There is an apparent discrepancy between the number of bull trout redds actually counted in the Cedar River Municipal Watershed and the number that might be expected based on the population estimate for the Chester Morse/Masonry Pool Reservoir complex (Section 3.5.6). The actual number of bull trout redds counted per year in the watershed has ranged from 6 to 109 (all known spawning areas were not surveyed in every year). By proportionally comparing the Chester Morse population with the population in Flathead Lake, Montana, between 184 and 334 redds might have been expected in the Cedar River Watershed. It should be noted, however, that the population in Flathead Lake is fished, whereas the population in Chester Morse Lake is not fished and, thus, is likely to include a larger fraction of post-reproductive adults or adults with declining reproductive rates. Radio tagging has been successfully used to track adult bull trout to previously unknown spawning areas in Oregon (Thiesfield, S., Oregon Department of Fish and Wildlife, 1997, personal communication).

The City will design a study to tag and radio track bull trout in Chester Morse Lake tributary streams to refine the understanding of spatial and temporal habitat use patterns. This 2-year study will be initiated within HCP years 2-7. The cost of this study may be up to $60,000 per year (Table 4.5-7).

While it is unknown if bull trout spawn along the shores of Chester Morse Lake, lake spawning is known to sustain the population of at least one bull trout stock in Washington State (Middle Hidden Lake, Okanogan County) and possibly one other (First Hidden Lake, Okanogan County) (WDFW 1997a). The City may tag and acoustically track adult bull trout in the Chester Morse Lake to learn if they might be spawning at selected locations in the reservoir. The cost of this study may be up to $70,000 (Table 4.5-7) and may be initiated within HCP years 3-9.

Fish Distribution Surveys

Although it is possible that bull trout with a resident life history strategy exist in the municipal watershed, ongoing studies have not provided clear evidence to confirm the existence of fluvial bull trout. Nevertheless, as it has been doing for the past several years, the City will continue its qualitative surveys of unsampled streams to further document bull trout distribution. Survey methods may include day or night snorkeling, angling, minnow traps, redd surveys, outmigrant netting, electrofishing, night spotlighting, and daylight counts timed to coincide with emergence. Fish distribution surveys will not be conducted every year, but they will be performed periodically up to five times during HCP years 1-20. The cost of these surveys may be up to $12,000 per year (Table 4.5-7), and the total cost for all surveys may be up to $60,000.

Bull Trout Redd Inundation and Egg Mortality Study

Bull trout construct redds and spawn every fall in the lower reaches of the Rex and Cedar rivers above Chester Morse Lake. In most years, rising reservoir levels inundate some of these redds (Section 3.5.6). The City assumes, although this has not been demonstrated, that this inundation and the change from a running-water to a lacustrine environment, may kill a large fraction of the developing eggs or alevins in the inundated redds.

The actual level of mortality caused by inundation of redds in the lower Rex and Cedar rivers is not known. It is somewhat puzzling that such a high percentage of Rex River bull trout redds is built at elevations that have been annually inundated by Chester Morse Lake for almost 85 years. Severe mortality to eggs and alevins usually would be expected to exert a strong selective pressure against those bull trout spawning in the annually inundated stream reaches. Inundation of salmonid redds is known to cause mortality in some reservoirs (Seattle City Light 1989). In Chester Morse Lake, one hypothesis is that the degree of impact is somewhat reduced by water upwelling through the spawning gravels in the inundated stream reaches. Upwelling in spawning gravels serves to aerate eggs and alevins and remove metabolic wastes. It is not known whether upwelling actually occurs in bull trout spawning areas in the lower Cedar or Rex rivers. The fact that regular inundation has been occurring for many decades in much of the area in which bull trout spawn, however, suggests that there has been relatively little selection exerted on bull trout to avoid these areas. Furthermore, even if a high degree of mortality from inundation does occur, it is probable that the limiting life stage for bull trout in the watershed is not spawning and egg incubation (especially in the lower reaches of the tributaries) but is juvenile rearing.

The City believes that the substantial measures in this HCP for the protection of bull trout and bull trout habitat, the implementation of an extensive monitoring and research program, and the incorporation of an adaptive management approach are sufficient mitigation for any current or future (during the term of the HCP) potential negative impacts of the City's operations on bull trout, including lethal redd inundation in tributary spawning streams. Nevertheless, as part of the City's effort to learn more about bull trout ecology in the Cedar River Watershed, the City will conduct a study of bull trout egg mortality that results from redd inundation. Redd caps will be placed over bull trout redds in stream reaches that are above and below the zone of reservoir inundation. The percentage of alevins emerging will be monitored. Alternatively, ripe adults will be captured at the experimental fish weir discussed above, and eggs and sperm will be taken from them. Fertilized eggs will be buried in experimental incubation boxes above and below the zone of eventual redd inundation. The egg boxes will be monitored to determine embryo development. This study will be conducted in one or more years during HCP years 1-9 and may cost up to $55,000 per year (Table 4.5-7).

Common Loon Monitoring

All common loon nesting habitat currently identified within the municipal watershed is located at the margins of Chester Morse Lake and the Masonry Pool and is vulnerable to the effects of fluctuating reservoir levels (Section 3.5.5). Common loons typically nest at the shore or waterline, or on emergent surfaces such as logs. The common loon nests and eggs in this habitat are vulnerable to both inundation and stranding from relatively small water level changes.

In natural systems, loons can compensate for small changes in water levels, but the range of water levels on Chester Morse Lake during common loon nesting season is typically as much as 10 ft in most years, but can be substantially greater in some years (see Figure 4.5-1 in Section 4.5.6). Fluctuations such as these may have significant adverse impacts on loon reproductive success. Future reservoir water levels will be modeled during the loon nesting season under both the new HCP instream flow regime and under a potential flow regime for the Cedar Permanent Dead Storage Project. The physical effects of these two operational scenarios will be evaluated to determine their potential effects on nesting loons (Section 4.5.6).

The monitoring and research described in section 4.5.6 will be used to determine if the conservation strategy for the common loon achieves its conservation objectives. The information collected will also be used to support the adaptive management program (section 4.5.7), which is designed to provide a means by which mitigation and conservation strategies can be altered to better meet conservation objectives.

The City intends to continue to investigate the ecology of common loons within the municipal watershed on a long-term basis, including the deployment of experimental nest platforms, with particular focus on the reservoir complex. This intensive program has typically included the annual deployment of one or more experimental nest platforms within each of the territories of the three loon pairs currently using the reservoir complex during the breeding and nesting seasons. The 10-year ecological investigation has indicated, however, that deployment of experimental nest platforms may not be needed or even appropriate in some years, or may not be warranted for particular territories within any given year. For example, if reservoir elevations were very low for an extended period of time during the nest establishment and mating seasons, platforms would have to be deployed far from the shoreline, in open water away from protective cover, and would therefore be exposed to excessive wind and wave action. If loons were induced to utilize experimental nest platforms in such precarious environmental conditions, vulnerability of nests to exposure and predation would be increased substantially, and unwarranted, detrimental effects on reproductive success (e.g., nest abandonment, platform destruction) would likely result in nearly all cases.

The City will evaluate prevailing environmental conditions in the reservoir complex annually during the late winter early spring period, including lake elevations, habitat availability (e.g., cover), and whether or not potential breeding pairs are present within breeding territories, and in addition, examine predicted lake level elevations and track realized conditions in order to determine the advisability of deploying experimental nest platforms. If potential breeding loons are present on the reservoir complex, and environmental conditions, including projected lake elevations and operating regimes, are deemed to be conducive to allow loons to nest on platforms without unreasonable risk, then experimental nest platforms will be deployed when and where appropriate based on and in accordance with cumulative results of the ongoing ecological investigations within the municipal watershed.

Surveys of common loon nesting success on Chester Morse Lake and Masonry Pool and the deployment of experimental nest platforms, when and where warranted based on evaluation of environmental conditions and results of ecological studies as discussed above, will be conducted on an annual basis throughout the term of the HCP. The City may discontinue or modify this program as appropriate, depending on the results of monitoring and research and with approval of the Services. The cost of these surveys and experimental research and monitoring will be up to $25,000 in each HCP year interval 1-10, 11-20, 21-30, 31-40, and 41-50 (Table 4.5-7).

4.5.5 Watershed Terrestrial Monitoring and Research

BACKGROUND

The watershed management, mitigation, and conservation strategies (Section 4.2.2) are designed to protect and restore fish and wildlife habitat, especially aquatic, riparian, and late-successional and old-growth forest communities. The Species Conservation Strategies and the control of public access to the watershed (also described in Section 4.2.2) will also to protect both habitat and species that are present within the watershed. These latter strategies are focused largely on controlling disturbance and impacts to individuals and reproductive pairs.

The Watershed Terrestrial Monitoring and Research Program is designed primarily to assess the effects of management and conservation strategies on key and sensitive vegetation communities and selected, closely associated wildlife species to support adaptive management over the term of the HCP (Section 4.5.7). Secondly, the program is designed to provide accurate and updated information on both forested and non-forested habitat types present in the watershed landscape throughout the 50-year term of the HCP. Elements of this program are designed to augment the existing knowledge of habitat conditions and selected wildlife species use in the watershed by providing an integrated system of monitoring and research projects that will: (1) improve the accuracy of the data that describes baseline habitat conditions; (2) develop systematic procedures to better identify, classify, and track changing habitat conditions; (3) establish both short-term and long-term monitoring projects to support adaptive management decisions and document HCP compliance; (4) predict future trends in forest habitat development, change, and potential use by selected wildlife species; and (5) ensure that management and conservation activities do not adversely impact species of concern, particularly those that rely on late-successional and old-growth forest communities.

A major focus of the Watershed Terrestrial Monitoring and Research Program is to more accurately characterize and classify upland habitats (forested and non-forested) in the municipal watershed so that significant expected trends in habitat and landscape changes over the 50-year term of the HCP (Section 4.2.2) can be documented and tracked. These changes in the municipal watershed will likely include: (1) advancement of forest seral stages overall, with development of forest in recently harvested areas; (2) recruitment, over time, of more areas of mature and late-successional forest that progressively exhibits a greater degree of late-successional and old-growth characteristics; (3) increased overall maturity and structural complexity of forests by the end of the HCP term; (4) improved habitat quality throughout the municipal watershed for most species of concern; and (5) increased contiguity and connectivity among habitats throughout the watershed, as well as between watershed and adjacent lands.

Accurate characterization and classification of habitats is a useful tool to help monitor certain wildlife populations, because wildlife abundance and species diversity are dependent on habitat quality and availability (Irwin et al. 1989). Although the City does not intend to specifically measure wildlife populations, several Watershed Terrestrial

Monitoring and Research Program elements are designed to generally evaluate the effects of management and conservation strategies on specific at-risk species in the municipal watershed through the collection and interpretation of accurate habitat information. This is an especially useful approach for monitoring potential impacts on individuals or populations of mobile species (Irwin et al. 1989), such as species that occur on adjacent lands, on a regional basis, or migrate, and can be significantly affected by conditions and activities outside the influence of the municipal watershed. In addition to tracking the availability and general condition of specific habitats types in the watershed, the use of reproductive habitat by two species, the marbled murrelet and the northern spotted owl, will also be monitored periodically.

The intends to develop and implement a *coordinated* system of monitoring and research methods that both will support evaluation of the success of the watershed management and conservation strategies at different scales of space and time, and will substantially augment scientific knowledge of selected site-specific, habitat-specific, and species-specific attributes within the municipal watershed. The biological and ecological information gathered from coordinated sampling and data collection will provide information needed for compliance monitoring, reporting, and adaptive management. Better understanding of the relationships between species and their habitats in the watershed will be necessary for the development of useful experimental, interactive habitat and species relationship models customized to the municipal watershed. The elements of the program were designed to be integrated at an ecosystem level by providing both site-specific information on projects and landscape level information on habitats that can be used to track changes in habitat patterns over time.

The tasks included in the Terrestrial Monitoring and Research Program will be accomplished using City staff supported by other appropriate means including cooperating agency personnel, consulting firms, consultation with experts in selected fields, workshops, academic students, and input from other interested parties when appropriate.

Unless otherwise specified, it is generally intended that HCP years 1-3 will be used to design the methods and sampling plans for the individual program tasks. HCP years 5-8 will focus on experimental implementation of sampling, monitoring, and modeling programs. Full implementation of sampling, data collection, and analysis will mostly occur after HCP year 8. Some elements are designed to provide monitoring data over a longer time period, and some tasks may proceed more quickly than anticipated and certain work products may be produced sooner than expected.

The community-based watershed management, mitigation, and conservation strategies (Section 4.2.2) are designed to protect and restore fish and wildlife habitat, especially aquatic, riparian, and late-successional and old-growth forest communities. These community-based strategies are integrated in Section 4.2.2 with the Species Conservation Strategies and Controlled Public Access to the Watershed to protect both habitat and species that are present within the watershed. These latter strategies are focused largely on controlling disturbance and impacts to individuals and reproductive pairs.

The Watershed Terrestrial Monitoring and Research Program is designed primarily to assess the effects of management and conservation strategies on key and sensitive vegetation communities and selected, closely associated wildlife species. Secondly, the program is designed to provide accurate and updated information on both forested and non-forested habitat types present in the watershed landscape throughout the 50-year term of the HCP. Elements of this program are designed to augment the existing knowledge of habitat conditions and selected wildlife species use in the watershed by providing an integrated system of monitoring and research projects that will: (1) improve the accuracy of the data that describes baseline habitat conditions; (2) develop systematic procedures to better identify, classify, and track changing habitat conditions; (3) establish both short-term and long-term monitoring projects to support adaptive management decisions and document HCP compliance; (4) predict future general trends in forest habitat development, change, and potential use by selected wildlife species; and (5) ensure that management and conservation activities do not adversely impact species of concern, particularly those that rely on late-successional and old-growth forest communities.

Principle monitoring and research program elements are designed to provide high quality information that will facilitate successful achievement of the objectives of the Watershed Management Mitigation and Conservation Strategies (Section 4.2.2) through adaptive management principles. Additionally, the program will potentially establish monitoring techniques, methods, and data that will contribute pertinent environmental information that will support beneficial land management decisions both by SPU and other agencies throughout the region.

A major focus of the Watershed Terrestrial Monitoring and Research Program is also to more accurately characterize and classify upland habitats (forested and non-forested) in the municipal watershed so that significant expected trends in habitat and landscape changes over the 50-year term of the HCP can be documented and tracked. It is anticipated that a substantial amount of beneficial change will be realized in both upland and riparian forest habitats, including a more natural distribution of forested and non-forested habitats over the entire watershed landscape, as a result of implementing the integrated management and conservation strategies provided in the HCP. These changes will likely include: (1) recruitment, through natural forest maturation over time, of substantial more area of mature and late-successional forest, distributed throughout the watershed, that progressively exhibits a greater degree of late-successional and old-growth forest characteristics; (2) an increased overall maturity and structural complexity of all forest that will contribute significantly to reestablishing more naturally functioning ecosystems within the watershed by the end of the HCP term; (3) improved habitat quality throughout the municipal watershed for most species of concern; and (4) increased contiguity and connectivity among upland habitats throughout the watershed, as well as between the watershed and adjacent lands.

Accurate characterization and classification of habitats is a useful tool to help monitor certain trends in wildlife populations, because wildlife abundance and species diversity are dependent on habitat quality and availability (Irwin et al. 1989). Although the City does not intend to specifically measure wildlife populations, several Watershed Terrestrial Monitoring and Research Program elements are designed to generally evaluate the effects of management and conservation strategies on specific at-risk species in the municipal watershed through the collection and interpretation of accurate habitat information. This is an especially useful approach for monitoring potential impacts on individuals or populations of mobile species (Irwin et al. 1989), such as species that occur on adjacent lands, on a regional basis, or that migrate, and can be significantly affected by, conditions and activities outside the influence of the municipal watershed. In addition to tracking the availability and general condition of specific habitat types in the watershed, the use of reproductive habitat by two species, the marbled murrelet and the northern spotted owl, will also be monitored periodically.

The objectives of the Watershed Terrestrial Monitoring and Research Program are to develop and implement a coordinated system of monitoring and research methods to evaluate the success of the watershed management and conservation strategies, as well as to substantially augment scientific knowledge that can form the basis for both habitat and species management decisions within the municipal watershed. This information will be necessary for the development of basic experimental, interactive habitat and species relationship models customized to the municipal watershed. In addition, the biological and ecological information gathered from coordinated sampling and data collection will provide information needed for compliance monitoring, reporting, and adaptive management.

Although each monitoring and research element in this program is designed to provide independent information on the status and dynamics of particular resources within the watershed, the program is also designed to be integrated at an ecosystem level and landscape scale. This holistic design will be critical for the support of adaptive management decisions related to implementation of this HCP (Section 4.5.7). Because of reliance on adaptive management, most program elements are described in general terms so the adaptive management process can be used to adjust and refine sampling schemes, techniques, and management guidelines as data is gathered, analyzed, and evaluated.

The tasks included in the Terrestrial Monitoring and Research Program will be accomplished using City staff supported by other appropriate means including cooperating agency personnel, consulting firms, consultation with experts in selected fields, workshops, academic students, and input from other interested parties when appropriate.

Unless otherwise specified, it is generally intended that HCP years 1-3 will be used to design the methods, specific techniques, and sampling plans for the individual program tasks. HCP years 5-8 will focus on experimental implementation of sampling, monitoring, and modeling programs. Full implementation of sampling, data collection, and analysis will mostly occur after HCP year 8. Some elements are designed to provide monitoring data over a longer time period, and some tasks may proceed more quickly than anticipated and certain work products may be produced sooner than expected.

WATERSHED LANDSCAPE AND HABITAT RESEARCH AND MONITORING PROGRAM

In addition to refining the application of remote-sensing data as was utilized in the preparation of the HCP, several ground-based methods will continue to be used to identify and classify habitats, tabulate acreage, and depict habitats and other landscape features within the Cedar River Municipal Watershed. These methods will be used to characterize existing conditions, document future changes in habitats and communities, and evaluate the effects of watershed management and conservation strategies that are implemented through this HCP.

Each of the elements in the Watershed Landscape and Habitat Research and Monitoring Program listed below is designed to support the watershed management and conservation strategies by improving the precision and accuracy of the existing habitat classification system and associated ecological data. The tasks are integrated, basically sequential, and include measures to provide quality control for existing data as well as for the updated and refined databases throughout the term of the HCP. Specific emphasis is placed on short-term refinement of habitat information, and on long-term documentation of habitat changes and development. Additionally, specific emphasis is placed on habitat changes and development resulting from restoration activities and experimental silivicultural techniques (Section 4.2.2).

Overall objectives of the Watershed Landscape and Habitat Research and Monitoring Program are to: (1) develop an improved habitat identification system (based on structural characteristics) that can be used to more accurately classify forested and non-forested habitats over the watershed landscape; (2) provide information necessary to evaluate restoration activities and experimental silvicultural applications, especially in riparian corridors; and (3) document and track trends in the development and change in habitat structure within selected types of forest or other selected habitats. These objectives will aid in documenting HCP compliance, supporting analyses of habitat potential for threatened, endangered, and sensitive species, and guiding land use management decisions through adaptive management. The individual elements of this program are described below.

Watershed Terrestrial Habitat Inventory

An accurate inventory of habitat types (forested and non-forested) existing at any given time over the entire watershed landscape is necessary to evaluate, even qualitatively, but especially quantitatively, the potential availability of wildlife habitat for any given species or group of species. In a similar manner, an accurate inventory of both upland and riparian forest and extensive attribute data associated with those forests are necessary in order to efficiently and effectively design and conduct a program of habitat restoration. This same inventory information is also necessary to assess compliance with specific elements of the HCP (see below).

The development of habitat conservation strategies for this HCP relied on the most up-to-date habitat inventory information contained in the City's GIS and Stand Projection System (SPS) databases (Section 3.3.7). These databases were used to produce the maps, tabular data, and appropriate analyses detailing baseline habitat classification, habitat condition, and habitat protection measures. The program tasks outlined below will provide supplemental data that, over the short term, will be used to update these databases and perform analyses of projected future habitat conditions. Over the 50-year term of the HCP, this program will track landscape changes, identify trends, and assess compliance. In addition, these databases will provide input for the Forest Growth and Habitat Development Model discussed in a following subsection.

The Watershed Terrestrial Habitat Inventory is composed of the specific elements described in the following subsections.

Assessment of Expanded Forest Polygon Data

Remote sensing data were used in a GIS analysis to delineate and classify polygons with similar reflectance values, indicating relatively homogeneous attributes of tree size, tree density, and species composition over the landscape of the municipal watershed. A specific subset of these polygons was sampled in the field and *standard* forest inventory information including tree species, height, dbh, crown volume, and defect was collected; all of these variables are typically used by forest land owners to characterize forest polygons to determine appropriate silvicultural applications and to estimate timber harvest volumes. Following standard practices of analysis, this standard polygon inventory information was related to the watershed-wide forest polygon classification based on satellite imagery, then field sampling data were expanded (extrapolated) to non-sampled polygons determined to be of similar type in an analysis of the remote sensing data used to delineate and classify polygons. The accuracy of the expanded classification of non-sampled forest polygons has not been verified to date, and an assessment of accuracy is necessary in order to effectively and appropriately plan management activities relative to habitat restoration and wildlife conservation activities within the watershed under the HCP.

The City will design and conduct a sampling program to evaluate the accuracy and applicability of expanded *standard* forest polygon data (typically called stand data) presently existing in the SPS and GIS databases (Section 3.3.7). These data used in the expansion consist of *standard* forest inventory information from selected forest polygons that were sub-sampled (see above).

The purpose of the evaluation included in this element is to determine the degree of accuracy of forest polygon characterization that can be achieved by this method of data expansion, to determine the extent to which further sampling may be needed in areas previously sampled, as well as in those not yet sampled. If the expanded forest polygon data are found to inadequately characterize sampled and/or unsampled areas based on a preliminary field survey, the City will conduct a comprehensive sampling program to correct these data. The cost of this program will be up to $50,000 in HCP years 1-5 for preliminary design and evaluation, and up to $25,000 in HCP years 6-10 to modify preliminary designs and complete the comprehensive sampling effort, if necessary, for a total cost of $75,000 (Table 4.5-7).

Assessment of Expanded Secondary Forest Attribute Data

Similar to the above element, the City will design and conduct a sampling program to evaluate the accuracy and applicability of FPS/GIS expanded forest attribute data collected by the City and its consultants that are *not* typically included in standard forest stand-based inventory procedures (see above). These s*econdary attribute* data consist of measurements and/or estimates of internal forest structure that were recorded in the same forest polygons, and at the same time, that the standard data were collected, and include estimates of (1) snag density by decay class, (2) large woody debris density, (3) understory vegetation characteristics, and (4) ground-level cover of herbaceous indicator species. Such secondary attributes, combined with standard inventory data, may be of use to characterize areas of watershed forest in terms of potential wildlife habitat availability and relative quality. As with the standard forest polygon data, the secondary forest attribute data were related to the watershed-wide forest polygon classification based on satellite imagery, then sampling data were subsequently expanded (extrapolated) to non-sampled polygons determined to be of similar type in an analysis of the remote sensing data used to delineate and classify polygons (see above).

The purpose of the evaluation included in this element is to determine if the existing secondary forest attribute data (combined with the standard forest inventory data) and expansion methods are adequate to effectively characterize wildlife habitat in order to determine the extent to which further sampling may be needed in areas previously sampled and/or those not yet sampled. If a preliminary field survey indicates that these expanded secondary forest attribute data are inadequate to characterize forest habitat in areas previously sampled and/or in unsampled areas, the City will design and conduct a comprehensive sampling program to correct and provide appropriate information necessary to support habitat management decisions. The cost of this program will be up to $50,000 in HCP years 1-5 for design and evaluation of the preliminary sampling effort, and up to $25,000 in HCP years 6-10 for completion of a comprehensive sampling effort, if necessary, for a total cost of $75,000 (Table 4.5-7).

Augmentation of Forest and Habitat Inventory

If, based on the evaluations of standard forest inventory data and secondary forest attribute data associated with GIS polygons as described in the two preceding elements above, the City determines that additional attributes need to be sampled or that more areas need to be sampled than can be sampled with the funding for the above two elements, the City will design and conduct an appropriate sampling program to augment existing forest and habitat inventory data for the watershed. The cost of this program will be up to $75,000 in HCP years 1-5 (Table 4.5-7).

Ecological Old Growth Classification

The City will design and conduct a sampling program to assess existing old-growth and late-successional forests within the Cedar River Watershed and classify these habitats on an ecological basis, extending the simple age-based classification used in developing the HCP. This new classification will not be based solely on chronological age, but will include structural attribute characteristics such as snag density, large woody debris density, and horizontal and vertical complexity. The purpose of more specifically classifying old-growth forest is to determine the relative habitat value of the remaining late-successional and old-growth forests in the watershed for both selected individual species and groups of species of concern, especially those threatened and endangered species dependent on old-growth ecosystems, such as marbled murrelets and spotted owls. The cost of this program will be up to $74,970 in HCP years 3-10 (Table 4.5-7).

Field Verification

The City will complete field verification of habitat classifications of forested and non-forested polygons in the watershed GIS that is not accomplished as part of the four program elements above. The cost of this program will be up to $56,220 in HCP years 1-5 (Table 4.5-7).

Long-term Forest and Habitat Inventory

Based on the evaluations of standard forest inventory and secondary forest attribute data, and augmentation of the forest and habitat inventory described in the elements above, the City will design and conduct a long-term program of sampling and monitoring to update the forest and habitat inventory periodically over the full term of the HCP. The cost of this program will be up to $18,750 for design in HCP years 1-5, up to $62,600 in HCP years 6-10, up to $42,500 in HCP years 11-15, up to $37,500 in HCP year interval 16-20, up to $75,000 in each HCP year intervals 21-30 and 31-40, and up to $82,500 in HCP year interval 41-50, for a total cost of $393,850 (Table 4.5-7).

WATERSHED HABITAT RESTORATION RESEARCH AND MONITORING

Although many riparian and upland forest restoration methods are derived from traditional silvicultural principles and techniques, their specific application in a wide array of restoration scenarios remains basically experimental, and long-term results have not been widely demonstrated to accomplish the ecological objectives of such methods. Therefore, it is critical that restoration projects be monitored, on both a short- and long-term time basis, to determine if the applied methods have produced the intended results. Many projects may also require modifications over time and would need to be evaluated, not merely from the biological perspective, but also from a cost-benefit perspective.

The objective of the Watershed Habitat Restoration and Monitoring Program is to provide a feedback mechanism to be used to evaluate and modify, where necessary, experimental techniques and applications (such as thinning and underplanting) that are implemented in forest as part of riparian and upland forest restoration programs in the watershed.

Riparian Restoration Structural Development

The City will design and conduct a sampling program to monitor habitat structural development and plant species composition changes, including pretreatment baseline information, in representative forest sites, and on other sites as needed, after implementation of selected riparian habitat restoration projects and application of experimental silvicultural treatments described in Section 4.2.2. The cost of this project will be up to $35,000 in HCP years 3-8 for design and initiation, and up to $75,000 in each HCP year intervals 9-15, 16-25, 26-35, 36-50, for a total cost of $335,000 (Table 4.5-7).

Upland Restoration Structural Development

The City will design and conduct a sampling program to assess pretreatment baseline information and will monitor habitat structural development and plant species composition changes in representative forests, and on other sites as needed, after implementation of selected upland habitat restoration projects and application of experimental silvicultural treatments. The cost of this program will be up to $35,000 in HCP years 3-8 to design and initiate, and up to $75,000 in each HCP year interval 9-15, 16-25, 26-35, 36-50, for a total cost of $335,000 (Table 4.5-7).

TERRESTRIAL SPECIES RESEARCH AND MONITORING PROGRAM

Recent planning guidelines for the USFWS (CFR Title 36, Vol. 2, Part 219) prescribe the use of management indicator species, selected because their population changes are believed to indicate the effects of management activities on other species. The assumption in this approach is that if habitat that is required by indicator species is provided, all other species dependent on the same limiting habitat conditions would be protected. Although the City does not intend to measure or track populations of individual species, it recognizes the value of periodic monitoring to determine the presence, or probable absence, of selected indicator species or other species of concern. In addition, the reproductive status and success of such species is also deemed to be a significant indication of the relative quality of available habitat, when such species are present.

Because northern spotted owls are considered an indicator species for other late-successional and old-growth forest dependent species, program elements designed to provide general information relative to habitat availability, habitat use, and reproductive success of this species will be established to not only monitor this species, but to also gain an understanding of habitat conditions available for other late-successional and old-growth forest dependent species in the municipal watershed. Additionally, marbled murrelets and their habitat will also be monitored, largely because this species uses forests in a unique manner.

Spotted owls and marbled murrelets were also selected for the Terrestrial Species Research and Monitoring Program because: (1) the City's HCP focuses on the protection of late-successional and old-growth forest and ecosystems within the watershed; (2) both of these avian species are presently thought to be obligates in late-successional and old-growth forest habitats; and (3) both are currently listed as threatened under the Endangered Species Act. In addition, spotted owl reproductive site centers have been documented over the past 10 years in and immediately adjacent to the watershed, thus providing a record of the species upon which to develop a long-term monitoring program and regional history.

Limited marbled murrelet activity has been recently detected in the watershed by WDFW surveys, but little is known about their local or regional status or what their specific habitat use patterns or requirements are in the watershed. This situation presents a wide variety of opportunities not only to document the present status of murrelets in the watershed but also to increase information on species ecology in the existing late-successional and old-growth habitats of the watershed and the region, as well as to gain valuable perspective on the success of habitat protection, development, and enhancement under the HCP.

The objectives of the elements in this program are to provide baseline information on the status and general distribution of selected threatened and endangered species (marbled murrelet and spotted owl) within the Cedar River Watershed, and to periodically update that information over the 50-year term of the HCP as habitat availability and potential for wildlife use change.

Northern Spotted Owl Monitoring and Research

A major component of the City's HCP is a commitment to forgo commercial timber harvest within the municipal watershed, thus effectively placing all forested land outside limited developed areas in reserve status for the 50-year term of the HCP (Section 4.2.2). This commitment will protect all watershed forest, in particular, all old-growth forest remaining in the Cedar River Watershed, all existing mature forest, all low-elevation, maturing second-growth forest, and all stream corridors. Placing virtually all watershed forest in reserve status will serve to protect existing spotted owl habitat and provide for the development of additional potential habitat in some areas of the watershed over the 50-year term of the HCP.

Spotted Owl Baseline Survey

The City will survey old-growth forest within the municipal watershed for spotted owl activity, if those areas are not actively being monitored by other agencies or interested parties (USFS, DNR, timber company), one or more years during HCP years 3-10. The City will either use an existing survey protocol (e.g., a USFWS protocol) or develop an appropriate modified protocol based on the best information available at the time of the survey and on consultation with regional experts and appropriate federal and state agency staff. The survey data collected as part of this monitoring and research program will be used, through adaptive management (Section 4.5.7), to determine if the mitigation and minimization strategies for spotted owls are achieving their conservation objectives and facilitating the adjustments needed to make the strategies better achieve their objectives. These data will also be used to ensure that active spotted owl nests and their surrounding habitat will be protected. The cost of the survey will be up to $75,000 in HCP years 3-10 (Table 4.5-7).

Spotted Owl Site Center Survey

The City will conduct, or coordinate with other agencies or interested parties to conduct, an annual survey of identified reproductive site centers for a period of 5 years after the last documented activity of spotted owls within a site. The cost of this survey will be up to $25,000 in each HCP year interval 11-20, 21-30, and 31-50, for a total cost of $75,000 (Table 4.5-7).

Marbled Murrelet Monitoring and Research

A major component of the City's HCP is a commitment to forgo commercial timber harvest within the municipal watershed, thus effectively placing all forested land outside limited developed areas in reserve status for the 50-year term of the HCP (Section 4.2.2). This commitment will protect all watershed forest, in particular, all old-growth forest remaining in the Cedar River Watershed, all existing mature forest, all low-elevation, maturing second-growth forest, and all stream corridors. Placing virtually all watershed forest in reserve status will serve to protect existing murrelet habitat in old-growth forest, and also provide for the development of additional potential habitat in many second-growth forests throughout the watershed over the 50-year term of the HCP. In addition, potential marbled murrelet habitat may currently exist within some areas of second-growth forest, especially in the lower elevations of the watershed. Because of this, the City will also evaluate the habitat potential of those second-growth stands and develop appropriate management prescriptions for those areas.

Marbled Murrelet Baseline Surveys, Old-growth Forest

The City will conduct baseline surveys for marbled murrelets in selected old-growth forest within the watershed according to established protocols during any two of HCP years 3-7. The cost of this program will be up to $75,000 in HCP years 3-7 (Table 4.5-7).

Marbled Murrelet Baseline Surveys, Second-growth Forest

Potential marbled murrelet habitat in second-growth forest stands will be evaluated by means of a multi-step assessment process based on the most current murrelet habitat evaluation criteria at the time of the initiation of the surveys, as recommended by WDFW and USFWS. The City recognizes the necessity to protect existing murrelet habitat, especially in low-elevation coniferous forest, and will initially focus habitat assessment efforts in areas deemed most likely capable of supporting use by murrelets, those areas with the most substantial potential for future development of murrelet habitat, and those areas where restoration activities (e.g., ecological thinning) may be conducted. In general, the assessment process will be based on stand attribute information such as density and distribution of large-diameter trees, and density of suitable nest platforms in large trees within forest stands.

Initially, second-growth forests will be classified according to parameters such as age, diameter class, and density of large trees. These classifications will be assigned using existing forest attribute data from GIS, SPS, or other data management systems available at the municipal watershed's headquarters. Extrapolation of measured forest attributes to unsampled areas will be field verified by subsampling. Those areas not meeting minimum attribute classification criteria for murrelets can then be eliminated from the assessment process. Areas that meet the minimum attribute criteria will be examined in the field to determine the density of suitable platforms available. Both of these steps will be based on appropriate statistical sampling designs and sampling methodologies. Depending upon the total amount of acreage necessary to be surveyed, subsampling may be used if appropriate.

At the completion of forest attribute and platform density evaluations, areas not meeting minimum criteria for either type of murrelet habitat classification will be eliminated from further assessment and will require no additional measures of protection or habitat management other than the protection conferred by reserve status. No additional surveys, evaluation, protection, or special management will be required for areas that do not meet the minimum criteria established during this assessment process, even if agency evaluation criteria and survey protocols are modified in the future, although the City may cooperate in any such surveys performed by WDFW or USFWS.

Areas of forest, or an appropriate subsample thereof, meeting minimum forest attribute and nest platform criteria for murrelets will be surveyed for marbled murrelet occupancy according to WDFW or USFWS protocols current at the initiation of the surveys. Forest found to be unoccupied by murrelets will not be required to be specially protected over and above protection in reserve status. However, at the City's discretion, unoccupied forest may be evaluated and considered on an individual basis for additional protection and special management, when appropriate.

The City will develop and implement a prioritized habitat sampling plan and conduct relevant field surveys in second-growth forests to evaluate marbled murrelet habitat potential, with emphasis on specific categories of sites as indicated above, and subsequently develop and implement a prioritized sampling plan to document occupancy within identified potential habitat in second-growth forests, during HCP years 5-8. The cost of this program will be up to $150,000 in HCP years 5-8 (Table 4.5-7).

Long-term Marbled Murrelet Surveys

If marbled murrelets have not been detected by HCP year 25 within second-growth forest in the watershed, the City will develop a prioritized sampling plan and conduct appropriate surveys in selected mature and late-successional forests within the watershed. These surveys will be conducted during HCP years 25-28 and HCP years 45-48. The cost of this program will be up to $50,000 per study period in HCP years 25-28 and 45-48, for a total cost of $100,000 (Table 4.5-7).

Experimental Marbled Murrelet Habitat Enhancement

The City will consider developing a monitoring and research program, in cooperation with the USFWS, to enhance potential marbled murrelet nesting habitat in selected second-growth within the watershed. The cost of this program will be up to $40,000 in HCP years 7-10 for development and initiation; up to $80,000 in HCP years 11-20 and $10,000 in HCP years 21-30 for habitat enhancement; up to $25,000 in HCP years 31-40 for monitoring and survey; and up to $30,000 in HCP years 45-48 for monitoring and survey, for a total cost of $185,000 (Table 4.5-7).

Optional Species Surveys and Research in Experimental and Sensitive Habitats

Specific monitoring and research programs have been described for selected terrestrial habitats, experimental treatments, and species in the sections above. Unspecified habitat conditions may develop, unexpected environmental circumstances might occur, or specific information may be lacking relative to a species of concern or other at-risk species, however, that is not addressed by monitoring and research as originally designed. The element described below serves to maintain the ability and flexibility to address such circumstances within the context of the HCP. Optional surveys and research conducted under this element may be designed and accomplished in cooperation with USFWS, other appropriate agencies, experts, and City personnel through a series of consultations and work groups.

The objective of this element is to provide a means for additional monitoring and research to help achieve the HCP objectives to avoid, minimize, or mitigate for the taking of species of concern. This program will be used to provide pertinent information on other wildlife species when necessary for compliance with the terms of the HCP. This program may also be implemented when it significantly contributes to adaptive management decisions that relate to specific aspects of the HCP.

The City will fund selected species surveys, monitoring, or research projects (the particular species or species groups and project scopes to be determined), as needed to support the efficient and successful implementation of HCP with respect to its conservation objectives. Reasons for implementation of this element may include increasing habitat quality assessments for a particular species or species group. The cost of this research will be up to $50,000 in HCP year interval 9-20, 21-35, and 36-48, for a total cost of $150,000 (Table 4.5-7).

DATA FORMATS AND GEOGRAPHIC INFORMATION SYSTEM COMPATIBILITY PROGRAM

Maintaining a well-organized and efficient system of accurate databases, integrated and compatible with the GIS, is essential to support many aspects of the HCP within the Cedar River Municipal Watershed. In addition, as indicated in this section, most of the program elements are interdependent and rely on data and analyses from several tasks in order to be fully functional and effective as management tools. Therefore, it is critical that all databases are designed, maintained, and updated by a procedure that will ensure accuracy and integration of information, including the acquisition and incorporation of pertinent information from outside sources.

The objective of this program is to provide a systematic and efficient means by which data collection formats, incorporation of data in databases, database management, and integration with modeling efforts can be designed and maintained to maximize the system's ability to support HCP-related management activities. In addition, databases should be updated with the most current and best available information whenever possible from both departmental and appropriate external sources.

For all monitoring and research programs indicated above, the City will integrate data collection formats to make them compatible with watershed GIS systems and provide for mapping and analysis capability. All data collected and incorporated into the GIS system that could support refinement and operation of the modeling efforts proposed below will be collected in a format appropriate for that purpose and compatible with all integrated processing systems to the greatest extent possible. The cost of this linkage will be up to $50,000 in HCP years 1-8 and then up to $25,000 in each HCP year interval 9-15, 16-25, 26-35, 36-50, for a total cost of $150,000 (Table 4.5-7).

FOREST GROWTH AND HABITAT DEVELOPMENT MODELING PROGRAM

Forest growth and habitat development models provide a valuable tool with which to predict and visually depict the general structural changes that are expected to take place within watershed forests over time. Typically, models have been designed to track forest succession and structural development using tree species and site characteristics under scenarios of fire or timber harvest, most often clearcutting. These models might be appropriate to characterize forest succession in a large portion of the Cedar River Watershed that has been logged over the past 100 years if specific site characteristics and environmental conditions are used in the modeling process. However, it is expected that existing models will need to be modified or new models developed to represent and predict habitat structure of forests generated from non-traditional forestry applications such as ecological thinning that may include variable tree densities, multiple species plantings, or conifer underplanting, in riparian corridors.

In addition, because wildlife respond to variations in vegetation structure and composition, an understanding of wildlife responses to changes in forest environments requires a basic knowledge of vegetation potential and changes over time (Irwin et al. 1989). Forest growth and habitat development models linked with wildlife habitat relationship models can be used to assess and predict habitat suitability and distribution for forest dwelling species over time. Therefore, development of an accurate integrated forest growth model customized to the Cedar River Municipal Watershed is important to provide the basic capability to effectively model wildlife habitat relationships (see below).

The objectives of the Forest Growth and Habitat Development Modeling Program are to develop and support a predictive model of forest growth and habitat structural development under varied condition and treatment scenarios. The goals of the program are to depict the resultant structure and distribution in both graphic and map formats for the purpose of fostering appropriate land and habitat management decisions, and to support the Species and Habitat Relationships Experimental Modeling Program discussed below. The City will evaluate applicable existing models and develop a set of forest and habitat growth models (e.g., SNAP) that include the capabilities of scheduling management activities and characterizing forest stand and wildlife habitat structural and spatial development in statistical, graphical, and visually conceptual formats. The cost of modeling will be up to $75,000 in HCP years 1-8 for design (Table 4.5-7).

SPECIES AND HABITAT RELATIONSHIPS EXPERIMENTAL MODELING PROGRAM

Computer modeling of the ecological relationships between selected wildlife species and existing, or potentially available, habitat on variable spatial and temporal scales can be an effective tool for comparing existing and expected habitat distributions over a given landscape area. Although models are necessarily based on many assumptions, the predictive capability of such comparative modeling can be effectively used in many cases as one means to evaluate various habitat conditions for wildlife. The capability both to assess existing habitat conditions and to make comparisons to potential future conditions and distributions can also provide information to support and guide land management and wildlife conservation strategies.

The effectiveness of wildlife habitat models is typically dependent on the extent of ecological knowledge available for an individual or group of wildlife species and the quality of the habitat attribute information. Therefore, in order to support the development of an effective wildlife habitat model for the Cedar River Municipal Watershed, it will be necessary to carefully plan, design, and integrate each aspect (variables measured, data types, formats, analyses, etc.) of all of the monitoring and research programs and their individual tasks described above. Coordinating environmental monitoring and research within the Cedar River Municipal Watershed in this manner will ensure that the information generated and the knowledge gained can be integrated into and can effectively support both the ongoing development and functional refinement of this Species and Habitat Relationship Experimental Model.

The objective of the Species and Habitat Relationship Experimental Modeling Program is to develop an effective model that can predict and test the potential effects of different habitat management scenarios on selected individual species or species groups within the landscape of the Cedar River Watershed. The management scenarios will be specifically customized to both existing and projected future potential habitat distribution and relative quality within the Cedar River Municipal Watershed.

The City will evaluate selected existing species and habitat relationship models for appropriateness of application to the landscape of the Cedar River Municipal Watershed. The City will incorporate appropriate existing models or develop a separate interactive and predictive wildlife species and habitat relationship model that can link with the existing watershed GIS system. This model will also be developed to have the capability to depict forest and wildlife habitat structure customized for use in the Cedar River Municipal Watershed. This may be accomplished in cooperation with appropriate agencies, experts, and City personnel through a series of consultations, workshops, and work groups. The cost of this modeling will be up to $100,000 in HCP years 1-5 for evaluation and design; up to $50,000 in HCP years 6-10 for development; and up $25,000 in HCP years 11-50 for maintenance, for a total cost of $175,000 (Table 4.5-7).

TERRESTRIAL HABITATS AND SPECIES COMPLIANCE MONITORING

The development and continued refinement of a coordinated system of sampling methodologies and data collection for terrestrial habitats and species, combined with customized GIS capability and integrated forest stand management models (e.g., FPS or SNAP), as described above, will provide a systematic means by which to track the effectiveness of specific management prescriptions (e.g., ecological thinning, riparian and upland habitat rehabilitation, and underplanting), natural habitat changes, and ecological relationships of selected species. This coordinated system of information management will contribute, in large part, to the City's ability to provide an assessment of compliance with the terms of the Habitat Conservation Plan.

The City will provide the following types of information, based on the most reliable sources available at the time of reporting, to evaluate compliance with all related terms of the HCP agreement applicable to management and conservation strategies of terrestrial habitats (forested and non-forested):

(1) Maps and appropriate tabular data for all forest restoration activities (acreage of each type of forest restoration activity by year, location, before and after density of any thinning, species planting densities, and other pertinent data).

(2) Tabular data (leave tree density, distribution) and appropriate diagrams representing adherence to management prescriptions associated with restoration and ecological thinning in upland and riparian areas.

(3) Maps and appropriate tabular data (location, acreage, species, etc.) indicating any necessary tree removals in riparian forest and within 200 ft of Special Habitats or in cases where reproductive pairs of covered species are potentially affected (Section 4.2.2).

(4) Maps and appropriate tabular data (location, acreage) documenting habitat classification as habitat units (polygons) are reclassified and remapped after field verification. This would also include new, unmapped habitat units (forested or small wetlands, caves, rock features, etc.) that are identified during the course of ongoing management activities or systematic surveys.

(5) Maps and appropriate tabular data (location, acreage) documenting habitat classification changes as a result of natural and human-caused catastrophic events such as fire, windthrow, or disease.

(6) Maps, tabular data, and relative modeling analyses on an appropriate periodic basis documenting habitat protection, habitat change, and habitat availability over time for species covered by this HCP.

(7) Maps and appropriate supporting information and justification documenting boundary and acreage revisions.

(8) Maps, appropriate tabular data (location, miles, prescription), and brief written summaries documenting road construction, maintenance, and decommissioning activities.

(9) Written and tabular summaries of wildlife surveys and research project results that provide information pertinent to the protection and management of terrestrial species of concern within the Cedar River Watershed (spotted owls, marbled murrelets, and other species that have disturbance restrictions).

4.5.6 Future Reservoir Management

BACKGROUND AND HISTORY

Potential benefits exist for augmentation of both stream flows and water supply through the development of permanent, non-emergency access to water stored below the natural gravity outlet of Chester Morse Lake. The natural lake outlet, at elevation 1,532 ft, limits the amount of water available by gravity flow. The volume of water that remains in the lake below the outlet elevation is referred to as water in dead storage. This water is not accessible for supply without pumping, creating a new drainage structure at lower elevation, or dredging the outlet.

Prior to this HCP, the City could access and use the dead storage of Chester Morse Lake under a permit from the WDOE only in the case of an emergency caused by an extremely severe drought. Under this emergency scenario, the expected frequency of dead storage use is estimated to be only 1 year in 50. A temporary pumping plant was constructed on Chester Morse Lake in 1987 for this emergency purpose.

During the course of the instream flow negotiations, the idea of using a portion of Chester Morse Lake's dead storage to enhance or supplement instream flows for anadromous fish downstream of Masonry Dam was first raised by agency and Muckleshoot Tribal fisheries biologists. Initial discussions focused on a long-term and regular use that would access the reservoir's dead storage by a permanent means and not by using the existing temporary pumps. Among the range of possible alternatives discussed was the construction of a permanent drainage tunnel or the installation of permanent pumps.

As a result of these discussions, a proposal was made that the City study and evaluate the water supply, environmental, economic, and engineering aspects of using a portion of the dead storage of Chester Morse Lake on a permanent basis to increase downstream anadromous fish flows as well as to augment municipal and industrial water supply (Section 4.4.2). A major project such as the permanent use of dead storage takes many years to study, evaluate, plan, and build. For this reason, the operating details of the Cedar Permanent Dead Storage Project have not yet been determined. The frequency that the reservoir's dead storage could be accessed and the lake level elevation that the reservoir could be drawn down to will be key factors in establishing both the value of the project and its potential environmental impacts.

For these reasons, the feasibility and timing of a Cedar Permanent Dead Storage Project are uncertain. If the project is ever built, it may not be built until many years in the future. Partly because they were faced with this realization, agency and Muckleshoot Tribal biologists with the City began exploring the possibility of a more immediate but less regular use of the reservoir's dead storage for anadromous fish flows by using the existing temporary pumps. As a result of these discussions, a new HCP flow regime was negotiated that allows additional water to be released during summer for steelhead incubation. This release of water causes a slight increase in risk to water supply and instream flows in the fall. This slight increase in risk may be partially mitigated by increased flexibility to use the existing temporary pumps to tap the reservoir's dead storage or by reducing instream flows during years of extreme drought. As described in Section 4.4.2, WDOE modified the permit for the temporary pumping plant to allow access to dead storage as a backup under circumstances in which water releases in the summer for fish creates water shortages in the fall, increasing the expected rate of use for the pumps. More details of this provision in the new HCP flow regime are explained in a subsection below entitled "Environmental Evaluation of the New HCP Flow Regime" and also in Section 4.4.

Reservoir management under both the new HCP instream flow regime and under the Cedar Permanent Dead Storage Project may alter lake levels. The potential environmental impacts of changes in reservoir levels are discussed below.

POTENTIAL ENVIRONMENTAL IMPACTS RELATED TO CHANGES IN RESERVOIR LEVELS

The current instream flow regime on the Cedar River, the new HCP instream flow regime, and the as yet undetermined instream flow regime under the Cedar Permanent Dead Storage Project all have the potential to make use of the reservoir's dead storage to a lesser or greater extent. As such, all three operating scenarios have potential environmental benefits and impacts. The negative environmental effects of all three instream flow regimes fall somewhere on an impact continuum, which ranges from very minor to potentially significant. Because the current instream flow regime uses the reservoir's dead storage only under emergency conditions brought on by a severe drought year (approximately 1 year in 50), its environmental impacts are extremely infrequent. The new HCP instream flow regime could access the reservoir's dead storage slightly more frequently, but only to recover a relatively moderate volume of water (alternatively, instream flows may be reduced to recover water). In addition, the HCP flow regime's dead storage access is limited by a strict procedural protocol (see the subsection below entitled "Evaluation of the New HCP Flow Regime" below). In contrast, the Cedar Permanent Dead Storage Project, depending on its specific configuration and operation, has a greater potential for significant environmental impacts. These potential environmental impacts, however, will be thoroughly investigated in a comprehensive environmental evaluation, and potential mitigation options will also be explored prior to implementation of this project. This study is discussed in more detail in the subsection below entitled "Environmental Evaluation of the Cedar Permanent Dead Storage Project."

Both the new HCP flow regime and the Cedar Permanent Dead Storage Project may alter current reservoir levels and the timing of those levels. Both operating scenarios (but particularly the Cedar Permanent Dead Storage Project) may have potential negative impacts to a lesser or greater extent on three species of greatest concern that rely on the reservoir for key habitat. These three species are bull trout, pygmy whitefish, and common loons. Basic habitat needs for these species are discussed in sections 3.6, 3.7, and 3.5, respectively. Potential negative impacts of both operating scenarios on all three species are discussed below.

POTENTIAL BLOCKAGE OR IMPEDANCE OF BULL TROUT SPAWNING MIGRATIONS

A potential impact to bull trout from both the new HCP instream flow regime and the Cedar Permanent Dead Storage Project is the possible blockage or impedance of bull trout spawning migrations in the fall (mid-September through mid-December). The current average, low-water, drawdown elevation of Chester Morse Lake is approximately 1,540 ft. The reservoir's minimum drawdown elevation (lowest elevation) without using the temporary pumps is 1,532 ft. If the Cedar Permanent Dead Storage Project is constructed, the average drawdown elevation of the reservoir will be lower and the new minimum drawdown elevation could be as low or lower than 1,517 ft. At elevations below 1,540 ft, the reservoir's receding waterline begins to expose steeply sloped delta fans at the mouth of the Cedar and Rex rivers. A delta is an accumulation of sediment formed in standing water by deposition at the mouth of a river. When a river enters a reservoir the water velocity and energy are greatly reduced. Therefore, when the sediment-laden water reaches a reservoir, the larger suspended particles and the bedload are deposited as a delta, usually near the head of the reservoir (Linsley et al. 1992). The finer material is carried farther into the reservoir before deposition on the delta. The gradient of the face of the Cedar River's delta fan is about 14 percent, and the gradient of the face of the Rex River's fan is about 17 percent. If exposed by lowered reservoir levels, these steeply sloped delta faces might be potential barriers to bull trout spawning migrations.

The degree of potential impact is smallest immediately below 1,540 ft, as only a short distance of steep gradient stream channel may be exposed. However, as the reservoir level drops below 1,535 ft, the steep channel gradients are believed to extend for sufficient length to potentially impede or block migration (R2 Resource Consultants, in preparation). Actual field observations of this phenomenon with low reservoir levels have never been made.

In an effort to learn if similar situations exist or have ever existed in other Pacific Northwest reservoirs, SPU staff conducted an informal, non-systematic telephone survey of water and hydroelectric utility biologists and managers. Almost all responses fell into one of two categories: (1) respondents either said that currently there *was not* a migration blockage or impedance problem at their reservoir and that they did not know if there ever had been one in the past, or (2) respondents said that they were *uncertain* if there was a current migration blockage or impedance problem at their reservoir and that they did not know if there ever had been one in the past.

The one instance in which SPU staff found that there was a problem occurred in Tabor Reservoir (also known as St. Mary’s Lake), Montana, on the Flathead Indian Reservation (Hansen, B., Confederated Salish and Kootenai Tribes, 1997, personal communication). In the 1980's a new reservoir drawdown rule curve was implemented after the signing of a new irrigation agreement. The reservoir’s new operating regime caused historically low reservoir drawdowns to occur. Because of the nature of the substrate of the newly exposed reservoir bottom, the reservoir's one bull trout tributary spawning stream braided into a number of critically shallow channels in the newly exposed zone. These shallow braided channels blocked 100 percent of the upstream bull trout spawning migration. An attempt to mechanically dig a new, deeper channel was successful for only 2 days before a higher flow washed it out. The ultimately successful solution was to revise the reservoir’s rule curve, which kept the water level higher during the spawning season. The higher reservoir level allowed bull trout to avoid and bypass the shallow braided channel areas.

After construction of the Cedar Permanent Dead Storage Project on Chester Morse Lake, the annual lower drawdown levels may cause the steeply sloped delta fans to flatten out and eventually re-equilibrate to the new average operating conditions. Without detailed field investigations, it is impossible to accurately predict if this re-equilibration will take place, and if it does, how long it might take or whether a new migration barrier might eventually become exposed. Bases on information gained during a preliminary telephone and literature search, the City believes that the re-equilibration of the delta fans could take from one to many years if the Cedar Permanent Dead Storage Project is built. Because the vast majority of bull trout need to migrate through the deltas to reach their spawning grounds, this time before re-equilibration of the delta fans might prevent some or all of the lake's bull trout from spawning in certain years.

POTENTIAL BLOCKAGE OR IMPEDANCE OF PYGMY WHITEFISH SPAWNING MIGRATIONS

Pygmy whitefish spend most of their lives in the deeper portions of Chester Morse Lake and Masonry Pool (Section 3.5.7). However, during early December 1996, City biologists observed spawning migrations of thousands of pygmy whitefish in the Cedar River above Chester Morse Lake. In early December 1997, hundreds or thousands of pygmy whitefish were also observed during spawning migrations in Boulder Creek and the Rex River, as well as in the Cedar River. As the fish make these migrations from the lake into the tributary streams, pygmy whitefish spawners may be vulnerable to potential blockage or impedance of their migrations in the same way that bull trout may be. Because pygmy whitefish appear to spawn later in the fall than most of reservoir's bull trout, however, the lake's elevation is usually higher when their spawning migration takes place. This later timing of spawning combined with the usually higher reservoir levels during this period will tend to reduce substantially but not eliminate entirely the risk of blockage or impedance to pygmy whitefish spawning migrations.

POTENTIAL IMPACTS TO COMMON LOON NESTING

Common loons typically nest at the water's edge (WDFW 1991). On natural lakes and ponds, loons can compensate for small changes in water levels. However, large fluctuations in reservoir levels that can inundate or strand nests, can pose substantial, adverse impacts to the reproductive success of loons. Nesting habitat is potentially available in willow-dominated zones of the Cedar and Rex river deltas and in small areas of Masonry Pool. However, this nesting habitat is currently subjected to springtime water level fluctuations over the course of the nesting season (April through mid-June) of up to 10 ft under the present reservoir operating regime. Implementation of the new HCP instream flow regime or implementation of the Cedar Permanent Dead Storage Project may have an impact on the current level of reservoir fluctuations during the common loon nesting season from April through mid-June.

ENVIRONMENTAL EVALUATION OF THE NEW HCP FLOW REGIME

Background

In some years, high stream flows during the late spring can force steelhead to spawn in areas where their redds will subsequently experience increased risks of dewatering. To address these situations, the City has agreed to provide an additional supplemental block of water to be allocated, as directed by the Instream Flow Commission, in normal years when the need exists for increased steelhead incubation protection and if specific hydrologic conditions and risk-sharing mechanisms provide the flexibility to do so (Section 4.4). The City will, under a defined protocol, supplement normal minimum instream flows by an additional 3,500 acre-feet of water in 63 percent of all years between June 17 and August 4. In addition to providing benefits for incubating steelhead, this supplemental water will benefit rearing steelhead and rearing coho and chinook salmon.

The parties to the Instream Flow Agreement recognize that supplementation of minimum instream flows for anadromous fish early in the dry season increases the overall risk of shortage in meeting both water supply needs and minimum instream flow commitments as actual conditions unfold throughout the summer and fall. In years of shortage, the parties to the Instream Flow Agreement have agreed to allow the City to elect to recover a volume of water equal to the volume released from storage. At the recommendation of the Instream Flow Commission, the City's recovery options may include modifications to the use of the low-normal instream flow curve or use of the existing temporary Chester Morse Lake pumping plant.

Because of this ability to use or even to plan to use some of the reservoir's dead storage and because of other changes in water management under the HCP flow regime, the new regime has the potential to alter water levels in Chester Morse Lake at certain times of year. Lower reservoir levels in the fall potentially may impact the spawning migrations of bull trout and pygmy whitefish, and reservoir fluctuations in the spring may affect the nesting of common loons. In order to compare the frequency and magnitude of potential changes in reservoir levels as a result of the new HCP instream flow regime, the City modeled the current and proposed regimes as described below.

Modeling and Analyses

To assess the incremental effect of the new HCP instream flow regime on Chester Morse Lake reservoir levels, a simplified numerical water balance model of the Cedar River system was used that incorporated representations of (1) the new HCP instream flow regime, and (2) the 1979 Washington State Instream Resources Protection Program (IRPP) minimum instream flow requirements (Section 3.3.2). This model was used for the purpose of providing a comparison of modeled weekly Chester Morse Lake reservoir levels resulting from the two different instream flow scenarios. Both modeled scenarios used simplified assumptions about the Cedar River system and operational constraints. The results from the model are not intended to precisely predict actual future or past reservoir levels in Chester Morse Lake, but rather are used to predict if there will be significant differences in reservoir levels as a consequence of providing the new HCP instream flow regime compared to following the IRPP instream flow regime.

The major assumptions in the model include: (1) historical streamflows are used to represent future streamflows, with historical streamflow records used for this reservoir modeling covering the period from October 1, 1928, to March 24, 1993; (2) the reservoir's full pool elevation is modeled as 1,560 ft for both the IRPP and the new HCP flow scenarios; (3) under the IRPP scenario, the City voluntarily follows the 1979 Washington State IRPP instream flow regime requirements even though the City considers them non-binding; (4) under the new HCP scenario, the City follows the proposed new minimum instream flow regime requirements; and (5) under the HCP scenario, the City provides the supplemental HCP instream flow commitments and uses its best professional judgment to model them. The City notes the difficulty associated with modeling actual real-time operational constraints, and the difficulty in modeling the outcome of the collaborative decision-making processes that will occur between the City, state, and federal resource agencies, and the Muckleshoot Indian Tribe.

Model analyses involved comparisons of weekly reservoir levels between the two regimes during the 13-week bull trout spawning period from 9/16-12/16, the 3-week pygmy whitefish spawning period from 11/26-12/16, and the 11-week common loon nesting period from 4/1-6/16. Additional discussion of the analysis of reservoir operations can be found in Section 4.6 in the effects analyses for bull trout, pygmy whitefish, and common loon.

Results and Discussion

Differences in Lake Levels during the Bull Trout Spawning Season

Table 4.5-2 shows the differences in occurrence and frequency between projected reservoir levels during the 13-week bull trout spawning period modeled under the IRPP flow regime and the new HCP flow regime. On average, the HCP flow regime generally results in slightly lower reservoir levels during the bull trout spawning season compared to the IRPP flow regime. This is understandable because the 13-week bull trout spawning season follows the release by the City of the summer non-firm block of water for downstream anadromous fish. In addition, if necessary for municipal and industrial purposes, the City may recover this previously released water volume from the reservoir in the late summer and fall.

The difference between the projected lake levels for the two operating regimes is less than 1 ft higher or lower 77.9 percent of the time. Under the new HCP flow regime, the reservoir levels are more than 1 ft lower than under the IRPP flow regime 18.1 percent of the time, and 3.9 percent of the time they are more than 1 ft higher. Over the 64+ bull trout spawning seasons, the projected lake levels under the new HCP operating scenario average 0.41 ft lower (1,547.74 ft) than under the IRPP operating scenario (1,548.15 ft) (Table 4.5-2). Both of these mean elevations are well above the 1,540 ft elevation at which the steeply sloped delta fans begin to be exposed.

Field observations are necessary for verification, but it is believed that an incremental change in lake levels projected for the new HCP flow regime of up to plus or minus 1 ft would likely have little additional impact on bull trout spawning migrations. Modeled HCP reservoir levels are more than 2 ft lower than modeled reservoir levels under the IRPP flow regime 6.7 percent of the time (57 weeks out of 843 weeks), more than 3 ft lower 4.1 percent of the time (35 weeks), and they are more than 4 ft lower only 2.1 percent of the time (18 weeks) (Table 4.5-2).

The elevation at which the steeply sloped delta fans begin to be exposed is approximately 1,540 ft. There is relatively little difference between the two flow regimes in the amount of time that the modeled reservoir elevations fall below the 1,540 ft level. The IRPP flow regime results in modeled reservoir levels below 1,540 ft elevation 5.1 percent of the time (43 weeks) and the HCP flow regime results in modeled reservoir levels below 1,540 ft elevation 6.4 percent of the time (54 weeks). It is believed that the new HCP flow regime will probably have little additional impact on bull trout spawning migrations.

Table 4.5-2. Differences and frequency of occurrence between modeled weekly Chester Morse Lake levels under the new HCP flow regime and under the IRPP flow regime during the 64+ bull trout 13-week spawning periods (9/16-12/16) using the historical streamflow record between October 1, 1928, and March 24, 1993.

Difference between HCP regime compared to IRPP regime	Number of weeks	Percent of weeks
more than 6 ft higher	0	0.0
5 to 6 ft higher	4	0.5
4 to 5 ft higher	4	0.5
3 to 4 ft higher	0	0.0
2 to 3 ft higher	7	0.8
1 to 2 ft higher	18	2.1
0 to 1 ft higher	54	6.4
0	406	48.2
0 to 1 ft lower	197	23.4
1 to 2 ft lower	96	11.4
2 to 3 ft lower	22	2.6
3 to 4 ft lower	17	2.0
4 to 5 ft lower	9	1.1
5 to 6 ft lower	2	0.2
6 to 7ft lower	5	0.6
7 to 8 ft lower	1	0.1
8 to 9 ft lower	1	0.1
more than 9 ft lower	0	0.0
Total	**843**	**100.0**
No difference (0 ft) to difference less than +1ft or -1 ft	657	77.9
Difference greater than +1 ft or -1 ft	186	22.1
Difference more than 1 ft lower	153	18.1
Difference more than 1 ft higher	33	3.9
Average elevation under IRPP	**Average elevation under HCP**	**Average weekly difference**
1,548.15 ft	1,547.74 ft	- 0.41 ft

Differences in Lake Levels during the Pygmy Whitefish Spawning Season

Table 457.2 shows the differences in occurrence and frequency between projected lake levels during the 3-week pygmy whitefish spawning period under the IRPP flow regime and the new HCP flow regime. On average, the HCP flow regime generally results in slightly lower reservoir levels during the pygmy whitefish spawning season compared to the IRPP flow regime.

The difference between projected lake levels for the two operating scenarios is less than 1 ft higher or lower 92.8 percent of the time. Under the HCP operating regime, reservoir levels are more than 1 ft lower than under the IRPP operating regime 5.1 percent of the time, and 2.1 percent of the time they are more than 1 ft higher. Over the 65 years of pygmy whitefish spawning seasons, the projected lake levels under the new HCP flow regime average 0.23 ft lower (1,548.47 ft) than those under the IRPP flow regime (1,548.70 ft) (Table 4.5-3).

Field observations are necessary for verification, but it is believed that an incremental change in lake levels projected for the new HCP flow regime of less than plus or minus 1 ft would likely have little additional impact on pygmy whitefish spawning migrations. HCP reservoir levels are more than 3 ft lower than IRPP reservoir levels 4.6 percent of the time (9 weeks), more than 4 ft lower 2.5 percent of the time (5 weeks), and more than 5 ft lower only 1.0 percent of the time (2 weeks).

The elevation at which the steeply sloped delta fans begin to be exposed is approximately 1,540 ft. There is relatively little difference between the two flow regimes in the amount of time that the modeled reservoir elevations falls below the 1,540 ft level. The IRPP flow regime results in reservoir levels below 1,540 ft elevation 6.2 percent of the time (12 weeks) and the HCP flow regime results in reservoir levels below 1,540 ft elevation 6.7 percent of the time (13 weeks).

Table 4.5-3. Differences and frequency of occurrence between modeled weekly Chester Morse Lake levels under the new HCP flow regime and under the IRPP flow regime during the 65 pygmy whitefish 3-week spawning periods (11/26-12/16) using the historical streamflow record between October 1, 1928, and March 24, 1993.

Difference between HCP regime compared to IRPP regime	Number of weeks	Percent of weeks
more than 2 ft higher	0	0.0
1 to 2 ft higher	4	2.1
0 to 1 ft higher	7	3.6
0	158	81.0
0 to 1 ft lower	16	8.2
1 to 2 ft lower	1	0.5
2 to 3 ft lower	0	0.0
3 to 4 ft lower	4	2.1
4 to 5 ft lower	3	1.5
5 to 6 ft lower	0	0.0
6 to 7ft lower	1	0.5
7 to 8 ft lower	0	0.0
8 to 9 ft lower	1	0.5
more than 9 ft lower	0	0.0
Total	**195**	**100.0**
No difference (0 ft) to difference less than +1 ft or -1 ft	181	92.8
Difference greater than +1 ft or -1 ft	14	7.2
Difference more than 1 ft lower	10	5.1
Difference more than 1 ft higher	4	2.1
Average elevation under IRPP	**Average elevation under HCP**	**Average weekly difference**
1,548.70 ft	1,548.47 ft	- 0.23 ft

Differences in Lake Levels and Lake Level Fluctuations during the Common Loon Nesting Season

Common loons, bull trout, and pygmy whitefish are vulnerable to long-term seasonal water level fluctuations over the course of their critical life history periods (typically associated with reproduction). However, in addition to this long-term seasonal vulnerability, loons are also susceptible to short-term (daily) reservoir fluctuations. This is especially true during the time of nest establishment and incubation because nests are typically built at a fixed elevation relative to the current lake level. Unfortunately, the City's numerical water balance model is capable of predicting only weekly reservoir levels. This modeling limitation should be kept in mind while reading the results and discussion below.

Table 4.5-4 shows the differences in occurrence and frequency between projected lake levels during the 11-week common loon nesting and incubation season under the IRPP flow regime and the new HCP flow regime. Because the non-firm block of water for anadromous fish instream flows is released (if it is available) in the summer and because loons nest in the spring after the winter precipitation has occurred, the comparison of projected differences between lake levels for the IRPP and new HCP operating regimes shows the least difference for any of the three species of greatest concern examined.

On average, during the common loon nesting season, the HCP flow regime results in similar or only slightly lower reservoir levels than are predicted under the IRPP flow regime. The change in modeled lake levels between the two operating regimes during the loon nesting season is within 1 ft higher or 1 ft lower 94.9 percent of the time. Reservoir levels modeled under the HCP flow regime are more than 1 ft lower than reservoir levels modeled under the IRPP flow regime only 2.7 percent of the time, and they are more than 1 ft higher only 2.4 percent of the time. Over the 64 common loon nesting seasons, the lake levels under the new HCP flow regime are predicted to average only 0.01 ft lower (1,557.66 ft) than those under the IRPP regime (1,557.67 ft) (Table 4.5-4). Field observations are necessary for verification, but in general, it is believed that the relatively small change in modeled lake levels due to the HCP flow regime would likely have no or only minor additional impacts on loon nesting and incubation in the great majority of years.

The loon nesting season roughly corresponds to the time period in which potential inundation of bull trout redds occurs. Because of a relative lack of data and the City's stated assumption that mortality in inundated redds is probably very high (see "Bull Trout Redd Inundation and Egg Mortality Study" contained in section 4.5.4), the potential impacts of the two different flow regimes and their corresponding lake levels on bull trout redd inundation were not analyzed. However, it can be seen from the analysis of reservoir elevations during the loon nesting season that the differences between the two flow regimes during this roughly similar period are very small or nonexistent (~0.01 ft).
Another measure of the potential incremental impact of the new HCP flow regime on the nesting of common loons is the amplitude of the reservoir's fluctuations during the nesting season. Amplitude is defined as the maximum absolute value of a periodic fluctuation. The fluctuation amplitude of Chester Morse Lake during loon nesting is the maximum absolute value of the periodic seasonal fluctuations in reservoir elevation that the loons experience over the 11-week nesting season. Nesting loons adapt poorly to fluctuating water levels unless they choose naturally floating logs or are provided with floating artificial nest platforms. Even if floating platforms are used by loons, nests can still be stranded by severe drops in water levels, or if the platforms are under substantial overhead vegetation, nests can be obstructed or tipped over by the overhead vegetation as a result of large increases in water levels. The seasonal fluctuation amplitude may be considered a relative overall index of suitability for successful loon nesting. The additional incremental impact of the HCP flow regime may be examined by comparing its projected amplitude fluctuations with those of the IRPP flow regime during the 11-week loon nesting season over the 64 years of record.

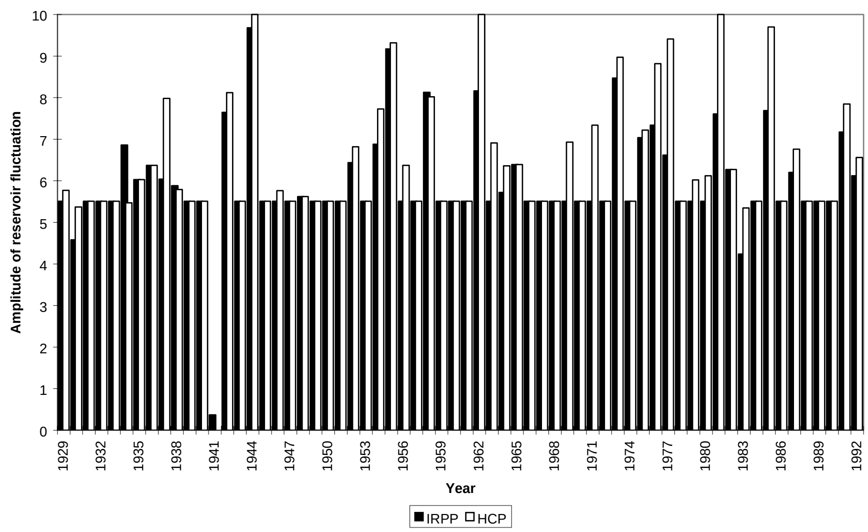
Table 4.5-4. Differences and frequency of occurrence between modeled weekly Chester Morse Lake levels under the new HCP flow regime and under the IRPP flow regime during the 64 common loon 11-week nesting periods (4/1-6/16) using the historical streamflow record between October 1, 1928, and March 24, 1993.

Difference between HCP regime compared to IRPP regime	Number of weeks	Percent of weeks
more than 4 ft higher	0	0.0
3 to 4 ft higher	3	0.4
2 to 3 ft higher	2	0.3
1 to 2 ft higher	12	1.7
0 to 1 ft higher	55	7.8
0	547	77.7
0 to 1 ft lower	66	9.4
1 to 2 ft lower	10	1.4
2 to 3 ft lower	6	0.9
3 to 4 ft lower	3	0.4
more than 4 ft lower	0	0.0
Total	**704**	**100.0**
No difference (0 ft) to difference less than +1 ft or -1 ft	668	94.9
Difference greater than +1 ft or -1 ft	36	5.1
Difference more than 1 ft lower	19	2.7
Difference more than 1 ft higher	17	2.4
Average elevation under IRPP	**Average elevation under HCP**	**Average weekly difference**
1,557.67 ft	1,557.66 ft	- 0.01 ft

Figure 4.5-1 illustrates that in many years the seasonal reservoir fluctuation amplitudes predicted from the two instream flow regimes are nearly identical. In those years when the reservoir fluctuation amplitudes are greater under the HCP flow regime, the mean amplitude is 0.99 ft greater and the range in amplitude is from 0.15 ft to 2.79 ft greater. In these particular years, loons that use non-floating natural nest sites could potentially have more problems nesting successfully than they would have under the IRPP flow regime. During these same years, loon pairs that select floating nest platforms (natural or artificial) are more likely to be successful.

The mean amplitude of reservoir fluctuations during the 11-week loon nesting season under the IRPP operating regime is 5.99 ft, and the mean amplitude of reservoir fluctuations under the new HCP operating regime is 6.37 ft, or 0.38 ft greater than under the IRPP regime. The seasonal amplitudes of reservoir fluctuations under the IRPP flow regime range from 0.37 ft to 9.68 ft, while the amplitudes of reservoir fluctuations modeled under the new HCP flow regime have a slightly greater range from 0 to 10.00 ft. In the 64 years examined, the mean amplitude of reservoir fluctuations modeled for both flow regimes is the same 51.6 percent of the time (33 years), is greater under IRPP flows 6.3 percent of the time (4 years), and is greater under HCP flows 42.2 percent of the time (27 years).

Figure 4.5-1. Amplitudes of modeled Chester Morse Lake Reservoir fluctuations under the new HCP flow regime and under the IRPP flow regime during the 64 common loon 11-week nesting periods (4/1-6/16) using the historical streamflow record between October 1, 1928, and March 24, 1993.



Further examination of fluctuations in reservoir elevations during the loon nesting season indicates that reservoir levels typically increase during this period in response to melting snow and the planned filling of the reservoir's flood pocket (Section 2.2.4). On average, the reservoir reaches full pool (modeled as 1,560 ft) around the second week of May, which is about the sixth week (5/6 - 5/12) of the loon nesting season.

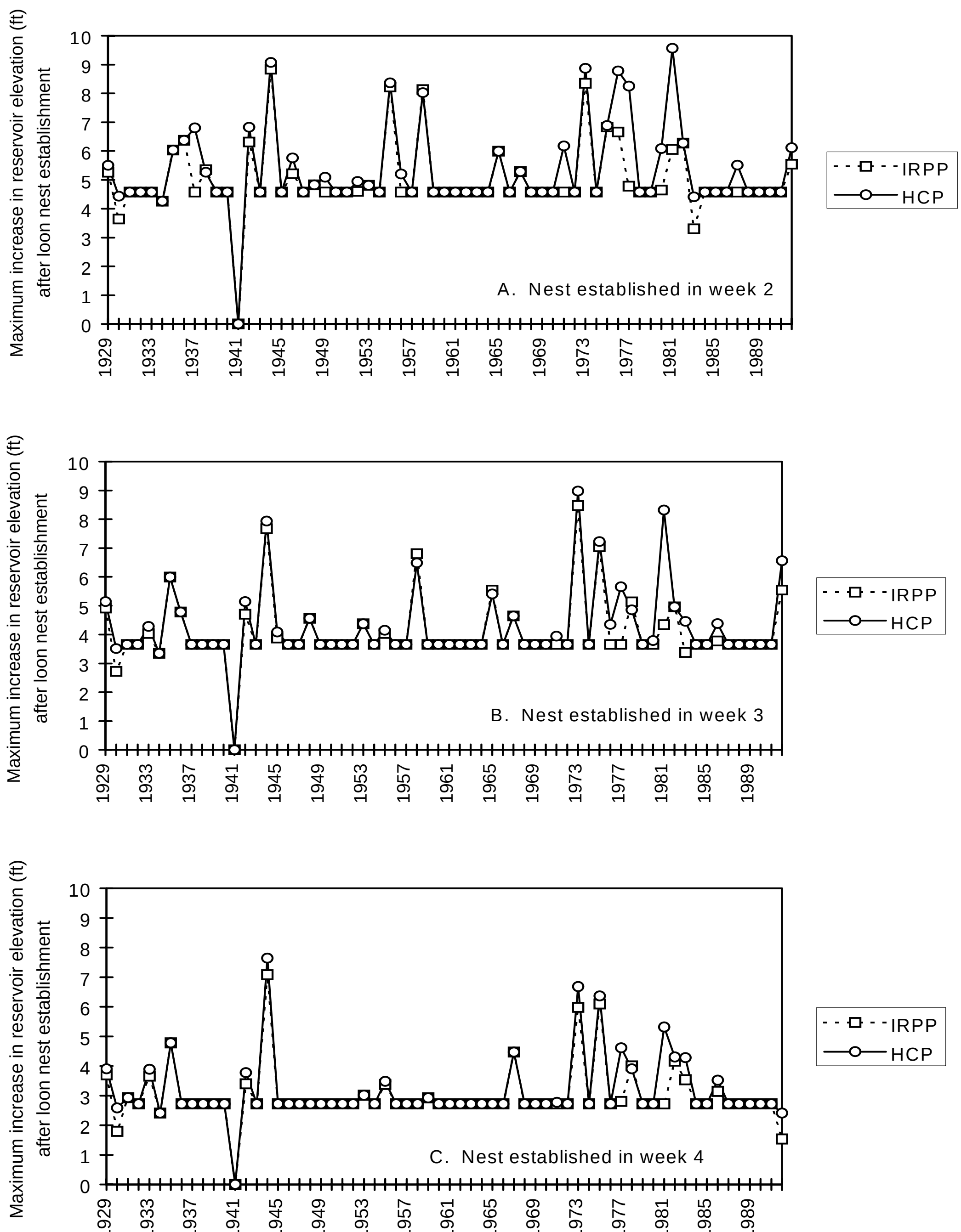
The additional incremental impact of the rise in reservoir levels during the loon nesting season that is a result of the new HCP flow regime is probably relatively small in most years. Averaged over the 3 weeks (4/8 - 4/28) of potential nest establishment for the 64 years of record, the average maximum increase in reservoir levels under the HCP regime is 0.22 ft greater than the average maximum increase in reservoir levels under the IRPP flow regime (Table 4.5-5).

Table 4.5-5. Average maximum increase in modeled Chester Morse Lake levels after each of 3 potential weeks of loon nest establishment under the new HCP flow regime and under the IRPP flow regime during the 64 common loon nesting periods using the historical streamflow record between October 1, 1928, and March 24, 1993. Week 2 of nest establishment is 4/8-4/14; week 3 of nest establishment is 4/15-4/21; and week 4 of nest establishment is 4/22-4/28.

Week of loon nest establishment	Increase in lake levels (ft) under IRPP flows	Increase in lake levels (ft) under HCP flows
2	4.99	5.32
3	4.07	4.26
4	3.00	3.15
Mean of the 3 weeks	4.02	4.24

Loon nest establishment on the reservoir typically occurs between the second and fourth weeks (4/8-4/28) of the 11-week nesting season. Depending on the week of nest establishment, modeled water levels typically continue to rise a maximum of approximately 3-5 ft under both flow regimes. If a loon nest is established in the second week of the nesting season (4/8-4/14), the coincident reservoir level is estimated to increase by an average maximum of 4.99 ft under the IRPP flow regime and 5.32 ft under the new HCP flow regime (Table 457.4). If loon nest establishment occurs later than week 2, it is predicted that the coincident maximum increase in reservoir levels decreases by approximately 1 ft for each week that nesting is delayed. This relationship between the week of loon nest establishment and the average maximum rise in reservoir levels is illustrated in Figure 4.5-2.

Figure 4.5-2. Maximum increase in modeled Chester Morse Lake levels after each of 3 potential weeks of loon nest establishment under the new HCP flow regime and under the IRPP flow regime during the 64 common loon nesting periods using the historical streamflow record between October 1, 1928, and March 24, 1993. Week 2 of nest establishment is 4/8-4/14; week 3 of nest establishment is 4/15-4/21; and week 4 of nest establishment is 4/22-4/28.

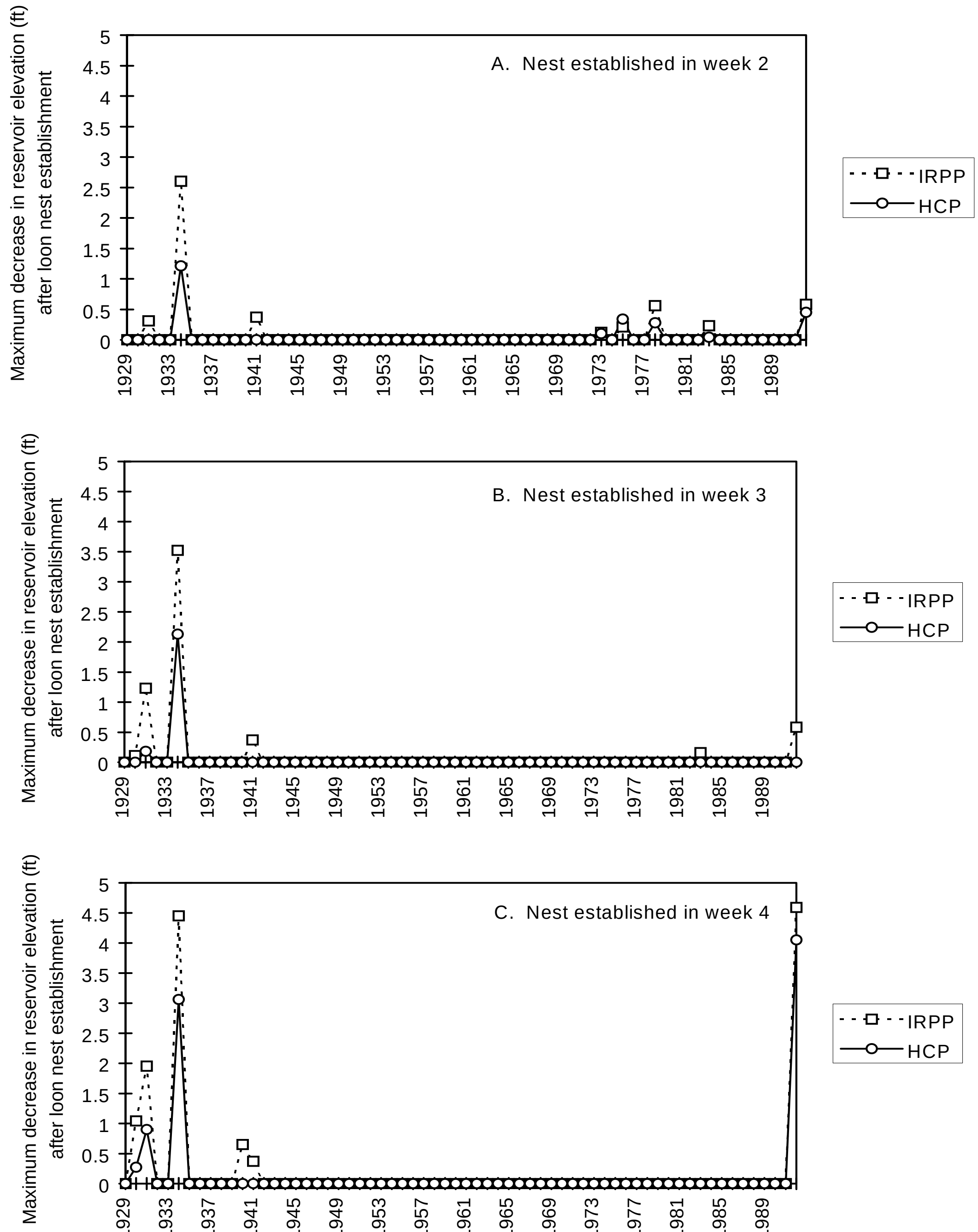


Reservoir water levels in most years typically do not decrease or decrease very little during the loon nesting season. Averaged over the 3 weeks of potential nest establishment for the 64 years of record, the average maximum decrease in reservoir levels under the HCP regime is 0.07 ft and the average maximum decrease in reservoir levels under the IRPP flow regime is 0.12 ft (Table 4.5-6). However, in very dry years loons can experience maximum decreases in reservoir levels from less than 1 ft to almost 4.5 ft (Figure 4.5-3). The incremental impact of the new HCP flow regime on maximum reservoir decreases during the loon nesting season appears to be positive. Although decreases in lake levels are predicted to occur infrequently, the model indicates that they are larger and occur more frequently under the IRPP flow regime.

Table 4.5-6. Average maximum decrease in modeled Chester Morse Lake levels after each of 3 potential weeks of loon nest establishment under the new HCP flow regime and under the IRPP flow regime during the 64 common loon nesting periods using the historical streamflow record between October 1, 1928, and March 24, 1993. Week 2 of nest establishment is 4/8-4/14; week 3 of nest establishment is 4/15-4/21; and week 4 of nest establishment is 4/22-4/28.

Week of loon nest establishment	Decrease in lake levels (ft) under IRPP flows	Decrease in lake levels (ft) under HCP flows
2	0.08	0.04
3	0.09	0.04
4	0.20	0.13
Mean of the 3 weeks	0.12	0.07

Figure 4.5-3. Maximum decrease in modeled Chester Morse Lake levels after each of 3 potential weeks of loon nest establishment under the new HCP flow regime and under the IRPP flow regime during the 64 common loon nesting periods using the historical streamflow record between October 1, 1928, and March 24, 1993. Week 2 of nest establishment is 4/8-4/14; week 3 of nest establishment is 4/15-4/21; and week 4 of nest establishment is 4/22-4/28.



Although the additional incremental impact of the fluctuations in reservoir levels resulting from the HCP flow regime probably is relatively small, the overall negative impact of the large seasonal fluctuations in reservoir water levels under either flow scenario during the loon nesting season is much more significant. This is because nesting loons adapt poorly to fluctuating water levels (unless they choose naturally floating logs or are provided with floating artificial nest platforms, and even then loons often experience nesting difficulties). The largest fluctuations usually occur during the first 6 weeks of the loon nesting season and these coincide with the critical period of nest establishment.

SUMMARY AND CONCLUSIONS

Over the 64+ projected bull trout spawning seasons, 65 projected pygmy whitefish spawning seasons, and 64 projected common loon nesting seasons, the modeled lake levels under the new HCP flow regime average 0.41, 0.23, and 0.01 ft lower, respectively, than under the IRPP flow regime. The differences between the projected lake levels for the two operating regimes are less than 1 ft higher or lower 77.9, 92.8, and 94.9 percent of the time for the bull trout spawning season, the pygmy white fish spawning season, and the common loon nesting season, respectively. For all three species, it is believed that the incremental differences in lake levels projected under the new HCP flow regime will probably have little additional impact on bull trout and pygmy whitefish spawning migrations and common loon nesting success.

In many years the reservoir fluctuation amplitudes during the common loon nesting season predicted under the two instream flow regimes are nearly identical. Over the 64 loon nesting seasons, the mean amplitude of the modeled reservoir fluctuations under the HCP flow regime (6.37 ft) is 0.38 ft greater than under the IRPP flow regime (5.99 ft).

The additional incremental impact of the rise in reservoir levels during the loon nesting season that results from the new HCP flow regime is probably relatively small in most years. Averaged over the 3 weeks (4/8-4/28) of potential nest establishment for the 64 years of record, the average maximum increase in modeled reservoir levels under the HCP regime (4.24 ft) is 0.22 ft greater than the average maximum increase in reservoir levels under the IRPP flow regime (4.02 ft).

Reservoir water levels in most years typically do not decrease or decrease very little during the loon nesting season. Averaged over the 3 weeks of potential nest establishment for the 64 years of record, the average maximum decrease in modeled reservoir levels under the HCP regime (0.07 ft) is actually 0.05 ft less than the average maximum decrease in reservoir levels under the IRPP flow regime (0.12 ft).

The additional incremental impact of the fluctuations in reservoir levels during the common loon nesting season due to the HCP flow regime is probably relatively small. But, the overall negative impact of the large seasonal fluctuations in reservoir water levels during the loon nesting season under either the IRPP or the new HCP flow scenarios is much more significant. Under these circumstances, loon pairs that select floating nest platforms (natural or artificial) are more likely to be successful.

ENVIRONMENTAL EVALUATION OF THE CEDAR PERMANENT DEAD STORAGE PROJECT

The City has agreed to conduct a multi-year evaluation of the Cedar Permanent Dead Storage Project. The Permanent Dead Storage Project has many potential benefits for downstream anadromous and resident fish (Section 4.4). However, the primary focus of the environmental portion of the study and evaluation will be on the potential impacts of the Cedar Permanent Dead Storage Project on resident fish and wildlife upstream of Masonry Dam, particularly bull trout, pygmy whitefish, and common loons. Adaptive management will be a key component of all aspects of the study (Section 4.5.7), and funds can be shifted (Appendix 1) among elements of the biological investigations.

The study of the Cedar Permanent Dead Storage Project will occur concurrently with other reservoir-related HCP studies. To the extent possible and practicable, the City will coordinate all these efforts to maximize their efficiency. The environmental studies may cost up to $745,000 for the period from years 1999 through 2003 (HCP years 1-5). The engineering studies are estimated to cost $700,000 for the same period (Table 4.5-7). If, subsequent to the preparation of this HCP, a decision is made to build the Permanent Dead Storage Project, a site-specific EIS will be developed under SEPA, and an EA or EIS will be developed under NEPA.

Reservoir Modeling

Planning-level reservoir modeling will be conducted to help assess potential environmental impacts of the Cedar Permanent Dead Storage Project. One of the possible first steps in the study may be to model the projected reservoir elevations that likely will occur after the project is constructed and is operational. The frequency and magnitude of potential changes in reservoir elevations may be compared to the timing of the adfluvial bull trout spawning migration, pygmy whitefish spawning migration, and loon nesting season to see if and how often potential conflicts may occur.

Delta Fans Geomorphological Investigation and Modeling

To better understand and determine if bull trout or pygmy whitefish might have difficulty migrating through the delta fan areas, a detailed geomorphological field investigation and modeling analysis may be performed. The objective of this analysis will be to assess the nature of the deltas, their shape, composition, and potential persistence or reconfiguration under the new operating regime for the reservoir.

The investigation and modeling project may include the following four phases:

(1) The initial phase will entail gathering relevant information to facilitate the effective design of more detailed studies later. This information will be used for making decisions regarding the surface area and the depth of the deltas that will need to be mapped, and the preferred methods to be used. Design of this first phase will be based on a literature search, consultation with experts, and an analysis of existing acoustic survey data produced for an earlier dead storage study completed for City Light (Quinlan 1984). Additional fieldwork is anticipated during the first study phase to determine the presence or absence, spatial distribution, and depth of larger-size sediments. The presence of sediments of coarse gravel size or larger or coarse woody debris has been found to seriously limit several survey methods (USDI 1995b). Knowing the maximum

sediment size to be sampled will allow effective choice of the methods and size of apparatus to be used for ground truthing and detailed mapping of the deltas in phase 2.

(2) The second phase of the study will entail mapping the structure of the delta fans to provide information on the response of the deltas to various stream flows at potentially different lowered reservoir levels as input for the final phase modeling effort.

(3) Phase 3 of the study will entail characterizing and quantifying the sediments carried to the deltas by the Cedar and Rex rivers, otherwise known as a sediment delivery budget.

(4) The final study phase will entail developing and calibrating models to predict streamflow and associated delta down-cutting.

Geomorphological sampling and modeling may cost up to $290,000 in HCP years 1-4 (Table 4.5-7).

Bull Trout Passage Assistance Plan

After completion of the delta fans geomorphological investigation and modeling, the City will analyze the results and integrate them with the results of the reservoir modeling study. If the results indicate that the morphology and persistence of the steeply sloped delta fans poses a significant threat to bull trout spawning migrations, either before or after the potential implementation of the Cedar Permanent Dead Storage Project, the City will develop a bull trout passage assistance plan to aid successful upstream passage of bull trout.

In writing the bull trout passage assistance plan, the City will take into consideration the fact that bull trout may be sensitive to handling and the presence of instream structures such as traps. Research indicates that some individual bull trout, after being trapped and released upstream, have altered their spawning migrations and returned downstream (Stelfox and Eden 1995; Oliver 1979).

The final assistance plan can be implemented whenever a relatively dry water year results in an extraordinary low reservoir level, *regardless of whether the proposed Cedar Permanent Dead Storage Project is ever built*. It should be noted, however, that an extraordinary low reservoir water level is more likely to occur after the Cedar Permanent Dead Storage Project is operational, if that project is built. The bull trout passage assistance plan will be completed by HCP year 5 and may cost up to $65,000 (Table 4.5-7). If an extraordinary low reservoir level occurs before the bull trout passage assistance plan is completed, the occasion will be treated as an empirical learning experience. If this occurs, the principles of adaptive management will be applied to minimize the impacts to the bull trout population and to gain an understanding of the consequences of the event.

Adaptive Management and Risks to the Bull Trout Population

The City and the Services recognize that while the Cedar Permanent Dead Storage Project will provide quantifiable flow benefits for downstream anadromous fish, the project poses some risks to the bull trout population in Chester Morse Lake. The City and the Services believe that the watershed management conservation and mitigation measures included Section 4.2.2, along with monitoring and research program (this section) and adaptive management (Sections 4.5.7) proposed in this HCP, will minimize, but may not completely eliminate, those risks. Under an unlikely but worst-case scenario, bull trout could become extinct in Chester Morse Lake. The City acknowledges the grave and extremely unsatisfactory nature of this result. If the Cedar Permanent Dead Storage Project is built, and, in spite of the City's conservation strategies and mitigation efforts described in this HCP, the project endangers the survival of Chester Morse Lake's bull trout population, the City, in consultation with the Services, will take all necessary and reasonable additional steps to correct the problem.

Additional Studies of Impacts to Pygmy Whitefish and Rainbow Trout

The City will conduct an examination of the potential impacts of the Cedar Permanent Dead Storage Project on pygmy whitefish and rainbow trout. The investigation will begin in HCP year 3 or 4. Study design and methods will be worked out at that time with the Cedar Permanent Dead Storage Work Group.

Relatively little is known about pygmy whitefish life history (Section 3.4.6). In order to adequately assess the potential impacts of the Cedar Permanent Dead Storage Project on the population of pygmy whitefish, the City will fund a study to investigate their life history including general seasonal distribution and reproductive habits. The City may conduct a telemetry study as a part of this investigation. Significantly more effort will be spent studying pygmy whitefish than rainbow trout because so little is known about pygmy whitefish, and they are a key item in the diet of bull trout (R2 Resource Consultants, in preparation). The study of the potential impacts of the Cedar Permanent Dead Storage Project on pygmy whitefish and rainbow trout may cost up to $280,000 (Table 4.5-7).

Assessment of Potential Impacts to Common Loon Nesting Habitat

As part of the Cedar Permanent Dead Storage Project evaluation, the City will model the new reservoir operating regime and evaluate the potential for future adverse impacts to common loon nesting habitat on the reservoir complex resulting from fluctuating lake levels. The City may also evaluate the results of the delta vegetation monitoring project in relation to projections of new reservoir fill and drawdown regimes. The purpose would be to determine if impacts to vegetation, such as recession and re-establishment of willow vegetation, might have potential adverse impacts to loon nesting habitat and behavior. Surveys of common loon nesting success on Chester Morse Lake and Masonry Pool will be conducted on an annual basis throughout the term of the HCP. Based on the evaluations above, and any additional pertinent information, the City will decide if and what type of continued monitoring or mitigation is appropriate. The assessment of impacts to loon nesting habitat will cost up to $30,000 (Table 4.5-7).

River Delta Wetland Plant Community Monitoring

Background

In 1987, the City of Seattle completed minor modifications to the two dams on its Chester Morse Lake/Masonry Pool reservoir system and implemented a modified water management program (Section 2.2.5). At that time, a 10-year study was initiated to document baseline conditions in the extensive wetland communities of the two major river deltas in the system, the Cedar and Rex river deltas (Raedeke 1998). Although the study was designed to document changes to vegetation communities resulting from both modified fill and drawdown regimes, particular attention was given to potential effects of extended drawdown conditions created by use of emergency pumps during low water supply conditions at cessation of gravity flow. However, drawdown conditions did not approach extended low levels, and it was not possible to measure impacts to the delta vegetation communities resulting from extended low levels (see Figure 22-1 in Appendix 22). However, impacts to delta wetland vegetation communities resulting from higher late winter and early spring water levels and extended fill regimes were documented (Appendix 20). Impacts included recession of delta sedge and willow communities, and death of mature deciduous and coniferous trees on some of the Cedar River floodplain (Raedeke 1998).

If the Cedar Permanent Dead Storage Project is constructed, both fill and drawdown regimes in the reservoir system may be significantly modified. A key element of those modifications would be a potential new minimum drawdown elevation significantly lower than the natural gravity outlet of the lake at an elevation of 1,532 ft. Potential new extremes of fill and drawdown could create conditions such as inundation, exposure, and desiccation, which significantly affect delta vegetation communities. However, the Raedeke (1998) report suggests that the seasonal timing and especially the duration and persistence of particular conditions may be of even greater significance, as evidenced by the recession of sedges after prolonged inundation during the growing season.

Delta Plant Community Monitoring

As part of the Cedar Permanent Dead Storage Project evaluation, the City will model the new reservoir operating regime, make comparisons to past conditions, and evaluate the potential for future adverse impacts to the delta plant communities (including floodplains). In addition, the City will evaluate the results of the delta vegetation monitoring project (Raedeke 1998) in relation to new reservoir fill and drawdown regimes predicted by modeling exercises. Based on these evaluations and other additional pertinent information, the City will decide if continued monitoring of the delta plant communities is needed. If continued monitoring is necessary, the City then will design and implement the appropriate studies. If needed, future monitoring efforts could be developed as an extension of the recent delta vegetation monitoring project. These could include necessary modifications to the original design to accommodate the potential new lower drawdown elevation resulting from Cedar Permanent Dead Storage Project. The additional study will occur within HCP years 1-5 and may cost up to $80,000 (Table 4.5-7).

4.5.7 Adaptive Management

RELATIONSHIP OF CHANGED AND UNFORESEEN CIRCUMSTANCES TO ADAPTIVE MANAGEMENT

The final No Surprises Policy for HCPs (Fed. Reg. Vol. 63, No. 35, pp. 8859-8873) requires that HCPs identify potential “changed circumstances” that may arise during plan implementation and include measures to respond to those changed circumstances. As defined in the final rule, “Changed circumstances means changes in circumstances affecting a species or geographic area covered by a conservation plan *that can reasonably be anticipated* by plan developers and the [USFWS *or* NMFS] *and that can be planned* *for* (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)" (italics added for emphasis).

In effect, the final rule requires that the adaptive management program in an HCP incorporate provisions for changes in circumstances that an applicant can expect to occur during the term of an HCP and that could affect either the species addressed in the HCP or the potential effectiveness of the mitigation and conservation measures in the HCP. In the case of this HCP, such changed circumstances include moderate forest fires, windstorms, insect and disease outbreaks, landslides, floods, and droughts.

Changed circumstances in this HCP also include the results of three studies described in preceding subsections of Section 4.5 that could provide new information requiring an adaptive response, including (1) the study of accretion flows downstream of Landsburg, with the possible need to adjust instream flows if assumptions are shown to be incorrect; (2) drinking water quality monitoring related to passage of chinook and coho salmon over the Landsburg water intake, with the potential need to restrict the numbers of chinook and/or coho salmon passed above the water intake in order to protect drinking water quality; and (3)studies related to the operation of the sockeye hatchery under adaptive management to minimize impacts on wild fish. The HCP includes mitigation and conservation measures for the 76 unlisted species the City believes most likely to be listed during the term of the HCP; therefore, the potential for new listings of species during the term of the HCP has already been addressed.

Unforeseen Circumstances and Responses by the City and Services

The final No Surprises rule distinguishes "unforeseen circumstances" from changed circumstances in terms of predictability and required actions by a permittee. Under the final rule, unforeseen circumstances are defined as "changes in circumstances affecting a species or geographic area covered by a conservation plan that *could not reasonably have been anticipated* by plan developers and the [USFWS or NMFS] at the time of the conservation plan's negotiation and development, *and that result in a substantial and adverse change in the status of the covered species*" (italics added for emphasis).

In effect, unforeseen circumstances include severe, catastrophic *environmental events that are not predictable as to occurrence or severity*. For this HCP, unforeseen circumstances include (1) the effects of global climate change; (2) earthquakes; (3) significant natural or human-caused events (not the responsibility of the City) that are outside the municipal watershed and that affect species for which some or all individuals spend part of their lives outside the municipal watershed; and (4) and severe forest fires, windstorms, insect and disease outbreaks, droughts, floods, landslides. The criteria for distinguishing changed circumstances from unforeseen circumstances for severe forest fires, windstorms, insect and disease outbreaks, droughts, floods, and landslides are discussed below.

Although some scientists are beginning to speculate as to what changes in disturbance regimes could occur as a result of global climatic change (e.g., Franklin et al. 1991), it is unlikely that consensus among scientists could be achieved regarding the details of such scenarios. Nor could consensus be achieved regarding the type and magnitude of severe earthquakes that might occur in the municipal watershed (or the relevant damage they might cause), nor regarding the type or magnitude of severe events outside the watershed that could affect species addressed in the HCP. Because unforeseen circumstances cannot, by definition, be reasonably anticipated, then such unforeseen circumstances cannot be and are not addressed by the provisions for adaptive management described below under the section entitled “Specific Applications of Adaptive Management for Changed Circumstances.”

However, both the City and Services would be greatly concerned should unforeseen circumstances occur. Should a severe environmental event or unexpected facility failure occur, such as an earthquakes or a large-scale forest fire, the City intends to take whatever actions, including emergency actions, that it deems necessary and appropriate to protect water quality, infrastructure, and the environment. Under such circumstances, the Services intend to use their authority under the ESA and other laws to protect listed species and unlisted species covered by the incidental take permit.

The final No Surprises rule provides for response to unforeseen circumstances. Should such circumstances occur, the City and Services would consult as soon as feasible regarding appropriate actions. The final rule states that if additional conservation and mitigation measures are deemed necessary by the Services to respond to unforeseen circumstances, the Services “. . . may require additional measures of the permittee where the conservation plan is being properly implemented, but only if such measures are limited to modifications within conserved habitat areas, if any, or to the conservation plan’s operating conservation program for the affected species, and maintain the original terms of the conservation plan to the maximum extent possible.” The rule further states that “Additional conservation and mitigation measures will not involve the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the conservation plan without the consent of the permittee.”

The Services have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available. If additional mitigation measures are subsequently deemed necessary to provide for the conservation of a species that was otherwise adequately covered under the terms of a properly implemented HCP, the obligation for such measures does not rest with the HCP permittee, except as provided for under the final No Surprises rule described above. Changes to the HCP could be accomplished by reallocation of resources within the commitments in the HCP, or mitigation could be provided by the Services.

Summary

The provisions in sections 4.2, 4.3, and 4.4 of the HCP were developed to provide for minor disturbances and environmental events, including such events as small forest fires, windthrow, landslides related to expected road failures during winter storms, and fluctuations in precipitation that affect inflows to the Cedar River. The adaptive management program described below includes provisions to respond to the moderate disturbances or environmental events defined as changed circumstances, but does not include provisions for events defined as unforeseen circumstances.

In the discussion below, the range of severity or extent of moderate environmental events that qualify as changed circumstances are defined and distinguished from the levels of the more severe events of the same type that qualify as unforeseen circumstances. Contingency plans for changed circumstances are described that include the actions the City would take in response to such events. The three types of monitoring or studies included as changed circumstances are identified and cross-referenced to other sections of the HCP and appendices in which adaptive responses are described. In addition, adaptive management as used in this HCP is defined and the overall adaptive management program is described. A changed circumstance is just one type of condition that the adaptive management program is designed to encompass.

THE CONCEPT OF ADAPTIVE MANAGEMENT AS USED IN THE CITY'S HCP

Frissell and Bayles (1996) point out that each generation believes that the current ecological management paradigm is the good and proper one, yet history has consistently shown this assumption to be false. These authors argue that none of the schemes for managing ecological systems so far has resulted in truly sustainable resource use and ecological integrity (for a related discussion of the biological integrity of aquatic systems see Karr 1991). Many applications of ecosystem management include commodity production, which increases the challenge of maintaining biological integrity in manifold ways. Acknowledging this challenge, Jensen et al. (1996) argue that ecosystem management should only go forward with the knowledge that it is a continual learning process requiring clear goals, iterative monitoring, evaluation, and redirection.

Adaptive management is an approach that incorporates monitoring and research to allow projects and activities, including projects designed to produce environmental benefits, to go forward in the face of some uncertainty regarding consequences (Holling 1978; Walters 1986). The key provision of adaptive management is the ability and willingness to change adaptively in response to new understanding or information after an action is initiated.

Adaptive management has been used in many ways since the initial development of the concept. It has sometimes been simply a means to move forward in the face of uncertainty, lacking the safeguards inherent in a proper application of the concept. This can occur if some of the components of adaptive management are not clearly defined for a particular application.

One reason why the use of adaptive management has sometimes been less than successful is that no provision was made to limit or define the nature and magnitude of adjustments to a project or activity that may be required. For example, abandonment of a large capital project after it has been constructed and used could produce significant economic dislocations and failure of an organization to fulfill its mission. This outcome is unsatisfactory. Even when changes in levels or types of mitigation may be appropriate, such changes may be perceived as acceptable or unacceptable to different parties to an agreement. Clarifying the limits to and types of such changes early in a project can help to avoid conflict later. The final No Surprises rule (Fed. Reg. Vol. 63, No. 35, pp. 8859-8873), including its provisions for changed circumstances, is an example of both providing for adaptive responses and constraining those responses by prior agreement.

On the other hand, there are circumstances in which management can be adaptive without such a rigorous application of criteria for adjustments developed *a priori*. The City believes that a more flexible approach may be most appropriate for decision-making bodies that deal with real-time decisions and/or a variety of decisions that collectively affect species covered by this HCP. A more flexible approach may also be most appropriate for mitigation or conservation programs that have many elements or projects, each of which has an idiosyncratic set of design constraints and objectives within the overall conservation objectives of the HCP. In these less well defined or more numerous situations, the important concept underlying a successful application of adaptive management is that *cumulative learning* takes place, so that decisions and projects can become more effective over time with respect to the conservation objectives of the HCP.

Adaptive management will generally be used for some elements of this HCP where impacts of activities are uncertain but could be adverse, and, in a general sense, for all restoration elements where techniques are highly experimental. The use of adaptive management within the HCP will provide flexibility to modify specific programs to respond to specified monitoring results, changes in circumstances, or new scientific information, if applicable. It will be applied, in general, to meet the long-term, overall biological goals of the HCP and to ensure that conservation strategies are producing the desired results. For any application of adaptive management in the HCP, no changes to mitigation or conservation strategies will be made that reduce the net biological benefit of the HCP.

The City intends to use adaptive management in this HCP in both of the ways described above: (1) for specific activities and events (changed circumstances), with development of criteria for adaptive changes; and (2) in a more general, flexible sense, with no formal criteria, but with a focus on cumulative learning to make mitigation activities more effective and successful. For specific applications of adaptive management to three key issues where substantial uncertainty exists, plans will be developed based on specific criteria within prearranged and agreed-upon limits, as necessary to meet plan objectives. For events that are defined as changed circumstances, contingency responses are described below. Because they are provided for in this HCP, such changes and responses under adaptive management do not constitute unforeseen circumstances or require amendment of the permit or HCP, unless specified in the Implementation Agreement (Appendix 1). A general description of how adaptive management will be implemented for this HCP is given in Section 5.5, including the schedule for development of specific approaches.

SPECIFIC APPLICATIONS OF ADAPTIVE MANAGEMENT FOR CHANGED CIRCUMSTANCES

General Approach

The City intends to apply adaptive management to many elements of the HCP, but will, at a minimum, develop specific adaptive management approaches for the three issues listed below in this subsection. As discussed above, these three issues meet the definition of “changed circumstances.” In addition, contingency plans are described for those types of environmental events defined below as changed circumstances.

In the event of changed circumstances related to environmental events, the City will consult with the Services regarding implementation of the contingency plans described below, including whether alteration of mitigation, within the scope of the HCP, might be warranted. If the City and Services agree that alteration of mitigation is needed, then the City and Services will agree upon any changes to the mitigation described in the HCP. After such agreement, the City will implement the changes to mitigation on a schedule agreed upon by the parties.

Environmental Events Defined as Changed Circumstances

Types of Events Covered by Changed Circumstances

In addition to the three issues related to monitoring mentioned above and discussed below, the Services have also identified six types of environmental events for which they believe this HCP should address changed circumstances: forest fires, windstorms, insect infestations and disease outbreaks, floods, landslides, and droughts. To qualify for treatment under *changed circumstances*, as opposed to *unforeseeable circumstances*, the City and Services *must be reasonably able to anticipate and plan for them*. As described below, relatively small events – in some cases moderate events – of all six types are addressed through the mitigation and conservation measures described in preceding sections of Chapter 4.

Adaptive Management for Forest Fires

Major Considerations Regarding Forest Fires

Fire is the major agent of forest regeneration on the western slopes of the Cascades Mountains in the Pacific Northwest (Spies and Franklin 1988; Agee 1993; Bunnell 1995). The average return interval of severe, landscape-level (stand replacing) fires is about 300 years for Douglas-fir/western hemlock forests (Western Hemlock Zone) in the Mt. Baker-Snoqualmie National Forest (Henderson 1993), and the return intervals for higher elevation forests (Pacific Silver Fir Zone and Mountain Hemlock Zone) are even longer (Agee 1993; Bunnell 1995).

If these average return intervals could be applied directly in this HCP, then there would be about a one in six chance of such a fire affecting any area in the Western Hemlock Zone of the municipal watershed during the 50-year term of the HCP (50/300 years), and a lower chance of fire affecting any area the Pacific Silver Fir Zone (perhaps one in eight to one in twenty). If fires were predictable in this manner, one might predict that about one-sixth of the Western Hemlock Zone might be affected and one-eighth to one-twentieth of higher elevation forests might be affected over a 50-year period.

However, fire return interval in western Washington is *not* a predictable quantity, nor are the specific results of such a severe fire (Spies and Franklin 1988). Historic return intervals are highly variable in western Washington (Campbell and Liegel 1996), and Agee (1993) points out that the notion of a regular fire cycle or return interval is not as meaningful in western Washington as in drier forests, such as those on the eastern slopes of the Cascade Mountains. Agee (1993) describes the fire regime in Douglas-fir forests west of the Cascades as "episodic," as opposed to cyclic, and points out that the observed return intervals are substantially less than predicted by climatic models (900-3,500 years), suggesting that ignitions by Native Americans may have occurred.

Fires can be human caused or of natural origin, and fuel buildup (in the form of woody debris) from insect and disease outbreaks or substantial windthrow can foster ignition, spread, and severity of fires (Oliver and Larson 1990; Agee 1993). Small patch fires create canopy openings and habitat diversity, and are natural processes in forests that should not require mitigation (e.g., see McComb et al. 1993). Frequent, moderate fires that do not burn the canopy are rare in this region compared to such regions as southwest Oregon or eastern Washington (Agee 1993).

The watershed management conservation and mitigation strategies (Section 4.2.2) should provide sufficient buffering in the HCP in the event of relatively small fires. These strategies have the following relevant features:

(1) No timber will be harvested for commercial purposes, so that the removal rate of forest will be largely be determined by the nature, rate, and intensity of natural disturbances such as fire and wind. Absent any such disturbances, at HCP year 50 the acreage of mature, late-successional, and old-growth forest is projected to increase fourfold, producing a landscape much more similar to the average conditions over the last millennium than conditions today (Henderson 1990; Section 4.2.2).

(2) The restoration thinning proposed for the watershed (Section 4.2.2) will be designed to reduce the chance of forest fires by limiting development of conditions that can increase the probability of fire ignition, such as buildup of fuels and development of conditions that might lead to disease outbreaks or insect infestations.

(3) The pattern of mixed ages across the watershed landscape should serve to retard, to some extent, the spread of fires across a large area (Oliver and Larson 1990).

(4) The combination of controlled public access and aggressive fire suppression and control (Section 4.2.2) should serve to keep the chance of a serious human-caused fire starting and spreading lower than for most areas in the region (see also FEMAT 1993).

However, a large fire could cause the destruction of large areas of forest, which could impact habitat connectivity and result in soil erosion, slope failures, and sedimentation of streams, depending on the location, extent, and severity of the fire. If a substantial forest fire were to occur in the municipal watershed, the City would have significant concern for protecting water quality, and the City acknowledges that large fires can cause landscape-level impacts that could alter the effectiveness of forest restoration strategies in providing landscape-level ecological benefits for the covered species. Thus, the primary concerns in the event of a forest fire defined under changed circumstances would be (1) protection of water quality and aquatic habitat, and (2) landscape connectivity and fragmentation for forest habitat.

Changed Circumstances for Forest Fires

Changed circumstances for forest fires are defined as forest fires that remove forest cover on at least 300 acres but less than 2,000 acres in any major subbasin (Map 1). The lower threshold (300 acres) is equal to 10 percent of the smallest major subbasin and 2 percent of the largest major subbasin in the municipal watershed. The upper limit (2,000 acres) is equal to 30 percent of the smallest major subbasin and 6 percent of the largest major subbasin.

Unforeseen Circumstances for Forest Fires

Unforeseen circumstances for forest fires are defined as forest fires that remove forest cover on more than 2,000 acres in any major subbasin (Map 1).

Contingency Plan for Forest Fires

The contingency plan for forest fires under changed circumstances includes the following:

- Measures to reduce erosion and sedimentation, including stabilization of slopes and soils by such steps as reseeding, reforestation, and log terracing, and stabilization of streams and stream banks, if needed;
- Consultation with the Services regarding any planned salvage logging to develop a plan to minimize and mitigate impacts and to best meet the mitigation and conservation goals of the HCP; and
- Reconsideration and adjustment of forest restoration activities (e.g., thinning and planting), with potential changes where needed to minimize further impacts on streams and to accelerate redevelopment of forest in the most impacted areas.

Adaptive Management for Windstorms

Major Considerations Regarding Windstorms

Windstorms in the western Cascades produce small- to mid-scale disturbances that create habitat structure and foster biodiversity in developing stands (Spies et al. 1990). Wind damage is expected to be far less significant than fire in the western Cascade Mountains and generally occurs at a relatively finer scale, typically with damage to single trees or patches of trees less than 10 acres in extent (McComb et al. 1993). The City does not believe that the risk of severe damage from windstorms occurring in the municipal watershed over the term of the HCP is substantial. The landscape forest management proposed in the HCP, as described above for forest fires, provides significant buffering for relatively small losses of forest habitat to windthrow.

However, exposed groups of trees along streams may be particularly vulnerable to wind damage. If such trees were to blow down, the ecological functions of the riparian forest could be reduced or eliminated, resulting in the potential for erosion and sedimentation of streams, depending on the severity and location of the event, with potential impacts to water quality and aquatic habitats. Thus, the primary concerns in the event of a windstorm defined under changed circumstances would be (1) protection of water quality and aquatic habitat, and (2) the ecological functions of riparian forest habitat.

Changed Circumstances for Windstorms

Changed circumstances for windstorms are defined as events that result in (1) complete blowdown of 200 - 500 ft of riparian forest along any fish-bearing stream; or (2) complete blowdown along any stream from which substantial amounts of sediment could be delivered downstream as a result of the blowdown that would result in significant adverse impacts to reaches equal to 200 - 500 ft of a fish-bearing stream (Map 8).

Unforeseen Circumstances for Windstorms

Unforeseen circumstances for windstorms are defined as events that result in (1) complete blowdown of more than 500 ft of riparian forest along any fish-bearing stream; or (2) complete blowdown along any stream from which substantial amounts of sediment could be delivered downstream as a result of the blowdown that would result in significant adverse impacts to reaches equal to more than 500 ft of a fish-bearing stream (Map 8).

Contingency Plan for Windstorms

The contingency plan for windstorms under changed circumstances includes the following:

- Measures to reduce sedimentation, including measures to stabilize slopes, if feasible, by reprioritizing use of funds for riparian and/or stream restoration activities in the HCP;
- Measures to restore riparian forest, including such measures as replanting trees by reprioritizing HCP funds for riparian restoration or other restoration activities; and
- Reconsideration and adjustment of forest restoration activities (e.g., thinning and planting), with potential changes where needed to minimize further impacts on streams and to accelerate redevelopment of forest in the most impacted areas.

Adaptive Management for Disease Outbreaks and Insect Infestations

Major Considerations Regarding Disease Outbreaks and Insect Infestations

Based on historic patterns in western Washington, the chance that a large proportion of the forest in the municipal watershed would suffer disease outbreaks or insect infestations, such as severe episodes of widespread defoliation, can be expected to be small relative to many areas in the Pacific Northwest (Campbell and Liegel 1996). Spies and Franklin (1988) consider disturbances from wind, insects, and pathogens in this region to be “finer scale” than disturbances by fire, and point out that disease spreads slowly, is widely distributed, and may affect 10 percent of stands in a region. McComb et al. (1993) note that such fine-scale disturbances generate forest diversity.

The HCP includes measures to reduce the risk of disease outbreak and serious insect infestations. As Campbell and Liegel (1996) point out, planting and managing for tree species diversity and maintaining a mosaic of age classes should ameliorate risk of such outbreaks. The provisions in the HCP to plant and manage for tree species diversity and the forest thinning regimes (Section 4.2.2) should collectively reduce the chance of developing conditions that might lead to disease outbreaks or severe insect infestations. Should relatively small outbreaks or infestations occur, the projected amount of late seral forest should be adequate to buffer effects on a landscape level (Section 4.2.2). On a small to moderate scale, such events can be considered to be natural phenomena that generate biological diversity (Spies and Franklin 1988; McComb et al. 1993).

However, a substantial insect infestation or disease outbreak that led to defoliation of large areas of forest could impact habitat connectivity, increase the risk of fire through fuel (woody debris) buildup, and result in erosion and sedimentation of streams, depending on severity and location, with potential impacts to water quality and aquatic habitats. If a substantial area were to be affected in this way, the City would have significant concern for protecting water quality, and the City acknowledges that large fires can cause landscape-level impacts that could alter the effectiveness of the watershed management mitigation and conservation strategies in providing landscape-level ecological benefits for the covered species. Thus, the primary concerns in the event of a substantial disease outbreak or insect infestation defined under changed circumstances would be (1) protection of water quality and aquatic habitat, (2) increased risk of forest fire through fuel buildup, and (3) landscape connectivity and fragmentation for forest habitat.

Changed Circumstances for Disease Outbreaks or Insect Infestations

Changed circumstances for disease outbreaks or insect infestations are defined as events that defoliate forests on at least 300 acres but less than 2,000 acres in any major subbasin (Map 1).

Unforeseen Circumstances for Disease Outbreaks or Insect Infestations

Unforeseen circumstances for disease outbreaks or insect infestations are defined as events that defoliate forests on more than 2,000 acres in any major subbasin (Map 1).

Contingency Plan for Disease Outbreaks or Insect Infestations

The contingency plan for disease outbreaks or insect infestations under changed circumstances includes the following:

- Measures to reduce risk of forest fires, such as reduction of fuels from woody debris, but consistent with biological goals of HCP regarding maintenance of large woody debris for ecological reasons;
- Measures to reduce sedimentation, if needed to limit impacts to streams, including measures to stabilize slopes, if feasible by reprioritizing HCP funds for other restoration activities;
- Measures to restore defoliated forest, including such measures as replanting trees; and
- Reconsideration and adjustment of forest restoration activities (e.g., thinning and planting) in the most impacted areas, with potential changes where needed to minimize further impacts on streams and to accelerate redevelopment of forest.

Adaptive Management for Floods

Major Considerations Regarding Floods

Flooding from severe storms is a concern both within the municipal watershed and downstream of Landsburg in mainstem of the Cedar River. Natural peak flows (flood events) perform ecological functions in stream and riparian habitats that create and maintain habitat, such as channel formation, regeneration of deciduous components of riparian forests, sediment transport, and cleaning of spawning gravels (National Research Council 1996). The frequency and magnitude of flood events depends on regional climate and weather, but both the magnitude of peak flows and the severity of impacts can be influenced by human activities and alterations of the landscape.

Large flood events can damage aquatic habitats, particularly in developed areas where the natural capacity of streams and their associated floodplains to absorb floodwaters can be significantly reduced (Booth 1991; Booth and Reinelt 1993; Booth and Jackson 1994). In the Cedar River below Landsburg, narrowing of the river channels to about half its original width, bank hardening along about 64 percent of the river, and extensive development in the floodplain have significantly reduced the natural capacity of the river/floodplain system to absorb floodwaters without damage to fish habitats (King County 1993). Flood flows in the lower river can produce significant scouring of the river bed and loss of the eggs of salmon and steelhead. Because of the development in the floodplain, there is also a public interest in reducing the magnitude of floods for the purpose of protecting property along the river and in the floodplain.

Mitigation to minimize the risk of above-normal peak flows and the effects of such events *within* the municipal watershed is provided in the HCP by designation of watershed forests in reserve status (Section 4.2.2), and by a variety of management guidelines and prescriptions. These guidelines and prescriptions include measures to reduce impacts, such as road improvement and commissioning, and the modification or replacement of undersized culverts with larger culverts or bridges to avoid failures of stream crossing structures during storms, which cause sediment loading to streams (Sections 4.2.2). The proposed mitigation for watershed management (Section 4.2.2) includes funding for road repair and improvements, culvert replacements, and stream restoration in the municipal watershed that is designed to address not only current problems but also expected rates of damage from future storms.

Although the reservoir complex is not designed as a flood control facility, the City attempts to control the effects of river flooding on property and fisheries resources downstream of the Masonry Dam. Some mitigation of flood events downstream of the Masonry Dam is provided by the City's flood control management, but limitations of storage capacity constrain the City's ability to reduce peak downstream flows during such events (Section 2.2.4). The City's flood control activities, however, do not materially impair the habitat-forming effects of floods on the Cedar River, such as channel formation or gravel cleaning. The redesign of the Masonry Dam in the 1980s now allows the City to be able to pass floodwaters from the reservoir equivalent to the probable maximal flood, a capability that protects the dam from failure and protects habitat downstream from the consequences of a dam failure.

Thus, the primary concerns in the occurrence of large flood events defined under changed circumstances would be (1) sedimentation of streams within the municipal watershed as a result of landslides related to road or timber harvest, (2) damage to stream habitats within the municipal watershed from debris flows, and (3) effects on fish habitat downstream of Masonry Dam. A primary effect of floods in the municipal watershed is slope failure related to forest roads or past timber harvest, for which a response is provided below in the subsection discussing landslides.

Changed Circumstances for Floods

Changed circumstances for floods are defined as (1) floods that cause, or are likely to cause, significant long-term adverse alteration of stream habitat conditions in 10-25 percent of the total reach of any fish-bearing stream within the municipal watershed; and (2) floods within the capacity for control by the reservoir facilities.

Unforeseen Circumstances for Floods

Unforeseen circumstances for floods are defined as (1) floods that cause, or are likely to cause, significant alteration of stream habitat conditions in more than 25 percent of the total reach of any fish-bearing stream within the municipal watershed; and (2) floods beyond the capacity for control by the reservoir facilities.

Contingency Plan for Floods

The contingency plan for floods under changed circumstances includes the following:

- Measures to stabilize the unstable material added to the stream and any unstable material that could be the source of further damage to the stream if a flood causes debris flows that have impacted or could impact stream habitat conditions in 10-25 percent of the total reach of any fish-bearing stream; and

- Best efforts by the City to reduce damage to downstream fish habitat, consistent with its other responsibilities regarding water supply and protection of covered species and their habitats, in the event of a severe flood with potential consequences downstream of the reservoir.

Adaptive Management for Landslides

Major Considerations Regarding Landslides

Landslides can be natural or human-caused (Sidle et al. 1985), but the cause of deep-seated landslides (as opposed to shallow, rapid landslides) often cannot be determined. Deep-seated landslides are unpredictable and typically severe in their impacts. Naturally caused landslides are natural processes that create forest openings and provide sediment to streams that creates habitat for a wide variety of species (National Research Council 1996). Human-caused landslides on lands managed for timber production are typically related to forest roads or timber harvest, and often occur as a result of storm events (Sidle e al. 1985).

Mitigation to minimize the risk of human-caused landslides is provided in the HCP by management guidelines and prescriptions, and by a program to decommission and improve forest roads, with predicted long-term improvement of aquatic habitat quality (Section 4.2.2). The program of forest road maintenance, repair, improvement, and decommissioning provides mitigation not only to deal with problems identified during development of the HCP but also to deal with expected future road problems that could cause or do cause landslides that could affect aquatic habitat and water quality.

The primary concern in the event of large landslides defined under changed circumstances is sedimentation of streams within the municipal watershed as a result of landslides related to road or timber harvest.

Changed Circumstances for Landslides

Changed circumstances for landslides are defined as shallow, rapid landslides that are demonstrably related to roads or past timber harvest and that cause, or are likely to cause, significant long-term adverse alteration of stream habitat conditions in 10-25 percent of the total reach of any fish-bearing stream.

Unforeseen Circumstances for Landslides

Unforeseen circumstances for landslides are defined as deep-seated landslides and human-caused landslides that cause, or are likely to cause, significant alteration of stream habitat conditions in more than 25 percent of the total reach of any fish-bearing stream.

Contingency Plan for Landslides

The contingency plan for landslides under changed circumstances includes measures to minimize the occurrence of sediment inputs that could accumulate with the landslide event and exacerbate impacts to streams and covered species that use streams, accomplishing these measures, if feasible, by reprioritizing HCP funds for road maintenance or improvement.

Adaptive Management for Drought

Major Considerations Regarding Drought

Droughts are natural phenomena in the region that affect the City's ability to provide instream flows for fish and meet its water supply responsibilities. Low stream flows that occur during natural droughts reduce habitat for fish and can be accompanied by increased water temperatures that may reduce survival (National Research Council 1996). Droughts also could affect bull trout and pygmy whitefish, species that use the reservoir but spawn in tributaries, if the reservoir were to be drawn down such that access to those tributaries could be impaired for some period during their spawning seasons (Section 4.5.6).

Mitigation for the effects of droughts on the City's ability to maintain instream flows for fish is provided in the HCP by commitment to a set of critical flows and procedures and criteria for switching to critical flows (Section 4.4.2). Mitigation for the effects of drought on reservoir operations, and potentially on bull trout and pygmy whitefish, is already provided in the HCP by the mitigation and conservation measures benefiting bull trout and pygmy whitefish, including (1) measures to protect and restore spawning and rearing habitat for both species; and (2) development of a passage assistance plan for bull trout that could be used, if needed, under conditions of significant reservoir drawdown.

In addition, the operation of the Cedar River Instream Flow Oversight Commission (see Appendix 27) provides a large degree of adaptive capability for improving responses to drought conditions over the term of the HCP to best protect fish species addressed. Provisions for water conservation, water shortage contingency planning, and criteria for shifting to critical flows collectively address the issue of drought directly (Section 4.4.2).

The major concerns during droughts are (1) management of instream flows to protect anadromous fish and (2) effects of reservoir drawdown on bull trout.

Changed Circumstances for Droughts

Changed circumstances for droughts are defined as hydrological conditions producing relatively low streamflows characteristic of the worst 10 percent of years for the 64.5-year period of record for the Cedar River (see Exhibit A to the Instream Flow Agreement, Appendix 27).

Unforeseen Circumstances for Droughts

Unforeseen circumstances for droughts are defined as droughts of severity beyond those experienced in the 64.5 period of record for the Cedar River.

Contingency Plan for Droughts

The contingency plan for droughts under changed circumstances includes the following:

- Implementation of the instream flow management included in the HCP, which provides for dealing with droughts through switching to critical flows and criteria for switching to critical flows, as described in Section 4.4.2, and the Instream Flow Agreement (Appendix 27), which includes following a water shortage contingency plan for reducing drinking water demand and use; and

- Implementation of a passage assistance plan for bull trout, after its development, in years when drawdown can be shown to likely jeopardize the ability of the species to move upstream to spawn during a significant portion of the spawning season.

Adaptive Management for Studies or Monitoring under Changed Circumstances

The three issues listed below, and the contingent responses to potential outcomes, are discussed in the sections of the HCP that are cited for each. Each of these issues is defined as a changed circumstance for the HCP. All three issues entail monitoring or other studies related to outcomes about which there is uncertainty. In each case, there is a commitment to adjusting measures in the HCP based on the results of the studies or monitoring.

(1) Accretion Flows. The study of accretion flows downstream of Landsburg, with limited potential adjustment in instream flows based on results (sections 4.4.2 and 4.5.2), as provided for in the Instream Flow Agreement (Appendix 27).

(2) Landsburg Fish Passage. Contingent mitigation if, based on monitoring results, the City must curtail passage of chinook and/or coho salmon over the Landsburg Dam for water quality reasons, including regulatory changes (sections 4.3.2 and 4.5.3), as provided for in the Landsburg Mitigation Agreement (Appendix 28).

(3) Sockeye Hatchery Operation and Effectiveness. Monitoring and operation of the sockeye hatchery needed to control undesired impacts on wild fish and to determine effectiveness in helping to meet long-term goals for harvestable runs (sections 4.3 and 4.5.3), with provisions for altering hatchery operations or developing alternative mitigation, as provided for in the Landsburg Mitigation Agreement (Appendix 28).

The sections cited for each of the three issues described above specify the type and extent of additional or alternative mitigation that would occur under changed circumstances, describe a process for determining that alternative or additional mitigation, or do both.

For each of the three specific applications of adaptive management described above, the City will develop and present in a document, as provided for in the Implementation Agreement (Appendix 1), the following elements and criteria:

(1) A general monitoring and/or research plan based on explicit hypotheses, the biological objectives described in this HCP, and the appropriate research and/or monitoring plans described in the foregoing parts of Section 4.5;

(2) Threshold criteria for triggering additional or changed mitigation;

(3) Limits to the type of and commitments to any long-term mitigation triggered by monitoring criteria;

(4) A procedure for dispute resolution over interpretation of results consistent with dispute resolution procedures specific to the relevant agreement; and

(5) A process for developing and implementing any additional mitigation for which the need is demonstrated and that clearly identifies the responsibilities of the parties involved.

The timing for preparation of the adaptive management plans for the three issues referenced above is specified in Section 5.5.1.

OTHER APPLICATIONS OF ADAPTIVE MANAGEMENT

Adaptive Management as a General Tool

In those cases where adaptive management is used simply as a general tool for adaptively responding to new information or understanding, decisions about effectiveness and changes to mitigation or conservation strategies will be based on the conservation objectives of the relevant mitigation or conservation strategies. Such cases include experimental projects for watershed restoration (Section 4.2) for which adaptive responses can be expected to be needed yet the results of which are not predictable without specific project designs. The adaptive management program and the procedures in Section 5.3.2 (related to shifting funds among HCP mitigation elements) allow flexibility to make changes in this mitigation as needed, even shifting priorities among related types of mitigation or conservation activities. All such changes will be based on whether the projects are appropriately meeting their specific conservation objectives, and each project will be planned expressly so that such judgments can be made through follow-up monitoring. For any such applications of adaptive management, no changes to mitigation or conservation strategies will be made that reduce the net biological benefit of the HCP.

Adaptive Management Related to Instream Flows

Adaptive changes in the allocation of “discretionary water” and other decisions regarding instream flow management will be handled under the provisions of the Instream Flow Agreement through operation of the Cedar River Instream Flow Oversight Commission (Section 4.4.2 and Appendix 27). As described in Section 4.4.2 and Appendix 27, the

City will prepare annual instream flow compliance reports, which will include descriptions of decisions made by the City and the Commission with respect to provisions of the non-firm flows and volumes of water. The Commission will review relevant decisions at the end of each year and recommend measures that could improve performance. The City expects that this forum and procedure will result in cumulative learning and incrementally better decisions over time to best protect the anadromous salmonid for which the instream flow regime was developed.

Oversight and Flexibility to Alter Mitigation

Other ways in which implementation of the HCP provides for adaptive management include:

- The operation of oversight committees that will provide advice on project planning, review of progress during the term of the HCP, and adjustments to the plan (Section 5.4).
- The ability to transfer funds among elements of the HCP, or to new elements, but within limits to ensure that the integrity of the plan is maintained (Section 5.3.2; Appendix 1).

New information may become available for some of the species addressed in the HCP during the term of the HCP, either from monitoring or from outside sources. For example, a better general understanding of habitat relations may develop for a particular species dependent on riparian habitat, or survey results may reveal a habitat association in the municipal watershed different from that assumed for such species in developing mitigation and conservation strategies. In addition, the population status or legal status of one or more of the species addressed in the HCP may change during the term of the HCP.

In each of these two above cases, or for other reasons, it may be appropriate to alter mitigation or conservation measures to better achieve the overall conservation goals and objectives of the HCP. Several features of the HCP allow application of adaptive management in such cases: (1) the ability to reprioritize habitat restoration projects and (2) the ability to reprioritize funds or transfer funds among elements of the HCP to new elements (Section 5.3.2; Appendix 1).

For any such applications of adaptive management, no changes to mitigation or conservation strategies will be made that reduce the net biological benefit of the HCP. Such changes in mitigation and conservation measures would also have to be consistent with provisions of the Instream Flow Agreement (Appendix 27) or Landsburg Mitigation Agreement (Appendix 28), if the affected activities fall within the scope of either of these agreements. The Implementation Agreement (Appendix 1) also provides for minor modifications to the HCP (Appendix 1, § 12.1) and procedures for amending the plan to implement major modifications (Appendix 1, § 12.2).

Limitations on City Commitments

The effects of adaptive management on mitigation measures in the HCP are specified in the Implementation Agreement (Appendix 1). Reduction of specific mitigation may be allowed, but only if such changes maintain or increase the net biological benefits of the HCP (Appendix 1, § 9.3). Except as specified above under the subsection entitled “Specific Applications of Adaptive Management for Changed Circumstances,” application of adaptive management in this HCP is subject to the overall cost constraints described in Section 5.3.1, and §§ 7.4 and 9.1 of Appendix 1.

Table 4.5-7. Monitoring and research schedule and costs.

CATEGORY			
Major Element •Element +Sub-element	HCP Years	Costs	Notes
INSTREAM FLOW MONITORING			
Instream Flows			
•Maintain two existing gages	1. year 1-50	$547,000	1. USGS Cedar River below Landsburg Dam $10,940/yr
	2. year 6-50, following fish ladder installation	$246,150	2. USGS Cedar River at Cedar Falls $5,470/yr
•Establish and maintain a new gage above Cedar Falls Powerhouse	6-50, following fish ladder installation	$525,000	$30K to install $11K/yr to maintain
•Install and temporarily maintain a new Renton gage	For an estimated 10 continuous years within 1-13	$121,000	For accretion flow study $30K to install, $9100/yr to maintain
•Establish 2 temporary gages between Landsburg Dam and Renton	For an estimated 10 continuous years within 1-13	$130,000	For accretion flow study $15K/gage to install, $5K/gage/yr to maintain.
Flow Downramping Monitoring	1-50	Included in other costs	Use same gages as above
Lower Cedar River Accretion Monitoring Study	For an estimated 10 continuous years within 1-13	$400,000	
Flow Switching Criteria Study	Completed by the end of year 4	$200,000	
Cedar River Steelhead Redd and Incubation Monitoring	1-8	$240,000	$30K/year
Supplemental Studies	1-8	$1,000,000	Varies by year

CATEGORY			
Major Element •Element +Sub-element	HCP Years	Costs	Notes
ANADROMOUS FISH MONITORING AND RESEARCH			
Fish Passage Monitoring at Landsburg Dam			
•Fish Ladder Counts	For 12 years after fish ladder installation	$110,000	$50K equip. $5K/year O&M
•Intake Screening Evaluation and Monitoring			
+Installation evaluation	~6	$15,000	
•Monitoring Fish Carcass Impacts on Drinking Water Quality			
	Most likely in 1, 6, 8, 13, 18, 23	$120,000	$60K in Year 1 for recolonization studies, $10K each year for other monitoring
Sockeye Salmon Monitoring			
•Phase 1: Sockeye Fry and Juvenile Studies			
+Fry condition at release	5-50	$92,000	$2K/year
+Fry marking and mark evaluation			
	1-8, 24-27, 42-45	$320,000	$20K/year
+Wild and supplemental fry trapping/counting			
	1-8, 24-27, 42-45	$560,000	$35K/year
+Fish health	5-12, 24-27, 42-45	$320,000	$20K/year
	13-23, 28-41, 46-50	$300,000	$10K/year
+Evaluation of short-term fry rearing			
	1	$35,000	$35K
	2-4	$30,000	$10K/year
+Lake Washington plankton studies			
°Year-round studies	1-4, 24-27, 42-45	$480,000	$40K/year
°Spring studies	5-12	$56,000	$7K/year
•Phase 2: Monitoring Survival, Distribution, and Characteristics of Returning Adults			
+Adult survival, distribution, and homing studies			
	1-12, 28-31, 46-49	$800,000	$40K/year
+Phenotypic and molecular genetic study of supplemental and wild fish			
	1-4, 9-12, 28-31, 46-49	$480,000	$30K/year

CATEGORY Major Element •Element +Sub-element	HCP Years	Costs	Notes
ANADROMOUS FISH MONITORING AND RESEARCH (continued)			
Interim Steelhead, Chinook, and Coho Supplementation Monitoring or Restoration Studies			
	1-6		Cost ($720,000) included in supplementation or restoration studies
WATERSHED AQUATIC MONITORING AND RESEARCH			
Experimental Two-year Watershed Stream Monitoring and Research Program			
	-2, -1(project begun prior to effective date of HCP)	($280,000)	Study completed; no further funding needed under HCP
Long-term Watershed Stream Monitoring and Research Program			
		$459,000 total	$50K cap in any one year. Includes temp., channel stability, and BIBI
•Temperature	4-7	$16,000 (estimate)	$4K equip. $3K/year Additional study depending on results
•Channel stability and stream habitat surveys			
	4, 7, 10, 15, 20, 25	$144,000 (estimate)	$24K/year
•Benthic macroinvertebrate sampling and BIBI			
	4-8, 10, 12, 15, 20, 25, 30, 40, 50	$299,000 (estimate)	Only to be initiated if initial BIBI is successful. Early termination if warranted by results. $23K/year

CATEGORY			
Major Element •Element +Sub-element	HCP Years	Costs	Notes
WATERSHED AQUATIC MONITORING AND RESEARCH (continued)			
Watershed Aquatic Habitat Restoration Monitoring			
	4-16, 18, 20, 25, 30, 40, 50	$875,000	Up to $25K/year for years 4, 5, 6. Up to $50K/year for remaining 16 years
Watershed Aquatic Species Monitoring and Research			
•Bull Trout Monitoring and Studies			
+ Bull Trout Surveys and Relative Population Indices			
° Adult Surveys			
- Experimental Fish Weir and Live-Box Trap Counts			
	1-4 (5, 6, 10, 15, 20, 30 depending on results)	$350,000	$200K for year 1-4. Additional years and methods dependent on study results ($25K/year).
-Spawning Surveys			
	1-8	$280,000	$35K/year
-Other Adult Surveys			Included with money for other indices.
°Juvenile/Fry Surveys			
	1-8	$280,000	$35K/year
+ Bull Trout Distribution Studies			
°Bull Trout Telemetry Studies			
- Stream	For 2 years w/in 2- 7	$120,000	$60K/year
- Lake	Within years 3-9	$70,000	
°Stream Distribution Surveys			
	Five times periodically, within 1-20	$60,000	$12K/year
°Bull Trout Redd Inundation and Egg Mortality Verification Study			
	1 or more years within 1-9	$110,000	$55K/year

CATEGORY			
Major Element			
•Element +Sub-element	HCP Years	Costs	Notes
WATERSHED AQUATIC MONITORING AND RESEARCH (continued)			
Watershed Aquatic Species Monitoring and Research (continued)			
•Common Loon Monitoring	1-50	$125,000	Up to $25K/interval: 1-10, 11-20, 21-30, 31-40, 41-50
WATERSHED TERRESTRIAL MONITORING AND RESEARCH			
Watershed Habitat Research and Monitoring			
•Watershed Terrestrial Habitat Inventory			
+Assess "Expanded" Forest Polygon Data			
°Sample and evaluate	1-5	$50,000	
° Redesign and sample	6-10	$25,000	If existing data found inadequate
+Assess "Expanded" Secondary Forest Attribute Data			
° Sample and evaluate	1-5	$50,000	
°Redesign and sample	6-10	$25,000	If existing data found inadequate
+Augment Forest/Habitat Inventory	1-5	$75,000	Finish forest polygon inventory sampling if data incomplete after "assessment" sampling above

CATEGORY Major Element •Element +Sub-element	HCP Years	Costs	Notes
WATERSHED TERRESTRIAL MONITORING AND RESEARCH (continued)			
Watershed Habitat Research and Monitoring (continued)			
•Watershed Terrestrial Habitat Inventory (continued)			
+Long-term Forest/Habitat Inventory			
°Design	1-5	$18,750	
°Sample/ Monitor	During intervals: 6-10, 11-15 16-20 21-30 31-40 41-50	 $62,600 $42,500 $37,500 $75,000 $75,000 $82,500	Total $393,850 (including $18,750 above) over HCP years 1-50
+Field Verification	1-5	1-5	$56,220
+Ecological Old Growth Classification	3-10	$74,970	
•Watershed Habitat Restoration Research and Monitoring			
+Riparian Restoration Structural Development			
°Design/initiate	3-8	$35,000	
°Sample/monitor	During intervals: 9-15, 16-25, 26-35, 36-50	$300,000	Up to $75K/interval
+Upland Restoration Structural Development			
°Design/initiate	3-8	$35,000	
°Sample/monitor	During intervals: 9-15, 16-25, 26-35, 36-50	$300,000	Up to $75K/interval

CATEGORY			
Major Element			
•Element +Sub-element	HCP Years	Costs	Notes
WATERSHED TERRESTRIAL MONITORING AND RESEARCH (continued)			
Terrestrial Species Research and Monitoring Program			
•Marbled Murrelet			
+Baseline Survey, Old Growth Forest	Any two years of 3-7	$75,000	
+Baseline Survey, Second Growth			
- Design and implement habitat sampling with subsequent sampling to document occupancy, if appropriate	5-8	$150,000	
+Long-term Survey	During intervals: 25-28 and 45-48	$100,000	If murrelets not detected in 2nd growth prior to year 25. Up to $50K/interval
+Experimental Habitat Enhancement			
° Develop/ initiate	7-10	$40,000	
°Habitat enhancement			
	11-20 21-30	$80,000 $10,000	
° Monitor/ survey	During intervals: 31-40 45-48	$25,000 $60,000	
•Spotted Owl			
+Baseline Survey	One or more years during 3-10	$75,000	
+Site Center Survey	Annually for up to 5 years during intervals: 11-20, 21-30, 31-50	$75,000	Up to $25K/interval
•Optional Species/Habitat Survey(s) in Experimental/Sensitive Habitats			
+Species Survey/Research	During intervals: 9-20, 21-35, 36-48	$150,000	Up to $50K/interval

CATEGORY			
Major Element •Element +Sub-element	HCP Years	Costs	Notes
WATERSHED TERRESTRIAL MONITORING AND RESEARCH (continued)			
Data Formats and Geographic Information System (GIS) Compatibility			
	1-50	$150,000	Up to $50K for years 1-8, up to $25K/interval: 9-15, 16-25, 26-35, 35-50
Forest Growth/Habitat Development Modeling Program			
•Forest/Habitat Spatial and Structural Modeling			
	1-8	$75,000	
Species/Habitat Relationship Modeling Program			
•Species/Habitat Relationship Model(s)			
+Evaluate/Design	1-5	$100,000	
+Develop	6-10	$50,000	
+Maintain	11-50	$25,000	
Terrestrial Habitats and Species - Compliance Monitoring		Included in other costs	see text
FUTURE RESERVOIR MANAGEMENT			
Environmental Evaluation of the Cedar Permanent Dead Storage Project			
•Engineering Studies	1-5	$700,000	
•Delta Fans Geomorphological Investigation and Modeling			
	1-4	$290,000	
•Bull Trout Passage Assistance Plan			
	Completed by year 5	$65,000	
•Adaptive Management and Risks to the Bull Trout Population			
			see text
•Study of Impacts to Pygmy Whitefish and Rainbow Trout			
	Begins in 3 or 4	$280,000	Design and methodology to be worked out when study begins.

CATEGORY			
Major Element •Element +Sub-element	HCP Years	Costs	Notes
FUTURE RESERVOIR MANAGEMENT (continued)			
•Common Loon Nesting Habitat Monitoring +Loon Nesting Habitat Assessment		$30,000	see text
•River Delta Wetland Plant Community Monitoring	Twice within years 1-5	$80,000	$60K for dry years, $20K for wet years. (In budget for Cedar Permanent Dead Storage Project Evaluation)

Section 4.6 Contents

4.6 Effects of the HCP on Species of Concern

4.6.1 Introduction to Effects Analysis

The federal ESA requires that an applicant for an incidental take permit must "... to the maximum extent practicable, minimize and mitigate the impacts of such taking . . ." so that the ". . . taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild . . ." (16 U.S.C. 1539(a)(2)(B)). Previous sections in Chapter 4 of this HCP have presented the conservation and mitigation measures the City proposes to meet the foregoing standards.

The granting of an incidental take permit by the Services requires an analysis of the effects of the HCP as the basis for a biological opinion on each species to be covered by the permit. Section 4.6 summarizes information included in this HCP that is relevant to the biological opinions for the species addressed by this HCP. The Services will use the information in Section 4.6, along with other information presented in this HCP and otherwise available to the Services, to determine whether sufficient information exists to issue an incidental take permit for each of the species addressed in the HCP and the level of incidental take to be allowed under the incidental take permit for each covered species.

Note that the term "take" technically applies only to those species listed under the ESA as endangered, and the take prohibitions described in Section 9 of the ESA apply to endangered species. Take applies to species listed as threatened only if the respective Service publishes a rule to that effect under Section 4(d) of the ESA. The USFWS has a standing rule that the take prohibitions under Section 9 of the ESA apply to any species listed as threatened.

The remaining subsections of Section 4.6 present a description of how the species were grouped for analysis (Section 4.6.2); a tabular summary of the minimization and mitigation measures the City proposes to meet the standards of the ESA (Section 4.6.3); and an analysis of effects of the HCP and activities allowed under the HCP, presented for individual species and groups of species (Section 4.6.4).

Conservation and mitigation strategies are generally organized by biological community types, as described in Section 4.2.2. Habitat and community associations for each species addressed by the HCP are given in Table 4.2-3.

The effects analyses address both City operations covered by the incidental take permit and the conservation and mitigation measures included in the HCP. Both negative and positive effects are described. As described in previous sections of this HCP, the primary activities that could affect the species addressed in the HCP, both positively and negatively, include:

- Construction, use, and maintenance of forest roads, including use of gravel pits and rock sources;
- Operation of the Landsburg Diversion Dam;
- Operation of the Chester Morse Lake reservoir complex to supply drinking water and provide instream flows for fish;
- Regulation of instream flows;
- Operation of the hydroelectric power generation facility at Cedar Falls;
- Activities described in Section 4.2 in the subsection entitled “City Operations and Activities within the Municipal Watershed,” including facility maintenance, right-of-way maintenance, the public education program, recreation at specific sites, scientific research (and maintenance of research facilities), habitat projects not associated with the HCP, cultural resource management, construction of an interpretive center at Rattlesnake Lake;
- Conservation and mitigation measures that entail active intervention, such as road improvements and deconstruction, forest habitat restoration (including thinning and planting trees), construction and operation of fish passage facilities at Landsburg, downstream habitat restoration projects, and operation of a sockeye hatchery; and
- Conservation and mitigation measures that involve passive protection.

The general effects of specific measures on the species addressed have been described throughout the previous sections of Chapter 4. Many of these effects were discussed largely on a habitat basis, and were discussed in the context of a single measure or limited set of measures. The purpose of Section 4.6 is to present, in a fairly systematic format, the effects of the HCP as a whole by species or by small groups of species that share habitat associations and common effects.

4.6.2 Grouping of Species for Discussion of Effects

To reduce redundancy, yet still adequately represent the effects of the HCP and City activities on the species addressed by the HCP, some of the species were grouped for the effects analysis. Species were first grouped by community and habitat association (see Table 4.2-3), then subgroups were formed based on shared life history traits, finer similarities and differences in habitat associations, and similarity of the expected effects of minimization and mitigation measures.

Table 4.6-1 Grouping of species for the effects analysis.

Species	Group Number
Aquatic and Riparian Ecosystem	
Common Loon	**4**
Bull Trout	**5**
Pygmy Whitefish	**6**
Sockeye Salmon	**7**
Chinook Salmon, Coho Salmon, Steelhead Trout	**8**
Bald Eagle	**9**
Harlequin Duck	**13**
Great Blue Heron	**14**
Osprey	**15**
Willow Flycatcher	**16**
Northern Water Shrew, Masked Shrew	**25**
River Lamprey, Pacific Lamprey	**29**
Kokanee	**30**
Cutthroat Trout (sea run)	**31**
Tailed Frog, Pacific Giant Salamander, Cascade Torrent Salamander	**32**
Long-toed Salamander, Roughskin Newt, Northwestern Salamander, Western Toad, Red-legged Frog, Cascades Frog, Oregon Spotted Frog, Western Pond Turtle	**33**
Van Dyke's Salamander	**34**
Papillose Taildropper, Fender's Soliperlan Stonefly, Carabid Beetles (6 species)	**37**
Beller's Ground Beetle, Hatch's Click Beetle, Long-horned Leaf Beetle	**38**
Carabid Beetles (3 species)	**39**
Snail (*Valvata mergella*)	**40**
Late-successional and Old-growth Communities	
Northern Spotted Owl	**1**
Marbled Murrelet	**2**
Northern Goshawk	**3**
Three-toed Woodpecker	**17**
Pileated Woodpecker, Vaux's Swift	**18**
Olive-sided Flycatcher	**19**
Brown Creeper	**20**
Hoary Bat, Silver-haired Bat, Big Brown Bat, Long-eared Myotis, Long-legged Myotis, California Myotis, Little Brown Myotis, Keen's Myotis, Yuma Myotis, Fringed Myotis, Townsend's Western Big-eared Bat	**26**
Fisher, Marten, Wolverine	**27**
Canada Lynx	**28**
Western Redback Salamander	**35**
Johnson's (Mistletoe) Hairstreak	**41**
Blue-gray Taildropper, Puget Oregonian, Oregon Megomphix	**42**
Special Habitats	
Peregrine Falcon	**10**
Grizzly Bear	**11**
Gray Wolf	**12**
Band-tailed Pigeon	**21**
Rufous Hummingbird, Western Bluebird	**22**
Golden Eagle, Merlin	**23**

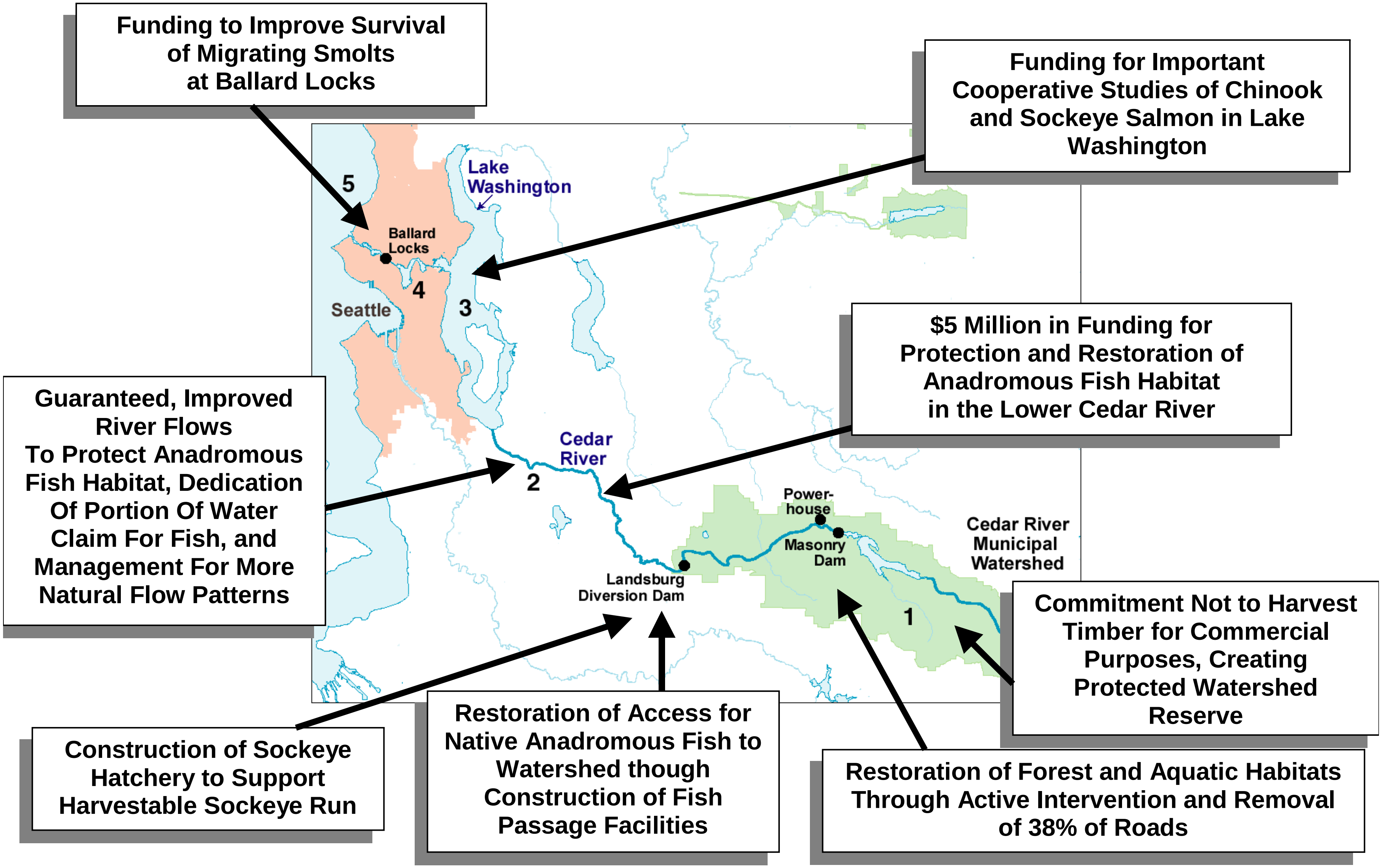
Species	Group Number
Black Swift	**24**
Larch Mountain Salamander	**36**

4.6.3 Summary of Minimization and Mitigation Measures

INTRODUCTION

This section summarizes the minimization and mitigation measures presented in sections 4.2 through 4.5 of this chapter. Habitat-based measures for the municipal watershed are discussed in detail in Section 4.2.2 (Watershed Management Mitigation and Conservation Strategies) for the Aquatic and Riparian Ecosystem, Late-successional and Old-growth Forest Communities, and Special Habitats. Measures to mitigate for the effects of the Landsburg Diversion Dam on anadromous fish are described in detail in Section 4.3.2. Measures related to management of instream flows to protect habitat for anadromous fish species are described in Section 4.4.2. Species-specific measures are described in detail in the subsection in Section 4.2.2 entitled “Species Conservation Strategies” for the 14 species of greatest concern. Applicable research and monitoring are discussed in Section 4.5. All these measures integrate on a regional basis to provide many benefits for the species addressed by the HCP (Figure 4.6-1).

Figure 4.6-1. Major contributions of HCP to regional fish and wildlife addressed by the HCP.



INTEGRATION OF MINIMIZATION AND MITIGATION MEASURES

The minimization and mitigation measures were developed on a long-term, integrated, landscape basis (Figure 4.6-1). The minimization and mitigation measures for the municipal watershed include site-specific measures to minimize or avoid impacts of City activities and to rehabilitate or restore habitats. On a landscape level, these measures will result in recruitment of additional late-seral forest habitat, acceleration of development of late-successional forest characteristics through silvicultural interventions, and reduction of anthropogenic sediment input to streams through improvement and decommissioning of forest roads. Measures that entail active intervention, including restoration and ecological thinning in forests and culvert replacement at stream crossings, entail some short-term habitat disturbance but will be designed to produce long-term habitat benefits.

With the commitment not to harvest timber for commercial purposes, these measures for the municipal watershed collectively will combine to produce landscape-level habitat improvements that, over the term of the HCP and barring catastrophes, should:

- Compared to current conditions in the municipal watershed, increase the total amount of mature, late-successional, and old-growth forest by a factor of nearly five, increase the total amount of mature and late-successional forest by a factor of thirteen, and increase the amount of mature and late-successional forest at elevations below 3,000 ft elevation by a factor of about forty-one;
- Eliminate early-seral forest habitat (less then 30 years old) created by commercial timber harvest, with early seral habitat being created primarily by natural processes and disturbances;
- Through active silvicultural intervention, accelerate development of late-successional and old-growth forest habitat conditions in about one-fifth of the forest in previously harvested areas;
- Through protection and active intervention, contribute significantly to restoring the natural ecological functions of large areas of riparian forest over time;
- Through protection and active intervention, contribute significantly to improving and restoring stream habitats over time in many areas;
- Restore and improve landscape connectivity for aquatic, riparian, and upland forest habitats through habitat improvements and through elimination or reduction of barriers to movement; and
- Improve water quality, with benefits for aquatic species in the municipal watershed and downstream of Landsburg.

The minimization and mitigation measures applying to the four anadromous salmonids addressed (chinook, sockeye, and coho salmon, and steelhead trout) are presented in three places in Chapter 4, and combine to provide a comprehensive set of conservation measures with multiple landscape-level effects from headwaters to the marine environment.

First, Section 4.2 presents minimization and mitigation measures for the municipal watershed that are also applicable to anadromous fish, especially to native stocks and species, which will be allowed into the protected municipal watershed with construction of fish passage facilities at Landsburg (Section 4.3). Because the municipal watershed contains the headwaters for the major tributary to Lake Washington, its protection is essential to the long-term well being of anadromous fish in the Lake Washington Basin.

Second, Section 4.3 presents comprehensive measures developed to mitigate for the blockage to anadromous fish posed by the Landsburg Diversion Dam. This mitigation will provide:

- Access for chinook, coho, and steelhead, as well as other native anadromous species, to some of the best refuge habitat in the region, with improvements to the Landsburg Diversion Dam and drinking water intake to minimize impacts of these facilities on anadromous fish;
- Interim mitigation for chinook salmon, coho salmon, and steelhead trout that includes funding for either key research on these species or emergency population support measures, if warranted, for one or more of these three species;
- More than $1.6 million in funding for habitat protection and restoration downstream of the municipal watershed within King County jurisdiction;
- Measures that will contribute to maintenance of harvestable populations of sockeye though direct population support provided by a fry-production facility to replace the current interim facility;
- Approximately $3.5 million in funding for monitoring and research related to the sockeye fry-production program to support adaptive management; and
- Collection of information on run sizes, timing, and distribution in the Cedar River that will make possible improved harvest management by the fisheries co-managers (WDFW and the Tribe).

Third, Section 4.4 presents measures related to management of instream flows to protect habitat in the Cedar River, along with other measures to protect and restore habitat for anadromous fish in the mainstem of the Cedar River and other measures related to water management that will provide benefits to anadromous fish and the riverine ecosystem on which they depend. The measures described in Section 4.4 include not only commitments to minimum and supplemental flows for key life stages and species but also:

- Flexible, adaptive management through an oversight commission that can provide improved flows and habitat when environmental conditions permit;
- Improvements to the hydroelectric facilities that will reduce mortality and injury to fish above Landsburg;
- Commitments regarding rate of decrease in flows (downramping) that will protect young fish from stranding during water supply and hydroelectric operations;
- A commitment to manage instream flows to more closely mimic natural patterns of flow that sustain the riverine ecosystem;
- Approximately $3.3 million in funding for habitat protection and restoration downstream of the municipal watershed within King County jurisdiction (in addition to the more than $1.6 million included in Section 4.3); and

- Adequate water for operating the Ballard Locks and funding for projects designed to increase survival of smolts moving through the locks to Puget Sound, a passage now known to be a source of significant mortality.

SUMMARY OF MINIMIZATION AND MITIGATION MEASURES

Consistent with the organization of the Watershed Management Mitigation and Conservation Strategies (Section 4.2), the minimization and mitigation measures are presented in Table 4.6-2 by the community-based strategies described in Section 4.2.2. Short names are given to each group of measures in Table 4.6-2 that apply in concert to produce specific or general effects on particular species or groups of species. Table 4.6-3 summarizes specific measures for each of the 14 species of greatest concern that are *additional* to those summarized in Table 4.6-2.

Please note that the descriptions of minimization and mitigation measures presented in tables 4.6-2 and 4.6-3 are necessarily simplified and incomplete. These tables are presented here to provide, in one place, a better overview of these measures in their totality. The reader is referred to the sections of chapters 4 and 5 cited in the tables for complete, accurate descriptions of all minimization and mitigation measures included in this HCP, as well as discussions of their effects on habitats.

Table 4.6-4 shows how each of the sets of minimization and mitigation measures apply by species or groups of species. Short names for sets of measures are as presented in Table 4.6-2.

Table 4.6-2. Summary of minimization and mitigation measures.

Subsection	Community-based focus	Short name	Major measures included
Section 4.2: Watershed Management Mitigation and Conservation Strategies			
4.2.2: Watershed management mitigation and conservation strategies	Late-successional and old-growth forest communities	Reserve status	• Commitment not to harvest timber for commercial purposes in the municipal watershed Protection through reserve status of: • All old growth forest • Spotted owl CHU • All second-growth outside limited developed areas
	Late-successional and old-growth forest communities	Habitat restoration	To accelerate development of late-successional forest characteristics and increase structural and species diversity, conduct: • Restoration planting • Restoration thinning • Ecological thinning
	Aquatic and riparian ecosystem	Reserve status	• Commitment not to harvest timber for commercial purposes in the municipal watershed Protection through reserve status of: • All streams, open water bodies, and wetlands, with riparian habitat • Inner gorges and headwalls (to prevent erosion and landslides) • Sensitive soils (to prevent erosion and habitat damage) • Wetland complexes
	Aquatic and riparian ecosystem	Habitat restoration	• To reduce sediment loading to streams, deconstruction of about 38% of roads (no longer needed for commercial timber harvest) over about 20 years • To reduce erosion and landslide potential, road improvement (stabilization) • To reduce sediment loading to streams, replacement of stream-crossing structures that are inadequate for peak flows • To restore stream connectivity, replacement of stream-crossing culverts that block fish passage • To reduce erosion into streams, stabilization of streambanks • To restore natural forest structure and function in some previously harvested areas, conifer-underplanting, restoration thinning, and ecological thinning

Subsection	Community-based focus	Short name	Major measures included
			• To improve stream habitats, placement of large woody debris in deficient stream channels
	Aquatic and riparian ecosystem	Management guidelines	• To reduce chance of landslides and erosion, strict standards for road construction, stabilization, and decommissioning • Improved standards for road maintenance and repair • Minimum road construction, and then only with previous geotechnical analysis and under strict standards • No ground-based equipment with in 50 ft of aquatic habitats • No tree cutting with 25 ft of streams, except when needed for restoration projects • No tree cutting within wetlands, except in limited circumstances when needed for restoration projects
	Special habitats	Reserve status	• Commitment not to harvest timber for commercial purposes in the municipal watershed Protection through reserve status of: • Talus and felsenmeer slopes, cliffs, and rock outcrops • Meadows and persistent shrub • Taylor town site (deciduous forest)
	Special habitats	Management guidelines	• Limitations and restrictions on activities within 200 ft of Special Habitats
	All	Public access	• Current closure of watershed to unsupervised public access, providing protection from human disturbance, hunting and fishing mortality, and poaching

Subsection	Community-based focus	Short name	Major measures included
	All	Management guidelines	• Prevention and suppression of forest fires • Watershed assessment prescriptions (Appendix 16) • Guidelines for incidental and catastrophic timber salvage • Reforesting with diverse native tree species • Restrictions on log sales and on use of any net revenues form log sales • Possible certification of forest management program under SmartWood program • No use of herbicides • Use of native seeds and plant materials in revegetation of disturbed areas • Restrictions on activities that could affect habitat and species • Forest thinning *only* for habitat improvement
	All	Species conservation strategies	• See Table 4.6-3 (for 14 species of greatest concern)
	All	Oversight and adaptive management	• Oversight by agencies, public, and outside scientists through HCP Oversight Committee (Chapter 5) • Monitoring and provisions to alter mitigation to better meet conservation objectives (Section 4.5 and Chapter 5)
Section 4.3: Minimizing and Mitigating the Effects of the Anadromous Fish Barrier at the Landsburg Diversion Dam			
4.3.2: Conservation Strategies	Aquatic and riparian (anadromous fish)	Interim: chinook, coho, and steelhead	Either one or a combination of both: • Population studies to support development of best long-term protection and rehabilitation measures • Emergency artificial propagation (if needed for any species)
	Aquatic and riparian (anadromous fish)	Interim: sockeye	• Extended funding of existing interim hatchery (fry-production facility) • Evaluation of short-term rearing of hatchery fry

Subsection	Community-based focus	Short name	Major measures included
	Aquatic and riparian (anadromous fish)	Long-term: chinook, coho, and steelhead	• Fish ladders at dam and pipeline crossing at Landsburg, providing access to 17 miles of protected, refuge habitat in municipal watershed • Fish sorting and holding facilities to allow separation of sockeye from other species and their return downstream. • Downstream passage facilities for adult and juvenile fish at Landsburg Dam • Fish screening and bypass facilities to prevent entrainment of juvenile (newly emerged fry through smolts) and adult salmonids into the water intake at Landsburg Dam • Maintenance and operation of fish passage facilities • Water quality monitoring for effects of salmon carcasses, to supply information allowing either an increase or decrease in number of fish allowed upstream; if a decrease, funding to be provided for alternative mitigation • Monitoring of fish passage and screening facilities • Measures for municipal watershed (under 4.2.2 above) • Instream flow protection between Lower Cedar Falls and Lake Washington, downramping prescriptions, and tailrace barrier at Cedar Falls hydroelectric project (under 4.4.2 below) • More than $1.6 million in funding for habitat protection and restoration on the Cedar River downstream of Landsburg (see funding also under 4.4.2 below)
	Aquatic and riparian (anadromous fish)	Long-term: sockeye	• Funding for construction and operation of fry-production facility • Monitoring and research to determine effectiveness and effects of mitigation program (see Table 4.6-3)
	Aquatic and riparian (anadromous fish)	Oversight and adaptive management	• Oversight committee to advise City on mitigation • Joint decision-making of the City and agencies to adaptively manage hatchery and other mitigation, to ensure conservation objectives are met
Section 4.4: Instream Flow Management Strategy			
4.4.2: Conservation Strategies for Instream Flow Management	Aquatic and riparian (anadromous fish)	Stream flows below Landsburg	• Binding minimum flows in the Cedar River, based on extensive, cooperative studies, that benefit all life history stages of chinook, sockeye, coho, and steelhead as prioritized by interagency Cedar River Instream Flow Committee • Annual instream flow pattern that reflects natural flow patterns and the body of scientific information about Cedar River salmonids

Subsection	Community-based focus	Short name	Major measures included
			• Instream flow regime and adaptive management designed to minimize conflicts among species Minimum flow commitments: • From early October through early August, flow commitments greater than or equal to flows required to provide maximum habitat (WUA) for key species and life history stages • From early August through late September, commitments providing 98-99% of maximum WUA for steelhead rearing • Flows greater than or equal to the level that provides maximum WUA for chinook and sockeye spawning for most of the fall • Winter/spring flows to protect salmon redds from dewatering • Summer block (volume) of water (2,500 acre ft) in all normal years to protect steelhead redds • Summer flows to protect rearing steelhead and coho • Flows during drought years (critical flows) that provide protection for species Supplemental flows: • Additional block of water (3,500 acre-feet) during summer to reduce risk of steelhead redd dewatering in 70% of normal years • Additional normal and critical flows for early spawning chinook and sockeye when overflow dike flashboards are in place • High normal flows in at least 63% of all normal years for increased sockeye cumulative spawning habitat and edge habitat, and higher flows for chinook spawning • Increased flow for outmigrating sockeye fry 70% of time from early February through mid-April in normal years To help maintain the riverine ecosystem: • Management of river flows to achieve more natural patterns, taking into consideration the disturbed nature of channel in lower Cedar River Conserving water for fish: • City efforts to dedicate one-third (100 mgd) of Seattle’s water right claim for fish • City commitment to goal of reducing per capita water consumption over a decade by 10% in both Seattle and wholesale service areas

Subsection	Community-based focus	Short name	Major measures included
			Based on 50-year projections of expected, actual river flows below Landsburg: • Cumulative WUA for priority species and life stages greater than under current *or* unregulated conditions in Cedar River
		Stream flows above Landsburg	• Flows near or above levels that provide maximum habitat (WUA) between hydroelectric powerhouse at Cedar Falls and Landsburg Dam. • Flows for rearing salmon and steelhead in (hydroelectric plant) bypass reach between Masonry Dam and powerhouse
		Flow downramping	• Limited allowable flow downramping rates at Landsburg Dam, Cedar Falls Hydroelectric Powerhouse, and Masonry Dam to minimize risk of stranding juvenile salmonids
		Hydro facility improvements	• Emergency bypass capability at Cedar Falls Hydroelectric Facility to minimize impact of shutdowns • Tailrace rack to exclude fish from turbine effluent pipes at Cedar Falls Hydroelectric Facility
		Downstream habitat funding	Total of approximately $3.3 million for downstream habitat, including: • More than $4.6 million in funding for protection and restoration of habitat in the Cedar River below Landsburg (King County jurisdiction) • $270,000 for habitat restoration in the Walsh Lake system, if matched by King County (see also additional $1.6 million under 4.3.2 above, with total funding about $5 million)
		Ballard Locks improvements	• Local match funding for feasibility study and implementation of project to save freshwater, resulting in improved fish survival • Funding for smolt passage improvements to increase survival
		Permanent dead storage evaluation	• Analysis of permanently accessing water below the natural outlet of Chester Morse Lake, potentially allowing both improved instream flows and increased water supply • Bull trout passage assistance plan, which can be used even if Cedar Permanent Dead Storage Project is never built

Subsection	Community-based focus	Short name	Major measures included
		Flow studies	• Studies to improve flow switching criteria • Monitoring of steelhead redds to better protect incubating steelhead • Accretion flow study in the lower Cedar River, with potential adjustment of flows if warranted • $1 million in funding for supplemental studies focussed primarily on chinook salmon in Cedar River and Lake Washington
		Flow oversight and adaptive management	• Cedar River Instream Flow Oversight Commission • Agency participation in flow allocation decisions and response to study results in cooperative management model • Real-time and long-term adaptive management, with cumulative learning and improved decision-making by City and Commission

Table 4.6-3. Summary of specific minimization and mitigation measures included in the individual species conservation strategies for the 14 species of greatest concern (Section 4.2.2) that are additional to those summarized in Table 4.6-2.

Species	Additional species-specific measures
Northern spotted owl	• Protection in reserve status of entire spotted owl CHU, all old-growth forest, and all second-growth forest outside limited developed areas • Restricted activities near active nests • Protection of habitat within reproductive site centers • Baseline survey and annual surveys of reproductive site centers • Habitat quality monitoring
Marbled murrelet	• Protection in reserve status of entire spotted owl CHU, all old-growth forest, and all second-growth forest outside limited developed areas • Occupancy surveys in old growth and second growth forest • Restricted activities near active nests • Protection of potential nest trees • Determination of potential habitat and experimental habitat improvements in second growth • Habitat quality monitoring
Northern goshawk	• Protection in reserve status of entire spotted owl CHU, all old-growth forest, and all second-growth forest outside limited developed areas • Restricted activities near active nests • Habitat quality monitoring
Bull trout	• Public access for fishing prohibited • Major studies: life history, habitat needs, population status, management impacts, success of restoration projects • Bull trout passage assistance plan, which can be implemented even if Cedar Permanent Dead Storage Project is never built • Study results used for adaptive management
Pygmy whitefish	• As for bull trout, except that passage assistance plan not needed
Chinook, coho, and steelhead	• Public access for fishing prohibited within municipal watershed • As in Table 4.6-2
Sockeye salmon	As in Table 4.6-2, with monitoring and research to determine effectiveness and effects of mitigation program, including: • Fish health monitoring at hatchery • Evaluation of short-term rearing of hatchery fry • Marking and evaluation of hatchery fry condition • Genetic and phenotypic studies of adults • Studies to determine relative survival of hatchery vs. wild adults and fry • Studies of straying into Bear Creek and its impacts to facilitate adaptive management • Studies of potential effects of broodstock collection methods on other species
Bald eagle	• Restricted activities near active nests • Restricted activities near active communal roost sites Note that measures to increase anadromous fish populations and provide passage into the municipal watershed will benefit bald eagles

Species	Additional species-specific measures
Common loon	• Restricted activities on reservoir during breeding season • Experimental nest platform project • Annual nesting surveys • Evaluation of future reservoir operating regimes for impact on nesting habitat and food resources
Gray wolf	• Restricted activities near active dens and rendezvous sites • Careful observation of active dens Note that restricted public access and reduction of road system by about 38% will provide significant benefits
Grizzly bear	• Restricted activities near active dens • Careful observation of active dens Note that restricted public access and reduction of road system by about 38% will provide significant benefits
Peregrine falcon	• Restricted activities near active nests • Careful observation of active nests

Table 4.6-4. Applicability of minimization and mitigation measures to species and groups of species.

			Minimization and Mitigation Measures (short names from Table 4.6-2)																			
		Strategy:	Watershed						Fish Mitigation					Instream Flows								
Group Number	Species in Group by Primary Habitat or Community Association	Community or Habitat	Reserve status	Management guidelines	Habitat restoration	Controlled pubic access	Oversight & adaptive management	Species conservation strategies	Interim: chinook, coho, & steelhead	Interim: sockeye	Long-term: chinook, coho, & steelhead	Long-term: sockeye	Oversight & adaptive management	Stream flows below Landsburg	Stream flows above Landsburg	Flow downramping	Hydro facility improvements	Ballard Locks improvements	Downstream habitat funding	Permanent Dead Storage evaluation	Flow studies	Oversight & adaptive management
	Aquatic & Riparian																					
4	Common Loon	lk	k	x	s	x	x	x												pi		
5	Bull Trout	lk, st	k	x	x	x	x	x												pi		
6	Pygmy Whitefish	lk, st	k	x	x	x	x	x												pi		
7	Sockeye Salmon	lk, st	s	s	s			x		x		x	x	x		s	s	x	x	pb	x	x
8	Chinook Salmon, Coho Salmon, Steelhead Trout	st	k	x	x	x	x	x	x		x		x	x	x	x	x	x	x	pb	x	x
9	Bald Eagle	lk,st,rip,mf	k,r	x	x	x	x	x		s	s	s		s	s				s	pi	s	
13	Harlequin Duck	st,rip	k,r	x	x	s	x															
14	Great Blue Heron	st,rip,sh	k,r	x	x	x	x				s											
15	Osprey	st,rip	k,r	x	x	x	x			s	s	s		s	s				s	pi		
16	Willow Flycatcher	rip,sh	k,r	x	x	s	x															
25	Northern Water Shrew, Masked Shrew	st,rip,sh	k,r	x	x	s	x															
29	River Lamprey, Pacific Lamprey	st	k	x	x	s	x							x	x	x			x	pb		
30	Kokanee	lk,st	k	x	x	x	x												x			
31	Cutthroat Trout (sea run)	lk,st	k	x	x	x	x				x		x	x	x	x	x	x	x	pb	x	x
32	Tailed Frog, Pacific Giant Salamander, Cascade Torrent Salamander	st,rip	k,r	x	x	s	x															

			Minimization and Mitigation Measures (short names from Table 4.6-2)																			
		Strategy:	Watershed						Fish Mitigation					Instream Flows								
Group Number	Species in Group by Primary Habitat or Community Association	Community or Habitat	Reserve status	Management guidelines	Habitat restoration	Controlled pubic access	Oversight & adaptive management	Species conservation strategies	Interim: chinook, coho, & steelhead	Interim: sockeye	Long-term: chinook, coho, & steelhead	Long-term: sockeye	Oversight & adaptive management	Stream flows below Landsburg	Stream flows above Landsburg	Flow downramping	Hydro facility improvements	Ballard Locks improvements	Downstream habitat funding	Permanent Dead Storage evaluation	Flow studies	Oversight & adaptive management
	Aquatic & Riparian																					
33	Long-toed Salamander, Roughskin Newt, Northwestern Salamander, Western Toad, Red-legged Frog, Cascades Frog, Spotted Frog, Northwestern Pond Turtle	st,rip,sh	k,r	x	x	s	x															
34	Van Dyke's Salamander	rip,sh,mf	k,r	x	x	s	x															
37	Papillose Taildropper, Fender's Soliperlan Stonefly, Carabid Beetles (6 species)	st,rip,mf	k,r	x	x	s	x															
38	Beller's Ground Beetle, Hatch's Click Beetle, Long-horned Leaf Beetle	rip,sh	k,r	x	x	s	x															
39	Carabid Beetles (3 species)	sh	k	x	x	s	x															
	Late-seral Forest																					
1	Northern Spotted Owl	mf	k,r	x	x	x	x	x														
2	Marbled Murrelet	mf	k,r	x	x	x	x	x														
3	Northern Goshawk	mf	k,r	x	x	x	x	x														
17	Three-toed Woodpecker	mf	k,r	x	x	s	x															
18	Pileated Woodpecker, Vaux's Swift	mf,sh	k,r	x	x	s	x															
19	Olive-sided Flycatcher	mf,sh	k,r	x	x	s	x															
20	Brown Creeper	mf,sh	k,r	x	x	s	x															

			Minimization and Mitigation Measures (short names from Table 4.6-2)																			
		Strategy:	Watershed						Fish Mitigation					Instream Flows								
Group Number	Species in Group by Primary Habitat or Community Association	Community or Habitat	Reserve status	Management guidelines	Habitat restoration	Controlled pubic access	Oversight & adaptive management	Species conservation strategies	Interim: chinook, coho, & steelhead	Interim: sockeye	Long-term: chinook, coho, & steelhead	Long-term: sockeye	Oversight & adaptive management	Stream flows below Landsburg	Stream flows above Landsburg	Flow downramping	Hydro facility improvements	Ballard Locks improvements	Downstream habitat funding	Permanent Dead Storage evaluation	Flow studies	Oversight & adaptive management
	Late-seral Forest																					
26	Hoary Bat, Silver-haired Bat, Big Brown Bat, Long-eared Myotis, Long-legged Myotis, California Myotis, Little Brown Myotis, Keen's Myotis, Yuma Myotis, Fringed Myotis, Western Big-eared Bat	lk,st,rip,sh,mf	k,r	x	x	x	x															
27	Fisher, marten, wolverine	mf,rip,sh	k,r	x	x	x	x															
28	Lynx	mf,rip,sh	k,r	x	x	x	x															
35	Western Redback Salamander	rip,sh,mf	k,r	x	x	s	x															
40	Johnson's (Mistletoe) Hairstreak	mf	k,r	x	x	s	x															
41	Blue-gray Taildropper, Puget Oregonian, Oregon Megomphix, Carabid Beetle (1 species)	mf	k,r	x	x	s	x															
	Special Habitats																					
10	Peregrine Falcon	sh	k	x	s	x	x	x														
11	Grizzly Bear	rip,sh,mf	k,r	x	s	x	x	x														
12	Gray Wolf	rip,sh,mf	k,r	x	s	x	x	x														
21	Band-tailed Pigeon	rip,sh	k	x	x	s	x															
22	Rufous Hummingbird, Western Bluebird	sh,rip	k	x	x	s	x															

Group Number	Species in Group by Primary Habitat or Community Association	Community or Habitat	Reserve status	Management guidelines	Habitat restoration	Controlled pubic access	Oversight & adaptive management	Species conservation strategies	Interim: chinook, coho, & steelhead	Interim: sockeye	Long-term: chinook, coho, & steelhead	Long-term: sockeye	Oversight & adaptive management	Stream flows below Landsburg	Stream flows above Landsburg	Flow downramping	Hydro facility improvements	Ballard Locks improvements	Downstream habitat funding	Permanent Dead Storage evaluation	Flow studies	Oversight & adaptive management
			Minimization and Mitigation Measures (short names from Table 4.6-2)																			
		Strategy:	Watershed						Fish Mitigation					Instream Flows								
	Special Habitats																					
23	Golden Eagle, Merlin	sh,mf	k	**x**	**x**	**x**	**x**															
24	Black Swift	rip,sh,mf	k	**x**	**x**	s	**x**															
36	Larch Mountain Salamander	sh	k	**x**	**x**	s	**x**															

Community or Habitat

lk	lake
st	stream
rip	riparian
mf	mature, late-successional, or old-growth forest
sh	special habitats

Cell entries

k	All key habitat protected through reserve status
r	Habitat recruited (increased) over time
x	Applies in significant fashion
s	Applies to some extent
pb	Potential benefit if project implemented
pi	Potential impact if project implemented
(shaded)	Shading indicates significant contribution

Strategy

	Section	*Name*
Watershed management	4.2.2	Watershed Management Mitigation and Conservation Strategies
Fish mitigation	4.3.2	Minimizing and Mitigating theEffects of the Anadromous Fish Barrer at the Landsburg Diversion Dam
Instream flows	4.4.2	Instream Flow Management Strategy

4.6.4 Effects of HCP and Activities Allowed under the HCP

SUMMARIES OF EFFECTS

This section presents the results of the effects analyses performed for the species and groups of species identified in Table 4.6-1. Minimization and mitigation measures applicable to each species or group of species are not repeated below, but references are made to tables 4.6-2 and 4.6-3. For each species or group, the following are presented:

- Brief summary of status regionally and in the municipal watershed, primary habitat associations, and activities that could produce impacts;
- Pertinent minimization and mitigation measures;
- Primary beneficial and detrimental effects, including habitat effects, disturbance effects and potential for direct take, population-level effects, and other effects that may occur; and
- Determination of whether the HCP produces net benefits for the species addressed.

LATE-SUCCESSIONAL AND OLD-GROWTH COMMUNITIES

Group #1 – Northern Spotted Owl

Introduction

Northern spotted owls are present in the Cedar River Municipal Watershed. One recently active reproductive site center and one currently inactive reproductive site center have been documented in the watershed. Both of these site centers are within the CHU. Two single, resident site centers and one single, status-unknown spotted owl have been documented in the watershed. One of the two single, resident site centers is also within the CHU.

Potential key habitats for the northern spotted owl in the Cedar River Municipal Watershed are primarily mature, late-successional, and old-growth forests. Coniferous forest in older age classes is the most likely to have developed “old forest habitat” structural characteristics needed by spotted owls for nesting, roosting, foraging, and dispersal (N/R/F/D) as defined in WAC 222-16-085(1), or “sub-mature habitat” characteristics needed by owls for roosting, foraging, and dispersal (R/F/D) as defined in WAC 222-16-085(1). Three of the four spotted owl site centers documented within the watershed are in unharvested native forest greater than 189 years old (i.e., old growth as defined by SPU). Both reproductive site centers are in forest older than 250 years. All four documented site centers are in the eastern (higher elevation) section of the municipal watershed; three of the four are within the CHU.

The combination of mitigation and minimization measures committed to in the HCP protects the northern spotted owl population in the municipal watershed. The likelihood of direct injury or death of any northern spotted owls resulting from restoration or ecological thinning or other operational activities is expected to be very low under the

HCP, as is the likelihood of disturbance to any actively nesting spotted owl pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute take under the ESA. A net gain of potential spotted owl habitat (nesting, roosting, foraging, and dispersal) is expected over the 50-year term of the HCP.

The HCP is expected to result in both short-term and long-term benefits to northern spotted owls through: (1) protection of all existing old-growth forest; (2) elimination of timber harvest for commercial purposes in the watershed, including within the spotted owl CHU; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) restoration thinning of about 11,000 acres, ecological thinning of about 2,000 acres, and restoration planting of about 1,400 acres designed to facilitate structural development of mature forest characteristics in second-growth forest in some areas; (5) removal of 38 percent of existing watershed roads; (6) monitoring and research; and (7) protection from human disturbance around reproductive site centers with actively nesting pairs.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the northern spotted owl are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

All watershed forest (outside limited developed areas), including 13,889 acres of old growth, is placed in reserve status under the HCP and no timber harvest for commercial purposes will occur. Therefore, all virtually all forest in the municipal watershed is protected that has documented spotted owl site centers, that currently has “old forest habitat” structural characteristics preferred by spotted owls for N/R/F/D, and that could be used for dispersal.

The oldest forest present in the watershed, with the exception of old growth (over 189 years old), is second growth classified as mature (over 80 years old). The remaining forested area is in younger seral stages (some recently harvested). Because no existing second-growth forest is sufficiently old enough at present to reach 189 years of age over the 50-year term of the HCP, it follows that no additional old-growth forest (as defined by age) will be produced in the watershed by 2050. However, increases in the quantity of both mature and late-successional forest seral stages are expected under the HCP as a result of natural maturation of second-growth forests and silvicultural treatments to accelerate such development. Approximately 13,889 acres of old-growth forest, 23,918 acres of late-successional forest and 34,932 acres of mature forest are projected to exist in the watershed by the year 2050 under the HCP (Section 4.2.2). This represents nearly a five-fold increase in combined mature, late-successional, and old-growth forest compared to current conditions.

Not all of the mature, late-successional, or even old-growth forest in the watershed is expected to provide N/R/F/D or R/F/D habitat of equal quality or potential for northern spotted owls either on a short-term (year 2020) or long-term (year 2050) basis. This is because forest characteristics (e.g., species composition, canopy closure, number of canopy layers, tree density, snags and logs, average tree diameter) not only vary naturally in unharvested forest as a result of different site conditions, aspect, and elevation, but also vary in second-growth forest as a result of historic harvest practices and recent forest management regimes.

Under the HCP, potential northern spotted owl habitat in selected second-growth forest stands within the watershed is expected to benefit from management actions - ecological thinning and restoration thinning - intended to accelerate development of second-growth forests with “old forest habitat” structural characteristics needed by owls for N/R/F/D or “sub-mature habitat” characteristics needed by owls for R/F/D. Natural maturation and silvicultural restoration of upland forests, including restoration thinning of second-growth regeneration stands, and eventual ecological thinning of older developing stands, will hasten the establishment of forest cover on recently harvested areas of the upper watershed and promote increased forest habitat connectivity over the term of the HCP. Increases in connectivity of forested habitat, especially between extant patches of old-growth forest, will be of particular significance in the CHU. In addition, silvicultural treatments including ecological thinning and limited restoration thinning, in selected, second-growth reserve forest in the lower elevations of the watershed may also improve habitat conditions for spotted owls by fostering the development of mature and late-successional structural characteristics. Approximately 11,000 acres is projected to be treated by restoration thinning and approximately 2,000 acres by ecological thinning.

However, these management actions to accelerate development of late-successional characteristics may have immediate, short-term, negative effects upon owls living in the immediate vicinity. The thinning operations could reduce habitat suitability for owls in the near term by altering and/or removing structural characteristics important to owls, such as snags, perching sites, shrub understory, or intermediate canopy layers. However, approaches to thinning should ameliorate risks to owls. Such features as large trees and snags will generally be preserved by the City during thinning, because of their contribution to natural forest structure and function, and efforts will be made to minimize disturbance of shrubs and other features of importance to owls. In the long term, SPU anticipates that these treated stands will respond favorably to the thinning, and after several years to a decade, the thinning treatment will have produced a net positive effect on habitat for spotted owls.

Removal of 38 percent (approximately 240 miles) of forest roads in the watershed will also improve habitat conditions for spotted owls over the long term by reducing the amount of forest fragmentation and thus the amount of non-forested edge habitat present in the watershed. A reduction in non-forested edge habitat would be expected to make forest habitat conditions in general less favorable to other avian species that are predators on spotted owls (Section 3.5.2).

An additional benefit derived from the combined effects of habitat protection (especially of old growth), natural maturation of second-growth forest, and silvicultural treatments to foster the accelerated development of “old forest” structural characteristics in younger forests is the long-term development of a more natural distribution and adjacency of habitat types and stand age classes across the landscape of the municipal watershed than currently exists. Eventually, reserve forests within the watershed will be restored to conditions typical of landscapes prior to logging in the region and will provide significant benefits to highly mobile species such as the northern spotted owl.

Disturbance Effects

The primary activities that could result in disturbance, and possibly take of spotted owls in the watershed, include any operations that involve human activities on roads or in suitable habitat, including the following: restoration thinning of about 11,000 acres, ecological thinning of about 2,000 acres, and restoration planting of about 1,400 acres; and road removal (about 240 miles over the first twenty years, with the potential for additional road removal later), maintenance of about 520 miles of road/year at the beginning of the HCP, diminishing as roads are removed over time to about 380 miles/year at year 20, improvement (about 4-10 miles year, occasionally more), or use. However, the likelihood of disturbance to any actively nesting spotted owl pair in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in section 4.2.2 of the HCP: (1) protection of all documented spotted owl nest sites, all suitable habitat for nesting pairs, and reproductive site centers in the watershed; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules [NOTE: the HCP will waive any state rules under WAC-222-16-085, NSO Habitat Protection]; (4) avoidance of construction and other activities near active nests that could disrupt successful nesting; (5) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting spotted owl pairs and other resident or transient owls; and (6) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term.

Direct Take

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to or death of any spotted owl resulting from restoration planting or thinning; ecological thinning; road removal, maintenance, improvement or use, or other operational activities is expected to be extremely low.

Population-level Effects

The mitigation and minimization measures committed to in the HCP will substantially decrease, and nearly eliminate, habitat fragmentation within the CHU and the watershed as a whole during the 50-year term of the HCP, thereby increasing the effectiveness of the CHU (and the entire watershed) as habitat for the northern spotted owl population in the Snoqualmie Pass area. In addition, the watershed, especially the CHU, is an important north-to-south link for spotted owls dispersing from the Alpine Lakes Wilderness Area and Forest Service lands designated as Late-successional Reserve (LSR) to the north, and a spotted owl CHU centered on the Green River and Greenwater River watersheds to the south. The development of potential spotted owl habitat in a more natural pattern of distribution over the entire landscape of the watershed will also allow individual owls to locate potentially suitable habitat in a substantially greater area of the watershed than at present and possibly foster potential population expansion within and adjacent to the watershed.

Other Effects

The monitoring and research program committed to in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the northern spotted owl (Section 4.2) are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #2 – Marbled Murrelet

Introduction

Marbled murrelets were detected during one survey period in the Cedar River Municipal Watershed in recent years. The detection site is located in an upper elevation sub-basin that contains remnant patches of old-growth forest that are among the oldest (approximately 850 years) remaining in the watershed.

Marbled murrelets winter on marine waters and move inland up to a maximum of 66 miles (most located within 40 miles) during summer to nest in west slope coniferous forests. The easternmost extent of the municipal watershed is within 45 miles of marine waters. Potential key inland habitat for the marbled murrelet is older mature, late-successional, and old-growth forest. Most remaining old growth is at higher elevations in the eastern portion of the watershed and the western, lower elevations support mostly young and mature second-growth forest. Forest in the mature and late-successional stages is lacking throughout most of the watershed landscape. It can be expected that, at least in the short term, upper elevation old-growth forests may continue to receive a relatively higher level of use by nesting murrelets. However, on a long-term basis, as second-growth forests at lower elevations mature and develop suitable habitat characteristics, they may become of equal or even greater significance to murrelets because of their closer proximity to marine wintering and foraging areas.

The combination of mitigation and minimization measures committed to in the HCP are expected to protect any marbled murrelets nesting in the municipal watershed. The likelihood of direct injury or death of any marbled murrelet resulting from silvicultural treatments, road management or use, or other operational activities is expected to be extremely low under the HCP, as is the likelihood of disturbance to any actively nesting murrelet pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute take under the ESA. A net gain of potential marbled murrelet nesting habitat is expected over the 50-year term of the HCP. The HCP is expected to result in both short-term and long-term benefits to marbled murrelets through: (1) protection of all existing old-growth forest; (2) elimination of timber harvest for commercial purposes within the watershed; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests; (5) habitat and occupancy surveys of potential second-growth habitat, as well as surveys in old growth; (6) experimental silvicultural treatments in second growth to promote forest structure conducive to murrelet nesting; (7) removal of 38 percent of watershed roads; and (8) protection of nesting pairs from human disturbance that could disrupt nesting.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the marbled murrelet are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no timber harvest for commercial purposes will be conducted in the watershed, all forested land outside limited developed areas is in reserve status, including all 13,889 acres of old growth and virtually all second-growth forest. The protected, low-elevation forest represents a substantial portion of the watershed and although in mostly young and mature seral stages at present, potentially could provide an important source of suitable habitat for marbled murrelets on a long-term basis.

The oldest forest present in the watershed, with the exception of old growth (over 189 years old), is second growth classified as mature (over 80 years old). The remaining forested area is in younger seral stages (some recently harvested). Because no existing second-growth forest is sufficiently old enough at present to reach 189 years of age over the 50-year term of the HCP, it follows that no additional old-growth forest (as defined by age) will be produced in the watershed by 2050. However, increases in the quantity of both mature and late-successional forest seral stages are expected under the HCP as a result of natural maturation and silvicultural treatments designed to accelerate the development of mature forest characteristics in second-growth forests. Approximately 23,918 acres of late-successional forest and 34,932 acres of mature forest are projected to exist in the watershed by the year 2050.

Not all of the mature, late-successional, and even old-growth forest in the watershed that currently exists or will mature during the term of the HCP, is expected to provide nesting habitat of equal quality or potential for marbled murrelets. This is because forest characteristics (e.g., species composition, canopy closure, snags, average tree diameter, branching structure) not only vary naturally in unharvested forest as a result of different site conditions, aspect, and elevation, but also vary in second-growth forest as a result of historic harvest practices and recent forest management regimes. For example, only one minor subbasin (8,089 acres) in the entire watershed, containing just 788 acres of old growth (less than 0.06 percent of the 13,889 acres of old-growth forest in the watershed), has had documented use by murrelets. This subbasin contains several of the oldest patches of forest in the watershed, ranging up to 850 years old. In marked contrast, the majority of the old growth in the watershed ranges from 250-350 years old. Also, most of the old growth in this subbasin is in a single, contiguous stand (444 acres) that exhibits advanced development of both vertical and horizontal structural characteristics and ecological function. The remainder of the surrounding habitat is in variable stages of post-harvest seral development (mostly advanced conifer regeneration).

Considerable acreage of low-elevation mature and late-successional coniferous forest is also expected to develop over the 50-year term of the HCP as a result of natural maturation and silvicultural treatments designed to accelerate the development of mature forest characteristics in second-growth forests. Overall, the municipal watershed is expected to have 33,858 more acres of mature forest and 23,827 more acres of late-successional forest by the year 2050 under the HCP, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). Most of this older forest habitat in year 2050 will develop at low elevations, where the second-growth is currently older than in most other parts of the watershed (Section 4.2.2). Second-growth forest will be evaluated to determine its potential as marbled murrelet habitat (sections 4.2.2 and 4.5.5), for the purposes of planning habitat improvement projects and monitoring change in murrelet use over the term of the HCP.

The following management actions committed to in the HCP will provide significant benefits to marbled murrelet habitat in the watershed: (1) elimination of timber harvest for commercial purposes in the municipal watershed, with consequent recruitment of a substantial amount of potential habitat over the 50-year term of the HCP; (2) restoration thinning of about 11,000 acres, ecological thinning of about 2,000 acres, and restoration planting of about 1,400 acres designed to facilitate structural development of mature forest characteristics in second-growth; (3) an experimental program to try to create murrelet nesting trees in selected second growth (Section 4.2.2); and (4) removal of 38 percent (240 miles) of the forest roads. As was the case for the northern spotted owl, removal of forest roads in the watershed is expected to improve habitat conditions for marbled murrelets over the long term by reducing the amount of forest fragmentation and thus the amount of non-forested edge habitat present in the watershed. A reduction in non-forested edge habitat would be expected to make forest habitat conditions in general less favorable to predators of marbled murrelets (Section 3.5.2).

Restoration and ecological thinning activities entail some risk of negative effects on nesting murrelets, both directly (through accidental destruction of active nests) or indirectly by influencing habitat (overstory removal) or other disturbance. However, the risk is minimized by the commitments to conduct a habitat assessment program and site occupancy surveys in potential second-growth habitat (Section 4.5.5) and to forbid the removal of any suitable murrelet nest trees during ecological thinning (Section 4.2.2). Further, the ecological and restoration thinnings will typically be limited to stands 60 years or younger, which is usually thought to be far to young to constitute murrelet nesting habitat. With these mitigation and minimization measures in place, the likelihood of take resulting from habitat loss or disturbance of marbled murrelets is extremely low.

Also important for murrelets will be development, under the HCP, of older forest at lower elevations, nearer to marine waters, that could develop characteristics adequate for nesting. Finally, the combined effect of protection of all old growth, natural maturation of second growth, and silvicultural treatments to foster the accelerated development of “old forest” structural characteristics in younger stands (see below) will ultimately serve to produce a broader distribution of potential marbled murrelet nesting habitat over the entire landscape of the watershed than currently exists.

Disturbance Effects

As was the case for the spotted owl, the primary activities that could result in disturbance, and possibly take, of marbled murrelets in the watershed include any operations that involve human activities on roads or in suitable habitat, including the following: restoration thinning of about 11,000 acres, ecological thinning of about 2,000 acres, and restoration planting of about 1,400 acres; and road removal (about 240 miles over the first twenty years, with the potential for additional road removal later), maintenance (of about 520 miles of road/year at the beginning of the HCP, diminishing as roads are removed over time to about 380 miles/year at year 20, improvement (about 4-10 miles year, occasionally more), or use. However, the likelihood of disturbance to any actively nesting marbled murrelets by silvicultural treatments, road management or use, or other operational activities is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) elimination of timber harvest for commercial purposes (including virtually all log hauling) in the entire watershed; (2) habitat and occupancy surveys of potential second-growth habitat; (2) specific protection of known nesting pairs from human disturbance; (3) prior to ecological thinning, identification of potential habitat in second growth and avoidance of removing potential nest trees; (4) implementation of the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting marbled murrelet pairs; and (5) removal of 38 percent (240 miles) of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use in the watershed over the long-term.

Direct Take

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to or death of any marbled murrelet resulting from silvicultural treatments, road management or use, or other operational activities is expected to be extremely low.

Population-level Effects

Considered in concert with other efforts to conserve forested lands in the vicinity of the Cedar River Municipal Watershed (e.g., Mountains to Sound Greenway Project, Rattlesnake Mountain Scenic Area, Tiger Mountain State Forest, federal late-successional reserve northeast of the watershed, and U.S. Forest Service efforts to consolidate ownership through land exchanges), the HCP will have a cumulative positive effect on marbled murrelets. This cumulative positive effect will be critical to the regional marbled murrelet population as development pressure from the Seattle/Tacoma metropolitan area continues to push eastward, diminishing both the quality and quantity of forest habitat as it proceeds in the region.

Other Effects

The monitoring and research program committed to in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the marbled murrelet are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #3 – Northern Goshawk

Introduction

Northern goshawks are present in the Cedar River Municipal Watershed. Currently, only one northern goshawk nesting territory has been documented within the municipal watershed. The site is in unharvested native conifer forest, in close proximity to regenerating stands, within the 22,845-acre CHU at higher elevation in the eastern end of the watershed. Potential key habitats for the northern goshawk in the Cedar River Municipal Watershed are primarily mature, late-successional, and old-growth forests. Coniferous forest in these older age classes is the most likely to have developed the structural characteristics, particularly large snags, that northern goshawks prefer for nest and roost sites. Younger seral stage forest constitutes secondary habitat, with potential for use as foraging habitat by goshawks.

The combination of mitigation and minimization measures committed to in the HCP protects northern goshawks nesting in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any northern goshawk resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting goshawk pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute take under the ESA. A net gain of potential northern goshawk habitat (nesting, foraging, and dispersal) is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to northern goshawks through: (1) protection of all existing old-growth forest; (2) elimination of timber harvest for commercial purposes within the watershed; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (5) removal of 38 percent of watershed roads; (6) monitoring and research; and (7) protection of nesting pairs from human disturbance.

The northern goshawk could be negatively affected by road management or other operational activities in watershed forests, especially in mature to old-growth forest, as well as by silvicultural treatments and restoration activities in younger second-growth forest. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of tree canopy or specific nest trees) or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the northern goshawk are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the municipal watershed, all forests outside limited developed areas, including both old growth and second growth, are in reserve status. As a result, all key habitat (mature to old-growth forest), as well as secondary and potential habitat, for the northern goshawk within the municipal watershed is protected.

A relatively small amount of mature (1,074 acres) and late-successional forest (91 acres) totaling 1,165 acres is distributed in small patches, mostly in the western portion of the lower watershed. However, most of the 13,889 acres of old-growth forest, with the exception of a few, relatively small, isolated patches, is concentrated in the eastern portions of the watershed within the CHU. Coniferous forest in these older age classes is the most likely to have developed the structural characteristics, especially large snags, that northern goshawks prefer for nest and roost sites.

With respect to secondary habitat (foraging habitat), of the 54,592 acres of mid-seral forest (30-79 years old) present in the watershed, 23,339 and 31,252 acres are found in upper and lower portions of the watershed, respectively. Although mid-seral forest is found throughout the watershed, about 75 percent (22,511 acres) of the second growth exhibiting the most advanced structural development (60-69 and 70-79 year-old age classes), and therefore the most potential as foraging habitat for goshawks, is found at lower elevations. It is notable that some of the second-growth forest in these older mid-seral stages is already developing structural characteristics typical of mature forest and thus has considerable potential for providing not only improved foraging habitat, but also some future nesting and roosting habitat for northern goshawks during the 50-year term of the HCP.

Two areas in particular within the watershed, the CHU/Rex River Basin and the Chester Morse and Taylor Creek basins, are especially important to the northern goshawk on both a short- and long-term basis. The CHU, including the Rex River Basin, currently contains the majority of the remaining old-growth forest, interspersed with large areas of younger seral stage regenerating forest. These areas presumably provide the most optimal combination of nesting and foraging habitat currently present within the watershed and are expected to improve, especially as a result of maturation of younger forest (a long-term gain). Although a much smaller amount of old-growth forest currently exists within the Chester Morse and Taylor Creek basins, a substantial area of these basins is currently in older young and mature forest stages that will mature over the term of the HCP to provide considerably more mature and late-successional habitat for northern goshawks. In addition, maturation of the forest in these basins will also decrease the existing level of fragmentation of old growth and create larger contiguous blocks of potentially suitable habitat for goshawks on a long-term basis during the 50-year term of the HCP. Such large blocks of suitable habitat are important to the long-term viability of the northern goshawk nesting population within the municipal watershed.

Increases in the quantity of mature and late-successional coniferous forest habitat for the northern goshawk are expected over the 50-year term of the HCP because of natural maturation of all second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second-growth in some areas. Approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2).

Under the HCP, some northern goshawk habitat in the municipal watershed is expected to benefit from ecological thinning and restoration thinning that is intended to produce mature and late-successional forest habitat characteristics in second-growth forests. Ecological thinning and restoration thinning in second-growth forests in the CHU and other parts of the watershed is expected to hasten the development of late-successional and old-growth characteristics in those forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

The natural maturation and silvicultural treatment of select forest lands in the CHU, Rex River, Chester Morse, and Taylor Creek basins, and throughout the watershed as a whole, will not only increase the amount of potentially suitable habitat, but will also decrease the existing level of fragmentation of old growth. These two factors will thereby create larger, more contiguous blocks of potentially suitable habitat for goshawks on a long-term basis during the 50-year term of the HCP. Such large blocks of suitable habitat will be important to the long-term viability of a northern goshawk nesting population within the municipal watershed.

Habitat protection (especially for old growth) and maturation of second-growth forest within the watershed will also facilitate the long-term development of a more natural distribution and adjacency of habitat types and forest age classes across the landscape than currently exists. This distribution of habitat will approach that of preharvest conditions typical of the region, in which forest openings were created solely by natural events. This more natural and improved habitat distribution will provide a significant benefit to a highly mobile species such as the northern goshawk.

Disturbance Effects

The primary activities that may result in disturbance, and possibly take, of northern goshawks in the watershed under the HCP include any operations that involve human activities on roads or in suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years, with the potential for additional road removal later; (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year, with occasionally more; and (7) routine road use.

However, the likelihood of disturbance to any actively nesting northern goshawk pair in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of active northern goshawk nest sites from human disturbance; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term. It is notable that previously undocumented goshawk nests within the municipal watershed will have a high probability of being detected (and thus protected) during spotted owl and marbled murrelet nest site surveys and monitoring efforts committed to in the HCP.

Direct Take

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of any goshawk resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Under the HCP, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral stage forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation), because forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP and no additional commercial harvest will be conducted. The total amount of late seral habitat (over 80 years) is expected to increase by a factor of nearly five. The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit the northern goshawk population in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout the watershed and by providing critical older forest habitat for nesting and foraging.

The HCP also promotes the development over time of a large block of older forest in the CHU, and throughout the watershed as a whole. The CHU block is contiguous with lands to the north, east, and south of the watershed at its upper (eastern) end, including lands within the federal late-successional reserve (LSR). This landscape connectivity may benefit northern goshawk populations on a more regional level by facilitating movement and dispersal of individuals between the Cedar River Municipal Watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the northern goshawk are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #17 - Three-Toed Woodpecker

Introduction

No comprehensive surveys to determine the presence or absence of the three-toed woodpecker have been conducted in the Cedar River Municipal Watershed, and no incidental observations of this species have been documented to date. Potential key habitat for the three-toed woodpecker in the municipal watershed includes high-elevation mature, late-successional, and old-growth forests, especially those specific habitats containing large snags.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any three-toed woodpeckers that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any three-toed woodpeckers resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting three-toed woodpecker pairs. However, any such death, direct injury, or disturbance of three-toed woodpeckers leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the three-toed woodpecker are similar to those described for the northern goshawk (Group #3). Long-term benefits are expected to accrue to the three-toed woodpecker especially through preservation of old-growth forest and recruitment of mature and late-successional forest, as well as the creation and recruitment of large snags in the upper watershed. A net gain of potential three-toed woodpecker habitat (nesting, foraging, and dispersal) is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to three-toed woodpeckers that may use the watershed through: (1) protection of all existing old-growth forest; (2) elimination of timber harvest for commercial purposes within the watershed; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (5) retention, creation, and recruitment of large snags during silvicultural treatments; (6) removal of 38 percent of watershed roads; (7) monitoring and research; and (8) protection of nesting pairs from human disturbance.

The three-toed woodpecker could be negatively affected by silvicultural treatments, road management, or other operational activities, especially in mature to old-growth forests. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of large snags, tree canopy, or specific nest trees) or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the three-toed woodpecker are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests outside developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (high-elevation mature, late-successional, and old-growth forest) for the three-toed woodpecker within the municipal watershed is in reserve status. Of the 13,889 acres of old-growth forest, 11,323 acres (82 percent) are above 3,000 ft elevation and 4,201 acres (30 percent) are above 4,000 ft elevation.

Major habitat effects on the three-toed woodpecker are generally as described for the northern goshawk. Although old growth (by definition) will not increase in area under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for the three-toed woodpecker are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2).

Based on the three-toed woodpecker's apparent preference for higher elevation mature, late-successional, and old-growth forest habitats and its current range distribution, it is probable that the species will benefit most from protection of old growth (particularly above 3,000 ft) and maturation of second growth forest, mainly at higher elevations, within the watershed. Although much of the increase in mature and late-successional forest habitat, especially during the first two decades under HCP, will occur at elevations below 3,000 ft, a substantial increase in the amount of mature coniferous forest (approximately 10,000 acres) is also expected at elevations above 3,000 ft during the last three decades of HCP. The combination of old growth within the watershed being concentrated at higher elevations (82 percent above 3,000 ft) and the maturation, over time, of second growth to mature stages within the same elevation zone, will thereby provide a net habitat benefit for the three-toed woodpecker within the municipal watershed on both a short- and long-term basis. Similarly, as was the case for the northern goshawk, the 22,845-acre CHU, including the upper Rex River Basin will form a large, contiguous block of interspersed old growth and mature forest, over time, that will be of particular, potential value to the three-toed woodpecker.

Under the HCP, some potential three-toed woodpecker habitat in the municipal watershed is expected to improve as a result of ecological- and restoration-thinning projects that are intended to promote the development of mature and late-successional forest habitat characteristics in second-growth forests. Ecological and restoration thinning in second-growth forests in the CHU, as well as other parts of the watershed, is expected to hasten the development of mature, late-successional, and old-growth characteristics in those forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

There may be some short-term loss of large snags important to these species, especially in ecological thinning areas, because state worker safety laws require the removal of dangerous snags during restoration and ecological thinning operations. Loss of large snags during restoration thinning will be minimal because this silvicultural treatment will be conducted primarily in regenerating stands in early seral stages (less than 30 years old) that typically contain few, if any, large snags. Snag densities are variable, although typically low, in most young second-growth forest (40-60 years old) in which ecological thinning may be conducted, and in some cases selected snags may need to be removed. In the long term, however, the overall density of large snags is expected to increase significantly in the watershed, because of overall objectives to retain, create, and recruit large snags during restoration and ecological thinning (Section 4.2.2).

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of three-toed woodpeckers that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbing any actively nesting three-toed woodpecker pair in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of active three-toed woodpecker nest sites from human disturbance prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access (including no access for hunting) to the Cedar River

Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any three-toed woodpeckers resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Population-level effects on the three-toed woodpecker are generally as described for the northern goshawk. Under the HCP, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP and no additional commercial harvest will be conducted. The total amount of late seral habitat (over 80 years) is expected to increase by a factor of nearly five. The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit the three-toed woodpecker population in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout the watershed and by providing critical older forest habitat for nesting and foraging.

In particular, the large block of older forest at higher elevations in the CHU will benefit a three-toed woodpecker population by providing connectivity with lands in the federal LSR system in the Cascades. This landscape connectivity may further benefit three-toed woodpecker populations on a more regional level by facilitating movement and dispersal of individuals between the municipal watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the three- toed woodpecker are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #18 – Pileated Woodpecker, Vaux’s Swift

Introduction

The pileated woodpecker and Vaux’s swift commonly occur and are known to breed in the Cedar River Municipal Watershed. Key habitats for the pileated woodpecker and Vaux’s swift in the watershed are mature, late-successional, and old-growth forests, especially those areas with abundant snags, and, for swifts, large, hollow trees.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect pileated woodpeckers and Vaux’s swifts that nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any pileated woodpeckers or Vaux's swifts resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting pileated woodpecker or Vaux's swift pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute the equivalent of take for species listed under the ESA. As indicated for the three-toed woodpecker (Group #17), the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, these species are similar to those described for the three-toed woodpecker. Long-term benefits are expected to accrue to the pileated woodpecker and Vaux's swift through preservation of old-growth forest, the recruitment of mature and late-successional forest in the watershed over time, and through the retention, creation, and recruitment of large snags. A net gain of potential habitat (nesting, foraging, and dispersal) for these species is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to pileated woodpeckers and Vaux's swifts that may use the watershed through: (1) protection of all existing old-growth forest; (2) elimination of timber harvest for commercial purposes within the watershed; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (5) removal of 38 percent of watershed roads; (6) retention, creation, and recruitment of large snags; (7) monitoring and research; and (8) protection of nesting pairs from human disturbance.

Pileated woodpeckers and Vaux's swifts could be negatively affected by silvicultural treatments, road management, or other operational activities in mature to old-growth forests. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of large snags, tree canopy, or specific nest trees) or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the pileated woodpecker and Vaux's swift are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the municipal watershed, all forests outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (mature, late-successional, and old-growth forest with abundant snags and large hollow trees) for the pileated woodpecker and Vaux's swift within the municipal watershed is protected.

Coniferous forest in older age classes is the most likely to have developed the structural characteristics, in particular, large snags for pileated woodpeckers and large hollow trees for Vaux's swifts that these species prefer for nest and roost sites. A relatively small amount of mature (1,074 acres) and late-successional forest (91 acres) totaling 1,165 acres is currently present in the western portion of the lower watershed, distributed entirely in small patches. In contrast, most of the 13,889 acres of old-growth forest, with the exception of a few, relatively small, isolated patches, is concentrated in the eastern portions of the watershed within the CHU.

Although Vaux's swifts, and especially pileated woodpeckers, have been observed in association with both old-growth and several age classes of second growth forest in widely separated areas of the watershed, two areas in particular, the CHU/Rex River Basin and the Chester Morse and Taylor Creek basins, are especially important to the pileated woodpecker and Vaux's swift on both a short- and long-term basis. The CHU, including the upper Rex River Basin, currently contains the majority of remaining old-growth forest, interspersed with large areas of younger seral stage regenerating forest, remaining in the watershed. Both habitat distribution and habitat quality are expected to improve, particularly in this area, primarily as a result of maturation of younger forest (a long-term gain). Although a much smaller amount of old-growth forest currently exists within the Chester Morse and Taylor Creek basins, a substantial area of these basins is currently in older young and mature forest stages that will continue to mature over the term of the HCP and provide considerably more mature and late-successional habitat for pileated woodpeckers and Vaux's swifts. In addition, maturation of the forest in these basins, as well as throughout the watershed landscape, will decrease the existing level of fragmentation of old growth and create larger contiguous blocks of potentially suitable habitat for these species on a long-term basis during the 50-year term of the HCP. Such large blocks of suitable habitat are important to the long-term viability of the pileated woodpecker and Vaux's swift populations within the municipal watershed.

Major habitat effects on the pileated woodpecker and Vaux's swift are generally as described for the three-toed woodpecker; in contrast, however, these species utilize low- and mid-elevation forest, as well as high-elevation mature, late-successional, and old-growth forest. Substantial increases in the quantity of mature and late-successional coniferous forest habitat for these species are expected over the 50-year term of the HCP primarily because of natural maturation of all second-growth forests (a long-term habitat gain), but also because of silvicultural intervention designed to accelerate development of older forest characteristics in second growth forest in some areas. In the near term, there will be more than a 30-fold increase in the amount of mature (80-119 year old) conifer forest present in the watershed during the first two decades of the HCP, totaling 34,745 acres by the year 2020. And, over the long term, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). As was the case for the other late-successional and old-growth associate species discussed, the 22,845-acre CHU and associated old growth in the Rex River Basin will form a large, contiguous block of mixed old growth and mature forest over time that will be of particular value to these species over the long term.

Under the HCP, some pileated woodpecker and Vaux's swift habitat in the watershed is expected to benefit from ecological and restoration thinning that is intended to produce mature and late-successional forest habitat characteristics in second-growth forests. Ecological thinning and restoration thinning in second-growth forests in the CHU and other parts of the watershed is expected to hasten the development of mature, late-successional, and old-growth characteristics in those forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

There may be some short-term loss of large snags important to these species, especially in ecological thinning areas, because state worker safety laws require the removal of dangerous snags during restoration and ecological thinning operations. Loss of large snags during restoration thinning will be minimal because this silvicultural treatment will be conducted primarily in regenerating stands in early seral stages (less than 30 years old) that typically contain few, if any, large snags. Snag densities are variable, although typically low, in most young second-growth forest (40-60 years old) in which ecological thinning may be conducted, and in some cases selected snags may need to be removed. In the long term, however, the overall density of large snags is expected to increase significantly in the watershed, because of overall objectives to retain, create, and recruit large snags during restoration and ecological thinning (Section 4.2.2).

The combined effects of natural maturation and silvicultural treatment of selected forest lands in the CHU, Rex River, Chester Morse, and Taylor Creek basins, as well as throughout the entire watershed landscape, will not only decrease the existing level of old growth fragmentation and increase the total amount of potentially suitable habitat, but will also result in an improved distribution of key habitat throughout the municipal watershed. The combination of these factors will thereby create larger, more contiguous blocks of potentially suitable habitat for pileated woodpeckers and Vaux's swifts on a long-term basis during the 50-year term of the HCP. Such large blocks of suitable habitat will be important to the long-term viability of pileated woodpecker and Vaux's swift nesting populations within the municipal watershed.

Disturbance Effects and Direct Take

As was the case for the three-toed woodpecker, the primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of these species in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbing any actively nesting pileated woodpecker or Vaux's swift pair in the watershed is expected to be very low and only short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of active pileated woodpecker and Vaux's swift nest sites from human disturbance prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any pileated woodpeckers or

Vaux's swifts resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Population-level effects on pileated woodpeckers and Vaux's swifts are generally as described for the three-toed woodpecker. In addition to increasing the habitat carrying capacity of the municipal watershed over time for this species, the large block of older forest at higher elevations in the CHU will provide connectivity with lands in the federal LSR system in the Cascades. This large-scale landscape connectivity may benefit pileated woodpecker and Vaux's swift populations on a more regional level by facilitating movement and dispersal of individuals between the municipal watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for the pileated woodpecker and Vaux's swift are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #19 – Olive-Sided Flycatcher

Introduction

The olive-sided flycatcher is present and likely breeding in the Cedar River Municipal Watershed. Although the olive-sided flycatcher is known to utilize a variety of habitat types including early to late seral stages of coniferous forest, as well as open habitats, potential key habitats for this flycatcher in the municipal watershed are considered to be mature, late-successional, and old-growth forests (especially those with relatively high snag density), forested wetlands, and natural open habitats (e.g., meadows, persistent shrub). Other seral stage forest habitat and other open canopy habitat types are considered secondary.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect olive-sided flycatchers nesting in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any olive-sided flycatcher resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting olive-sided flycatcher pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to listed species under the ESA. As indicated for the three-toed woodpecker (Group #17), the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the olive-sided flycatcher are most similar to those described for the northern goshawk (Group #3). Long-term benefits are expected to accrue for this species through the protection of old-growth forest, forested wetlands, and natural open habitats, and also through the recruitment of mature and late-successional forest in the watershed. A net gain of potential olive-sided flycatcher habitat (nesting, foraging, and dispersal) is expected over the 50-year term of the HCP. The HCP is expected to result in both short-and long-term benefits to this species primarily through: (1) protection of all existing old-growth forest; (2) protection of forested wetlands; (3) protection of all non-forested, natural open habitats; (4) elimination of timber harvest for commercial purposes within the watershed; (5) natural maturation of second-growth forests to mature and late-successional seral stages; (6) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (7) removal of 38 percent of watershed roads; (8) monitoring and research; and (9) protection of known nesting pairs from human disturbance.

The olive-sided flycatcher may be negatively affected by silvicultural treatments, road management, or other operational activities, particularly in mature to old-growth forests, forested wetlands, or near natural open habitats in the watershed. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of large snags, tree canopy, or specific nest trees) or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the olive-sided flycatcher are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the municipal watershed, all forests outside limited developed areas are in reserve status. As a result, all key habitat (mature, late-successional, and old-growth forest, forested wetlands, and natural open habitats) for the olive-sided flycatcher within the municipal watershed is protected.

A relatively small amount of mature (1,074 acres) and late-successional forest (91 acres) totaling 1,165 acres is distributed in small patches, mostly in the western portion of the lower watershed. However, most of the 13,889 acres of old-growth forest, with the exception of a few, relatively small, isolated patches, is concentrated in the eastern portion of the watershed within the CHU. Coniferous forest in these older age classes is the most likely to have developed the structural characteristics that olive-sided flycatchers prefer for nest, roost, and foraging sites.

As is the case for the northern goshawk, two areas in particular – the CHU/Rex River Basin and the Chester Morse and Taylor Creek basins – are also important to the olive-sided flycatcher on both a short- and long-term basis. The CHU, including the upper Rex River Basin, currently contains the majority of the old-growth forest remaining in the watershed, interspersed with large areas of earlier seral stage regenerating forest. These areas presumably provide the most optimal combination of nesting and foraging habitat currently present within the watershed and are expected to improve over the long term, primarily as a result of maturation of younger forest. Relative to the CHU and Rex River Basin, the Chester Morse and Taylor Creek basins contain a much smaller amount of old-growth forest and, in contrast, have a substantial portion of basin area currently in older young and mature forest stages. However, these second-growth forests will all mature within the term of the HCP to provide considerable more mature and late-successional habitat in these basins for the olive-sided flycatcher.

Major habitat effects on the olive-sided flycatcher are generally as described for other species groups presented that are associated with late-successional and old-growth forests, especially avian species (e.g., spotted owl, marbled murrelet, 3-toed woodpecker, pileated woodpecker, Vaux's swift), and particularly the northern goshawk. The olive-sided flycatcher, similarly to the pileated woodpecker (Group #18), utilizes high-elevation, as well as low- and mid-elevation mature, late-successional, and old-growth forest; however, in contrast, this species also uses forested wetlands and natural open habitats (e.g., meadows and persistent shrub). Increases in the quantity of mature to late-successional coniferous forest habitat for the olive-sided flycatcher are expected over the 50-year term of the HCP as a result of natural maturation of all second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second growth in some areas. In the near term, and solely as a result of second-growth forest maturation, there will be more than a 30-fold increase in the amount of mature (80-119 year old) conifer forest present in the watershed during the first two decades of the HCP, totaling 34,745 acres by the year 2020. And, over the long term, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2).

In addition to the reserve status of watershed forests (includes forested wetlands), the non-forested, open habitats that are utilized by olive-sided flycatchers, and described as Special Habitats in the HCP (e.g., meadows, persistent shrub), are also protected by management guidelines. Watershed operations, including silvicultural activities, near any Special Habitats will be regulated within 200 feet of the specific habitat element. Also, any proposed road construction in or near Special Habitats will be evaluated by an interdisciplinary team and designed to avoid or minimize impacts or disturbance to olive-sided flycatchers.

Under the HCP, some olive-sided flycatcher habitat in the municipal watershed is expected to benefit from ecological and restoration thinning intended to produce mature and late-successional forest habitat characteristics in second-growth forests in some areas. These thinning activities in the CHU, and other parts of the watershed, are expected to hasten the development of late-successional and old-growth forest characteristics in treated forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

The combined effects of natural maturation and silvicultural treatment of selected forest lands in the CHU, Rex River, Chester Morse, and Taylor Creek basins, as well as throughout the entire watershed landscape, will not only decrease the existing level of old growth fragmentation and increase the amount of potentially suitable habitat, but will also result in an improved distribution of key habitat throughout the municipal watershed. The combination of these factors will thereby create larger, more-contiguous blocks of potentially suitable habitat for olive-sided flycatchers on a long-term basis during the 50-year term of the HCP. Such large blocks of suitable habitat will be important to the long-term viability of an olive-sided flycatcher nesting population within the municipal watershed.

As indicated for the goshawk, habitat protection (especially of old growth) and maturation of second-growth forest within the watershed will also facilitate the long-term development of a more natural distribution and adjacency of habitat types and forest age classes across the landscape than currently exists. This distribution of habitat will approach that of preharvest conditions typical of the region, in which forest openings were created solely by natural events. This more natural and improved habitat distribution will provide a significant benefit to olive-sided flycatchers.

Because no commercial timber harvest will be conducted outside of limited developed areas within the watershed, all forests, as well as all natural open habitats (e.g., meadows, persistent shrub, wetlands) constituting key habitat, are also in reserve status and therefore protected. Virtually all of these natural open habitats are expected to persist throughout the 50-year term of the HCP and provide foraging habitat for olive-sided flycatchers. Also, certain open habitats associated with operational activities (e.g., road edges, right-of-ways), constituting secondary habitat, are also expected to persist. However, because commercial timber harvest will not be conducted, early seral stage forest habitats (e.g., grass-forb, forb-shrub, shrub, etc.) previously maintained within the watershed through timber harvest, will substantially decrease under HCP. In the future, such early seral stage forest habitat will be created and/or maintained solely by natural events (e.g., windthrow, disease, fire). Therefore, this type of secondary habitat for olive-sided flycatchers is expected to substantially decrease relative to current conditions under the HCP.

The amount of grass-forb-shrub habitat (13,673 acres) and open canopy, early regeneration stage, habitat (1,937 acres) currently existing in the watershed is projected to decrease to 1,164 acres of grass-forb-shrub habitat (92 percent decrease) and zero open canopy habitat (100 percent decrease) by the year 2020. With the exception of open habitats created by natural events, no grass-forb-shrub or open canopy habitat is projected to be present in the municipal watershed by the year 2050. However, a more natural level of occurrence of these habitat types will be reestablished in the watershed by the end of the 50-year term of the HCP. Although early seral stage forest openings offer some foraging opportunities for the olive-sided flycatcher, net long-term benefits are expected to accrue for this species from the protection of old growth forest, protection of natural open habitats, and the recruitment of substantial amounts of mature and late-successional forests over time.

Disturbance Effects and Direct Take

Disturbance effects and the potential for direct take of the olive-sided flycatcher are generally as described for the other species presented that are associated with late-successional and old-growth forest. The primary activities that may result in disturbance, and possibly take, of olive-sided flycatchers in the watershed under the HCP include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian forest habitat restoration; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of disturbance to any actively nesting olive-sided flycatchers in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active olive-sided flycatcher nest sites from human disturbance; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term; and (6) management guidelines limiting silvicultural and operational activities in and/or near Special Habitats.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of any olive-sided flycatchers resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Under the HCP, the current substantial amount of watershed forest in fragmented condition will be replaced mostly by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral stage forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation), because forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP and no additional commercial harvest will be conducted. The total amount of key, late seral, habitat (over 80 years) is expected to increase by a factor of nearly five. The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit the olive-sided flycatcher population in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout the watershed and by providing critical older forest habitat for nesting and foraging.

The HCP also promotes the development, over time, of a large block of older forest in the CHU, and throughout the watershed landscape. The CHU block is contiguous with lands to the north, east, and south of the watershed at its upper (eastern) end, including lands within the federal late-successional reserve (LSR). This landscape connectivity may benefit olive-sided flycatcher populations on a more regional level by facilitating movement and dispersal of individuals between the Cedar River Municipal Watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for olive-sided flycatchers are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #20 – Brown Creeper

Introduction

Brown creepers are present and known to breed in the Cedar River Municipal Watershed. Potential key habitats for the brown creeper in the municipal watershed are mature, late-successional, and old-growth forests, including forested wetlands.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect brown creepers nesting in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any brown creepers resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting brown creeper pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the brown creeper are generally as described for the other species groups presented, especially avian species, that are associated with late-successional and old-growth forest. Long-term benefits are expected to accrue to this species through the preservation of old-growth forest, the recruitment of mature and late-successional forest, and the protection of forested wetlands in the watershed. A net gain of potential brown creeper habitat (nesting, foraging, and dispersal) is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to this species primarily through: (1) protection of all existing old-growth forest and forested wetlands; (2) elimination of timber harvest for commercial purposes within the watershed; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (5) retention, creation, and recruitment of large snags during silvicultural treatments; (6) removal of 38 percent of watershed roads; (7) monitoring and research; and (8) protection of known nesting pairs from human disturbance.

The brown creeper may be negatively affected by silvicultural treatments, road management, or other operational activities particularly in mature to old-growth forests in the watershed. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of large snags, tree canopy, or specific nest trees) or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the brown creeper are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the municipal watershed, all forests outside limited developed areas, including the 13,889 acres of old growth and all forested wetlands, are in reserve status. As a result, all key habitat (mature to old-growth forest and forested wetlands) for the brown creeper in the municipal watershed is protected.

Major habitat effects on the brown creeper are generally as described for other species groups presented that are associated with late-successional and old-growth forests, especially avian species (e.g., spotted owl, marbled murrelet, goshawk, 3-toed woodpecker, pileated woodpecker, Vaux’s swift), and in particular, the olive-sided flycatcher (Group #19). The brown creeper, similarly to the olive-sided flycatcher, utilizes mature to old-growth forest, including forested wetlands; however, in contrast, the brown creeper is not known to utilize natural open habitats.

As is the case for the other species groups presented that are closely associated with late-successional and old-growth forest, two areas in particular – the CHU/Rex River Basin and the Chester Morse and Taylor Creek basins – are also important to the brown creeper on both a short- and long-term basis. The CHU, including the upper Rex River Basin, currently contains the majority of old-growth forest remaining in the watershed. Relative to the CHU and Rex River Basin, the Chester Morse and Taylor Creek basins contain a much smaller amount of old-growth forest and, in contrast, have a substantial portion of basin area currently in older young and mature forest stages. However, these second-growth forests will all mature within the term of the HCP to provide considerable more mature and late-successional habitat in these basins for the brown creeper.

Increases in the quantity of mature and late-successional coniferous forest habitat for the brown creeper are expected over the 50-year term of the HCP as a result of natural maturation of all second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second growth in some areas. In the near term, and solely as a result of second-growth forest maturation, there will be more than a 30-fold increase in the amount of mature (80-119 year old) conifer forest present in the watershed during the first two decades of the HCP, totaling 34,745 acres by the year 2020.

And, over the long term, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2).

Under the HCP, some brown creeper habitat in the municipal watershed is expected to benefit from ecological and restoration thinning intended to produce mature and late-successional forest habitat characteristics in selected second-growth forests. These thinning activities in selected second-growth forests within the CHU, and other areas of the watershed, are expected to hasten development of late-successional and old-growth characteristics in treated forests, as well as accelerate the development of very large trees with rugose (rough) bark that the brown creeper prefers as foraging substrate. Such thinning activities, in combination with natural forest maturation, are expected to effectively connect all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

The combined effects of natural maturation and silvicultural treatment of selected forest lands in the CHU, Rex River, Chester Morse, and Taylor Creek basins, as well as throughout the entire watershed landscape, will not only decrease the existing level of old growth fragmentation and increase the amount of potentially suitable habitat, but will also result in an improved distribution of key habitat throughout the municipal watershed. The combination of these factors will thereby create larger, more-contiguous blocks of potentially suitable habitat for brown creepers on a long-term basis during the 50-year term of the HCP. Such large blocks of suitable habitat will be important to the long-term viability of a brown creeper nesting population within the municipal watershed.

Because no commercial timber harvest will be conducted in the municipal watershed, all forests outside limited developed areas, including all forested wetlands, are in reserve status. As a result, this type of key habitat (forested wetland) for brown creepers is also protected. In addition, by virtue of placing forests adjacent to forested wetlands in reserve status, sensitive wetland recharge areas are also protected.

Disturbance Effects and Direct Take

Disturbance effects and the potential for direct take of the brown creeper are generally as described for the other species associated with late-successional and old-growth forest. The primary activities that may result in disturbance, and possibly take, of brown creepers in the watershed under the HCP include any operations that involve human activities on roads or in suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian forest habitat restoration; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of disturbance to any actively nesting brown creepers in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active brown creeper nest sites from human disturbance; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

As is the case for the other species groups presented that are closely associated with late-successional and old-growth forest, the likelihood of disturbance to, direct injury to, or death of brown creepers resulting from silvicultural treatments, road management, or other operational activities in the watershed is very low because of the specific mitigation and minimization measures committed to in the HCP. Some nests could be inadvertently destroyed during planting, thinning, or road management operations, however, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in order to minimize direct impacts.

Population-level Effects

Population-level effects on the brown creeper are generally as described for the other species groups presented, especially avian species, that are closely associated with late-successional and old-growth forest as discussed above. The amount of key habitat will increase substantially over time, as should the habitat carrying capacity of the watershed for this species. In addition, improved landscape connectivity may benefit the brown creeper population on a more regional level by facilitating movement and dispersal of individuals between the municipal watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the brown creeper are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #26 – Hoary Bat, Silver-Haired Bat, Big Brown Bat, Long-Eared Myotis, Long-Legged Myotis, California Myotis, Little Brown Myotis, Keen's Myotis, Yuma Myotis, Fringed Myotis, Western Big-Eared Bat

Introduction

The long-legged myotis and little brown myotis are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted, and it is unknown whether any of the other bat species in Group #26 are present. Because the long-legged myotis and little brown myotis are present, it is likely that the other bat species in Group #26 are also present and breeding. Although each bat species in Group #26 has slightly different habitat requirements, key habitats for the group in the municipal watershed are generally considered to be mature, late-successional, and old-growth forests, forested riparian areas, open wetlands, stream corridors, open water bodies, natural open habitats (meadows and persistent shrub communities), and cliffs, rock outcrops, and caves. Bats roost and hibernate in hollow trees and snags in late-successional and old-growth forests, in caves and cracks in cliffs and rock outcrops, and also in and under artificial structures such as bridges (Barbour and Davis 1969, Maser et al. 1981, and van Zyll de Jong 1985, all in Christy and West 1993). Bats forage over open water bodies (e.g., lakes, ponds, reservoirs, open wetlands, large streams) and over meadows and persistent shrub communities.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect bats breeding, roosting, and foraging in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any bats resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any breeding bats. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to those species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to bat species are generally as described for the other species groups presented that are associated with late-successional and old-growth forest. A net gain of potential habitat (breeding, roosting, and foraging) for bats is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to these species primarily through: (1) protection of all existing old-growth forest; (2) protection of natural, non-forested habitats (open wetlands, streams, lakes, cliffs, rock outcrops, and caves); (3) elimination of timber harvest for commercial purposes within the watershed; (4) natural maturation of second-growth forests into mature and late-successional seral stages; (5) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (6) retention, creation, and recruitment of large snags during silvicultural treatments; (7) removal of 38 percent of watershed roads; (8) monitoring and research; and (9) protection of known breeding and roosting sites or hibernacula from human disturbance.

Bat species in Group #26 may be negatively affected by silvicultural treatments, road management, or other operational activities in the watershed. Such effects can be both direct (e.g., through direct injury or mortality of individuals in roost trees or hibernacula) or indirect (e.g., through effects on habitat such as destruction of roost trees or hibernacula) or disturbance (e.g., arousal of hibernating individuals).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the bat species are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests and wetlands, outside developed areas, including all 13,889 acres of old growth, are in reserve status. As a result, all key habitat for bat species in Group #26 including mature to old growth forest, riparian areas, wetlands, open water bodies, natural open habitats, cliffs, and caves, within the municipal watershed is in reserve status.

Major habitat effects on bat species in Group #26 are generally as described for the other species groups presented that are closely associated with late-successional and old-growth forest. Increases in the quantity of mature and late-successional coniferous forest habitat for these species of bats are expected over the 50-year term of the HCP as a result of natural maturation of all second-growth forests (a long term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second-growth in some areas. As a result, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). Long-term benefits are also expected to accrue to these species of bats as a result of recruitment of large snags in watershed forests.

Relative to most other species groups discussed that are closely associated with mature to old-growth forest, bats in Group #26 generally utilize a broader range of habitats, including riparian areas, open wetlands, lakes, ponds, natural open habitats (meadows and persistent shrub communities), caves, cliffs, and rock outcrops. Bats in this species group are therefore expected to also benefit from management actions designed to protect, enhance, or restore these habitats. For instance, the HCP includes management actions designed to help restore and enhance aquatic and riparian habitats used by bats. Programs for restoration planting and ecological and restoration thinning are focused on accelerating the development of mature and late-successional forest structural characteristics in younger second-growth forest in selected riparian areas. In addition, other programs to stabilize stream banks and replace large woody debris in streams are directed at improving stream habitat conditions. The combination of these restoration programs is expected foster the reestablishment of more natural aquatic and riparian ecosystem function in these habitat communities within the municipal watershed.

Restoration of more naturally functioning aquatic and riparian ecosystems will benefit species of bats in Group #26 over the long term. In addition, many stream crossing structures (culverts and log stringer bridges) will be replaced with concrete bridges during the term of the HCP as part of a comprehensive program to improve forest road standards and restore fish passage in certain stream systems within the municipal watershed. These artificial structures may also increase potential roosting habitat for bats in this species group.

In addition to the reserve status of watershed forests, which also serves to protect the aquatic system (wetlands, streams, lakes, ponds), both aquatic habitats and Special Habitats (e.g., meadows, persistent shrub, cliffs, caves) utilized by species of bats in Group #26 are also protected by management guidelines. Cutting of trees near streams and other aquatic habitats will be limited to restoration and ecological thinning with no ground-based equipment used within 50 feet and cutting further restricted within 25 feet. Silvicultural activities, including any necessary road construction, conducted near streams and other aquatic habitats will be designed by an interdisciplinary team to minimize and mitigate any impacts on or disturbance to species of bats in Group #26. Watershed operations near any Special Habitats will be regulated within 200 feet of the specific habitat element. Also, any proposed road construction in or near Special Habitats will be evaluated by an interdisciplinary team and designed to avoid or minimize impacts or disturbance to species of bats in Group #26.

Under the HCP, some key habitat for bats in Group #26, outside aquatic systems and riparian forests, within the municipal watershed is also expected to benefit from ecological and restoration thinning intended to produce mature and late-successional forest habitat characteristics in second-growth forests. Ecological and restoration thinning in second-growth forests in the CHU, and in other selected areas of the watershed, are expected to hasten the development of mature, late-successional, and old-growth characteristics in treated forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. In addition, restoration and ecological thinning in the watershed will benefit the species of bats in Group #26 over the long term as a result of retention, creation, and increased recruitment of large snags. Over the 50-year term of the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

It is notable that certain species of bats are likely to forage, at least to some degree, over early seral habitats. Because no commercial timber harvest will be conducted, outside limited developed areas, within the watershed, early seral stage habitat (grass-forb-shrub and open canopy) is expected to decrease substantially over the term of the HCP. This reduction in early seral stage habitat may result in some negative effects on certain species of bats in Group #26. The amount of grass-forb-shrub habitat (13,673 acres) and open canopy, early regeneration stage, habitat (1,937 acres) currently existing in the watershed is projected to decrease to 1,164 acres of grass-forb-shrub habitat (92 percent decrease) and zero open canopy habitat (100 percent decrease) by the year 2020. With the exception of open habitats created by natural events, no grass-forb-shrub or open canopy habitat is projected to be present in the municipal watershed by the year 2050. However, a more natural level of occurrence of these habitat types will be reestablished in the watershed by the end of the 50-year term of the HCP. Although early seral stage forest openings offer some foraging opportunities for bats in Group #26, net long-term benefits are expected to accrue for these species because of the protection of old growth forest, riparian forest, aquatic systems, including wetlands, natural open habitats, and the recruitment of substantial amounts of mature and late-successional forests over time.

In addition, some HCP management actions (e.g., ecological and restoration thinning) may cause some localized decline in habitat function and/or loss of snags in the short-term because state worker safety laws require removal of dangerous snags. However, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions to avoid disturbance or destruction of breeding, roosting, or hibernation sites. In addition, the overall density of large snags and hollow trees should increase significantly in the watershed over the long term, because of overall objectives to retain, create, and recruit large snags and trees with defects during thinning activities (Section 4.2.2).

Disturbance Effects and Direct Take

Disturbance effects and the potential for direct take of bats in species Group #26 are generally as described for the other species groups presented that are closely associated with late-successional and old-growth forest. The primary activities that may result in disturbance, and possibly take of bats (Group #26) in the watershed under the HCP include any operations that involve human activities on roads, or in or adjacent to suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian forest habitat restoration; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of disturbance to any actively roosting or hibernating bats in the watershed is expected to be very low and short-term in nature, however, because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of known active roost sites or hibernacula from human disturbance prior to silvicultural treatment or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to roosting, hibernating, or foraging bats; (5) removal of 38 percent of forest roads which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term; and (6) management guidelines limiting silvicultural and operational activities in and/or near both aquatic habitats and Special Habitats.

As is indicated for the other species groups presented that are closely associated with late-successional and old-growth forest, the likelihood of disturbance to, direct injury to, or death of bats included in Group #26 as a result of silvicultural treatments, road management, or other operational activities in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP. Management activities near roost and hibernation sites may have negative impacts on species of bats and some roost sites could be destroyed inadvertently during planting, thinning, or road management operations, however, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in order to minimize direct impacts on bat species in the watershed.

Population-level Effects

Population-level effects on the species of bats in Group #26 are generally as described for the other species groups presented that are closely associated with late-successional and old-growth forest. Under the HCP, the current substantial amount of watershed forest in fragmented condition will be replaced mostly by large blocks of older forest habitat, interrupted only by natural openings, roads, right-of-ways, and limited areas of development. By HCP year 50, no early- or mid-seral forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five.

Mitigation and minimization measures in the HCP protect aquatic and associated riparian habitats that facilitate the dispersal and movement of organisms dependent on riparian habitats such as the species of bats in Group #26, as well as protect large areas of older forest in upland areas between stream systems. The increased acreage of preferred forest habitat and landscape connectivity should benefit populations of bats within the municipal watershed by providing critical older forest habitat for nesting and foraging and by facilitating the daily and/or seasonal movement of individuals throughout the watershed. In particular, the large block of older forest in the CHU will benefit populations of bats in Group #26 by providing connectivity with lands in the federal LSR system in the Cascades. This landscape connectivity should benefit populations of bats on a more regional level by facilitating daily and/or seasonal movement of individuals between the municipal watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for bats are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #27 – Fisher, Marten, Wolverine

Introduction

No comprehensive surveys to determine the presence or absence of the fisher, marten, and wolverine have been conducted in the Cedar River Municipal Watershed, and no incidental observations of these species have been documented to date.

Although the fisher, marten, and wolverine each have somewhat different habitat requirements, potential key habitat in the municipal watershed for the species as a group, is considered to be mature, late-successional, and old-growth forests, forested wetlands, and forested riparian areas. Younger forest seral stages and some other habitat types are secondary habitat for all three species, and may be used at variable levels for foraging, dispersal, and other travel.

Fishers are found primarily below about 3,300 ft elevation, in the western hemlock and Pacific silver fir zones, and prefer forest with large trees and abundant large woody debris, using cavities as resting and denning sites. In this region, marten are typically found at higher elevations than fisher. Martens also prefer older forest with complex structure, including large woody debris, which is used for resting and denning. Wolverines also are found at higher elevations, in remote montane areas, and in other areas are known to use talus slopes, tree root complexes, and coarse woody debris as denning sites. Both wolverine and fisher are sensitive to human disturbance, and wolverines are believed to avoid areas altered or inhabited by humans.

Human disturbance (e.g., vehicle traffic, recreational activities) likely influences the suitability and use of habitat by wolverines and fisher, and the availability of habitat away from forest roads, motorized trails, or high-use hiking trails is likely an important factor influencing the distribution of these two species in this region. Significantly, because the primary function of the Cedar River Watershed is to supply drinking water to the City of Seattle and the surrounding region, the types and extent of human activities conducted within the municipal watershed differ substantially from those taking place on many nearby lands, especially those areas open to commercial timber harvest and/or a wide variety of public recreational activities.

Fisher, marten, and wolverine may be negatively affected by silvicultural treatments, road management, or other operational activities in mature to old-growth forests. Such effects could be direct (e.g., through injury or mortality of individuals resulting from collision with vehicles), or indirect, through influences on habitat or disturbance.

Three very significant factors associated with the Cedar River Municipal Watershed relative to protection of all three species in the Washington Cascades are (1) the substantially lower level (and type) of human disturbance occurring within the watershed relative to surrounding areas; (2) the protection of all key habitats, including all old-growth forest; (3) recruitment of a significant amount of mature and late-successional forest, with efforts intended to develop complex forest structure. Given the extreme rarity of older seral forest at low elevations in the Puget Sound region, the recruitment of large areas of mature and late-successional forest below 3,300 ft elevation in the municipal watershed is also a very important factor for fisher. Of importance to both wolverine and marten is the fact that the municipal watershed, particularly the CHU in the easternmost portion, serves as an important link in the federal late-successional reserve system, helping to connect the Alpine Lakes Wilderness Area to the north and Mt. Rainier National Park to the south.

The combination of mitigation and minimization measures committed to in the HCP protects any fisher, marten, or wolverines that may occur in the municipal watershed. The likelihood of direct injury to, or death of, any individual of these species resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low under the HCP, as is the likelihood of disturbance to any actively denning individual or adult with offspring. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to those species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the fisher, marten, and wolverine are, in general, as described for the other species groups addressed by the HC P that are associated with late-successional and old-growth forest. A net gain of potential habitat of all three species and a reduction in the effects of human disturbance are expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to fisher, marten, and wolverine through: (1) elimination of timber harvest for commercial purposes within the watershed, virtually eliminating large scale habitat impacts and substantially reducing disturbance resulting from road use; (2) removal of 38 percent of watershed roads, thereby providing additional undisturbed habitat and reducing overall disturbance levels; (3) continued closure of the municipal watershed to unsupervised public access, thus essentially eliminating disturbance resulting from recreational activity; (4) protection of all existing old-growth forest; (5) natural maturation of second-growth forests into mature and late-successional seral stages, thus reestablishing more natural ecosystem function; (6) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (7) protection of known breeding sites from human disturbance; and (8) monitoring and research.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for fisher, marten, and wolverine are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, forests outside limited developed areas, including all 13,889 acres of old-growth forest, are protected in reserve status under the HCP. As a result, all key habitat for fisher, marten, and wolverine (mature to old-growth forest stages), as well as secondary habitat, within the municipal watershed is in reserve status. A majority of older seral habitat is currently found within the spotted owl CHU in the higher elevation, eastern portion of the watershed. Protection of key habitat in the CHU is also of primary significance because the CHU is the most remote and least roaded part of the watershed. Also, because of its proximity to the Alpine Lakes Wilderness Area, the CHU is the area of the watershed most likely to be occupied by colonizing wolverine and marten or traversed by dispersing or transient individuals of these species. Over the 50-year term of the HCP the commitment not to harvest timber for commercial purposes will also result in substantial recruitment of mature and late-successional forest as a result of natural maturation. In addition, silvicultural treatments designed to accelerate the development of mature and late-successional forest characteristics in second-growth forests will also increase the availability and/or quality of potential habitat for these three species.

Overall, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by year 2050, a near fivefold increase over current conditions for these three seral stages in total and a fiftyfold increase in mature and late-successional forest (Section 4.2.2). Not all of the mature, late-successional, or even old-growth forest that currently exists or will mature in the watershed during the term of the HCP, however, is expected to provide habitat of equal quality for fisher, marten, and wolverine. This is because forest characteristics (e.g., species composition, canopy closure, snags, average tree diameter, branching structure) not only vary naturally in unharvested forest as a result of different site conditions, aspect, and elevation, but also vary in second-growth forest as a result of historic harvest practices and recent forest management regimes.

Because the vast majority of the lower-elevation forest in the watershed was harvested in the early twentieth century, most of the mature and late-successional forest habitat, by the year 2050, will develop at low elevations, where the second-growth is currently older than in most other parts of the watershed (Section 4.2.2). At elevations below 3,000 ft elevation, mature and late-successional forest is projected to total 47,988 acres by year 2050, a forty-one fold increase over current conditions, and mature, late-successional, and old-growth forest is projected to total 50,563 acres. This increase will be especially important for fisher.

In addition, the HCP will benefit fisher, marten, and wolverine through the management actions designed to accelerate the development of mature, late-successional, and old-growth characteristics in second-growth forests. Ecological thinning, restoration thinning, and restoration planting in second-growth forests in the CHU and other parts of the watershed is expected to hasten the development of late-successional and old-growth characteristics in those forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning, approximately 2,000 acres by ecological thinning, and 1,400 acres by restoration planting, especially in riparian corridors, within the watershed.

The HCP also includes management actions designed to help restore and enhance riparian habitats used by the fisher, marten, and wolverine. Short- and long-terms gains in the quality and/or quantity of riparian habitats for these species are expected under the HCP as a result of the natural maturation of younger seral stage forest in riparian areas, as well as restoration planting, restoration thinning, and ecological thinning in riparian areas designed to accelerate the reestablishment of naturally functioning riparian ecosystems.

In contrast to the fisher and marten, wolverines utilize elk and black-tailed deer carrion as a principal food item. Elk and black-tailed deer populations require a mix of open habitats and closed forests to provide an adequate combination of foraging areas and cover. The elimination of commercial timber harvest called for in the HCP is expected to reduce the amount of early seral habitat in the watershed, and thus may negatively affect prey populations for wolverines. Despite a decrease in early seral-stage habitat, especially in the upper watershed, both elk and deer populations will continue to exist under the HCP management regime and will re-equilibrate with the maturing forest landscape, presumably at some lower population level. Because types and relative amounts of open habitat other than harvest units are limited in the watershed, this particular effect of forest habitat maturation on ungulate populations will not especially favor the wolverine.

Several other considerations, however, may counteract this expected reduction in prey base for wolverine: (1) that both the overall watershed landscape and relative abundance of prey will become, over the term of the HCP, more similar to the natural condition that preceded commercial harvest, and to which wolverines in the region were adapted, and (2) considerable early seral-forest habitat is being, and presumably will continue to be, created by commercial timber operations on land adjacent to the watershed, supporting populations of ungulates that are likely larger than those present prior to commercial timber harvest in the region. Considering the large home range of wolverines and the high availability of ungulate prey in areas adjacent to the watershed, it is possible that the reduction of early seral habitat within the watershed may be less important to future wolverine populations than the combination of planned reduction in road density, decrease in human activity on roads, potential increase in the amount of security habitat, and potential increase in denning sites during the term of the HCP, and the City believes that the HCP will have a net positive effect on habitat for the wolverine.

Disturbance Effects and Direct Take

Wolverines and fishers, in particular, are known to be sensitive to disturbances caused by human activities. Disturbance effects and the potential for direct take of the fisher, marten, and wolverine are, in general, as described for the other species addressed by the HCP that are associated with late-successional and old-growth forests. The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of fishers, martens, or wolverines that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat, including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) some types of research and monitoring.

However, the likelihood of disturbance to any actively breeding fishers, martens, or wolverines denning in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of known active den sites from human disturbance prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to breeding pairs and other resident or transient individuals; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term.

Because martens and, especially, wolverines and fishers require areas away from human disturbance during reproductive periods, restrictions on unsupervised public entry into the watershed (Section 4.2.2), road removal, and elimination of commercial timber harvest activities in the watershed in particular are expected to benefit each of these three species. Restriction of public access on watershed roads reduces potential mortality or injury from motor-vehicle collisions and reduces the ability of poachers and trespassers to harass or harm these species.

Unsupervised public access to the municipal watershed is not allowed except within the Rattlesnake Lake Recreation Area and below the water supply intake at Landsburg on the western administrative boundary. Therefore, recreational activities (e.g., hiking, motor and trail bikes, camping) are restricted within the watershed. Some hiking trails, including a section of the Pacific Crest Trail at the eastern end of the watershed, currently exist or are planned for development along selected sections of the watershed boundary. No recreational trails are currently present or planned within the interior of the municipal watershed. In addition, all road access points to the municipal watershed are gated (locked) at the administrative boundary and access is by permit only. In order to provide a relative measure of the potential disturbance level that might be incurred by these three species within the municipal watershed a general comparison can be inferred from an analysis of “security” or “core” habitat (areas more than 0.3 mile from a road) as applied for the grizzly bear (see effects analysis for Group #11; see below).

Since no commercial timber harvest will be conducted within the municipal watershed and virtually all log hauling will be eliminated, road use and traffic levels will be significantly different from those incurred on commercial forest transportation systems and recreational lands. The types of traffic on the watershed transportation system will result primarily from: 1) road maintenance and limited construction activities for road improvements and decommissioning; (2) silvicultural treatment projects; (3) surveillance activities related to drinking water protection; (4) research and monitoring projects; and (5) other routine operational activities. With the exception of routine road maintenance, limited road construction and silvicultural projects, and in some cases, operational activities, light vehicle traffic will predominate. Many roads, especially at higher elevations and in more remote areas of the watershed, will receive minimum vehicle trips in most years. Most vehicle traffic will, in all probability, be confined to major roads, road systems, and sampling routes most directly associated with operating the water supply system or conducting some types of monitoring and research.

A conservative, preliminary analysis estimating the availability of core habitat available for grizzly bear (see effects analysis for Group #11), which should have applicability for fisher, marten, and wolverine, indicates that a total of 6,554 acres of core habitat, in 51 individual blocks, currently exists within the watershed. The individual blocks of core habitat included in this total range in size from less than one acre to more than 2,000 acres. The four largest individual blocks of contiguous core habitat within the watershed, totaling 5,061 acres (77 percent), are located mostly in the CHU. These four blocks of core habitat contain 2,038, 1,616, 960, and 447 acres and are located in the areas of Mt. Baldy/Abiel Peak/Tinkham Peak on the northern boundary, Findley Lake, Meadow Mountain, and Goat Mountain, respectively. The remaining 1,493 acres (23 percent) of habitat greater than 0.3 miles from a road, contained in 47 smaller blocks, is scattered throughout other areas of the watershed, but no single block is greater than 200 acres in size.

Under the HCP, after projected road removal is completed, a total of 12,975 acres of core habitat (67 individual blocks), representing an increase of 6,421 acres (98 percent increase) from current conditions, will exist by the end of the 50-year HCP term. In fact, most of the substantial increase of core habitat will be realized during the first two decades of the HCP, solely as a result of an aggressive road decommissioning program. The individual blocks of core habitat included in this projected total range in size from less than one acre to more than 3,000 acres. The five largest individual blocks of contiguous core habitat, totaling 8,353 acres (64 percent of total) are, as before, located mostly within the CHU. This acreage consists of large blocks containing 3,001, 2,418, 1,221, 932, and 781 acres. The increases in core habitat will accrue primarily to the large blocks of contiguous core habitat in the same areas as indicated above with the addition of one unit in the upper Taylor Creek Basin. This analysis of projected core habitat indicates that each of the original existing blocks of core habitat will increase in area under the HCP and a fifth block of core habitat greater than 500 acres in size will be created. An additional 4,622 acres of habitat (36 percent of total) greater than 0.3 miles from a road is present, distributed in other areas of the watershed, including six individual blocks, each greater than 300 acres in size.

The amounts of core habitat potentially available within the Cedar River Municipal Watershed, as described above, are considered conservative estimates. All roads in the watershed were considered “open” and not differentiated as to type and level of use for the analyses, nor were they classified by seasonal usage. Therefore, since the maximum amount of road was used in the analyses, the area estimates represent the minimum amount of core habitat that would be available within the watershed during any given season or year. Because many roads, especially at higher elevations and in more remote areas of the watershed, are not driveable or will, in all probability, receive a minimum number of vehicle trips in most years, they could be classified as “impassable” or “restricted” and considered as part of core habitat. In such case, the estimates of core habitat for both current and future conditions under the HCP would increase substantially.

Thus, the primary activities under the HCP that may result in disturbance, and possibly take, of fisher, marten, and wolverine that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat, and include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year after year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) some types of research and monitoring.

The likelihood of disturbance to any actively denning individuals of these three species in the watershed is, however, expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and avoidance of silvicultural treatments, road management, and other operational activities near known active dens; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which reduces potential mortality or injury from motor-vehicle collisions and reduces the ability of poachers and trespassers to harass or harm animals; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term. For marten and wolverine, road removal, particularly in the upper municipal watershed (within the CHU), and closure of roads to public use is important for three reasons: (1) animals are potentially more likely to occur in the upper municipal watershed, (2) the greatest amount of existing core habitat occurs in the upper municipal watershed, and (3) the greatest opportunity to produce additional core habitat through selective road decommissioning also occurs in the upper municipal watershed.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any fishers, martens, or wolverines resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Under the HCP, the current substantial amount of watershed forest in fragmented condition will be replaced mostly by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years) is expected to increase by a factor of nearly five. The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit the populations of fishers, martens, or wolverines that may exist in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout the watershed, and by providing critical older forest habitat for breeding and foraging.

The large block of older forest at higher elevations in the CHU will benefit marten and wolverine, and to a lesser extent fisher, by providing connectivity with lands in the federal late-successional reserve system in the Cascades. This landscape connectivity may further benefit populations of these three species on a more regional level by facilitating movement and dispersal of individuals between the Cedar River Municipal Watershed and other watersheds to the north, east, and south (especially the Alpine Lakes Wilderness Area to the north).

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for fisher, marten, and wolverine are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #28 – Canada Lynx

Introduction

No comprehensive surveys to determine the presence or absence of the Canada lynx have been conducted in the Cedar River Municipal Watershed and no incidental observations of the species have been confirmed to date. In addition, because the species is relatively easy to identify by sight and/or by tracks, and yet has not been detected despite extensive field activity, it is unlikely that lynx are present in the Cedar River Municipal Watershed on any consistent basis. This evaluation is consistent with the fact that the Cedar River watershed is situated at the western and southern extent (south of I-90) of the recently documented primary range of the Canada lynx within the Washington Cascades. In addition, the small size of the municipal watershed relative to lynx home range requirements (up to 115 mi^2) make it likely that only a few resident lynx would use the municipal watershed as a portion of their home range. Although no lynx observations have been documented in the municipal watershed, the occurrence of reliable sightings south of the municipal watershed within the past 10 years suggests that an individual lynx may occasionally travel through the watershed.

Canada lynx are most common from Canada southward into the North Cascades, eastward through the Okanogan region and into northern Idaho. In recent years, Canada lynx have been found on the west side of the Cascades Crest only in the northern section of the North Cascades (Ruggiero et al. 1994). As a result, it is significant to note that much of the information indicating that lynx utilize a wide range of habitat types including early successional to mature coniferous and deciduous forest habitat, as well as non-forested types such as rock outcrops, bogs, and thickets (McCord and Cardoza 1990; Ruggiero et al. 1994), has been established in ecosystems (e.g., northern and east slope of

Cascades) that are substantially different from those present within the municipal watershed. In addition, the apparent lack of a strong cyclical relationship between lynx populations and snowshoe hare abundance in the southern portions of the range of the Canada lynx (Koehler 1990), as typically exhibited by northern populations, may indicate a lesser reliance on snowshoe hare as a prey species and a broader prey base, and, therefore, less reliance on early seral-stage forests as foraging habitat in marginal areas of its range. The relatively lower densities of snowshoe hares in west slope Cascade forests compared to forests in the lynx's northern range may also be an indication that west side forests are not optimal habitat for Canada lynx and that comparable populations should not be expected to exist throughout the region. Therefore, it may be presumptuous to think that predictions of habitat use within the Cedar River watershed can be made with any certainty.

Assuming that Canada lynx would utilize habitat on the west side of the central Cascades similar to that used in other regions and ecosystems of Washington, however, potential key habitat in the municipal watershed is considered to be higher elevation, mature, late-successional, and old-growth forest (especially above 4,000 ft elevation, with abundant logs, and relatively undisturbed) for denning. In east side forests, early and mid-seral stage, closed-canopy forest (e.g., sapling/pole stage) is used as foraging habitat by lynx, and riparian forest and ridgeline habitats are used as travel corridors. Habitat conditions in closed-canopy early and mid-seral forests on the west side of the Cascades, however, are very different from conditions in such forests on the east side. Young, closed-canopy forest on the west side typically has much less capacity to support potential prey for lynx, particularly when such habitat has been artificially created by commercial timber harvest, where habitat complexity, diversity, and understory development are relatively poor on most sites. In view of these observations, the City considers early seral, closed-canopy forests created only by *natural* processes to be secondary habitat for lynx, along with riparian forest and ridgeline habitats.

Other habitat types may receive variable levels of use for foraging and travel by lynx, including open non-forested habitats (rock outcrops, talus/felsenmeer, bogs, persistent shrub, thickets, forest openings created by natural processes). Relative habitat quality and levels of lynx use in these habitats may depend substantially upon prey availability (including snowshoe hares), habitat patch size, and proximity to denning sites.

Similar to the case for grizzly bear (Group #11) and gray wolf (Group #12), human disturbance (e.g., vehicle traffic, recreational activities) has been identified as a major factor influencing the suitability and use of habitat by Canada lynx, especially during the denning season, and excessive trapping has, in some cases, been a significant mortality factor affecting population levels. Significantly, because the primary function of the Cedar River Municipal Watershed is to supply drinking water to the City of Seattle and the surrounding region, the types and extent of human activities conducted within the municipal watershed differ substantially from those taking place on many nearby lands, especially those areas open to commercial timber harvest and/or a wide variety of public recreational activities.

Although the overall density of "open" roads is now 4.2 mi/mi^2 and will be reduced to about 2.7 mi/mi^2 once the road decommissioning plan has been completed after about HCP year 20, the relatively low level of human use of most municipal watershed roads compared to other watersheds may result in many areas of the municipal watershed effectively providing suitable habitat for lynx with respect to levels of human disturbance. This condition may particularly be the case in the CHU, in the easternmost portion of the watershed, in larger blocks of native old-growth forest, and at higher elevations where road density will be lowest and road use will likely be the least.

The most significant factors associated with the Cedar River Municipal Watershed relative to protection of the Canada lynx in the Washington Cascades are 1) the fact that the municipal watershed is located in a potential zone of recolonization, and is a potential dispersal corridor between the population in the North Cascades and several areas of protected habitat to the south (e.g., Mt. Rainier National Park) that may play a significant role in linking important areas of potential lynx habitat within the region; (2) the substantially lower level (and different type) of human disturbance occurring within the watershed relative to surrounding areas; and (3) the protection of all key and secondary habitats.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Canada lynx that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any lynx resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any breeding lynx. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to those species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the Canada lynx are generally as described for other species addressed by the HCP that are closely associated with mature, late-successional, and old-growth forest, especially those that require relatively low levels of human disturbance (e.g., Group #11, grizzly bear; Group #12, gray wolf). Both immediate and long-term benefits are expected to accrue to lynx through protection of old-growth forest and recruitment of mature and late-successional forest in the watershed, and through protection of other forested (secondary) habitats used for foraging or travel. A net overall gain of potential habitat (breeding, foraging, and dispersal) for the lynx is expected over the 50-year term of the HCP, assuming that early seral forest created by commercial timber harvest is not important to lynx on the west slope of the Cascades.

Under the HCP, all key habitat will be protected, and a net gain of Canada lynx habitat may occur over the 50-year term as a result of extensive road decommissioning that will cause a reduction in the level and effects of human disturbance in many areas. The HCP is expected to result in both short- and long-term benefits to Canada lynx through: (1) elimination of timber harvest for commercial purposes within the watershed, virtually eliminating large scale habitat impacts and substantially reducing disturbance resulting from road use; (2) removal of 38 percent of watershed roads, thereby providing additional habitat with reduced disturbance levels; (3) continued closure of the municipal watershed to unsupervised public access, thus essentially eliminating disturbance and/or mortality resulting from recreational/sport activities; (4) protection of denning lynx from human disturbance; (5) protection of all existing old-growth forest, which provides denning sites and also serves to protect inclusions of non-forested habitat (secondary); (6) protection of all riparian areas and ridgeline travel corridors; (7) natural maturation of second-growth forests into mature and late-successional seral stages, thus reestablishing more natural ecosystem function and providing more denning sites; (8) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; and (9) monitoring and research.

As a consequence of eliminating timber harvest for commercial purposes, however, the snowshoe hare populations in the watershed may be expected to decrease over the term of the HCP. As no early seral-stage forest habitat will be created by other than natural processes, the amount of early seral habitat, and the concurrent herbaceous/shrub forage supply for snowshoe hares, is likely to decrease in many areas of the watershed. Insofar as Canada lynx depend on a snowshoe hare prey base on the west slope of the central Cascades, the capacity of the watershed to support lynx may diminish in this respect over time, unless the reduced level of human disturbance, increased level of habitat development, and key habitat protection is more important than the reduced prey base in this geographic region. Two additional considerations are (1) that the overall watershed landscape will be more similar to the natural landscape to which lynx previously inhabiting the region were adapted, and (2) considerable early seral forest habitat is being created by commercial timber operations on land adjacent to the watershed, supporting populations of snowshoe hare that are likely larger than those present prior to commercial timber harvest in the region.

The lynx could also be negatively affected by silvicultural treatments, road management, or other operational activities. Such effects could be direct (e.g., direct injury or mortality of individuals as a result of vehicle collision), or indirect, through effects on habitat or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Canada lynx are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Major habitat effects on the Canada lynx are generally as described for the other species groups addressed by the HCP that are most closely associated with late-successional and old-growth forest. In contrast to several of these species which utilize habitats over a broad range of elevations, however, in other portions of its range, at least, the Canada lynx typically exhibits a preference for high-elevation, rather than mid- and low-elevation, mature, late-successional, and old-growth forest, especially such forest habitat above 4,000 ft. Although early and mid-seral stage, closed-canopy forest (e.g., sapling/pole stage) has been identified as receiving variable levels of foraging and travel use by lynx in other areas of the species' range, these habitats, although also protected in reserve status, are of unknown importance as foraging habitat for any lynx that may occur within the watershed. Other habitat types used at some level by lynx in other areas for foraging and travel include open non-forested habitats (rock outcrops, talus/felsenmeer, bogs, persistent shrub, thickets, forest openings created by natural disturbances), all of which are present in the municipal watershed.

Because no commercial timber harvest will be conducted in the watershed, all forests outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat is protected in reserve status, as well as all forest outside limited developed areas, all secondary habitats, and all other habitat types that could be used potentially as foraging habitat and/or travel corridors by Canada lynx within the municipal watershed. In addition, the amount of habitat available to lynx within the watershed receiving substantially lower levels of human disturbance than in the past is expected to increase over time, because no commercial logging will take place and road densities will be decreased through decommissioning.

Of the 13,889 acres of old-growth forest currently present in the watershed, 11,323 acres (82 percent) is located above 3,000 ft elevation, including 4,201 acres (30 percent of total) that is located above 4,000 ft elevation. No mature or late-successional forest presently exists within the watershed at these elevations. A majority of key old-growth forest habitat that may be suitable for denning Canada lynx is located in a few large contiguous blocks within the spotted owl CHU in the eastern portion of the watershed near the Cascade Crest, and in smaller scattered blocks and along high ridges (travel corridors) to the west, all mostly at relatively high elevations. Relatively little old-growth forest, however, is located west of Chester Morse Lake. Protection of key old-growth habitat for lynx is of primary importance, especially in the CHU, because the CHU is the most remote and least roaded part of the watershed (see effects analysis for Group #11, grizzly bear). Also, because of its proximity to the Alpine Lakes Wilderness Area, the CHU is the area of the watershed most likely to be occupied by colonizing lynx or traversed by dispersing or transient individuals.

Although the structure and ecological function of all forests with the watershed will continue to develop over time, the amount of old-growth forest available to lynx, 13,889 acres on a watershed wide basis and 11,323 acres above 3,000 ft, will remain the same and in reserve status under the HCP, barring severe natural disturbances. The HCP is also expected to benefit Canada lynx, however, through the restoration and/or development of certain potential key habitats for lynx in the municipal watershed. The proposed HCP is expected to result in short- and long-term benefits to lynx through: (1) natural maturation of second-growth forests into mature and late-successional seral stages, providing additional den sites in close proximity to foraging areas and travel corridors; (2) management actions designed to restore a more naturally functioning forest ecosystem; and (3) management actions designed to accelerate the development of mature, late-successional, and old-growth characteristics in second-growth forests.

Although only 165 acres of mature forest above 3,000 ft elevation, key habitat for Canada lynx, will occur during the first two decades of the HCP, a substantial increase will accrue during the last thirty years. During the last three decades of the HCP, a 10,690-acre increase in the total amount of late-successional forest (30 acres) and mature forest (10,660 acres) will be realized in areas of the watershed above 3,000 ft elevation. Most of this habitat will develop in areas between 3,000 and 4,000 ft elevation, thereby improving both the horizontal and vertical distribution of potential key habitat and connectivity with secondary habitats, including riparian and ridgeline travel corridors, for lynx within the municipal watershed. In addition, solely as a result of forest maturation on a watershed wide basis (i.e., at all elevations), approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). The combination of natural forest maturation and proposed silvicultural treatments in selected areas of the watershed will result in an overall increase in habitat potential for lynx throughout the entire elevation range of the watershed landscape, with the possible exception of reduced amounts of early seral forest created artificially by timber harvest.

By year 2050, there will be no early seral-stage forest (0-29 years of age) that is created by commercial timber harvest, a reduction from 15,610 acres in 1997. The extent of early seral habitat at year 2050, however, would be more typical of levels existing in a mature coniferous forest ecosystem than those that have developed under historic harvest management regimes. Any additional early seral-stage habitats would result solely from natural disturbance events such as fire, landslide, insect infestation, or other disease. On average over the last millenium, about 280 acres of forest per year have been removed by forest fires in this region, but such fires are episodic and not periodic (Henderson 1990, 1993).

Only 7 percent (6,104 acres) of the land within the watershed that is classified as forested is located above an elevation of 4,000 ft. Approximately 30,444 acres (36 percent) of the forested land is located at elevations above 3,000 ft, and the remaining 54,786 acres (64 percent) falls below that level. Canada lynx appear to demonstrate a habitat preference for forested lands located above 4,000 ft, but all forested, as well as non-forested, lands within the municipal watershed are well within the overall elevation range of habitats used by Canada lynx. Although lower elevation forest may not be used as preferred or key habitat, it may function adequately at some level as secondary foraging or dispersal habitat. Below 3,000 ft, the amount of old-growth (2,565 acres) and non-forest habitat will remain constant over the term of the HCP, barring severe natural disturbances. However, there will be a substantial increase in the amount of mature and late-successional forest habitat in this elevation range, from 1,165 acres in 1997 to 47,997acres in 2050. These changes in total amounts of habitat and their relative landscape distribution, resulting both from natural maturation processes and restoration activities (see below), will result in habitat potential for Canada lynx more typical of an older, naturally functioning coniferous forest ecosystem.

Canada lynx are carnivorous predators that typically rely on snowshoe hares as a primary component of their diet, especially in more northern portions of their range. In northern regions lynx tend to display cyclic population fluctuations closely linked to snowshoe hare densities (also cyclic) and to require adequate populations of hares within their range in order to sustain viable populations. However, this cyclic relationship does not appear to be as strongly exhibited by lynx populations on the outer extent of its geographical range, especially on the southern and western boundaries of its range (i.e., the west slope of the central Washington Cascades), where hare densities typically are relatively low in unmanaged forests. High levels of commercial timber harvest, however, create an artificially high abundance of herbaceous and small shrub forage for snowshoe hares as compared with more natural systems, and hare populations typically often respond accordingly.

Snowshoe hares are present in the watershed. While populations appear to be consistent in density with those in other areas of the west slope of the Washington Cascades, no numeric estimates are available. Snowshoe hares use a wide variety of habitats, including dense, second-growth forests, old growth, forested wetlands, and edge habitats over a wide range of elevation. All forest that could be habitat for snowshoe hares within the watershed, including old growth, second growth, forested wetlands, and riparian forest, is protected in reserve status. As a result, all non-forested habitat (e.g., wetlands, persistent shrub), present as inclusions surrounded by forest cover, are also protected. Many natural edge habitats (e.g., the transition zone between persistent shrub, rock outcrop, or talus/felsenmeer habitats and old-growth forest) utilized by hares are also protected. Also, early and mid-seral stage forest that supports populations of snowshoe hare will, in all probability, continue to be available to any lynx that might inhabit the municipal watershed on the many adjacent lands managed for commercial timber production on a typically short harvest rotation that fall within the characteristically large home range of Canada lynx.

In addition, the restoration and ecological thinning included in the HCP will result in the production of a certain amount of herbaceous and shrub forage in thousands of acres of treated forests, somewhat offsetting the lack of availability in commercial timber harvest units, as well as creating some additional edge habitat as small forest openings are made. Although provisions of the HCP will reduce the amount of early seral forest habitat at elevations above 3,000 ft, presumably reducing prey for lynx in that zone, the overall landscape distribution and connectivity of all seral stages of forest succession fostered by the HCP conservation policies will more closely approach conditions of habitat availability and prey densities characteristic of a mature and naturally functioning coniferous forest ecosystem. This change in conditions is important because a primary purpose of the ESA is to conserve the ecosystems on which threatened or endangered species depend. Within the coniferous forest ecosystem, lynx and hare populations, as well as other populations of lynx prey, will fluctuate relative to a more natural ecological balance with only limited influence of timber harvest.

Short-term and long-terms gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in buffer areas, and as a result of management actions designed to help restore and enhance riparian habitats (e.g., restoration planting, restoration thinning, and ecological thinning in buffer and riparian areas). Development into mature and late-successional forest and restoration of a more naturally functioning riparian ecosystem potentially benefit the lynx through the creation of more favorable travel corridors and better habitat for its prey.

Restoration of more natural riparian ecosystem functioning (development of mature forest canopy) through silvicultural intervention would benefit the lynx over the long term by providing a more preferred habitat type, especially for denning, with a broader distribution over the watershed landscape. However, restoration activities (e.g., restoration thinning) might also have temporary, short-term effects in terms of behavioral disturbance that would cease at the time of project completion. Site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in aquatic buffers to ensure that habitat for lynx is minimally impacted.

Disturbance Effects and Direct Take

Disturbance effects and the potential for direct take of the Canada lynx are generally as described for the other species addressed by the HCP that are associated with late-successional and old-growth forest, especially those that require relatively low levels of human disturbance (e.g., Group #11, grizzly bear; Group #12, gray wolf). The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of lynx that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to

10 miles of road per year (occasionally more in some years); and (7) routine road use.

If Canada lynx were eventually to occur in the watershed, however, the likelihood of disturbance to any actively breeding Canada lynx denning in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of known active den sites from human disturbance prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to breeding pairs and other resident or transient individuals; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term.

Because lynx require areas away from human disturbance during reproductive periods, restrictions on unsupervised public entry into the watershed (Section 4.2.2), road removal, and elimination of commercial timber harvest activities in the watershed in particular are expected to benefit this species. Road decommissioning and restricted public access in the upper municipal watershed within the CHU are especially important to the lynx for three reasons: (1) lynx are more likely to occur in the upper portion of the municipal watershed; (2) the greatest amount of existing lynx core habitat (away from roads) occurs in the upper municipal watershed; and (3) the greatest opportunity to produce additional core habitat through selective road removal also occurs in the upper municipal watershed. Restriction of public access on watershed roads will reduce potential mortality or injury from motor-vehicle collisions and reduce the ability of poachers and trespassers to harass or harm this species.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of any Canada lynx resulting from silvicultural treatments, road management, or other operational activities is expected to be very low. Rarely, however, an individual Canada lynx crossing or utilizing watershed roads as travel corridors may be injured or killed inadvertently by vehicles.

Population-level Effects

Population-level effects on the Canada lynx are, generally, as described for the other species addressed by the HCP that are closely associated with late-successional and old-growth forest, especially those that require relatively low levels of human disturbance (e.g., Group #11, grizzly bear; Group #12, gray wolf). The City expects that the habitat carrying capacity of the watershed for the lynx should increase over time and that the HCP will have an overall net positive effect on the lynx population in the Cascades. The City does not expect, however, that Canada lynx will become resident on any consistent basis within the watershed in the near future, and lynx may not even occupy suitable habitat within the 50-year term of the HCP. Under the HCP, however, the substantial amount of watershed forest currently in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development

By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will have matured over the term of the HCP, as no additional commercial harvest will have been conducted. The total amount of late-seral forest habitat (over 80 years) is expected to increase by a factor of nearly five. The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit the populations of Canada lynx that may exist in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout the watershed and by providing critically important older forest habitat for breeding and foraging.

The development of a large block of older forest at higher elevations in the CHU will benefit the lynx by providing connectivity with lands in the federal LSR (late-successional forest reserve) system in the Cascades. This block is also located in the portion of the municipal watershed closest to the Alpine Lakes Wilderness Area and the Cascade Crest. As mentioned above, the CHU is the area most likely to be occupied by colonizing lynx or traversed by dispersing/transient lynx. Thus, this landscape connectivity may further benefit populations of Canada lynx on a more regional level by facilitating movement and dispersal of individuals between the Cedar River Municipal Watershed and other watersheds to the north, east, and south (especially the Alpine Lakes Wilderness Area to the north).

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Canada lynx are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #35 – Western Red-backed Salamander

Introduction

The western red-backed salamander is present and breeding in the Cedar River Municipal Watershed. Potential key habitat for this salamander in the watershed includes talus/felsenmeer slopes, rock outcrops, and dense coniferous forest, particularly forest that has accumulated substantial quantities of decaying logs, leaf litter, bark piles, and other debris on the forest floor, as is more typically and consistently present in mature, late-successional, and old-growth forest. The presence of organic debris on the forest floor in older forest and the moist environment of many talus/felsenmeer slopes and rock outcrops provides foraging and hiding cover for red-backed salamanders, as well as suitable microclimate conditions for egg deposition below the substrate surface. Other seral-stage coniferous forest, including riparian forest (especially streamside areas), is considered of secondary importance.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any western red-backed salamanders that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any western red-backed salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury of western red-backed salamanders would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Long-term benefits are expected to accrue to the western red-backed salamander, especially through protection of mature, late successional, and old-growth forest in reserve status and the recruitment of additional mature and late-successional forest over time. All key non-forested habitat (talus/felsenmeer slopes and rock outcrops) will also be protected within reserve forest. A net gain of potential western red-backed salamander habitat is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to the western red-backed salamander through: (1) protection of all existing key forested habitat in reserve forest status; (2) protection of all key non-forested habitat (talus/felsenmeer slopes, rock outcrops) as inclusions within reserve forest; (3) elimination of timber harvest for commercial purposes within the watershed; (4) natural maturation of second-growth forests into mature and late-successional seral stages, potentially recruiting increased amounts of organic debris to the forest floor and improving habitat function; (5) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, also improving habitat conditions on the forest floor (long term); (6) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying organic debris to the forest floor on both a short- and long-term basis; (7) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; (8) protection of secondary habitats including younger, closed canopy forest and riparian stream corridors in reserve status; and (9) monitoring and research.

The western red-backed salamander could be negatively affected by silvicultural treatments, road management, or other operational activities, especially in or adjacent to key habitat. Such effects could be direct (e.g., through injury to individuals) or indirect, through influences on habitat (e.g., disturbance of cover objects or removal of tree canopy).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the western red-backed salamander are described in Section 4.2.2 and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (mature, late-successional, and old-growth forest, talus/felsenmeer slopes, rock outcrops), as well as all secondary habitat, for the western red-backed salamander within the municipal watershed is protected in reserve status.

Major habitat effects on the western red-backed salamander are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests. Although old growth (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for the western red-backed salamander are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range, than under current conditions. And, only 4,708 acres (less than 7 percent) of key forested habitat will be above 4,000 feet, beyond the documented extent of the western red-backed salamander's elevation range.

In addition to forested habitats, western red-backed salamanders also utilize open, non-forested talus/felsenmeeer slopes and rock outcrops. The western red-backed salamander is thus also expected to benefit from management actions designed to protect, restore, or enhance these habitats. All vegetated talus/felsenmeer (329 acres) and non-vegetated talus/felsenmeer (1,189 acres) slopes, and rock outcrops, most of which are surrounded by or are adjacent to key forested habitat, are protected in reserve status. In addition, during watershed operations near any talus/felsenmeer slopes or rock outcrops a 200-foot zone, in which activities will be restricted, will be established to minimize the potential for habitat impacts or disturbance to western red-backed salamanders.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in direct take of western red-backed salamanders in the watershed include any operations that involve human activities on roads or in suitable habitat. Such activities include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) monitoring and research. Occasionally, individual red-backed salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

The likelihood of direct take occurring at a level that may compromise the viability of western red-backed salamander populations in the watershed is expected to be very low, due to the specific mitigation and minimization measures committed to in the HCP: (1) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing impacts to key forest habitat and essentially eliminating the chance of mortality associated with log hauling; (2) interdisciplinary team site evaluations prior to silvicultural or road management activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing salamanders; and (5) removal of 38 percent of forest roads which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any western red-backed salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low in any given year, although occasionally, individual western red-backed salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

Population-level Effects

Population-level effects on the western red-backed salamander are, in general, as described for other species addressed by the HCP that are associated with late-successional and old-growth forest. Under the HCP, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early- or mid-seral forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early-seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five.

Mitigation and minimization measures in the HCP create a linear system of protected forested corridors adjacent to streams for the dispersal and movement of organisms dependent on riparian habitats, as well as large areas of older forest in upland areas between stream systems. This increased acreage of preferred forest habitat and landscape connectivity will benefit populations of western red-backed salamanders by increasing the overall habitat carrying capacity of the municipal watershed, thereby potentially increasing populations and also by facilitating the movement or dispersal of individuals between patches of available habitat throughout the Cedar River Municipal Watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the western red-backed salamander are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #41 – Johnson's (Mistletoe) Hairstreak

Introduction

No comprehensive surveys to determine the presence or absence of the Johnson's (mistletoe) hairstreak have been conducted in the municipal watershed, and no incidental observations of this species have been documented to date. Potential key habitat for Johnson's (mistletoe) hairstreak in the Cedar River Municipal Watershed is low-elevation (below 3,500 feet) mature, late-successional, and old-growth coniferous forests containing dwarf mistletoe of the genus *Arceuthobium*. Coniferous forest in younger seral stages, if mistletoe is present in sufficient abundance, is considered secondary habitat.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Johnson's (mistletoe) hairstreaks that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any Johnson's (mistletoe) hairstreaks resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any breeding individuals. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to those species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the Johnson’s (mistletoe) hairstreak are generally as presented for other species associated with late-successional and old-growth forest. The HCP is expected to result in long-term benefits to the Johnson’s (mistletoe) hairstreak through protection of old-growth forest and recruitment of a substantial amount of mature and late-successional forest over time. A net gain of potential habitat (breeding, foraging, and dispersal) for the Johnson’s (mistletoe) hairstreak is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to individuals of this species that may use the watershed through: (1) protection of all existing old-growth forest; (2) elimination of timber harvest for commercial purposes within the watershed; (3) natural maturation of second-growth forests into mature and late-successional seral stages; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (5) restriction on the use of insecticides and herbicides; (6) removal of 38 percent of watershed roads; (7) monitoring and research; and (8) protection of identified breeding sites from human disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures pertinent to the Johnson’s (mistletoe) hairstreak are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (low-elevation mature to old-growth coniferous forests containing dwarf mistletoe of the genus *Arceuthobium*) for the Johnson’s (mistletoe) hairstreak within the municipal watershed is protected in reserve status.

Major habitat effects on the Johnson’s (mistletoe) hairstreak are generally as described for the other species presented that are associated with late-successional and old-growth forest. Many of these species utilize higher elevation forests or forests over a broad range of elevations. In contrast, the Johnson’s (mistletoe) hairstreak apparently utilizes primarily low-elevation (below 3,500 feet) mature to old-growth forest and requires the presence of dwarf mistletoe (*Arceuthobium*) to serve as the main food source during the caterpillar stage. Increases in the quantity of mature and late-successional coniferous forest habitat for this species are expected over the 50-year term of the HCP as a result of natural maturation of all second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second growth in some areas. In the near term, mature and late successional coniferous forest (over 80 years old) below 3,000 feet elevation will increase from a current level of 1,165 acres to 35,844 acres by the end of the second decade of HCP. In this elevation zone on a long-term basis, approximately 24,109 acres of mature forest, 23,889 acres of late-successional forest, and 2,565 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a nine-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (5,727 acres total).

Under the HCP, some habitat for the Johnson's (mistletoe) hairstreak in the municipal watershed is expected to benefit from ecological and restoration thinning intended to produce mature and late-successional forest habitat characteristics in second-growth forests. Ecological thinning and restoration thinning in second-growth forests in the CHU and other areas of the watershed are expected to hasten the development of late-successional and old-growth characteristics in treated forests, thereby more effectively connecting all extant patches of old-growth forest within the term of the HCP from the standpoint of the hairstreak. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

Disturbance Effects and Direct Take

Disturbance effects and the potential for direct take of the Johnson's (mistletoe) hairstreak are generally as described for the other species presented that are associated with late-successional and old-growth forests. The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take of individuals of this species that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbance to any actively breeding Johnson's (mistletoe) hairstreaks in the watershed is expected to be very low and short-term in nature, however, because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of occupied sites from human disturbance prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to breeding, resident, or transient individuals; and (5) removal of 38 percent of forest roads which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any Johnson's (mistletoe) hairstreaks resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Population-level effects on the Johnson's (mistletoe) hairstreak are generally as described for the other species associated with mature, late-successional, and old-growth forests. Under the HCP, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP, as no additional commercial harvest will be conducted. The total amount of late seral habitat (over 80 years) is expected to increase by a factor of nearly five in the watershed on the whole, and by a factor of nearly nine at elevations below 3,000 ft.

The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit the Johnson’s (mistletoe) hairstreak population in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout the watershed, and also by providing critical older forest habitat for breeding and foraging. This landscape connectivity may further benefit Johnson’s (mistletoe) hairstreak populations on a more regional level by facilitating movement and dispersal of individuals between the municipal watershed and other watersheds to the north, east, and south.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the Johnson’s (mistletoe) hairstreak are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #42 – Blue-gray Taildropper, Puget Oregonian, Oregon Megomphix

Introduction

No comprehensive surveys to determine the presence or absence of the mollusk species blue-gray taildropper, Puget Oregonian, and Oregon megomphix have been conducted in the Cedar River Municipal Watershed, and no incidental observations of these species have been documented to date. The municipal watershed, however, is located within the identified range of each of these species. Although habitat associations are not well established for each individual species in this group of mollusks, they, as a group, appear to be most closely associated with low- to mid-elevation, moist forest, especially where organic debris has accumulated on the forest floor, as well as certain aquatic habitats such as streams, seeps, and springs. It is also significant to note that Frest and Johannes (1993) estimated that the Northwest Forest Plan has a relatively low probability of providing sufficient habitat to maintain well-distributed, interacting populations of these species across their ranges on federal lands in the next 100 years (blue-gray taildropper and Oregon megomphix, 30 percent; Puget Oregonian, 0 percent) and relatively high risks of extirpation (blue-gray taildropper and Oregon megomphix, 20 percent; Puget Oregonian, 50 percent).

Potential key habitat for the blue-gray taildropper, Puget Oregonian, and Oregon megomphix in the municipal watershed includes low- to mid-elevation mature, late-successional, and old-growth coniferous forest, especially areas including riparian habitat corridors. Other seral-stage, closed canopy coniferous forest, deciduous forest, and non-forested habitats are considered of secondary importance.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect blue-gray taildroppers, Puget Oregonians, and Oregon megomphix that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any of these species resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any breeding individuals of these species. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to those species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the blue-gray taildropper, Puget Oregonian, and Oregon megomphix are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests. Long-term benefits are expected to accrue to these species of mollusks, especially through protection of mature, late-successional, and old-growth forest in reserve status, protection of riparian corridors included in reserve status forests, and the recruitment of additional mature and late-successional forest in the watershed over time. A net gain of potential habitat (breeding, foraging, and dispersal) for these species is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to individuals of these species that may use the watershed through: (1) protection of all existing key forested habitat, including riparian corridors, in reserve status; (2) elimination of timber harvest for commercial purposes within the watershed, reducing the level of habitat disturbance; (3) natural maturation of second-growth forests into mature and late-successional seral stages, potentially recruiting increased amounts of organic debris to the forest floor and improving habitat function; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, including riparian forests, and improving habitat conditions on the forest floor (long term); (5) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying organic debris to the forest floor on both a short- and long-term basis; (6) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; (7) protection of secondary habitat including younger, closed canopy forest; and (8) monitoring and research.

The blue-gray taildropper, Puget Oregonian, and Oregon megomphix could be negatively affected by silvicultural treatments, road management, or other operational activities in low- to mid-elevation mature to old-growth forests. Such effects could be direct (i.e., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., microclimate changes due to the removal of overstory vegetation) or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the blue-gray taildropper, Puget Oregonian, and Oregon megomphix are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests outside developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (low- to mid-elevation mature to old-growth forest and riparian corridors) for the blue-gray taildropper, Puget Oregonian, and Oregon megomphix within the municipal watershed is in reserve status.

Major habitat effects on the blue-gray taildropper, Puget Oregonian, and Oregon megomphix are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forest. Increases in the quantity of mature and late-successional coniferous forest habitat for these species are expected over the 50-year term of the HCP as a result of natural maturation of all second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second-growth in some areas. In the near term, and solely as a result of natural maturation, there will be more than a 30-fold increase in the amount of mature (80-119 year old) conifer forest realized in the watershed within the first two decades of the HCP, totaling 34,745 acres by the year 2020. Of that increase of mature forest, 34,580 acres (99.5 percent) will occur below an elevation of 3,000 feet. Overall, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). As discussed for Group #34, the amount of mature, late-successional, and old-growth forest in the riparian zone will also increase nearly fivefold.

All riparian corridors (key habitat), forested wetlands, substantial areas of mixed and deciduous forest seeps, springs, lakes, and ponds are also protected as reserve forest or as inclusions in reserve forest and constitute potential habitat for the blue-gray taildropper, Puget Oregonian, and Oregon megomphix within the municipal watershed. In particular, the large Walsh Lake wetlands and forest complex, in the western section of the watershed, represents a diverse, low-elevation ecosystem that includes extensive forested riparian corridors, mixed coniferous/deciduous forest, extensively developed horizontal diversity and organic debris accumulation, and a relatively high level of tree species diversity. It also including a substantial number of mature big leaf maple and black cottonwood, many of which have survived since historic harvest activity many decades ago.

Under the HCP, some potential habitat for Group #42 species in the watershed, particularly riparian habitat, is also expected to benefit from ecological thinning and restoration thinning that is intended to produce mature and late-successional forest habitat characteristics in second-growth forests. Ecological thinning and restoration thinning in second-growth forests in the CHU and other parts of the watershed is expected to hasten the development of late-successional and old-growth characteristics in those forests, thereby effectively connecting all extant patches of old-growth forest within the term of the HCP. Under the HCP, approximately 11,000 acres are projected to be treated by restoration thinning and approximately 2,000 acres are projected to be treated by ecological thinning in the watershed.

In addition, during restoration activities, existing biological legacies (logs, snags) will, whenever possible, be retained and protected and substantial amount of large woody debris will be added to the forest floor on both a short- and long-term basis. As a result, both habitat diversity and potential for the blue-gray taildropper, Puget Oregonian, and Oregon megomphix will be increased, especially within riparian corridors, throughout the landscape of the municipal watershed. Tree species diversity, including both coniferous and deciduous species (big leaf maple, vine maple, black cottonwood, alder) will also be retained and/or encouraged in appropriate areas.

Development of late-successional characteristics, especially ecological diversity on the forest floor, in younger second-growth forests is also expected to benefit the three Group #42 species over the long term. However, over the short term, ground-disturbing management actions, including silvicultural treatments, may cause some localized decline in habitat function. Site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in the watershed to ensure that habitat for the blue-gray taildropper, Puget Oregonian, and Oregon megomphix will be minimally impacted.

Disturbance Effects and Direct Take

Disturbance effects and the potential for direct take of the blue-gray taildropper, Puget Oregonian, and Oregon megomphix are generally as described for other species addressed by the HCP that are associated with late-successional and old-growth forests. The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of any of these species that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) monitoring and research.

However, the likelihood of disturbance to any blue-gray taildroppers, Puget Oregonians, and Oregon megomphix in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations prior to silvicultural or road management activities, to establish protection measures for potential habitat structure whenever possible, and limit human disturbance in suitable habitat; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to breeding other resident individuals; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP as listed above, the likelihood of disturbance to, direct injury to, or death of any Group #42 species as a result of silvicultural treatments, road management, or other operational activities is very low.

Population-level Effects

Population-level effects on blue-gray taildroppers, Puget Oregonians, or Oregon megomphix are similar to those described for other species addressed by the HCP that are associated with late-successional and old-growth forest. Under the HCP, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early-seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five. The improved landscape connectivity and increased acreage of preferred forest habitat within the municipal watershed should benefit populations of blue-gray taildroppers, Puget Oregonians, or Oregon megomphix that may exist in the vicinity by providing improved forest habitat conditions that facilitate movement and/or dispersal of individuals throughout suitable habitat within the watershed, and also by providing critical older forest habitat for breeding and foraging.

Because mechanisms and rates of dispersal are virtually unknown for these species, it is impossible, as well as impractical to hypothesize, as to the potential for population-level effects on a regional level except to recognize that if populations of these species do exist and are protected within the municipal watershed, then it is theoretically possible that they could, on a very long-term basis, serve as a source of population expansion and/or recolonization if and/or when potential suitable habitat in adjacent lands becomes available.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for the Group #42 species are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

AQUATIC AND RIPARIAN ECOSYSTEM

Group #4 – Common Loon

Introduction

Although common loons use many lakes in Washington as foraging and resting habitat, often tolerating high levels of human activity, only very few (approximately ten) of these lakes support breeding pairs in any given year or on a regular basis. Common loons are very sensitive to human disturbance when nesting, and such disturbance can substantially reduce nesting success. Because common loons nest very near the waterline, water level fluctuations during the nesting period in spring can also cause nesting failure, and loons require adequate populations of prey fish to reproduce successfully. In general, common loons use large wooded lakes (typically 30 acres or more in size) with high water quality, dense fish populations, and undisturbed shorelines (Vermeer 1973).

Adult common loons are present spring through fall in the Cedar River Municipal

Watershed as migrants, non-reproductive individuals, breeding pairs, and fledglings in successful reproductive years. Transient common loons are regularly observed during spring and fall migration on the reservoir complex, Rattlesnake Lake, and Walsh Lake, but loons have not nested on Walsh or Rattlesnake lakes, at least during the last decade of study, and no historic observations of nesting have been confirmed. Additionally, loons are not expected to nest on either Walsh Lake or Rattlesnake Lake on any regular basis because of unfavorable habitat factors relative to Walsh Lake (e.g., largemouth bass) and current levels of human disturbance in the case of Rattlesnake Lake. Three mated pairs of common loons have been present on Chester Morse Lake and Masonry Pool, however, during each nesting season for the years 1989-1997. Two of the three nesting territories have been occupied by reproductive pairs during all 9 years of the City's research study (Section 3.5.5). A pair has been present consistently in a third territory during all 9 years, but no nests were established during 3 of those years. In order to help protect nesting loons from the adverse effects of reservoir fluctuations, the City has conducted a program since 1990 that entails deployment of floating nesting platforms, when practical relative to seasonal timing, loon reproductive behavior, and prevailing reservoir level conditions.

Key habitat for common loons within the Cedar River Municipal Watershed includes Chester Morse Lake and Masonry Pool, with the amount of habitat available varying with lake and pool elevations, (for breeding, foraging, and resting), Rattlesnake Lake (for foraging and resting), and, to a substantially lesser degree, Walsh Lake (for foraging and resting), along with associated riparian vegetation important to provide nesting cover, protect these aquatic habitats, and to maintain high water quality (e.g., cool water temperatures, low sediment levels).

The combination of mitigation and minimization measures committed to in the HCP is expected to protect the common loon population in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any common loons resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting common loon pairs. The likelihood of direct injury to, or death of, any common loons resulting from reservoir operations is also expected to be very low in most years under the HCP, as is the likelihood of disturbance to any actively nesting common loon pairs, with the exception discussed below that eggs may be lost to some pairs in occasional years. However, any such death, direct injury, or disturbance of common loons leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Long-term benefits are expected to accrue to the common loon, especially through protection of all large lakes and associated riparian habitat, as well as restrictions of human activities on the reservoir during the breeding season. Protection of, and improvements in, water quality (e.g., reduced sediment, lower temperature) and lakeside habitat are of particular importance to support foraging and reproduction for this species, and protection of the rainbow trout, bull trout, pygmy whitefish, Cottids, and aquatic invertebrate populations that is afforded by the HCP is important to maintaining the prey base for loons (see effects analyses for Group #5, bull trout, and Group #6, pygmy whitefish). A net gain in both the quality of potential key aquatic habitat and the quantity and quality of key riparian habitat for the common loon is expected over the 50-year term of the HCP. The HCP is expected to result in both short-term and long-term protection and benefits to common loons through: (1) deployment of artificial nesting platforms that provide more stable alternatives than many natural nest sites to ameliorate some of the effects of fluctuating reservoir levels; (2) protection of nesting pairs from human disturbance; (3) protection in reserve status of the reservoir, all other large lakes, and all lakeshore habitat, which will support reproduction and foraging; (4) protection of all old growth and recruitment of a substantial amount of mature and late-successional forest over time in riparian areas, resulting in potential improvements in water quality, protection of lakeside cover, and eventual recruitment of organic substrates to the lake (i.e., large logs for nesting); (5) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of disturbance, both to habitat and to nesting birds; (6) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests, improving riparian habitat conditions; (7) stream habitat restoration projects, reestablishing more natural stream function and potentially increasing the availability of some prey fish species; (8) streambank stabilization projects to reduce sediment input to streams and lakes; (9) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and lakes; (10) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (11) removal of 38 percent of watershed roads, reducing the potential for human disturbance; (12) overall expected improvement in water quality; (13) closure of the municipal watershed to unsupervised public access, reducing the levels of human disturbance on nesting loons; and (13) monitoring and research related specifically to common loons.

Common loons could be negatively affected by reservoir operations, silvicultural treatments, road management, or other operational activities in or near streams and lakes. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat or water quality (e.g., removal of overstory vegetation, increased stream temperature). Common loons could also be negatively affected on a short-term basis by management actions that contribute sediment to streams (e.g., stream restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the common loon are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the Proposed HCP

Habitat Effects

A direct threat to common loons in Washington is the loss of lakeshore habitat, including some form of vegetative cover and potential nesting substrate or structures at the existing waterline (emergent vegetation, logs, and on rare occasions, rock). Effects on shoreline vegetation can occur as a result of reservoir operation and land management activities. Land management can also affect the quality of loon foraging habitat through effects on water quality and on populations of prey fish in the large lakes that migrant loons use for foraging during migration and that pairs and juveniles use during the breeding season prior to migrating in late fall.

Potential Effects of Land Management Activities on Habitat

Because no commercial timber harvest will be conducted in the municipal watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for the common loon within the municipal watershed (large wooded lakes and associated riparian habitat) is in reserve status.

Common loons may also be adversely impacted indirectly by negative impacts to prey populations (fish and aquatic invertebrates). Such impacts are typically caused by elevated sediment input to streams and aquatic systems resulting from silvicultural treatments in or near riparian areas, or potentially by fishing mortality. A major focus of the HCP is the reduction of sediment input to streams and aquatic systems, both to improve the quality of drinking water provided through the supply system and to improve the habitat potential of all aquatic systems in the watershed by protecting and/or restoring naturally functioning terrestrial and aquatic ecosystems. Major components of the HCP directed at reduction of sediment input to aquatic systems include: (1) elimination of timber harvest for commercial purposes in riparian and upland areas; (2) restrictions on the use of mechanical equipment and cutting of trees within 50 feet of streams; (3) planning and evaluation by interdisciplinary teams of silvicultural and operational projects in any key habitat, especially within riparian zones; (4) during restoration or ecological thinning activities, prohibition of any tree removal with the potential to reduce streambank stability within 25 feet of any stream; and (5) inclusion in the HCP of a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas and with road construction, maintenance, decommissioning, and use. These measures and other forest management strategies are expected to result in improvements in water quality over time. Closure of the watershed to unsupervised public access (Section 4.2.2), including access for fishing, virtually eliminates any quantitatively significant mortality of loon prey fish as a result of fishing.

The HCP also includes management actions designed to help restore and enhance aquatic and riparian habitats and develop a more naturally functioning aquatic/riparian ecosystem , which, over time, should serve both to improve water quality (and underwater visibility) for foraging loons and support, or potentially increase, prey fish populations. Stream bank stabilization projects, placement of large woody debris, a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas are expected to help accelerate (1) the restoration of natural aquatic and riparian ecosystem functioning and (2) the development of mature or late-successional characteristics in younger second-growth forests, especially in selected riparian corridors. Implementing these programs will indirectly benefit the common loon over the long term by reducing sediment and improving water quality as discussed above. Because these management actions may cause some localized, short-term impacts, site evaluations by interdisciplinary teams will be conducted to ensure that impacts to common loon habitat are minimized.

Road repair, maintenance, decommissioning, and use can all impact stream and riparian areas. The comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) are, however, intended to minimize the probability of erosion and mass wasting associated with forest roads. Implementing these prescriptions, along with the program to improve many roads and to decommission a substantial part of the total road system (Section 4.2.2), will reduce the rate of sediment loading to streams and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads come near streambanks, but improved road maintenance and a relatively low level of road use under the HCP will help mitigate those impacts.

Potential Effects of Reservoir Operations on River Delta Vegetation

Operation of water supply reservoirs typically involves large seasonal fluctuations in water levels that can vary in magnitude, timing, and duration from year to year. The pattern of fluctuations establishes a dynamic equilibrium with wetland plant communities and riparian forest along the reservoir edge, and operational changes in the pattern of fluctuations of reservoir elevation are known from experience on many reservoirs to have effects on wetlands and riparian forest within and around these reservoirs. As described in Section 4.5.6, changes in operation of the City's reservoir in the municipal watershed that have occurred over the last decade or two have substantially affected and are expected to continue to affect wetlands of the Rex and Cedar river deltas to an unpredictable degree.

A 10-year study of the extensive wetland communities of the Cedar River and Rex River deltas (Raedeke 1998) documented effects on delta wetland vegetation communities resulting from higher late winter and early spring water levels and extended reservoir fill regimes, including recession of delta sedge and willow communities, and death of mature deciduous and coniferous trees on some of the Cedar River floodplain. These changes in delta vegetation could negatively affect the suitability of the delta areas as common loon nesting habitat by reducing lakeshore cover and other available cover, as well as reducing availability of suitable nesting substrate, such as logs (Section 4.5.6). While it is possible that drawdown of the reservoir could also impact these deltas, extended low levels did not occur during the study, so it was not possible to measure such effects, if they might occur at all. As discussed for bull trout (Group #5) below and in Section 4.5.6, the magnitude of drawdown in the fall under the HCP is not expected to differ significantly from drawdown during the past 20 years.

The City does not expect, although it is possible, that significantly more reduction in the total area of sedge wetlands around Chester Morse Lake will occur as a result of the faster, higher, and longer duration spring refill that has characterized recent reservoir operations and that will characterize future operations. Changes in forest and willow vegetation around the reservoir, however, especially in delta zones, are likely to continue, as effects on these plant communities lag the changes in reservoir operations that initially caused them, and such changes may extend over a longer period of time than the period in which documented changes in the sedge communities occurred. The willow thickets have served and continue to serve as cover for nesting loons, so a further reduction in willows would reduce potential nesting cover in some locations within the delta zones. In the near term, further death of mature trees in delta and upstream zones should result in some degree of recruitment of additional logs to delta zones, some of which could possibly be used as nesting substrate for loons. Eventually, recruitment of logs from the riparian forest along the deltas and in upstream areas will increase as the forest matures, trees grow larger, and natural tree mortality occurs under a new dynamic equilibrium with reservoir operations.

Operation of Chester Morse Lake and the Masonry Pool during the term of the HCP will be similar to that which occurred in recent years (see discussions in Section 4.5.6 and in the effects analysis for bull trout, Group #5), however, and it can be expected that wetlands and lakeshore forests are progressing toward establishment of a new dynamic equilibrium with the current reservoir operating regime over the long term. Re-equilibration of willow communities, natural maturation of riparian forest, and silvicultural intervention to accelerate develop of natural riparian forest functions and late-successional forest characteristics should collectively, over the long term, lead to an overall improvement of conditions for potential nesting on the deltas, compared to current conditions, by producing higher rates of recruitment of trees that could eventually serve as adequate nesting substrate and, presumably, by redevelopment of dense willow thickets as nesting cover.

Implementation of the Cedar Permanent Dead Storage Project could have a substantial impact on the level of reservoir fluctuations, and thus on wetlands and riparian forests that provide important habitat elements for common loons. The Cedar Permanent Dead Storage Project would alter fill and drawdown regimes of Chester Morse Lake from the current regime, and changes would include likely modification of seasonal timing, extent, and duration of drawdown and fill. Although the Cedar Permanent Dead Storage Project may have potential negative effects on common loon habitat, such effects will be evaluated during a 5-year study, and mitigation will be developed if the project is implemented (Section 4.5.6). Implementation of the Cedar Permanent Dead Storage Project would require a plan amendment under Section 12.2 of the Implementation Agreement (Appendix 1).

Disturbance Effects and Direct Take

Disturbance and the potential for direct take of common loons could occur as a result of land management activities, other kinds of human activities, and reservoir operations during the nesting season.

Potential Disturbance Effects of Land Management

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of common loons that may occur in the watershed include any operations that involve human activities on roads and in or near suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some monitoring and research activities.

The likelihood of disturbance to any actively nesting common loons as a result of land management activities in the municipal watershed, however, is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of common loon habitat prior to silvicultural or road management activities that could disturb loons; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities; (3) compliance with Washington Forest Practice Rules; (4) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as described above, the likelihood of disturbance to, direct injury to, or death of common loons as a result of silvicultural treatments, road management, or other land management activities is expected to be very low. In addition, most active roads are either substantial distances away from known nest sites or are effectively screened by existing habitat or landscape features.

Potential Disturbance Effects of Other Human Activities

In addition to the activities listed above, adverse impacts from a wide variety of human disturbances, such as recreational activities, traffic, noise, and pets, especially near highly sensitive nest sites, pose a serious threat to common loons throughout their range. This fact is especially true in Washington State, because so few pairs are known to nest in any given year. Such effects are largely indirect and occur as a result of impacts on habitat (e.g., water quality) or through disturbance. Because disturbance, especially at nest sites or during foraging activity, can adversely affect common loons both directly and indirectly, the restriction of unsupervised public access to the Cedar River Municipal Watershed under controlled access regulations (Section 4.2.2) will continue to benefit loons throughout the watershed by minimizing such disturbance. In addition, the City's policy of carefully controlling the use of boats on the reservoir complex (boat use is typically sporadic and minimal), especially during the loon nesting season, minimizes disturbance and provides added protection for loons during the sensitive reproductive period.

Because Rattlesnake Lake and much of its surrounding shoreline are not closed to public access and are available for many recreational activities, however, disturbance in this area is much less restricted. While it is possible that lack of nesting activity on Rattlesnake Lake may be attributed to significantly higher levels of human activity (non-motorized boating, fishing, and swimming) than those experienced by loons using the protected reservoir system, there is no specific evidence that this is the case, and there has been no confirmed nesting of common loons on Rattlesnake Lake to the knowledge of current City staff. Despite the high and increasing level of human activity on Rattlesnake Lake, the numbers of loons foraging and resting on the lake and the extent of time they are present (i.e., foraging, resting) have typically been relatively high over the past decade, with some exception.

The likelihood of disturbance to any actively nesting common loons as a result of human activities in the municipal watershed other than land management activities is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) the City's policy restricting unsupervised public access (including no access for hunting or fishing) to the Cedar River Municipal Watershed, with the exception of Rattlesnake Lake, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds, as well as reducing potential fishing mortality on prey fish species; and (2) the City's policy of restricting boating activities on the reservoir during the common loon breeding season. The likelihood of disturbance to any transient common loons on Walsh Lake as a result of human activities in the municipal watershed other than land management activities is also expected to be very low and short-term in nature, because of the above listed mitigation and minimization measures. Some disturbance of transient common loons foraging or resting on Rattlesnake Lake during migration, however, is likely to occur as a consequence of recreational activities on and around the this lake. Based on observations of common loons on Rattlesnake, however, the City believes that this disturbance is highly unlikely to result in the equivalent of take, or in take should the common loon be listed under the ESA as threatened or endangered.

Because of specific mitigation and minimization measures committed to in the HCP, as described above, the likelihood of disturbance to, direct injury to, or death of common loons as a result of human activities in the municipal watershed other land management activities is expected to be very low for nesting adults. The likelihood of disturbance to, direct injury to, or death of transient common loons as a result of human activities in the municipal watershed other activities related to land management is expected to be very low, as well, except for the disturbance of loons on Rattlesnake Lake by recreationists, as described above.

Potential Disturbance Effects of Reservoir Operations on Common Loon Nesting

Common loons typically nest at the water's edge, and nests are vulnerable to fluctuations in water level. On natural lakes and ponds, loons can sometimes compensate for small changes in water levels by modifying nest structure. However, large fluctuations in reservoir levels that can inundate or strand nests can have substantial negative effects on the reproductive success of loons. Nesting habitat and structures are potentially available in willow-dominated zones of the Cedar and Rex River deltas and in specific small areas of Masonry Pool. However, this nesting habitat is currently subject to springtime water level fluctuations over the course of the nesting season (April through mid-June) of up to 10 ft or more under the present reservoir operating regime.

A simple modeling exercise was completed to assess the incremental effect of the proposed HCP instream flow regime on Chester Morse Lake reservoir levels compared to the current regime, called the IRPP regime (Section 4.5.6). Based on conditions represented in the 64-year period of record, weekly lake levels under the proposed HCP flow regime averaged 0.01 ft lower than under the IRPP flow regime during the typical 11-week common loon nesting season, although differences between the flow regime would occur during some years. The differences between the projected lake levels for the two operating regimes varies less than 1 ft (higher or lower) 94.9 percent of the time during the common loon nesting season. The relatively smaller decrease in reservoir elevation projected under the HCP than the decrease projected under the IRPP regime would constitute a positive effect on nesting loons (Section 4.5.6). Overall, the model results indicate that the incremental differences in lake levels, and fluctuations in lake levels, projected under the HCP flow regime will probably have little, if any, additional negative effect on common loon nesting success. However, the overall negative effect of relatively large seasonal fluctuations in reservoir water levels during the loon nesting season that currently exists, and will continue to exist, does represent a potential impact to nesting common loons.

In order to reduce adverse effects of reservoir fluctuations on nesting loons, since 1990 the City has been conducting an experimental nest platform program in which artificial floating platforms with native vegetation are deployed at the beginning of the loon nesting season, or when reservoir water levels allow, to provide more stable nest sites (sections 3.5.5 and 4.5.6). Although the platforms are not sufficient to counteract the effects of large reservoir fluctuations (more than about 5-8 ft), such as occur during a prolonged, early season drought, this program has demonstrated some success. Platforms were used by nesting loons in at least one, and typically two, of the three nesting territories on the reservoir in each of the 8 project years during the period 1990-1997; a platform was used in 7 consecutive years in one territory; and a platform was used in 6 of 8 years in a second territory. Of 21 nests on the reservoir during the period 1990-1997, 14 (two-thirds) were on platforms. Of the 24 chicks produced during this period, 6 chicks hatched on natural nests and 18 chicks (three-fourths) hatched on the platform nests. As part of the Species Conservation Strategies for the common loon (Section 4.2.2), the City intends to continue the experimental nest platform project, as long as monitoring continues to document the efficacy of the program.

The likelihood of disturbance to any actively nesting common loons in the watershed as a result of reservoir operations, however, is expected to be very low and short-term in nature in most years. As described above, artificial nest platforms are deployed to ameliorate some of the adverse effects of reservoir fluctuations on loon reproductive success. It is possible, however, that nesting opportunities, some eggs, or young chicks could be lost in years of extreme reservoir fluctuation during the nesting season, especially on natural nest sites, but also on artificial platforms under some environmental conditions (e.g., drought, excessive wind, storms) to which platform nests are vulnerable under some deployment conditions.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of adult common loons as a result of reservoir operations is expected to be very low. Eggs from some nests may be lost during some years, as described above, but the City believes that this type of loss is infrequent and would not have significant population-level consequences.

Implementation of the Cedar Permanent Dead Storage Project could affect the extent, duration, and timing of reservoir fluctuations and thus impact nesting loons during the common loon nesting season from April through mid-June. The Cedar Permanent Dead Storage Project would alter fill and drawdown regimes of Chester Morse Lake from the current regime, and changes would include modification of seasonal timing, extent, and duration of drawdown and fill. Although the Cedar Permanent Dead Storage Project may have potential negative effects on the common loon, including disturbance effects, such effects will be evaluated during a 5-year study and mitigation will be developed if the project is implemented (Section 4.5.6). Implementation of the Cedar Permanent Dead Storage Project would require a plan amendment under Section 12.2 of the Implementation Agreement (Appendix 1).

Population-level Effects

The substantial degree of habitat protection and water quality and habitat improvement provided under the HCP is expected to benefit nesting, transient, and other common loons which use the Cedar River Municipal Watershed. Under the HCP, all key aquatic and riparian habitat for common loons will be protected through reserve status, and, overall, is expected to improve in quality over time. Water quality will also improve over time as a result of a reduction of sediment input to aquatic habitats through habitat restoration, improved road maintenance, road improvement projects, substantial road decommissioning, and a reduced level of heavy road use under the policy of no commercial timber harvest. Any short-term, local impacts to common loons resulting from restoration activities in aquatic and riparian areas will be more than offset by long-term, landscape-level benefits.

Measures included in the HCP to protect and restore aquatic and riparian habitats and improve water quality over time may increase production of some of the fish that are prey of common loons and facilitate movement of some of these fish into and out of tributaries to the reservoir, potentially increasing prey availability for nesting loons. Measures in the HCP that reduce human activity levels will protect any nests in the watershed from human disturbance, also increasing the potential for nesting success. Overall, the City expects that population-level effects of the HCP on the common loon will be positive.

The importance of the Cedar River Municipal Watershed as habitat for common loons takes on added significance when considered in a regional or statewide context, as the three pairs of common loons that typically nest in the municipal watershed have constituted more than one-quarter of the loons nesting in Washington State in many recent years. The production of fledglings from the watershed has, in many years, constituted an even larger fraction of the fledged loons produced in the state, likely as a result of the degree of security within the watershed compared to the high levels of human disturbance to nesting loons on lakes open to the public. As population growth and development pressure from the Seattle/Tacoma metropolitan area continue to diminish the quantity (through housing development around lake and reservoir shorelines) and quality (through increasing recreational boat use of lakes and reservoirs, and through sediment input) of habitat for common loons, the availability of undisturbed habitat in the municipal watershed will play an increasingly critical role in maintaining the viability of populations of common loons that nest in the Puget Trough and the western Washington Cascades.

Other Effects

Common loons may also be adversely affected by deterioration of water quality resulting either from contamination by chemical pollutants (e.g., petroleum products and other toxic chemicals) directly by impacting individuals (potential mortality) or indirectly by impacting the prey base (fish and aquatic invertebrates). However, because the Cedar River Municipal Watershed is the major source of drinking water supply for the City of Seattle and many of the surrounding municipalities, rigorous water quality standards and regulations are set and enforced by regulatory agencies. Furthermore, use of many chemicals is restricted and/or tightly controlled within the municipal watershed, and Seattle Public Utilities has stringent standards designed to reduce the risk of spills of toxic materials and protect water quality in the case of any spill. These standards are maintained by controlling public access to the municipal watershed and by adhering to the strict regulations ascribed to all operational and other activities conducted in the watershed.

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the common loons are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives. The monitoring program includes annual surveys of common loons during the term of the HCP, and additional research will be done early in the HCP to better understand the effects of reservoir fluctuations on nesting loons and their habitat (Section 4.5.6).

Group #5 – Bull Trout

Introduction

Bull trout are present in the Cedar River Municipal Watershed upstream of Masonry Dam. The adfluvial life history form of bull trout, in which spawning and juvenile rearing take place in rivers, and fish grow to full maturity in lakes, is the only one known at this time to occur in the municipal watershed. Bull trout spawn and rear in the Cedar and Rex rivers, primarily within approximately five river miles and three river miles of Chester Morse Lake, respectively. Spawning and juvenile rearing also take place in some of the smaller tributaries of the Cedar and Rex rivers and Chester Morse Lake. Spawning in these smaller tributaries occurs mostly in lower reaches relatively near the river or lake confluence. Substantial rearing also occurs in several small tributaries that are apparently not utilized for spawning. Adult bull trout, for the most part, mature in the Chester Morse Lake and Masonry Pool reservoir complex. It is unknown if any lake spawning, observed in bull trout populations on an uncommon basis, occurs along the shores of Chester Morse Lake (see Section 3.5.6).

Low-velocity, shallow side-channels, alcove pools, and woody debris are important habitat features for newly emerged bull trout fry and juveniles in the municipal watershed, as are cool water temperatures and adequate food, both of which depend on channel structure and the condition of riparian vegetation. Potential key habitat for bull trout in the municipal watershed includes the reservoir complex, the Cedar and Rex rivers, and several smaller tributaries to the rivers and reservoir, as well as riparian habitat associated with the reservoir and its tributary system.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any bull trout within the municipal watershed. The likelihood of direct injury to, or death of, any bull trout resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. Some bull trout, however, may be killed or injured by entrainment through the intakes of the Cedar Falls Hydroelectric Project and through the Overflow Dike separating Chester Morse Lake and Masonry Pool, which regulates flow into the Pool when reservoir elevation is below 1550 ft. Some eggs or alevins could be adversely affected by inundation during the incubation period in spring, and there may be some degree of impedance of upstream migrating bull trout resulting from uncommon occurrences of reservoir drawdown during severe droughts. Any death or direct injury of bull trout would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The mitigation and minimization measures of the HCP are expected to maintain the natural processes important for creating and maintaining habitat for bull trout in the watershed. The HCP is expected to result in short- and long-term benefits to bull trout as compared to the current conditions by implementing: (1) protection of all key habitat (streams, the reservoir complex, and riparian habitat); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance; (3) protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with the reservoir complex and its tributaries; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) stream restoration projects, which are expected to improve microhabitat conditions (e.g., temperature regimes and instream habitat complexity) in many reaches; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research related to bull trout, including research targeted at determining the level of impacts to bull trout by future reservoir operations, with emergency provisions for upstream passage for spawning adults if needed during the fall.

Bull trout could be negatively affected by reservoir operations, silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect streams or the reservoir. Such effects could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Bull trout could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, road use, and road decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the bull trout are detailed in the Section 4.2.2 and Section 4.5.6, and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

The effects of the HCP on bull trout habitat are of two types: (1) the effects of land management and (2) the effects of reservoir operation. Reservoir operations can affect bull trout habitat in two primary ways (Section 4.5.6): (1) by inundation of redds during spring reservoir refill, potentially resulting in mortality of eggs, or possibly of alevins; and (2) by potentially impeding the fall passage of spawning adults upstream into the Rex and Cedar rivers, or lake tributaries, during severe droughts. Because both of these potential effects of reservoir operation could involve some form of disturbance, they are discussed below under "Disturbance Effects and Direct Take." Effects of land management are discussed in this subsection.

The effects of past land management in the municipal watershed have included (1) removal of riparian forest during timber harvest, reducing shading, the supply of food (invertebrates) to streams, and recruitment of large woody debris; and (2) construction and use of hundreds of miles of forest roads, which has increased sediment loading to streams through erosion and mass wasting (landslides). The current, disturbed condition of the majority of aquatic and riparian habitats in the municipal watershed presents opportunities for habitat rehabilitation and, over the long term, restoration of the natural ecological functions of the aquatic/riparian ecosystem.

Because no commercial timber harvest will be conducted in the municipal watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for bull trout within the municipal watershed (i.e., the reservoir complex and its tributaries, along with associated riparian habitat) is protected through reserve status. In addition, protection in reserve status of *all* forested areas of the watershed will decrease the likelihood of land management activities adversely affecting bull trout. In the short term, bull trout will benefit by increased levels of habitat protection and by active intervention to increase habitat complexity, such as through projects to retain and/or add large woody debris to deficient streams. In the long term, bull trout will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements, such as large woody debris, that are important to bull trout.

The City believes that instream habitat improvement and rehabilitation must be accompanied by upslope protection and restoration that will reduce impacts of upslope conditions or activities on stream habitat. For example, efforts to stabilize stream banks or add large woody debris to streams may not be effective in the long run if road failures occur that result in large inputs of coarse sediment to streams upstream of such projects. Thus, these kinds of activities will be coordinated under the HCP.

Short-term and long-term gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams and the reservoir complex, as well as protecting all wetlands associated with streams, along with their recharge areas. In addition, maturation of protected forest in riparian corridors near streams and the reservoir complex will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, increasing food production for fish, and maintaining cooler water temperatures.

Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus benefiting bull trout. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data, and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to improve and help restore aquatic and riparian habitats, including stream bank stabilization projects; placement of large woody debris (LWD); a stream bank revegetation program; a program of restoration planting, restoration thinning, and ecological thinning in riparian areas; a program to eliminate, modify, or replace stream-crossing culverts that could impede the passage of bull trout using tributaries, restoring habitat connectivity and continuity; a program to eliminate, modify, or replace stream-crossing culverts that are inadequate for passing peak storm flows, reducing the chance of failure and resulting sediment deposition in downstream habitat; programs to improve problem roads and the maintenance of roads that can affect streams, in both cases to reduce sediment loading to streams associated with erosion and mass wasting; and a program to decommission (remove) about 38 percent of forest roads, further reducing sediment loading to streams.

Collectively, these conservation and mitigation activities should (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Although restoration of a more naturally functioning aquatic ecosystem will benefit bull trout over the long term, some of these management interventions may cause some localized, short-term decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion, or disturbance of soils that could result in some level of erosion and sediment release into streams or the reservoir.

Because, no harvest for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to such activities in riparian areas will also help minimize any such impacts on bull trout. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments, especially in riparian areas. These prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitats for bull trout. One important set of constraints is that, during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams, no tree removal that has the potential to reduce streambank stability will be allowed, and no tree removal will be allowed within 25 ft of any stream.

Because many of the types of habitat rehabilitation and restoration measures included in the HCP are experimental, monitoring within the context of adaptive management is essential to the long-term success of these efforts (Section 4.5.7). The HCP includes two types of monitoring relevant to these efforts (Section 4.5.4): (1) long-term monitoring of stream habitat quality, to detect trends, and (2) monitoring of specific aquatic and riparian restoration projects, to provide feedback on the adequacy of project designs. Interdisciplinary teams will be involved in the design and monitoring of restoration projects.

Disturbance Effects and Direct Take

Potential disturbance effects of the HCP on bull trout are of two types: (1) the effects of land management and (2) the effects of reservoir operation, which is directly related to instream flow management. The potential effects of land management would most likely be from use of watershed roads, active intervention for the purpose of habitat rehabilitation and restoration, and general watershed management operations. The primary disturbance effects related to reservoir operations are:

(1) the potential effects of reservoir drawdown during severe droughts, which could impede passage of adult bull trout into tributaries to the reservoir during the fall spawning season (with timing and duration of impedance varying both within and among years), when relatively steep sections of the face of the delta fans of the Cedar and Rex rivers may be exposed;

(2) potential effects of inundation of redds, especially in lower reaches of the Cedar and Rex rivers, during spring reservoir refill, potentially causing reduction of oxygen and rate of removal of metabolites from eggs as a result of both sediment in interstitial spaces and reduced water velocity through spawning gravels; and

(3) potential entrainment at facilities in the Chester Morse Lake/Masonry Pool complex.

Analysis of reservoir levels for the evaluation of the first two kinds of potential effects (drawdown and refill) was accomplished in two ways:

(1) Projected reservoir levels under the IRPP flow regime (the modeled proxy for the current instream flow regime) were compared to projected reservoir levels under the new HCP instream flow regime, using a simplified numerical water balance model of the Cedar River system (see Section 4.5.6); and

(2) The frequency of different reservoir elevations under past and current operational regimes were compared with the expected frequency of elevations under the HCP by using analytically derived reservoir elevations for the HCP regime (Section 4.5.6 and Appendix 38), rather than modeled elevations.

Because it allows a consistent comparison of the two flow regimes, the first approach (i.e., modeled weekly elevations) is a reasonable approach to show the *differences* in reservoir elevation under the two operational regimes. Because the modeled elevation method does *not* do a good job of capturing short-term reservoir changes and actual operational decisions that can affect reservoir elevation in the short term, however, the second approach, the comparison of analytically derived reservoir elevations (Appendix 38), is best suited for evaluating the expected frequency of reservoir conditions under the HCP. This latter analysis looked at two time intervals (periods of record): (1) 1940-1999, representing a long-term record, and (2) 1980-1999, representing a shorter-term record that covers the period during which reservoir operations were most like current operations (the period following promulgation of the 1979 IRPP flows by the WDOE, during which the City voluntarily tried to adhere to the IRPP flows).

As noted in Appendix 38, reservoir elevations are essentially the same under both flow regimes (IRPP and HCP) during the recent period (1980-99), but some differences exist between the recent period and longer period of record (1940-99). The recent (20-year) period of record is used to represent the HCP for all comparisons to the longer (60-year) historic record below, with the exception noted in Appendix 38 that the longer period of record was used to characterize annual changes in reservoir elevations from late November until the end of February to better represent the range of conditions expected during the 50-year HCP.

For the analysis using analytically derived reservoir elevations, five operating zones of reservoir elevation were defined for bull trout (Figure 4, Appendix 38):

1. Very infrequent high elevations, of concern during spring incubation. Expected frequency of 1 in 50 years with a duration of 1 week, and 1 in 10 years with a duration of less than 1 week.

2. Infrequent high elevations, of concern during spring incubation. Expected frequency of 1 in 10 years with a duration of 1-2 weeks. This zone includes floods, which are short-term events.

3. Normal operating zone, with a 20 percent chance of short excursions outside this zone in any given week. In fall, elevations expected to be below 1540 ft 1 in 4 years, with a duration of 1-3 weeks.

4. Infrequent low elevations, of concern during fall spawning. Expected frequency of 1 in 10 years with a duration of 1-3 weeks, with the possibility of being in this zone for many weeks in the June-September period during droughts.

5. Very infrequent low elevations, of concern during fall spawning. Expected frequency of 1 in 50 years with a duration of 1 to several weeks. This zone includes severe droughts.

Disturbance Effects Related to Land Management

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of bull trout that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of direct take of bull trout from land management activities is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of bull trout habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential mortality from fishing; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of silvicultural treatments, road management, or other operational activities in riparian areas is expected to be very low in any given year.

The restriction of public access into the municipal watershed will provide benefits for bull trout by reducing potential disturbance and direct take from fishing. Little or no angling disturbance will occur when the species ascends the river to spawn in the fall, a period in which bull trout are highly susceptible to angling pressure, with the potential for fishing disturbance only by trespassers.

Disturbance Effects Related to Reservoir Drawdown

Chester Morse Lake pool levels under the current reservoir operation range from a normal high pool of 1,563 ft above sea level to a minimum drawdown of 1,532 ft. Under extreme emergency conditions, Chester Morse Lake can be lowered below 1,532 ft to as low as 1,502 ft using the existing emergency pumps. Access to tributary streams by fall spawning bull trout may be impeded or blocked because of the exposure of the steeply sloped faces of delta fans where the Cedar River delta (14 percent slope) and Rex River delta (17 percent slope) meet the main body of Chester Morse Lake. Exposure of several feet of the steep faces of the delta fans may present either a partial or a complete barrier to migrating bull trout, with timing and duration of impedance varying both within and among years, if the exposed channel gradient and resultant stream conditions exceed the swimming and leaping capabilities of bull trout.

A very conservative estimate is that the potential for exposure of the steeply sloped faces of the delta fans of the Cedar and Rex river deltas begins to occur initially as reservoir levels drop below about 1,540 ft. The degree of potential impact is relatively minor immediately below 1,540 ft, however, because water depths sufficient to allow fish passage (approximately 1-3 ft) typically remain, and because only some parts of each steeply sloped delta face could be completely exposed, if any parts are exposed at all. Although some uncertainty exists, the City does not expect that any substantial portions of the steep-gradient stream channels on the deltas are actually exposed or that each delta face, as a whole, will not carry flow sufficient to pass fish, at 1,540 ft surface elevation. As the reservoir level drops below 1,540 ft and approaches 1,535 ft, however, the steep channel gradients are believed to extend for sufficient length to potentially impede or block migration (R2 Resource Consultants, in preparation). The question regarding the potential impedance of passage of bull trout at the face of the delta fans during occasional low drawdown events, including the timing, extent, and duration, has been raised only recently. Since Chester Morse Lake levels have not dropped below 1,540 ft since 1991 and none of the critical portions of the channel confluence or face of the delta fans has been exposed, staff biologists have not had the opportunity to directly observe the substrate structure, or flow conditions, that exist either where or when impedance of passage of bull trout is thought to be the most likely to occur.

A comparison of *modeled* reservoir levels projected under the IRPP (current) flow regime to projected reservoir levels under the new HCP instream flow regime was done using historical data sets for the period of record (64-plus years including the annual 13-week bull trout spawning season) (see Section 4.5.6). Overall, the modeling analysis indicated that differences between current reservoir management and reservoir management under the HCP are small, with reservoir levels in the fall slightly lower under the HCP regime (an average weekly difference of –0.41 ft) as a result of commitments to higher summer streamflows for steelhead in the mainstem Cedar River downstream of Cedar Falls. The difference in reservoir levels was less than 1 ft (higher or lower) 78 percent of the time.

The modeling indicated that the IRPP flow regime resulted in reservoir levels below 1,540 ft elevation a total of 5.1 percent of the 843 weeks modeled. Projected reservoir levels dropped below 1,540 ft at least once every 5 years and were at those low levels for an average of 3.6 weeks, and remained continuously at those levels for an average of 3.3 weeks. Projected lake levels below 1,535 ft elevation were less common (1.4 percent of the modeled weeks), and occurred at least once every 13 years for an average of 2.4 weeks during the bull trout spawning season.

The modeled results for the IRPP flow regime showed that, when the reservoir drops below levels estimated to be sufficient to expose the steeply sloped faces of the Cedar and Rex river delta fans, those low levels exposing the steely sloped faces of the delta fans are rarely sustained for more than one-half of the 13-week bull trout spawning period. Additionally, as water levels drop, the Cedar and Rex rivers may cut newer, less steep channels in the delta sediment that would aid fish passage, but the time necessary for such a process to occur is not known. Furthermore, because the short, steep reaches occur at the mouths of the rivers, bull trout encounter the deltas at the onset of their upstream migration, when individuals are relatively fit for successful ascent through potentially marginal passage conditions. To date, there is no empirical evidence that suggests existing operations limit the numbers of bull trout that ascend the Cedar and Rex rivers to spawn or the timing of migration, which appears to be more related to river flow and temperature conditions.

Under the new HCP flow regime, modeled reservoir levels were projected to be below 1,540 ft elevation 6.4 percent of the time as compared to the 5.1 percent of the time for the IRPP flow regime. Modeled reservoir levels were projected to drop below 1,540 ft at least once every 4.5 years, to be at those low levels for an average of 3.9 weeks, and to remain continuously at those levels for an average of 3.6 weeks.

Differences in the percent of time that projections of modeled lake levels were below 1,535 ft elevation between the new HCP instream flow regime and the IRPP flow regime were extremely minor. Projected modeled reservoir levels under the HCP flow regime were below 1,535 ft about 1.2 percent of the modeled weeks and occurred at least once every 16 years for an average of 2.5 weeks during the bull trout spawning season, whereas projected modeled reservoir levels under the IRPP flow regime were below 1,535 ft about 1.4 percent of the modeled weeks and occurred at least once every 13 years for an average of 2.4 weeks during the bull trout spawning season. Over the 64-plus years of projected 13-week bull trout spawning seasons, the modeled lake levels under the new HCP flow regime averaged 0.41 ft lower than under the IRPP flow regime (Section 4.5.6, Table 4.5-2).

As mentioned above, the analysis of reservoir elevations comparing actual past elevations to *analytically derived* elevations under the HCP (Appendix 38), as opposed to the modeled elevations described above, gives a better picture of the likelihood of potential impacts of reservoir drawdown on bull trout during fall spawning (mid-September until mid-December). Inspection of Figure 2 in Appendix 38 indicates that from early October through December reservoir elevations under the same environmental conditions should be nearly the same under the HCP as during the 60-year historic record, except for a few weeks in which there is a slightly higher frequency of lower elevations. As indicated by Figure 4 in Appendix 38, reservoir elevations can be expected to be below 1535 ft at frequencies of 1 in 10 years or less only part of the fall spawning period, and then only for periods of 1-3 weeks (within the “infrequent” operating zone, zone 4 as defined above). To place this effect in context, it should be noted that some delay of adults entering the Cedar and Rex rivers can be expected during the fall period in many years as a result of *natural* variability in both timing and volume of attraction flows that depend on the onset of heavy fall rains. Delays of several weeks during the fall migration upstream probably occur under natural conditions, although extreme reservoir drawdown could exacerbate this situation.

The City believes that the new HCP flow regime will probably have little additional impact on bull trout spawning migrations compared to current operations. Although the timing of bull trout entry into the Rex River and Cedar River potentially might be affected by extraordinary low reservoir levels during the fall, it is highly unlikely that these relatively short and infrequent delays will cause an overall reduction in the number of fish ascending the rivers to spawn or overall spawning success in most years. The potential for blockage or impedance of bull trout spawning migrations during infrequent periods of low reservoir levels will be thoroughly studied and analyzed under the HCP Monitoring and Research Program as part of Environmental Evaluation of the Cedar Permanent Dead Storage Project (Section 4.5.6). Furthermore, a passage assistance plan will be developed that can be implemented, if needed, pursuant to the contingency plan for droughts (Section 4.5.7). Steps taken under this plan should ameliorate effects of lake level fluctuations on impedance to bull trout passage at river delta fans during annual upstream spawning migration.

Disturbance Effects Related to Inundation of Redds

Inundation of bull trout redds by rising winter and spring reservoir levels occurs in the lower reaches of the tributaries of Chester Morse Lake. The probable result of this occurrence is diminished water flow over and through the redds and the death of some developing eggs or, possibly, alevins. The extent to which bull trout spawning habitat is inundated varies among years, depending on precipitation and operationally related fluctuations in the reservoir level (Section 2.2.4; Appendix 22, Figure 22-1).

The analysis of modeled reservoir elevations in the spring reveal virtually no differences in reservoir elevation between current operations (under the IRPP flow regimes) and operations under the HCP (Table 4.5-2, Section 4.5.6). Considering the longer (60-year) historic period of record, the analysis of analytically derived reservoir elevations (Appendix 38) suggests the following comparisons and conclusions regarding the spring incubation period:

- For the same environmental conditions, reservoir elevations are expected to be essentially the same until late February under the HCP as during the 60-year historic record.
- During the period March through the end of incubation (mid-June), higher reservoir elevations are expected to occur with slightly higher frequency under the HCP than during the 60-year period of record, but the elevations expected under the HCP should be similar to the elevations that occurred during the last 20 years under similar environmental conditions.
- Reservoir elevations are expected to be slightly higher under the HCP than levels during the longer (60-year) historic period of record for only several weeks at the end of the incubation/hatching period (mid-December through mid-March) (Appendix 38).

Because most emergence of fry in the upper Cedar River (above the reservoir) occurs prior to the end of April, and because most redds in the Cedar River have been located upstream of the zone of inundation during most years of observation, potential adverse effects on bull trout eggs or alevins in the Cedar River are likely minimal. Bull trout redds in the Rex River are typically at greater risk from inundation than those in the Cedar River, because many redds in the Rex River are located at lower elevations (i.e., down to about 1550 ft), and because bull trout fry emergence in the Rex extends into May (Section 3.5.6). The actual level of mortality caused by inundation of redds in the lower Rex and Cedar rivers is not known. It should be noted, however, that a substantial percentage of Rex River bull trout redds have been observed in recent years at elevations that have been inundated annually by impoundments in Chester Morse Lake for the 85-year period that occurred after the Masonry Dam was constructed and the reservoir began to be operated at new, much higher elevations (Section 3.5.6), but the bull trout population has persisted during this period and is believed to be in good condition now.

Nonetheless, bull trout apparently have persisted in spawning within the inundation zone on the Rex River, suggesting that mortality of eggs or alevins from inundation may not be high. It is possible, as well, that eggs may be relatively more sensitive to these potential impacts than alevins, which can move around to increase oxygen consumption, and potential effects of inundation may be relatively smaller post-hatching than during incubation.

In any event, severe mortality of eggs and alevins over a period of many decades usually would be expected to exert a strong selective pressure against those bull trout spawning in the regularly inundated stream reaches. One potential hypothesis that could explain the lack of evidence of such selection is that the degree of impact is somewhat reduced by water upwelling through the spawning gravels in the inundated stream reaches. Upwelling in spawning gravels serves to aerate eggs and alevins and remove metabolic wastes. It is not known whether upwelling actually occurs in bull trout spawning areas in the lower Cedar or Rex rivers. Because regular inundation has been occurring for decades in much of the area in which bull trout now spawn, however, it seems likely that there has been relatively little selection (through differential egg mortality) exerted on bull trout to avoid these areas. Furthermore, even if a high degree of mortality from inundation does occur, it is possible, even likely, that the limiting factor for bull trout in the watershed is not associated with spawning but rather with juvenile rearing (Section 3.3.4; Foster Wheeler Env. Corp. 1995d).

Although there are possibly other mitigating factors, the City has made the conservative assumption that the inundation and change from a running-water to a lacustrine environment does kill a large fraction of the developing bull trout eggs or alevins in the inundated redds. The fact that the reservoir's bull trout population has persisted for almost a century despite some annual level of redd inundation indicates that inundation has not significantly reduced the population's viability. However, as part of the City's effort to learn more about bull trout ecology in the Cedar River Watershed, a study will be conducted to evaluate bull trout mortality associated with redd inundation during HCP years 1-9.

Disturbance Effects Related to Entrainment

There may be some loss to the bull trout population in the Chester Morse Lake/Masonry Pool system resulting from entrainment through the intakes of the Cedar Falls Hydroelectric Project at Masonry Dam and through the Overflow Dike into Masonry Pool. A recent study concluded that any potential loss of fish from the Chester Morse Lake/Masonry Pool system is likely having little effect on the reservoir's population (Section 3.5.6, Appendix 19). The study estimated that about 200 bull trout per year may be lost to entrainment through Masonry Dam, with a possible range of 10 fish to several hundred fish (Knutzen 1997). An estimate of 200 fish lost, or 6.4 percent of the estimated 3,100 bull trout in Chester Morse Lake, is considered to be sustainable because any entrainment has continued for most of this century. In other systems, trout have been able to maintain stable population levels with annual exploitation rates greater than 20 percent (Nehring and Anderson 1982).

Potential entrainment losses from the Overflow Dike between Chester Morse Lake and Masonry Pool can occur whenever the reservoir level drops near or below 1,550 ft (the top of the modified Overflow Dike spillway), which occurs during about 36 percent of a typical year. At these lake levels, the flow from Chester Morse Lake to Masonry Pool is primarily through a 6.5-ft diameter discharge pipe and then onto a concrete energy dissipation block. It appears that some fish may likely be injured or killed from passing through this Overflow Dike pipe, but definite conclusions cannot be drawn from available information (Knutzen 1997). Knutzen postulated that the fish population probably incurs less damage from passing through the Overflow Dike than from entrainment from Masonry Pool.

The health and long-term sustainability of the Chester Morse Lake bull trout population, in spite of entrainment described in Section 3.5.6, is further supported by the fact that losses to the population above Cedar Falls have always occurred, even before the first dam was built on the original Cedar Lake in 1901 and Masonry Dam was constructed during World War I. Historically, any trout or char in the upper Cedar River watershed that migrated downstream on its own volition or during storm events would have made a one-way trip over Cedar Falls, which is a natural barrier to upstream passage.

Population-level Effects

The City believes that the relatively small incremental differences in lake levels projected under the HCP regime will have little influence on spawning migrations, redd inundation, and entrainment as compared to current operations. Annual high and low levels in the reservoir are expected to be changed minimally under the HCP as compared to the current regime. Modeling indicates that reservoir elevation will be an average of only 0.41 ft lower in the fall, when differences would be expected to be largest, and will be essentially the same in the spring for the current and HCP operational regimes (Section 4.5.6; Appendix 38).

The HCP provides a number of distinct benefits to bull trout as part of the Watershed Management Mitigation and Conservation Strategies (Section 4.2), including protection of key habitat through reserve status, improvements and substantial decommissioning of forest roads, and measures to help restore stream and riparian habitats over the long term to more natural conditions (see above). Any short-term, local impacts to bull trout from these restoration activities in streams and riparian areas will be more than offset by long-term, landscape-level benefits. Increases in the quantity and quality of accessible habitat, in both stream and riparian areas, will benefit the bull trout population.

The City believes that the HCP will have an overall positive effect on the watershed bull trout population over the long term for the following reasons:

- The watershed adfluvial bull trout population is believed to be in good condition;
- Incremental adverse effects of reservoir operations under the HCP on bull trout are expected to be minimal;
- It is likely that juvenile rearing habitat, not spawning habitat, is the limiting factor for bull trout (Section 3.5.6); and
- The HCP provides substantial benefits to key habitat for both juveniles and spawning adults.

Under the HCP, a monitoring and research program will be funded to track the relative status of the bull trout population and further investigate the influence of reservoir operations on bull trout. The HCP bull trout conservation strategy is designed to avoid, minimize, or mitigate for any incidental take of bull trout. The City believes that the potential for take as described in the paragraphs above does not constitute a threat to the bull trout population in the municipal watershed. The City also believes that the substantial measures in this HCP for the protection of bull trout and bull trout habitat, the implementation of an extensive monitoring and research program, and the incorporation of an adaptive management strategy are sufficient mitigation for any present or future potential negative impacts of the City's operations on bull trout during the term of the HCP.

Other Effects

Integral to the bull trout conservation strategy is a comprehensive program of monitoring and research. Elements within this program are designed to provide a better understanding of the life history, habitat needs, and population status of the Chester Morse Lake bull trout, to assess the success of restoration projects, to determine the impacts of reservoir management on reproductive success, to mitigate for any potential adverse impacts on the bull trout population from reservoir management, and to provide information needed for adaptive management. Monitoring and research pertinent to bull trout include population monitoring, spawning surveys, juvenile and fry surveys, telemetry studies of adult movement, stream distribution surveys, and a redd inundation study to evaluate the magnitude of potential egg and fry mortality as a result of spring refill.

As part of the evaluation of the Cedar Permanent Dead Storage Project, additional studies will focus on the potential impacts of reservoir elevation changes on the fall spawning migration of bull trout and development of an upstream passage assistance plan for bull trout should one be necessary. This plan is included in the contingency plan for droughts under provisions for changed circumstances (Section 4.5.7).

Group #6 – Pygmy Whitefish

Introduction

Pygmy whitefish are present in the Cedar River Municipal Watershed upstream of Masonry Dam. Adults occur in the deep waters of Chester Morse Lake and Masonry Pool, migrating into the Cedar and Rex rivers and several of their smaller tributaries to spawn during late fall and early winter; and juveniles apparently return to the lake for rearing. It is not known from recent observations whether any adults spawn along the margins of the reservoir complex (Chester Morse Lake and Masonry Pool), but Wydoski and Whitney (1979) state, without citation, that pygmy whitefish spawn in Chester Morse Lake in late December and early January.

The quality of stream habitat for spawning pygmy whitefish depends on water temperature, water quality, and habitat quality, including availability of pools and riffles, substrate structure, and cover (e.g., woody debris), which in turn depend, at least in part, on the condition of riparian vegetation and the extent of sediment loading incurred from anthropogenic sources. Potential key habitat for pygmy whitefish in the municipal watershed include the reservoir complex, the lower sections of the Cedar and Rex rivers upstream of Chester Morse Lake, and lower Boulder Creek, as well as riparian habitat associated with the reservoir and its tributaries. Other potential key habitat may include additional low-gradient streams that feed into the Cedar and Rex rivers or directly into the reservoir complex.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect pygmy whitefish within the municipal watershed. The likelihood of direct injury or death of any pygmy whitefish resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. Some pygmy whitefish, however, may be killed or injured by entrainment through the intakes of the Cedar Falls Hydroelectric Project and through the Overflow Dike separating Chester Morse Lake and Masonry Pool, which regulates flow into the Pool when reservoir elevation is below 1550 ft. There may also be some disturbance (e.g., run timing, impedance) to upstream migration of some pygmy whitefish resulting from reservoir drawdown during severe droughts, however, no direct observations to date indicate that such disturbance actually has occurred or what the extent of such disturbance might be if it were to occur in the future. Any death or direct injury of pygmy whitefish would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The mitigation and minimization measures of the HCP are expected to maintain the natural processes important for creating and maintaining habitat for pygmy whitefish in the watershed. The HCP is expected to result in short- and long-term benefits to pygmy whitefish as compared to the current conditions by implementing: (1) protection of all key habitat (streams, the reservoir complex, and riparian habitat); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and potential for delivery of fine sediment; (3) protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with the reservoir complex and its tributary system; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) stream restoration projects, which are expected to improve microhabitat conditions (e.g., temperature regimes and instream habitat complexity) in many reaches; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research related to pygmy whitefish.

Pygmy whitefish could be negatively affected by reservoir operations, silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect streams or the reservoir complex. Such effects could be direct (e.g., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Pygmy whitefish could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the pygmy whitefish are detailed in the Section 4.2.2 and Section 4.5.6, and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

At an estimated population in excess of 51,000 (Section 3.5.7), pygmy whitefish are the most abundant native salmonid species in Chester Morse Lake and are present, though in low abundance, in Masonry Pool (R2 Resource Consultants, in preparation). This species is an important prey item of bull trout in Chester Morse Lake. Relatively little is known about pygmy whitefish spawning behavior, incubation, and early life history in the municipal watershed. Large aggregations of sexually mature fish move into the Cedar River, Rex River, and Boulder Creek during early December (Map 7). Preliminary searches in some other accessible tributary streams along selected beach areas (e.g., small stream deltas) during the same time period revealed no pygmy whitefish. Detailed studies to investigate whether or not lake spawning occurs in Chester Morse Lake or Masonry Pool have not been conducted.

Habitat Effects

The effects of the HCP on pygmy whitefish habitat are of two types: (1) the effects of land management and (2) the effects of reservoir operation. Reservoir operations can affect pygmy whitefish habitat by potentially impeding the upstream passage of spawning adults into the Cedar or Rex rivers during severe drought conditions prevail (Section 4.5.6). Because this potential effect of reservoir operations would involve some form of disturbance, it is discussed below under "Disturbance Effects and Direct Take." Effects of land management on habitat are discussed in this subsection.

The effects of past land management in the municipal watershed have included (1) removal of riparian forest during timber harvest, reducing shading, the supply of food (invertebrates) to streams, and recruitment of large woody debris; and (2) construction and use of hundreds of miles of forest roads, which has increased sediment loading to streams through erosion and mass wasting (landslides). The current, disturbed condition of the majority of aquatic and riparian habitats in the municipal watershed presents opportunities for habitat rehabilitation and, over the long term, restoration of the natural ecological functions of the aquatic/riparian ecosystem.

Because no commercial timber harvest will be conducted in the municipal watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for pygmy whitefish within the municipal watershed (i.e., the reservoir complex and its tributaries, along with associated riparian habitat) is protected through reserve status. In addition, protection in reserve status of *all* forested areas of the watershed will decrease the likelihood of land management activities adversely affecting pygmy whitefish. In the short term, pygmy whitefish will benefit by increased levels of habitat protection and by active intervention to increase habitat quality, such as bank stabilization projects that would reduce sediment loading to streams used for spawning. In the long term, pygmy whitefish will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements, such as holding pools, that are important to pygmy whitefish.

The City believes that instream habitat improvement and rehabilitation must be accompanied by upslope protection and restoration that will reduce impacts of upslope conditions or activities on stream habitat. For example, efforts to stabilize stream banks or add large woody debris to streams may not be effective in the long run if road failures occur that result in large inputs of coarse sediment to streams upstream of such projects. Thus, these kinds of activities will be coordinated under the HCP.

Short-term and long-term gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams and the reservoir complex, as well as protecting all wetlands associated with streams, along with their recharge areas. In addition, maturation of protected forest in riparian corridors near streams and the reservoir complex will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, increasing food production for fish, and maintaining cooler water temperatures.

Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus benefiting pygmy whitefish. In order to estimate how the relative amount of older forest age classes will change in “riparian” forest over the 50-year term of HCP, “riparian” zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data, and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to improve and help restore aquatic and riparian habitats, including stream bank stabilization projects; placement of large woody debris (LWD); a stream bank revegetation program; a program of restoration planting, restoration thinning, and ecological thinning in riparian areas; a program to eliminate, modify, or replace stream-crossing culverts that could impede the passage of pygmy whitefish that may use tributaries, restoring habitat connectivity and continuity; a program to modify, eliminate, or replace stream-crossing culverts that are inadequate for passing peak storm flows, reducing the chance of failure and resulting sediment deposition in downstream habitat; programs to improve problem roads and the maintenance of roads that can affect streams, in both cases to reduce sediment loading to streams associated with erosion and mass wasting; and a program to decommission (remove) about 38 percent of forest roads, further reducing sediment loading to streams.

Collectively, these conservation and mitigation activities should (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Although restoration of a more naturally functioning aquatic ecosystem will benefit pygmy whitefish over the long term, some of these management interventions may cause some localized, short-term decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion, or disturbance of soils that could result in some level of erosion and sediment release into streams or the reservoir.

Because, no harvest for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to such activities in riparian areas will also help minimize any such impacts on pygmy whitefish. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments, especially in riparian areas. These prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitats for pygmy whitefish. One important set of constraints is that, during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams, no tree removal that has the potential to reduce streambank stability will be allowed, and no tree removal will be allowed within 25 ft of any stream.

Because many of the types of habitat rehabilitation and restoration measures included in the HCP are experimental, monitoring within the context of adaptive management is essential to the long-term success of these efforts (Section 4.5.7). The HCP includes two types of monitoring relevant to these efforts (Section 4.5.4): (1) long-term monitoring of stream habitat quality, to detect trends, and (2) monitoring of specific aquatic and riparian restoration projects, to provide feedback on the adequacy of project designs. Interdisciplinary teams will be involved in the design and monitoring of restoration projects.

Disturbance Effects and Direct Take

Potential disturbance effects of the HCP on pygmy whitefish are of two types: (1) the effects of land management and (2) the effects of reservoir operation, which is related to instream flow management. The potential effects of land management would most likely be from use of watershed roads, active intervention for the purpose of habitat rehabilitation and restoration, and general watershed management operations. The primary disturbance effects related to reservoir operations are:

(1) the potential effects of reservoir drawdown during severe droughts, which could impede passage of adult pygmy whitefish into tributaries to the reservoir during the late fall/early winter spawning season (with timing and duration of impedance varying both within and among years),, when relatively steep sections of the face of the delta fans of the Cedar and Rex rivers may be exposed; and

(2) potential entrainment at facilities in the Chester Morse Lake/Masonry Pool complex.

Analysis of reservoir levels for the evaluation of potential drawdown effects was accomplished in two ways:

(1) Projected reservoir levels under the IRPP flow regime (the modeled proxy for the current instream flow regime) were compared to projected reservoir levels under the new HCP instream flow regime, using a simplified numerical water balance model of the Cedar River system (see Section 4.5.6); and

(2) The frequency of different reservoir elevations under past and current operational regimes were compared with the expected frequency of elevations under the HCP by using analytically derived reservoir elevations for the HCP regime (Section 4.5.6 and Appendix 38), rather than modeled elevations.

Because it allows a consistent comparison of the two flow regimes, the first approach (i.e., modeled weekly elevations) is a reasonable approach to show the *differences* in reservoir elevation under the two operational regimes. Because the modeled elevation method does *not* do a good job of capturing short-term reservoir changes and actual operational decisions that can affect reservoir elevation in the short term, however, the second approach, the comparison of analytically derived reservoir elevations (Appendix 38), is best for evaluating the expected frequency of reservoir conditions under the HCP. This latter analysis looked at two time intervals (periods of record): (1) 1940-1999, representing a long-term record, and (2) 1980-1999, representing a shorter-term record that covers the period during which reservoir operations were most like current operations (the period following promulgation of the 1979 IRPP flows by the WDOE, during which the City voluntarily tried to adhere to the IRPP flows).

As noted in Appendix 38, reservoir elevations are essentially the same under both flow regimes (IRPP and HCP) during for the recent period (1980-99), but some differences exist between the recent period and the longer period of record (1940-99). The recent (20-year) period of record is used to represent the HCP for all comparisons to the longer (60-year) record below, with the exception noted in Appendix 38 that the longer period of record was used to characterize annual changes in reservoir elevations from late November until the end of February to better represent the range of conditions expected during the 50-year HCP.

For the analysis using analytically derived reservoir elevations, five operating zones of reservoir elevation were defined for bull trout (Figure 4, Appendix 38), which is also relevant for pygmy whitefish:

1. Very infrequent high elevations, of concern during spring incubation. Expected frequency of 1 in 50 years with a duration of 1 week, or 1 in 10 years with a duration of less than 1 week.

2. Infrequent high elevations, of concern during spring incubation. Expected frequency of 1 in 10 years with a duration of 1-2 weeks. This zone includes floods, which are short-term events.

3. Normal operating zone, with a 20 percent chance of short excursions outside this zone in any given week. In fall, elevations expected to be below 1540 ft 1 in 4 years, with a duration of 1-3 weeks.

4. Infrequent low elevations, of concern during fall spawning. Expected frequency of 1 in 10 years with a duration of 1-3 weeks, with the possibility of being in this zone for many weeks in the June-September period during droughts.

5. Very infrequent low elevations, of concern during fall spawning. Expected frequency of 1 in 50 years with a duration of 1 to several weeks. This zone includes severe droughts.

For reasons discussed below, the City does not believe that there will be any effects on pygmy whitefish from egg inundation during spring reservoir refill, such as is discussed for bull trout (Group #8).

Disturbance Effects Related to Land Management

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of pygmy whitefish that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of direct take of pygmy whitefish from land management activities is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of pygmy whitefish habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential mortality from fishing; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of silvicultural treatments, road management, or other operational activities in riparian areas is expected to be very low.

Disturbance Effects Related to Reservoir Drawdown

Chester Morse Lake pool levels under current reservoir operation range from a normal high pool of 1,563 ft above sea level to a minimum drawdown of 1,532 ft. Under extreme emergency conditions, Chester Morse Lake can be lowered below 1,532 ft to as low as 1,502 ft using the existing emergency pumps. Access to tributary streams by fall spawning pygmy whitefish may be impeded or blocked because of the exposure of the steeply sloped faces of delta fans where the Cedar River delta (14 percent slope) and Rex River delta (17 percent slope) meet the main body of Chester Morse Lake. Exposure of several feet of the steep faces of the delta fans may present either a partial or a complete barrier to migrating pygmy whitefish, with timing and duration of impedance varying both within and among years, if the exposed channel gradient and resultant stream conditions exceed the swimming and leaping capabilities of pygmy whitefish.

A very conservative estimate is that the potential for exposure of the steeply sloped faces of the delta fans of the Cedar and Rex river deltas begins to occur initially as reservoir levels drop below about 1,540 ft. The degree of potential impact is relatively minor immediately below 1,540 ft, however, because water depths sufficient to allow fish passage (approximately 1-3 ft) typically remain, and because only some parts of each steeply sloped delta face could be completely exposed, if any parts are exposed at all. Although some uncertainty exists, the City does not expect that any substantial portions of the steep-gradient stream channels on the deltas are actually exposed or that each delta face, as a whole, will not carry flow sufficient to pass fish, at 1,540 ft surface elevation. As the reservoir level drops below 1,540 ft and approaches 1,535 ft, however, the steep channel gradients are believed to extend for sufficient length to potentially impede or block migration (R2 Resource Consultants, in preparation). The question regarding the potential impedance of passage of pygmy whitefish at the face of the delta fans during occasional low drawdown events, including the timing, extent, and duration, has been raised only recently. Since Chester Morse Lake levels have not dropped below 1,540 ft since 1991 and none of the critical portions of the channel confluence or face of the delta fans has been exposed, staff biologists have not had the opportunity to directly observe the substrate structure, or flow conditions, that exist either where or when impedance of passage of pygmy whitefish is thought to be the most likely to occur.

A comparison of *modeled* reservoir levels projected under the IRPP (current) flow regime to projected reservoir levels under the new HCP instream flow regime was done using historical data sets for the period of record (64-plus including the annual 3-week pygmy whitefish spawning season, with river spawning assumed to occur from November 26 through December 16) (see Section 4.5.6). Overall, the modeling analysis indicated that differences between current reservoir management and reservoir management under the HCP are small, with reservoir levels in the fall slightly lower under the HCP regime (an average weekly difference of –0.23 ft) as a result of commitments to higher summer streamflows for steelhead in the mainstem Cedar River downstream of Cedar Falls. The difference in reservoir levels was less than 1 ft (higher or lower) 93 percent of the time. The modeling indicated that the IRPP flow regime resulted in reservoir levels below 1,540 ft elevation a total of 6.2 percent of the 843 weeks modeled, whereas the HCP flow regime resulted in reservoir levels below 1,540 ft elevation a total of 6.7 percent of weeks (Table 4.5-2; Section 4.5.6).

As mentioned above, the analysis of reservoir elevations comparing actual past elevations to *analytically derived* elevations under the HCP (Appendix 38), as opposed to the modeled elevations described above, gives a better picture of the likelihood of potential impacts of reservoir drawdown on pygmy whitefish during fall spawning (late-November until mid-December). Inspection of Figure 2 in Appendix 38 indicates that during the period late-November until mid-December reservoir elevations under the same environmental conditions should be essentially the same under the HCP as during the 60-year historic record. As indicated by Figure 4 in Appendix 38, reservoir elevations can be expected to be below 1535 ft at frequencies of 1 in 50 years during the spawning period, and then only for periods of 1-several weeks (within the "very infrequent" operating zone: zone 5 as defined above).

The City believes that the new HCP flow regime will probably have little additional impact on pygmy whitefish spawning migrations compared to current operations. Although the timing of pygmy whitefish entry into the Rex River and Cedar River potentially might be affected by extraordinary low reservoir levels during the fall, it is highly unlikely that these relatively short and infrequent delays will cause an overall reduction in the number of fish ascending the rivers to spawn or overall spawning success in most years. The potential for blockage or impedance of pygmy whitefish spawning migrations during infrequent periods of low reservoir levels will be studied and analyzed under the HCP Monitoring and Research Program as part of Environmental Evaluation of the Cedar Permanent Dead Storage Project (Section 4.5.6). To date, there is no evidence suggesting existing operations limit the numbers of pygmy whitefish that ascend the Cedar or Rex rivers to spawn.

The restriction of public access into the municipal watershed will provide benefits for pygmy whitefish by reducing potential disturbance and direct take from fishing. It is very unlikely that any significant level of disturbance resulting from angling will occur to the whitefish population either when resident within the reservoir or during spawning migrations into tributary streams. Observations indicate that a majority of the whitefish population in the reservoir complex remains consistently in deeper portions of the lake and are virtually inaccessible to trespassers who fish, except during the short period in late fall and early winter when they enter tributaries to spawn. Even during the fall/winter period when they might be potentially most vulnerable to angling pressure in streams, such pressure would come solely from a very low number of trespassers and in all probability be insignificant to the population, especially if lake spawning is included in the life history behavior of this population.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the City believes that the likelihood of disturbance to, direct injury to, or death of individuals as a result of reservoir operations that could impede upstream migration of pygmy whitefish is expected to be very low, and that any such adverse effects would be substantially outweighed by beneficial effects accruing from the conservation and mitigation measures in the HCP.

Disturbance Effects Related to Inundation of Redds

For the reasons described below, it is very unlikely that eggs of pygmy whitefish in the Cedar and Rex rivers, or tributaries, could be adversely affected by inundation during the incubation period in early winter.

- Pygmy whitefish are broadcast spawners and regularly spawn in lakes, which strongly suggests that their eggs may be relatively impervious to potential effects of inundation. Eggs in the margins of lakes are likely adapted to low water-velocity conditions with some degree of sedimentation. Because the eggs in a river environment are on the surface and not buried, and because eggs likely move around with river currents, velocities of water around eggs would not necessarily decrease with sedimentation that may occur during inundation.

- Pygmy whitefish spawning observed in the Cedar River has been largely upstream of the zone of spring inundation.

- Pygmy whitefish spawning in the Cedar and Rex rivers is believed to be completed in mid-December, and the incubation period of pygmy whitefish is only several weeks at most. Thus, emergence of fry should have occurred long before inundation begins in the lower reaches of the Cedar and Rex rivers immediately upstream from Chester Morse Lake (Appendix 38).

Because of the above-cited reasons, the City believes that the likelihood of disturbance to, direct injury to, or death of individuals as a result of reservoir operations during reservoir refill that could affect pygmy whitefish eggs is expected to be extremely low. For a discussion of potential impacts of inundation on bull trout redds, please see the effects analysis for Group #8.

Disturbance Effects Related to Entrainment

There may be some loss to the pygmy whitefish population in the Chester Morse Lake/Masonry Pool system resulting from entrainment through the intakes of the Cedar Falls Hydroelectric Project at Masonry Dam and through the Overflow Dike into Masonry Pool. A recent study concluded that any potential loss of fish from the Chester Morse Lake/Masonry Pool system is likely having little effect on the reservoir’s population. The study estimated that about 1,200 pygmy whitefish per year may be lost to entrainment through Masonry Dam (Knutzen 1997; Appendix 19). An estimate of 1,200 fish lost, or about 2 percent of the estimated 51,000 pygmy whitefish in Chester Morse Lake, is considered to be sustainable because any entrainment has continued for most of this century. In other systems, salmonids have been able to maintain stable population levels with annual exploitation rates greater than 20 percent (Nehring and Anderson 1982).

Potential entrainment losses from the Overflow Dike between Chester Morse Lake and Masonry Pool can occur whenever the reservoir level drops near or below 1,550 ft (the top of the modified Overflow Dike spillway), which occurs about 36 percent of a typical year. At these lake levels, the flow from Chester Morse Lake to Masonry Pool is primarily through a 6.5 ft diameter discharge pipe and then onto a concrete energy dissipation block. It appears that some fish may likely be injured or killed from passing through this Overflow Dike pipe, but definite conclusions cannot be drawn from available information (Knutzen 1997). Knutzen postulated that the fish population probably incurs less damage from passing through the Overflow Dike than from entrainment from Masonry Pool.

The health and long-term sustainability of the Chester Morse Lake pygmy whitefish population, in spite of entrainment described above, is further supported by the fact that losses to the population above Cedar Falls have always occurred, even before the first dam was built on the original Cedar Lake in 1901 and Masonry Dam was constructed during World War I. Historically, any whitefish in the upper Cedar River watershed that migrated downstream on its own volition or during storm events would have made a one-way trip over Cedar Falls, which is a natural barrier to upstream passage.

Population-level Effects

The City believes that the relatively small incremental differences in lake levels projected under the HCP regime will have little influence on spawning migrations and entrainment as compared to current operations. Annual high and low levels in the reservoir are expected to be changed minimally under the HCP as compared to the current regime. As discussed above, the potential effects of land management activities are also expected to be minimal.

The HCP provides a number of distinct benefits to pygmy whitefish as part of the Watershed Management Mitigation and Conservation Strategies (Section 4.2), including protection of key habitat through reserve status, improvements and substantial decommissioning of forest roads, and measures to help restore stream and riparian habitats over the long term to more natural conditions (see above). Any short-term, local impacts to pygmy whitefish from these restoration activities in streams and riparian areas will be more than offset by long-term, landscape-level benefits. Increases in the quantity and quality of accessible habitat, in both stream and riparian areas, will benefit the pygmy whitefish population.

The City believes that the HCP will have an overall positive effect on the watershed pygmy whitefish population over the long term for the following reasons:

- The watershed pygmy whitefish population is believed to be in good condition;
- Incremental adverse effects of reservoir operations under the HCP on pygmy whitefish are expected to be minimal; and
- The HCP provides substantial benefits to key habitat for pygmy whitefish.

Under the HCP, a monitoring and research program will be funded to fill critical knowledge gaps for pygmy whitefish (Section 4.5.6), and the HCP pygmy whitefish conservation strategy is designed to avoid, minimize, or mitigate for any incidental take of pygmy whitefish. The City believes that the potential for take as described in the paragraphs above does not constitute a threat to the pygmy whitefish population in the municipal watershed. The City also believes that the substantial measures in this HCP for the protection of pygmy whitefish and pygmy whitefish habitat, the implementation of an extensive monitoring and research program, and the incorporation of an adaptive management strategy are sufficient mitigation for any present or future potential negative impacts of the City's operations on pygmy whitefish during the term of the HCP.

Other Effects

As part of the evaluation of the Cedar Permanent Dead Storage Project, additional studies will focus on the potential impacts of reservoir elevation changes on the fall spawning migration of pygmy whitefish as well as the population ecology of pygmy whitefish.

Group #7 – Sockeye Salmon

Introduction

Conservation measures for sockeye salmon were developed to: i) avoid, minimize and mitigate the impacts of the City's water supply facilities and operations on the Cedar River; ii) comply with Washington State law as codified in R.C.W. 75.52; iii) comply with the direction provided by the Cedar River Sockeye Policy and Technical Committees established by the Washington State Legislature; and iv) complement other salmon recovery efforts in the Lake Washington watershed by helping to protect and restore upland, riparian and aquatic habitat and the ecological processes that shape and maintain habitat within the Cedar River basin. The Lake Washington basin has been substantially altered since the late 19^{th} century by a variety of anthropogenic activities. Many of the basin's natural features and processes have been modified resulting in a reduction in the capacity of the system to support naturally reproducing populations of a number of animal species, including sockeye salmon. Conservation measures for Group #7 species have been developed in a manner that will help preserve remaining functional elements of the ecosystem and help rehabilitate those that are presently impaired.

Sockeye are present in the lower 21.8 miles of the mainstem and associated tributaries outside of the municipal watershed and downstream of the Landsburg Dam. The Landsburg Dam prevents the passage of this species into over 17 stream miles (12.4 miles of the mainstem plus 4.9 miles in tributaries) of habitat between Landsburg and the natural anadromous fish barrier formed by lower Cedar Falls. All sockeye migrate through Lake Washington and the Ballard Locks as juveniles and adults. Habitat associations for sockeye salmon in the Cedar River basin are described in detail in Section 3.6 and are summarized below.

Life stage	Primary habitats	Secondary habitats	Important habitat elements
Adult migration	All areas of the mainstem channel with sufficient depth and suitable velocity.	Hold and mature for up to several months during the summer in deep areas of Lake Washington below the thermocline. May also hold for short periods in deep runs and pools in the river just before spawning in the fall.	Cool, high quality water in the lake and river and sufficient instream flow to allow upstream passage in the fall.
Spawning	Mainstem areas with gravel substrate that is	Also spawn in tributaries,	Clean, un-compacted gravel substrate with

	relatively free of sand and silt.	groundwater-fed side channels and ponds with beaches exhibiting substantial upwelling flow. Some limited beach spawning occurs in suitable habitat along near-shore areas of the lake.	substantial subsurface water flow. Sufficient stream flow to provide depths 0.3 to 2.5 feet and velocities of 0.3 to 3.3 feet per second over suitable substrate. Incubation survival in mainstem can be significantly influenced by peak flow events.
Juvenile rearing	Graze on zooplankton primarily in limnetic areas of the lake.	Newly emerged fry may rear in littoral areas of the lake for several weeks prior to moving into offshore areas. A very small number of fish may rear for short periods during the spring and early summer in backwater and off-channel areas located near the mainstem.	Of the anadromous species present in the basin, only sockeye are specifically adapted to rear as juveniles for an extended period in the limnetic area lake.
Juvenile migration	All areas of the mainstem with tendency to seek high velocity areas.	Newly emerged fry tend to hold in near-shore areas for several weeks before migrating to limnetic areas to rear. During emigration, smolts move onshore and migrate along shorelines to the locks.	Although not well quantified, in-river emigration survival appears to be higher during period s of elevated flow in the spring. Smolts are typically large and well adapted to migration through the lake.

The combination of mitigation and minimization measures provided by the HCP is expected to protect Group #7 species in the Cedar River basin. The principal mitigation and minimization measures for sockeye salmon under the HCP include: (1) water quality protection, and habitat protection and restoration measures in the municipal watershed which will help protect and improve water quality and habitat conditions in river downstream of the municipal watershed and in Lake Washington; (2) continued funding of the interim sockeye fry hatchery to reduce the present rate of population decline and provide additional information on the factors limiting sockeye production; (3) the construction and operation of a replacement hatchery facility capable of producing up to 34 million sockeye fry to replace the lost production capacity upstream of the Landsburg Dam; (4) funding for habitat protection and restoration in the lower Cedar River, downstream of the municipal watershed; (5) provision of the HCP instream flow management regime to improve habitat conditions in the lower river; (6) funding for projects at the Ballard Locks designed to increase survival of emigrating smolts; and (7) monitoring and research. These measures are expected to provide short-term protection for sockeye salmon habitat and enhance the long-term production of both natural and hatchery runs of sockeye in the basin. The benefits that may be derived from the mitigation measures result primarily from improved spawning, incubation, and emigration conditions in the river; increased fry recruitment; improved downstream passage conditions at the Ballard Locks; and improved understanding of the factors affecting sockeye salmon survival in the Lake Washington Basin.

Sockeye can be negatively affected by alterations in stream flow associated with water management activities that can potentially affect various sockeye life stages and their associated mainstem habitat downstream of the Landsburg Diversion Dam. If selected, some types of habitat restoration projects in the lower river could also result in short term impacts through increased sediment delivery and other associated disturbances. However, the likelihood of injury or death of any sockeye salmon as a direct result of the City's HCP instream flow management regime or habitat restoration is expected to be very low. Potential indirect effects associated with the HCP artificial propagation program could negatively impact sockeye in the basin. The potential risks associated with artificial propagation and the measures provided to avoid and minimize these risks are discussed in detail in section 4.3.2 and later in this section. The proposed conservation measures for sockeye salmon, including extensive monitoring and research activities and flexibility to adapt the program, are expected to result in net gains for Group #7 species over the 50-year term of the HCP.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for sockeye are detailed in the section entitled "Species Conservation Strategies" (Section 4.2.2). Additional measures that benefit Group #7 species are included in the Conservation Strategies for Minimizing and Mitigating the Effects of the Anadromous Fish Migration Barrier a the Landsburg Diversion Dam (Section 4.3.2), the conservation strategies for Instream Flow Management (Section 4.4.2), Watershed Management Mitigation and Conservation Strategies (Section 4.2), and Anadromous Fish Monitoring and Research (Section 4.5.3). Mitigation and minimization measures for Group #8 species are summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Effects of the Watershed Management Program

The Cedar River basin is the largest sub-basin in the Lake Washington watershed and provides approximately 50 percent of the total annual flow into the lake. Conservation measures in the municipal watershed, which comprises the upper 2/3 of the Cedar River sub-basin, are expected to deliver substantial water quality benefits to aquatic habitat within the municipal watershed, in the mainstem of the river downstream of the municipal watershed, and in Lake Washington. Migration corridors as well as spawning, incubation, and rearing habitat for sockeye salmon in the Lake Washington basin are expected to benefit from the provision of high quality water from the municipal watershed.

Effects of the Artificial Propagation Program

Because the presence of large numbers of spawning carcasses creates an unacceptable risk to drinking water quality and public health (Appendix 5), an artificial propagation program is provided as an alternative solution to mitigate for the lost sockeye salmon production capacity upstream of the Landsburg Dam. The City will construct a hatchery with the capacity to produce up to 34 million emergent sockeye fry per year. The program will employ recently developed sockeye culture techniques, as further refined during prototype testing at the Landsburg interim hatchery, to help ensure the production of robust, disease-free fish.

The artificial propagation program for sockeye salmon will provide an incubation refuge, increase fry recruitment from the river, and help ensure that adequate numbers of adult fish return to spawn naturally in the river. This restored fry production capability will increase the capacity of the population to maintain itself when challenged with adverse environmental conditions, while avoiding and minimizing risks to naturally reproducing salmonids.

The benefits that may be derived from a sockeye fry hatchery result primarily from increases in egg to fry survival. This increased survival will help compensate for the lost sockeye production capacity upstream of the Landsburg Diversion Dam. In addition, incubating sockeye are particularly vulnerable to mortality resulting from increased bedload scour during high flow events. During high flow events, the largely confined channel in the lower river results in increased water velocity, increased energy, and subsequent increases in bedload movement. Egg to fry survival in the Cedar River subsequent to the 2-year flood event is typically much lower than 10 percent (Seiler and Kishimoto 1997). In contrast, egg to fry survival within a hatchery can exceed 90 percent. Because egg to fry survival is an important factor that contributes to fish productivity early in the life history, the difference in survival rates means a hatchery can increase the overall productivity of the stock. However, as out-of-kind mitigation, the proposed sockeye hatchery program entails certain risks not encountered in other forms of mitigation.

A number of sources have detailed the problems associated with the misapplication of artificial propagation in the past and have cautioned against the continued misuse of this approach in the future (Hard et al. 1992; Hilborn 1992; National Research Council 1996; Reisenbichler 1997; WDFW 1997b). In many years, the number of fry released from the hatchery will represent a significant portion of the total sockeye fry produced in the Lake Washington Basin. Clearly, the artificial propagation program should not be viewed in isolation from the many rehabilitative features of the HCP. Nor should the risks associated with a relatively high-energy technological approach be dismissed.

Recently developed fish culture techniques have been used in Alaska since the early 1980s to successfully produce healthy, high quality sockeye fry (McDaniel et al. 1994). Prototype testing with the interim hatchery since 1991 has demonstrated that these same techniques can be successfully applied in the Cedar River. Data from the 1997 returns will provide the first substantial body of information on the relative performance and behavior of the hatchery fry when they return as adults. This recently collected data is still being analyzed and will require corroboration with data collected in subsequent years to adequately address a number of the uncertainties associated with the sockeye fry production program.

The City recognizes that, while the sockeye fry production program offers potential benefits for the population, it also entails a level of uncertainty and risk. As part of the sockeye mitigation program, the City intends to implement measures to manage risk and uncertainty first, through rigorous pre-project planning and operational guidelines, and second, through implementation of an effective monitoring and adaptive management program (see Kapuscinski and Miller 1993; Kapuscinski 1997). These provisions will minimize genetic risks to the naturally reproducing, introduced population of sockeye in the Cedar River. The Bear Creek sockeye population in north Lake Washington has been classified as a provisional Evolutionarily Significant Unit (ESU) by NMFS and is not presently considered at risk of extinction (Gustafson et al. 1997). In the absence of specific information for potential interactions of Cedar River hatchery sockeye with Bear Creek sockeye, NMFS considers the proposed hatchery program to pose a moderate level of genetic risk to the Bear Creek population (Waples 1998). The City, in consultation with NMFS and the CRAFC, will strive to minimize the genetic risk to Bear Creek sockeye by i) establishing thresholds for the rate at which Cedar River hatchery sockeye stray into the Bear Creek system, ii) monitoring the actual incidence of spawning Cedar River hatchery fish in Bear Creek and, if necessary, iii) implementing corrective measures such as reduced production levels and improved fry release strategies to reduce straying. By including HCP signatories, other stakeholder groups and technical experts in the Cedar River Anadromous Fish Committee, the City expects to bring to bear the best available science to adaptively manage risk and uncertainty associated with the artificial production program.

Instream Flow Management: Effects on Weighted Usable Area (WUA)

Stream flow can affect sockeye salmon production in the Cedar River by its influence on spawning habitat availability, incubation conditions, and downstream migration conditions for fry. The instream flow regime under the HCP influences each of these factors that can in turn affect the sockeye population

The HCP guaranteed and supplemental flow regime is summarized in Table 4.4-1. The relationships between guaranteed flows, the existing non-binding IRPP minimum flows and the flows that provide maximum weighted usable area (WUA) for key species and life stages as determined by collaborative PHABSIM analyses are summarized in Figures 4.4-2 through 4.4-5. Expected actual flows will often exceed guaranteed and supplemental flows during the fall, winter and spring because: i) inflows to the basin often exceed amounts required to meet the guaranteed flows and municipal water supply demands; ii) surface runoff in the lower 57 percent of the basin enters the Cedar River naturally and is not influenced by the water storage reservoir; and iii) flood storage capacity in the reservoir is relatively limited. Expected actual flows under the HCP instream flow management regime, under the existing IRPP regime, and under natural unregulated conditions are summarized in Appendix 36. Appendix 37 provides habitat duration analyses for expected actual flows under the HCP, IRPP and natural flow regimes using PHABSIM output for target species and life stages.

For most of the year, HCP guaranteed flows are higher than existing IRPP minimum flows and higher than the flows required to provide maximum WUA for key species and life stages. Although these higher flows result in a reduction in WUA when compared to the flows that maximize WUA, they will help ensure that the guaranteed regime more closely mimics natural basin hydrology and will provide a variety of important overriding biological benefits that are discussed later in this section. The effects of the proposed HCP flow regime on WUA for sockeye and associated target species are outlined below. The discussion begins with late summer and early fall flows, then proceeds sequentially throughout the remainder of the year.

Instream flows under the HCP are designed to improve sockeye spawning conditions throughout the fall. The first adult sockeye begin to enter river and spawn in early to mid-September. During the first two weeks of September, HCP guaranteed flows are slightly below the level that provides maximum WUA. At this time, HCP guaranteed flows provide 99 percent of maximum WUA. By September 16, with approximately 11 percent of the sockeye run typically in the river, HCP flows increase to a level that is slightly above the level required to provide maximum WUA for sockeye spawning. Although this results in a slight reduction in WUA, guaranteed flows during the third week in September still provide more than 98 percent of maximum WUA. By the last week of September, with approximately 20 percent of the run in the river, guaranteed flows increase to a level that provides 85 percent of maximum WUA. On October 8, with approximately 38 percent of the sockeye run in the river, flows increase further to either low normal or high normal levels, depending on existing hydrologic conditions in the basin. In an effort to maximize WUA for spawning chinook (see Group #8 Species Effects Analysis) and provide potential ancillary benefits to spawning sockeye, both low normal and high normal flows remain well above the levels required to provide maximum WUA throughout the remainder of the sockeye spawning season. From October 8 through December 30, low normal flows provide between 56 percent and 71 percent of maximum WUA for sockeye spawning. High normal flows provide between 51 percent and 61 percent of maximum WUA during this same period.

Although significant amounts of sockeye spawning habitat are lost at these higher flows, the losses in static habitat are partially offset by increases in potential cumulative sockeye spawning habitat. Flow increases that begin in late September will tend to encourage newly entering fish to spawn in new, previously unsuitable habitat away from areas that are already seeded. This stepped approach to flow regulation also accommodates the theory that edge spawning habitat is less vulnerable to damaging scour during subsequent peak flow events.

Additional Effects of the Instream Flow Management Regime

During the collaborative instream flow studies and development of the HCP instream flow management regime, the interagency Cedar River Instream Flow Committee viewed the extensive PHABISM analyses conducted on the Cedar River as a foundation for an instream flow management regime rather than as a prescriptive tool for determining preferred flows at any give time during the year. While the City believes that PHABSIM analyses are an important tool in developing effective instream flow management practices, anadromous salmonid biology is complex and habitat requirements for these species are not completely described by standard PHABSIM analyses. Additional information is helpful in prioritizing species and life stages during particular times of the year; addressing aspects of their biology not typically analyzed in standard PHABISM investigations; and understanding the complex relationships between hydrologic variation and natural ecological processes in the aquatic environment. During the course of collaborative studies and subsequent development of the HCP instream flow regime, a broad array of information was used in an effort to establish management provisions that would provide comprehensive protection for all life stages of anadromous fish and the habitat upon which they depend. These management provisions address key biological considerations determined to be of particular importance to Cedar River sockeye salmon by the Cedar River Instream Flow committee and include:

- Limits on the rate at which stream flows can be reduced as a result of City's water management activities to reduce the risk of fish stranding and better reflect natural rates of stream flow recession;
- Increased guaranteed flows during the fall to recruit additional sockeye spawning habitat along the margins of the stream and potentially reduce sockeye redd scour vulnerability during subsequent winter peak flow events;
- Increased guaranteed flows during sockeye incubation season in the fall, winter and spring to reduce the risk of redd dewatering;
- Increased guaranteed flows during the late winter and early spring to provide improved emigration conditions for sockeye fry;
- Higher guaranteed flows into Lake Washington for more flexibility to provide beneficial fish passage conditions at the Ballard Locks; and
- A number of commitments that will result in stream flows that better reflect natural hydrologic patterns including: i) relocation of the flow compliance point 20 miles upstream to Landsburg; ii) supplemental guaranteed flows linked to real time hydrologic conditions; and iii) collaborative management of flows above guaranteed levels to support important natural ecological processes and provide benefits to fish.

The spawn timing of sockeye salmon make their redds especially vulnerable to fluctuating stream flows associated with late fall and early winter freshets. Under the current IRPP flow regime with the measurement point in Renton, sockeye eggs deposited near the margins of the stream are at risk of desiccation during periods when local inflows are elevated in the lower river. With a measurement point 20 miles downstream at Renton, the City can substantially reduce releases at Landsburg and still meet IRPP flow targets during periods of normal to high inflows in the lower river. Therefore, any redds established near the margins of the stream in the upper portions of the river near Landsburg are subject to a significant risk of dewatering and eventual egg desiccation. By relocating the flow measurement 20 miles upstream at Landsburg, the HCP substantially reduces this risk and helps promote more natural variations in stream flow throughout the lower river.

To further reduce the risk of redd dewatering throughout the river, the HCP guaranteed flows remain elevated during the winter and early spring to reduce the risk of redd dewatering. HCP guaranteed flows remain well above existing IRPP flow targets throughout the entire winter and spring sockeye incubation season.

Recent information suggests that newly emerged sockeye fry can experience significant mortality during their 1- to 2-day migration downstream to Lake Washington. Preliminary investigations with hatchery fry releases just above the present upstream limit of sockeye migration and spawning suggest that fry may experience significantly higher emigration survival during periods of elevated flow (Seiler 1994, 1995; Seiler and Kishimoto 1996, 1997a).

The exact quantitative relationship between stream flow and the survival of emigrating wild sockeye fry is not presently known. Nevertheless, HCP guaranteed flow commitments during the period of sockeye fry emigration are significantly higher than under the existing IRPP regime. In addition, the proposed HCP flow regime contains provisions for 40 percent higher minimum flows at least 70 percent of the time during the peak of sockeye emigration from early February through mid-April.

Effects of the Adaptive Features of the Instream Flow Management Regime

Although a substantial amount of information was assembled over the last 10 years to guide the development of the HCP instream flow regime, the City anticipates that additional information will become available as the science of fluvial systems and strategies for managing stream flows in altered channels continue to evolve. In addition to well-defined, binding, instream flow management commitments, the City acknowledges the need to provide sufficient flexibility to adapt and improve instream flow management strategies, as new information becomes available. Therefore, the HCP provides substantial commitments to limit the City's future diversions from the Cedar River to ensure sufficient flexibility to meet additional needs for instream resources should such needs arise. In addition, the HCP provides over $ 3.4 million for further studies to: i) monitor natural and regulated stream flows throughout the basin; ii) better quantify the effects of natural local inflows on stream flow in the mainstem of Cedar River downstream of municipal watershed; iii) improve the ability of stream flow switching criteria to accurately reflect natural hydrologic conditions; iv) improve our understanding of key aspects of the biology of chinook salmon and other salmonids in the Cedar River; and v) better understand the effects of stream flow management on fish habitat in altered fluvial systems. Finally, the HCP establishes an Instream Flow Commission (Section 4.4.2 and Appendix 27) that will make use of the information gathered during future studies to guide the management of stream flows over and above the HCP guaranteed levels to provide additional benefits for instream resources.

Other Effects

The HCP provides nearly $5 million to implement habitat protection and restoration projects in the lower river downstream of the municipal watershed. The Cedar River below Landsburg has been impacted by urban development, channel modifications, reduction and harvest of riparian zones, and peak flow management practices (King County 1998). Mainstem and side-channel habitat quantity and quality have been reduced substantially compared to pristine conditions. In addition, these changes have increased the frequency of scour events that could negatively affect sockeye redds. Habitat restoration and protection projects downstream of the Landsburg Diversion Dam can help reverse this trend and provide further benefits to Group #7 species.

A range of habitat protection and restoration projects has been identified as candidates for future implementation in the Lower Cedar River (King County 1998). Likely projects include riparian habitat acquisition and protection, and reestablishment of groundwater-fed side channels and ponds in the floodplain. If groundwater-fed channels and ponds are included as the preferred measures, spawning and incubation conditions for sockeye are likely to improve significantly. These types of restoration and enhancement projects take advantage of the available groundwater by digging channels, modifying old stream meanders or side channels, or adding clean graded gravel (Althauser 1985). An important feature of groundwater-fed spawning channels is the protection of redds from scouring flows (Althauser 1985).

Habitat protection and restoration directly in or along the mainstem may provide less direct benefits for sockeye, but would nevertheless help protect structural and functional habitat elements that are used by sockeye for upstream migration and for spawning. Protection and restoration projects in tributaries can also provide direct and indirect benefits for sockeye, however the benefits of these projects are more difficult to predict and will vary depending upon the type and location of each particular project.

The Ballard Locks have been identified as a significant source of mortality to emigrating anadromous salmonids. The HCP provides funds to support implementation of passage improvement measures currently under consideration by the ACOE. The ACOE estimates that full implementation of these measures will substantially increase passage survival (Army Corps of Engineers 1997). The increased survival of smolts passing through the Ballard Locks will increase the productivity of sockeye salmon within the Cedar River and throughout the Lake Washington Basin.

The HCP contributes funds for fish passage improvements and improvements to the salt-water drain at the locks (or other measures to conserve freshwater). The saltwater drain is designed to help manage and reduce the accumulation of salt water that passes into Lake Union during normal operation of the locks. This system uses a considerable amount of freshwater to manage saltwater intrusion. These improvements are expected to save approximately 6,000 acre-feet of fresh water each year, which could then be allocated for other beneficial uses, such as to improve fish passage flows at the locks.

Disturbance Effects and Direct Take

National Marine Fisheries Service considers the sockeye salmon stock from the Cedar River to be introduced from outside the Lake Washington and does not recognize this stock as an Evolutionarily Significant Unit (Fed. Reg. Vol. 63, No. 46, March 10, 1998). Therefore, the purpose of the following discussion regarding habitat degradation or sources of mortality is to further disclose the likely outcomes of the HCP, but impacts to Cedar River sockeye are not considered “take” under the ESA, because this sockeye is not eligible for listing .

Although the instream flow regime is designed to improve spawning conditions for sockeye salmon as well as reduce the likelihood of mortality of incubating eggs and alevins during winter flood events, some level of redd scour and related mortality during incubation are normal parts of salmon life history. Because of the constrained nature of the lower Cedar River and the fact that the Masonry Dam has limited storage capacity and only captures runoff from the uppermost 43 percent of the basin, water management under the HCP will not eliminate all redd scour resulting from flood flows. Variability in sockeye incubation survival in the river can be substantial, varying with the magnitude of peak flows during incubation. Any such death, direct injury, or disturbance largely the result of natural hydrologic events. The actions of the HCP do not exacerbate these natural effects. To the contrary, the proposed artificial production program and downstream habitat protection and restoration commitments provide the potential to significantly off-set the damaging effects of natural peak flow events on incubating sockeye in the mainstem of the river.

Sockeye salmon are the most numerous naturally reproducing salmonids in the basin and, in years of high abundance, the population has supported a significant Tribal treaty harvest and one of the largest sport fisheries in the state (Fresh 1994). Sport, Tribal, and marine commercial harvest directly increase mortality and can thereby influence population, abundance, and reproductive potential. Although sport and Tribal harvests in Lake Washington are typically well controlled to ensure that adequate numbers of fish return to streams to spawn, Cedar River sockeye can be vulnerable to over-harvest, as demonstrated during the 1996 season when insufficient numbers of fish returned to meet escapement goals after substantial sport and Tribal harvests in the lake (WDFW 1997, unpublished data).

One of the major objectives of the City's mitigation plan is to contribute to the development of a viable Tribal and sport fishery in Lake Washington. Current sockeye production levels provide for a fishery 1 out of 4 years or fewer because run sizes are insufficient to meet escapement goals. The broad array of conservation measures provided by the HCP significantly increases the likelihood that the population of returning adults will more frequently exceed the escapement goal of 350,000 fish. Therefore, the HCP will likely increase the frequency of Tribal and sport fisheries in Lake Washington.

Under the HCP, all Cedar River sockeye are considered a single stock with a productivity level that includes a composite egg to fry survival rate from both hatchery and naturally reproducing fish. Therefore, a mixed-stock fishery only occurs when these fish are present in harvest areas containing other stocks originating from outside the Cedar River Basin, such as those in tributaries draining to the north end of Lake Washington. Mixed-stock fisheries have the risk of overexploiting weaker stocks when harvest rates are set for targeting a more productive stock.

Cedar River fish harvests are co-managed by the WDFW and Muckleshoot Indian Tribe. Although the mitigation in the City's HCP is expected to improve the likelihood of future harvests, harvest management falls under the jurisdiction of the co-managers. The State of Washington's Wild Salmonid Policy (WDFW 1997b), which has not been agreed to by the Muckleshoot Tribe, indicates that in areas of mixed stock, harvest rates will be targeted for the rate appropriate to the wild stock. Harvest management techniques such as area and timing restrictions can allow for substantial separation of the stocks within Lake Washington. Past restrictions have included limiting sport harvest to areas south of the State Route 520 bridge. Experience suggests that this management regime is quite effective in preventing incidental over-harvest of north-end sockeye. Overall, the City expects the negative effects of harvest to north Lake Washington stocks will be minimized as a result of the implementation of an appropriate harvest management strategy by WDFW and the Muckleshoot Indian Tribe.

Population-level Effects

Multiple age classes will be maintained through the sockeye hatchery program, habitat restoration efforts, and instream flow management regime specifically designed to improve spawning, incubation and emigration conditions for sockeye salmon. Management of the Cedar River by the City will be designed to protect all riverine life history stages of sockeye salmon. The combination of instream flow protection, habitat rehabilitation, and hatchery production measures will provide substantial population resilience to other adverse environmental conditions (i.e., floods, drought) that may occur. The City believes that disturbance effects as described in the paragraphs above do not pose significant risks to the sockeye salmon population of the Lake Washington Basin and are substantially outweighed by beneficial effects accruing from the HCP.

Group #8 – Chinook Salmon, Coho Salmon, and Steelhead Trout

Introduction

Conservation measures for chinook salmon, coho salmon, and steelhead trout were developed to: (1) avoid, minimize and mitigate the impacts of the City's water supply facilities and operations on the Cedar River; (2) to address key limiting factors for these species; and (3) complement other salmon recovery efforts in the Lake Washington watershed by helping to protect and restore upland, riparian and aquatic habitat and the ecological processes that shape and maintain habitat within the Cedar River basin. The Lake Washington basin has been substantially altered since the late nineteenth century by a variety of anthropogenic activities. Many of the basin's natural features and processes have been modified resulting in a reduction in the capacity of the system to support naturally reproducing populations of a number of animal species, including chinook, coho, and steelhead. Conservation measures for Group #8 species have been developed in a manner that will help preserve remaining functional elements of the ecosystem and help rehabilitate those that are presently impaired.

Chinook, coho, and steelhead are present in the lower 21.8 miles of the mainstem and associated tributaries outside of the municipal watershed and downstream of the Landsburg Dam. The Landsburg Dam prevents the passage of these species into over 17 stream miles (12.4 miles of the mainstem plus 4.9 miles in tributaries) of formerly occupied habitat between Landsburg and the natural anadromous fish barrier formed by lower Cedar Falls. All species migrate through Lake Washington and the Ballard Locks as juveniles and adults. Habitat associations in the Cedar River basin are described in detail in Section 3.6 for all Group #8 species and are summarized below.

Species/ Life stage	Primary habitats	Secondary habitats	Important habitat elements
Steelhead			
Adult migration	All areas of the mainstem channel with sufficient depth and suitable velocity	May hold for short periods in deep pools. Also may use the lake for final maturation during migration	
Spawning	Mainstem areas, with small cobble and gravel substrate that is relatively free of sand and silt. Frequently, but not always, spawn in areas closely associated with cover.	Limited spawning may occur in tributaries and groundwater-fed side channels.	Clean, uncompacted substrate with substantial subsurface water flow. Sufficient stream flow to provide depths of at least 0.5 feet and velocities of 1.0 to 3.5 feet per second over suitable substrate. Incubation success can be significantly influenced by susceptibility of redd

			location to dewatering during declining summer hydrograph.
Juvenile rearing	Mainstem areas with suitable velocities. Often, though not always, associated with cover provided by riparian structure, large woody debris, cobble and boulder substrate.	May use backwater areas, and off-channel areas located near the mainstem, and lower reaches of tributary streams; especially during period of elevated stream flow.	Most fish typically found in areas with velocities of 0.0 to 3.0 feet per second. Sub-yearlings and yearlings tend to prefer higher velocity than other salmonids. Newly emerged fish are often closely associated with cobble substrate in shallow areas of the stream.
Juvenile migration	All areas of the mainstem with tendency to seek high velocity areas	Must swim through approximately 19 miles of slack water in Lake Washington and the ship canal	Steelhead smolts are typically larger than of all other anadromous salmonid smolts are perhaps best able to avoid predators in the river and best suited to migration through the lake.
Chinook			
Adult migration	All areas of the mainstem channel with sufficient depth and suitable velocity	May hold for short periods in deep pools. Also may use the lake for final maturation during migration	Sufficient depth over key shallow riffle areas early in the fall migration. Peak chinook entry into Lake Washington occurs in mid- to late August when surface water temperatures in the lake are typically at their highest levels of the year
Spawning	Mainstem areas, often similar to those used by steelhead, with small cobble and gravel substrate that is relatively free of sand and silt.	Minor amounts of spawning may take place in larger tributaries such as Rock Creek.	Clean, uncompacted substrate with substantial subsurface water flow. Sufficient stream flow to provide depths of 1.0 to 3.4 feet and velocities of 1 to 3.5 feet per second over suitable substrate. Incubation success significantly

			influenced by magnitude of late fall and winter peak flows in the mainstem.
Juvenile rearing	Mainstem areas with suitable velocity. Often, though not always, associated with cover provided by riparian structure, large woody debris, cobble and boulder substrate.	May use backwater areas, and off-channel areas located near the mainstem, and lower reaches of tributary streams; especially during period of elevated stream flow.	Most fish typically found in areas with velocities of 0.0 to 1.9 feet per second. Newly emerged fish are often closely associated with cobble substrate in shallow areas along stream margins.
Juvenile migration	All areas of the mainstem with tendency to seek high velocity areas	Must migrate as relatively small fish through approximately 19 miles of slack water in Lake Washington and the ship canal	Most downstream migration in the river believed to occur at night. Potentially most vulnerable of group #8 species to predation in the river and lake and perhaps least well-adapted to migration through the lake. Considerations for in-river and in-lake rearing complicate considerations for migration
Coho			
Adult migration	All areas of the mainstem channel and accessible tributaries with sufficient depth and suitable velocity	May hold for short periods in deep pools. Also may use the lake for final maturation during migration	
Spawning	Spawn primarily in tributaries to the mainstem. May also used groundwater-fed side channels where available	Limited spawning may occur in the mainstem	Clean, uncompacted substrate with substantial subsurface water flow. Sufficient stream flow to provide depths of 0.4 to 3.4 feet and velocities of 0.25 to 3.4 feet per second over suitable substrate. Incubation success can be significantly influenced by peak flow events in

			tributaries.
Juvenile rearing	Tributary areas with suitable velocities. Usually associated with cover and prefer low velocity pool areas Make extensive use of backwater areas, groundwater fed-channels and other off-channel features.	May use shallow areas over gravel and cobble substrate in the mainstem.	Most fish typically found areas with velocities of 0.0 to 1.9 feet per second. Newly emerged fish are often closely associated with large woody debris and other types of in-channel structure.
Juvenile migration	All areas of the mainstem with tendency to seek high velocity areas	Must migrate through approximately 19 miles of slack water in Lake Washington and the ship canal	Subject to predation in the river, but larger size likely makes them less vulnerable than chinook. Due to larger size, migration through Lake Washington perhaps less of an impact than for chinook.

The combination of mitigation and minimization measures provided by the HCP is expected to protect any Group #8 species that may occur in the Cedar River Municipal Watershed or in the Cedar River downstream of Landsburg. The HCP is expected to result in both short- and long-term benefits for group #8 species through: (1) construction of fish passage and protection facilities at Landsburg Diversion Dam to allow the three species access to historic habitat; (2) water quality protection, and habitat protection and restoration measures which will improve habitat conditions in the municipal watershed; (3) funding for interim mitigation before the fish passage facilities are built, which may include funding for studies or emergency supplementation; (4) provision of the HCP instream flow management regime to improve habitat conditions in the lower river; (5) funding for habitat protection and restoration in the lower Cedar River, downstream of the municipal watershed; (6) funding for projects at the Ballard Locks designed to increase survival of emigrating smolts; and (7) monitoring and research. These measures collectively are expected to provide immediate protection to chinook, coho and steelhead habitat and provide the opportunity for increased long-term production of Group #8 species in the Cedar River basin.

Until the fish passage facilities are constructed at the Landsburg Diversion Dam, Group #8 species could be affected by the blockage posed by the dam. After the fish passage facilities are constructed, Group #8 species could be negatively affected by silvicultural treatments, road management, or other operational activities in riparian or upland areas within the municipal watershed. Such effects could be direct (e.g., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory vegetation). Group #8 species could also be negatively affected by management actions that contribute sediment to streams (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning). Group #8 species could be also negatively affected by alterations in stream flow associated with water management activities that could potentially affect various life stages of Group #8 species and their associated mainstem habitat downstream of the historic anadromous fish barrier at Lower Cedar Falls. In addition, some aspects of the HCP mitigation measures for Group #7 species, sockeye salmon, could potentially affect some Group #8 species.

The likelihood of direct injury or death of any Group #8 species resulting from silvicultural treatments, road management, water management or other operational or mitigation activities is expected to be low under the HCP. However, any such death or direct injury of Group #8 species would constitute take for chinook or an impact equivalent to take, as applied to species listed under the ESA, for coho or steelhead. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for chinook, coho, and steelhead are detailed in the section entitled “Species Conservation Strategies” (Section 4.2.2). Additional measures that benefit Group #8 species are included in the Conservation Strategies for Minimizing and Mitigating the Effects of the Anadromous Fish Migration Barrier a the Landsburg Diversion Dam (Section 4.3.2), the conservation strategies for Instream Flow Management (Section 4.4.2), Watershed Management Mitigation and Conservation Strategies (Section 4.2), and Anadromous Fish Monitoring and Research (Section 4.5.3). Mitigation and minimization measures for Group #8 species are summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

General Habitat Effects

The provision of fish passage and protection facilities at the Landsburg Diversion Dam is of particular importance to Group #8 species. These facilities will allow Group #8 species to recolonize their formerly occupied habitat upstream of the Landsburg Diversion Dam. Because a significant period of time will be required to complete final design, permitting, and construction of long-term mitigation facilities, the City will begin providing interim conservation measures as directed by the parties to the Landsburg Mitigation Agreement, with advice from Cedar River Anadromous Fish Committee, immediately in HCP year 1 in an effort to help halt the decline of anadromous fish populations in the basin.

Fish passage facilities are expected to be completed by the end of HCP year 3, subject to the City’s ability to gain the necessary permits and complete the SEPA/NEPA review process. The City will provide up to $90,000 per year to fund interim mitigation measures until all fish passage facilities are in operation. These funds would be used to: (1) fund the implementation of life history, genetic, demographic, and/or ecological studies to fill critical information gaps facilitating efforts to protect and restore habitat in the Lake Washington Basin; (2) implement emergency supplemental production programs designed to help sustain and rebuild the populations in a manner that helps ensure their long-term reproductive fitness and capacity to adapt to changing environmental conditions (a population support measure); and/or (3) fund other measures deemed appropriate by the parties to the Landsburg Mitigation Agreement to achieve the objectives of the Landsburg Mitigation Agreement.

Upstream and downstream fish passage facilities and new intake screens at the Landsburg Diversion Dam will be constructed to provide passage and protection for coho salmon, chinook salmon, and steelhead trout. These facilities are expected to open 12.4 miles of the mainstem Cedar River and 4.9 miles of associated tributary streams (Rock Creek, Taylor Creek, William Creek, and Steele Creek) in the protected municipal watershed for the spawning and rearing of these three species.

The proposed watershed management prescriptions for the municipal watershed, including the commitment to eliminate commercial timber harvest and associated habitat protection and restoration measures described in Section 4.2, confer a very high level of protection on all habitats in the municipal watershed by placing all lands outside limited developed areas in reserve status.. As a result of these commitments, all key habitat for Group #8 species within the municipal watershed (i.e., rivers, streams, ponds, lakes, wetlands, and riparian habitat) is protected through reserve status. In addition, protection in reserve status of all forested areas of the watershed will facilitate dispersal by these species. As a whole, Group #8 species clearly depend on a naturally functioning complex of aquatic, riparian, and upland habitats.

Short-term and long-terms gains in the quality of stream, wetland, and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral stage forest in riparian areas. Maturation of protected forest in riparian forests near streams will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole.

The HCP also includes management actions designed to improve and help restore aquatic, riparian, and upland forest habitats within the municipal watershed. Stream bank stabilization projects, placement of large woody debris (LWD), a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas is expected to help (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Restoration of a more naturally functioning aquatic ecosystem will benefit Group #8 species over the long term. However, over the short term, these management interventions may cause some localized decline in habitat function. To mitigate for such short-term, localized impacts, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments. These prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitats for all species in Group #8.

Forest management and management activities associated with forest roads (including road construction, repair, maintenance, and decommissioning) can, if not done properly, impact wetlands and streams through erosion and mass wasting that increases sediment loads and decreases water quality. Because no harvest for commercial purposes will occur in the municipal watershed, however, any potential impacts associated with commercial timber harvest are eliminated. The comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) included in the HCP will serve to minimize the probability of erosion and mass wasting associated with roads. These prescriptions and guidelines, along with the programs to improve watershed roads, to improve road maintenance, and to decommission about 38 percent of the road system, will collectively serve to reduce the rate of sediment loading to aquatic systems and help maintain and improve water quality.

Watershed management prescriptions, are expected to provide direct benefit for Group #8 species and their spawning, incubation and rearing habitat within the municipal watershed upstream of the Landsburg Diversion Dam once fish passage facilities are complete. The kinds of benefits described for Group #5 species (bull trout) upstream of the Chester Morse Reservoir will also apply to Group #8 species in the lower portion of municipal watershed downstream of Chester Morse Reservoir. This area encompasses some of the last remaining undeveloped lowland habitat in the Lake Washington basin and will provide important spawning, incubation and rearing habitat for all three species. Watershed Management Conservation and Mitigation Measures (Section 4.2.2) are expected to protect and restore upland, riparian and aquatic habitat and maintain the natural processes important for creating and maintaining complex stream channels that provide a diversity of fish habitats within the municipal watershed. In addition, the restriction of public access into the municipal watershed will provide benefits for all Group #8 species. Inside the municipal watershed, adult and juvenile fish will be protected from harvest and disturbances associated with angling and other activities in or near the river.

The Cedar River basin is the largest sub-basin in the Lake Washington watershed and provides approximately 50 percent of the total annual flow into the lake. Conservation measures in the municipal watershed, which comprises 2/3 of the Cedar River sub-basin, are expected to deliver substantial water quality benefits to aquatic habitat within the municipal watershed, in the mainstem of the river downstream of the municipal watershed, and in Lake Washington. Migration corridors as well as spawning, incubation, and rearing habitat for Group #8 species in the Lake Washington basin are expected to benefit from the provision of high quality water from the municipal watershed.

The lower Cedar River downstream of the municipal watershed has been impacted by urban development, channel modifications, riparian zone disturbance, and peak flow management practices (King County 1998). Mainstem and side-channel habitat quantity and quality have been reduced substantially in the lower river when compared to pre-development conditions. The HCP provides $4.6 million in funding to implement habitat protection and restoration projects in the river basin downstream of the City’s ownership boundary in the Lower Cedar River. If matched by contributions from King County, the HCP will provide an additional $270,000 for habitat restoration in the Walsh Lake sub-basin both within and downstream of the City’s ownership boundary.

A range of habitat protection and restoration projects has been identified as candidates for future implementation in the Lower Cedar River (King County 1998). Likely projects include riparian habitat acquisition and protection, and reestablishment of groundwater-fed side channels and ponds in the floodplain. If groundwater-fed channels and ponds are included as the preferred measures, spawning and rearing conditions for coho salmon are likely to improve significantly. Off-channel habitats and wall-based channels provide valuable habitat for coho salmon spawning, rearing, and over-winter habitat in other watersheds of the Pacific Northwest. It is likely that the confined nature of much of the lower Cedar River has resulted in a significant loss of what was once considered prime coho salmon habitat. Habitat protection and restoration directly in or along the mainstem may provide less direct benefits for coho, but would nevertheless help protect structural and functional habitat elements that are used by coho for upstream and downstream migration and, to a more limited extent, for spawning and rearing.

Benefits of groundwater-fed features for chinook and steelhead may be somewhat less direct than for coho. Although adult spawners may not make substantial use of off-channel and wall-based habitats, rearing juveniles will likely benefit to some degree from an increase in this type of habitat. Habitat protection and restoration in or along the mainstem can serve to protect important structural features and functional elements of riparian and aquatic habitat and can be expected to provide benefits to steelhead and chinook, which tend to select mainstem areas for spawning and rearing.

The provision of beneficial instream flows downstream of the City's water management facilities on the Cedar River is critical to the success of City's composite efforts to conserve Group #8 species. The HCP instream flow management regime is based upon over 10 years of collaborative scientific analysis and is expected to provide a variety of benefits to Group #8 species including: 1) guaranteed and supplemental flow assurances that better mimic the shape of the natural hydrograph, that are typically greater than the flows required to provide maximum weighted usable area (WUA) for key species and life stages and that are better tailored to meet the needs of anadromous salmonids; 2) limits on the City's future annual diversions, implementation of a monitoring program, and oversight by an interagency Commission providing flexibility and commitment to shape flows above guaranteed levels for greater ecological benefit; 3) downramping prescriptions to moderate the rate at which stream flows can be reduced to limit the risk of fish stranding; 4) relocation of the flow compliance point 20 miles upstream for improved operating precision, improved protection of the upper portions of the lower river and to encourage more natural patterns of flow variation throughout the lower river; 5) the provision of guaranteed flows in the bypass reach between Masonry Dam and the Cedar Falls powerhouse that will improve conditions for Group #8 species once they are passed upstream of the Landsburg Dam; 6) an increase in the guaranteed amount of water that flows into Lake Washington during the period of maximum water use at the Ballard Locks between June 15 and September 30 for more flexibility to provide beneficial fish passage conditions through the locks facilities; 7) nearly $5 million for habitat protection and restoration in the lower river downstream of the City's ownership boundary; and 8) nearly $2 million for fish passage improvements and water conservation at the Ballard locks. The effects of particular provisions of the instream flow management regime on the various life stages of each of the Group #8 species are discussed below.

Instream Flow Management: Effects on Weighted Usable Area (WUA)

The HCP guaranteed and supplemental flow regime is summarized in Table 4.4-1. The relationships between guaranteed flows, the existing non-binding IRPP minimum flows and the flows that provide maximum WUA for key species and life stages as determined by collaborative PHABSIM analyses are summarized in Figures 4.4-2 through 4.4-5. Expected actual flows will often exceed guaranteed flows during the fall, winter and spring because: (1) inflows to the basin often exceed amounts required to meet the guaranteed flows and municipal water supply demands; (2) surface runoff in the lower 57 percent of the basin enters the Cedar River naturally and is not influenced by the water storage reservoir; and (3) flood storage capacity in the reservoir is relatively limited. Expected actual flows under the HCP instream flow management regime, under the existing IRPP regime, and under natural unregulated conditions are summarized in Appendix 36. Appendix 37 provides habitat duration analyses for expected actual flows under the HCP, IRPP and natural flow regimes using PHABSIM output for target species and life stages.

For most of the year, HCP guaranteed flows are higher than existing IRPP minimum flows and higher than the flows required to provide maximum weighted usable area for key species and life stages. Although these higher flows result in a reduction in WUA when compared to the flows that maximize WUA, they will help ensure that the guaranteed regime more closely mimics natural basin hydrology and will provide a variety of important overriding biological benefits that are discussed later in this section. The effects of the proposed HCP flow regime on WUA for all target species and life stages throughout the year are outlined below. The discussion begins with late summer and early fall flows, then proceeds sequentially throughout the remainder of the year.

Although guaranteed flows are generally higher than the levels that provide maximum WUA for most of the year, in the late summer and early fall they are not. Guaranteed flows in August and the first two weeks of September, the typical period of lowest natural inflow, are slightly below the levels that provide maximum WUA for rearing steelhead and coho. At this time of year, guaranteed flows provide 98 to 99 percent of maximum WUA for juvenile coho and steelhead rearing. Habitat duration analyses summarized in Appendix 37 demonstrate that, for this period as a whole, expected flows under the HCP regime provide more WUA for juvenile steelhead rearing than expected flows under the existing IRPP regime or expected flows that would occur under natural conditions without the presence of water storage and diversion facilities.

In the fall, spawning conditions for salmon become a key biological consideration. The first returning adult chinook salmon begin to enter the river and spawn in early September. Guaranteed flows at this time are also below the level required to provide maximum WUA for chinook spawning. However, by September 15 with approximately 5 percent of the chinook run typically in the river, guaranteed flows increase to a level that provides 77 percent of maximum WUA. By September 23, with approximately 16 percent of the run in the river, guaranteed flows increase to a level that provides 95 percent of maximum WUA. By October 8, with 50 percent of the run typically in the river, guaranteed flows increase to a level that is equal to or greater than the level required to provide 100 percent of maximum WUA. For the rest of the chinook spawning season, low normal flows remain at the level that provides maximum WUA for chinook spawning.

In an effort to provide more edge spawning habitat for sockeye salmon and potentially reduce subsequent sockeye redd scour vulnerability, high normal guaranteed flows may be provided after October 7. High normal flows exceed the levels required to provide maximum WUA for chinook spawning for the duration of the spawning period, but still provide between 95 percent and 98 percent of maximum WUA for chinook spawning. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the chinook spawning period as a whole, expected flows under the HCP regime will provide more WUA for chinook spawning than expected flows under either the existing IRPP regime or the natural flow regime.

Coho salmon begin to enter the river and spawn in mid-October and continue to spawn into February. Coho spawning is believed to be concentrated in tributaries, but limited spawning may occur in the mainstem. HCP guaranteed normal flows are well above the flows required to provide maximum WUA for coho spawning and higher than the existing IRRP minimum flows throughout the entire coho spawning period. Guaranteed flows during this period provide between 64 percent and 75 percent of maximum WUA for coho spawning. Considerations for coho spawning during this period are secondary to considerations for a number of other important biological factors. Elevated guaranteed flows at this time are designed to provide: (1) increased WUA for chinook spawning; (2) increased edge habitat for sockeye spawning; (3) improved incubation protection for chinook, coho and sockeye; and (4) improved emigration conditions for sockeye fry. Habitat duration analyses based on expected flows, rather than guaranteed or minimum flows, demonstrate that, for the coho spawning period as a whole, the HCP regime provides more WUA for coho spawning than expected natural flows and about the same amount as provided by expected flows under the IRPP regime (See Appendix 37).

Steelhead begin to enter the river and spawn in early March and continue to spawn into early June. HCP guaranteed normal flows are well above the flows required to provide maximum WUA for steelhead throughout their entire spawning period and greater than IRPP flows for most of the period. Guaranteed flows during this period provide between 75 percent and 98 percent of maximum WUA for steelhead spawning. Elevated flows during the steelhead spawning season can encourage steelhead to spawn in less suitable areas that are more vulnerable to dewatering during the later portion of the incubation period as stream flows drop to normal base flow conditions. This concern is heightened during the later portion of the steelhead spawning period. After mid-May, HCP flows drop slightly below IRPP minimum flows but remain above the levels that provide maximum WUA. This drop in flows substantially increases WUA for spawning steelhead and provides the opportunity to reduce the risk of subsequent redd dewatering for the most vulnerable portion of the population. Habitat duration analyses based on expected flows, rather than guaranteed or minimum flows, demonstrate that, for the steelhead spawning period as a whole, expected flows under the HCP regime provide more WUA for steelhead spawning than expected flows under natural flow conditions or expected flows under the IRPP regime (see Appendix 37).

Concerns for steelhead spawning during this time are balanced with efforts to maintain higher flows to protect incubating salmon, improve conditions for emigrating sockeye fry and provide beneficial conditions for rearing chinook and coho. The generally elevated levels in guaranteed flows during this period result in a reduction in WUA for rearing chinook and coho salmon. Flows during this period provide gradually increasing levels of WUA for juvenile coho and chinook rearing that range from 58 percent of maximum WUA at the start of the period to 78 percent of maximum at the end of the period.

From mid-June through the end of July, incubating steelhead become a primary concern for instream flow management. As mentioned previously, steelhead redds can be vulnerable to dewatering when stream flows drop to normal summer base levels. The flexible HCP guaranteed flow regime, coupled with a real-time steelhead redd monitoring program provide key information and management flexibility that will allow full protection of all steelhead redds in most years. Flows during this period will generally be greater than existing IRPP minimum flows but typically less than expected natural flows. HCP guaranteed flows are generally well above the levels that provide maximum WUA for coho, chinook, and steelhead rearing during this period. Flows during this period provide between 76 percent and 84 percent of maximum rearing WUA for these three species.

Additional Effects of the Instream Flow Management Regime

During the collaborative instream flow studies and development of the HCP instream flow management regime, the interagency Cedar River Instream Flow Committee viewed the extensive PHABISM analyses conducted on the Cedar River as a foundation for an instream flow management regime rather than as a prescriptive tool for determining preferred flows at any give time during the year. While the City believes that PHABSIM analyses are an important tool in developing effective instream flow management practices, anadromous salmonid biology is complex and habitat requirements for these species are not completely described by standard PHABSIM analyses. Additional information is helpful in prioritizing species and life stages during particular times of the year; addressing aspects of their biology not typically analyzed in standard PHABISM investigations; and understanding the complex relationships between hydrologic variation and natural ecological processes in the aquatic environment. During the course of collaborative studies and subsequent development of the HCP instream flow regime, a broad array of information was used in an effort to establish management provisions that would provide comprehensive protection for all life stages of anadromous fish and the habitat upon which they depend. These management provisions address key biological considerations determined to be of particular importance to Cedar River anadromous fish by the Cedar River Instream Flow committee and include:

- Limits on the rate at which stream flows can be reduced as a result of City's water management activities to reduce the risk of fish stranding and better reflect natural rates of stream flow recession;
- Increased guaranteed flows during the fall to recruit additional sockeye spawning habitat along the margins of the stream and potentially reduce sockeye redd scour vulnerability during subsequent winter peak flow events;
- Increased guaranteed flows during the chinook and sockeye incubation season in the fall, winter and spring to reduce the risk of redd dewatering;
- Increased guaranteed flows during the late winter and early spring to provide improved emigration conditions for sockeye fry;
- Steelhead redd monitoring program and flexible blocks of supplemental water during the summer for increased flows to reduce the risk of steelhead redd dewatering;
- Higher guaranteed flows into Lake Washington for more flexibility to provide beneficial fish passage conditions at the Ballard Locks; and
- A number of commitments that will result in stream flows that better reflect natural hydrologic patterns including: i) relocation of the flow compliance point 20 miles upstream to Landsburg; ii) supplemental guaranteed flows linked to real time hydrologic conditions; and iii) collaborative management of flows above guaranteed levels to support important natural ecological processes and provide benefits to fish.

Effects of the Adaptive Features of the Instream Flow Management Regime

Although a substantial amount of information was assembled over the last 10 years to guide the development of the HCP instream flow regime, the City anticipates that additional information will become available as the science of fluvial systems and strategies for managing stream flows in altered channels continue to evolve. In addition to well-defined, binding instream flow management commitments, the City acknowledges the need to provide sufficient flexibility to adapt and improve instream flow management strategies, as new information becomes available. Therefore, the HCP provides substantial commitments to limit the City's future diversions from the Cedar River to ensure sufficient flexibility to meet additional needs for instream resources should such needs arise. In addition, the HCP provides over $ 3.4 million for further studies to: i) monitor natural and regulated stream flows throughout the basin; ii) better quantify the effects of natural local inflows on stream flow in the Cedar river downstream of municipal watershed; iii) improve the ability of stream flow switching criteria to accurately reflect natural hydrologic conditions; iv) to improve our understanding of key aspects of the biology of chinook salmon and other salmonids in the Cedar River; and v) better understand the effects of stream flow management of fish habitat in altered fluvial systems. Finally, the HCP establishes an Instream Flow Commission (Section 4.4.2 and Appendix 27) that will make use of the information gathered during future studies to guide the management of stream flows over and above the guaranteed levels to provide additional benefits for instream resources.

The use of this adaptive approach is particularly important in addressing the early life history of Cedar River chinook. Ocean-type juvenile chinook, such as those found in the Cedar River, typically express a tendency toward two early life history patterns. In one pattern, newly emerged juvenile chinook migrate directly downstream to the estuary where they rear for up to several months before moving into continental shelf waters. In the second pattern, juvenile chinook emerge from their redds and rear for up to three months in their natal stream before moving downstream to the estuary where they rear for shorter periods of time before moving into continental shelf waters (Healey, 1991).

Preliminary investigations conducted by WDFW suggest that substantial portions of the juvenile chinook population in the Cedar River display both of these early life history patterns (WDFW 1999, unpublished data). However, in the case of the Cedar River fish, young chinook no longer have ready access to an estuary. Because the Cedar River was rerouted into Lake Washington during the early 1900s, all juvenile chinook from the Cedar River must now swim through approximately 19 miles of slack water that supports a wide variety of native and introduced predators before reaching the marine environment. As they enter the marine environment, juvenile chinook must pass through the Ballard locks and cope with a highly modified marine/freshwater interface that has relatively little resemblance to a natural estuary. This hydrologic configuration is very atypical for ocean-type chinook in general. There are few, if any, examples of newly emerged, ocean-type chinook fry rearing and migrating through a large natural lake system en route to the marine environment. In particular, this configuration is foreign to native Cedar River chinook that historically migrated only a very short distance in the Duwamish River between the Cedar River and the Duwamish Estuary. It is not clear to what degree, Cedar River chinook have been able to adapt to this rather dramatic alteration of their environment. Nor is it clear to what degree either of the two early life history patterns contributes to the production of returning adults and overall survival of the population.

If, for example, juvenile chinook that migrate immediately out of the Cedar River contribute to the majority of the smolt production in the system, then spring juvenile rearing conditions in the river are less of a concern and spring in-river emigration conditions become a greater concern. Alternatively, if young chinook that rear in the river for three months in the Cedar before migrating through the lake survive better than fish that enter the lake as newly emerged fry, then juvenile rearing conditions in the river during the spring are a very important consideration.

Much of the Cedar River downstream of the Landsburg Dam is confined by levees. The average width of the active channel is now estimated to be approximately one half the width of the active channel in the mid-1800s prior to the impacts of development (King County 1998). During periods of high stream flow, the availability of suitable fry rearing and refuge habitat in this confined and narrowed channel can be substantially reduced. Preliminary studies conducted by WDFW indicate that large numbers of chinook fry emigrate from the river during high flow events in the spring. If high spring flows induce chinook fry to migrate to the lake, and these fish survive at a significantly lower rate than fish that rear in the river, then high spring flows could reduce overall smolt production. However, if fry that rear in the lake survive at a greater rate than fry in the river, then high spring flows may increase overall smolt production. The Cedar River constitutes one of the best opportunities in the region to protect and rehabilitate juvenile rearing habitat for chinook. Given that Lake Washington is completely surrounded by urban development, caution is advisable regarding changes to river flows during the chinook spring emigration period, particularly when other species are also considered.

Water management decisions on the Cedar River are very complex during the spring. Managers must consider the needs of (1) incubating salmon and steelhead, (2) spawning steelhead, (3) rearing juvenile steelhead, coho and chinook, (4) emigrating sockeye and chinook fry, and (5) emigrating chinook, coho and steelhead smolts in the lower river. In addition to protection of anadromous fish, decision makers must also consider (1) flood management, (2) refilling Chester Morse Lake in a manner that protects nesting loons and incubating bull trout and (3) continuing to provide a safe and reliable municipal water supply.

To make good instream flow management decisions, mangers must be supplied with accurate and reliable information. As mentioned above, such information on the early life history of chinook salmon is not presently available. To address this information gap and support instream flow management decisions, the HCP provides $1 million dollars specifically earmarked for studies that address the early life history of chinook salmon and other key life stages of anadromous salmonids in the Cedar River (Section 4.5.2). We expect that study results will be used by the Cedar River Instream Flow Commission to help make well informed and balanced instream flow management decisions during the spring and other key periods of the year.

In summary, the adaptive approach to instream flow management provided by the HCP is expected to improve our understanding of the complex biological requirements of anadromous salmonids in altered fluvial systems. This improved understanding, combined with the flexibility provide by the HCP, will support a more robust management framework that is expected to improve conditions for Group #8 species and help protect and restore ecological processes that shape and maintain aquatic habitat in the lower Cedar River.

Disturbance Effects

Instream flow management strategies have been designed to provide benefits to all Group #8 species during key life stages while avoiding and minimizing potential interspecies conflicts. Because individuals of different species at various life stages are simultaneously present in the river and often express different habitat preferences, it is not possible to optimize conditions for all species in the river at a given point in time. Therefore, key life history stages are given preference during certain periods of the year. For example, flows provided under the HCP in October, during the period of peak salmon spawning, are designed to provide maximum benefits for spawning chinook and sockeye. These flows are well above the levels that provide maximum WUA for rearing juvenile steelhead and coho. Resulting reductions in a rearing WUA are, however, relatively small and are offset by the substantial benefits of allowing flows to follow the shape of the natural hydrograph and providing more WUA for spawning chinook and more edge spawning habitat for spawning sockeye.

Similarly, HCP guaranteed flows during the coho and steelhead spawning season are designed to provide added protection for incubating chinook and sockeye as well as emigrating sockeye. The elevated flows during this period result in a reduction in WUA for spawning steelhead and coho. Elevated streamflows continue through July to provide added protection for incubating steelhead. These flows, designed to protect steelhead redds result in a reduction in WUA for rearing juvenile chinook, coho, and steelhead. However the reductions in WUA are relatively small and are believed to be of secondary importance to steelhead incubation protection.

These potential effects that result from interspecies tradeoffs associated with instream flow management are not believed to constitute a significant impact. Further, these effects will be offset by the full range of benefits provided by the (1) comprehensive instream flow management regime for key life stages of all Group #8 species, (2) the provision of access to 17 miles of high quality habitat upstream of Landsburg and associated watershed management provisions in the municipal watershed, (4) investments in habitat protection and restoration in the lower river downstream of the City’s ownership boundary, and (5) the City’s commitments to monitoring and adaptive management.

Interspecies conflicts can potentially also occur when implementing mitigation measures for the effects of the Landsburg Dam on Group #7 (sockeye salmon) and Group #8 species. The need to sort sockeye from upstream migrating chinook and coho as they pass over through upstream fish passage facilities in the future may result in increased handling stress for adult sockeye that must be captured and transported back downstream.

An increase in sockeye fry production due to the proposed sockeye mitigation program could potentially lead to an increase in potential predator populations in the river that may also prey upon chinook and coho fry which overlap with sockeye in their emergence timing. Conversely, short-term increases in sockeye fry abundance could serve to overwhelm predators during parts of the year and thus reduce predation rates on other species. An increase in sockeye fry abundance could also result in an increase in the forage base for yearling steelhead and coho and thus provide benefits to these species. An increase in the number of spawning sockeye could potentially affect spawning chinook. This potential effect is expected to be minimal because, chinook are larger than sockeye, tend to select somewhat different spawning habitat and generally bury their eggs deeper in the gravel than do sockeye. An increase in the number of adult steelhead returning to spawn could result in the disruption of a larger number of chinook and sockeye redds late in the incubation season. Since chinook tend to complete incubation in April, well before the completion of sockeye incubation, spawning steelhead are more likely to disturb incubating sockeye than incubating chinook.

The proposed mitigation for sockeye salmon (Group #7) includes measures to collect sockeye broodstock for the proposed artificial production program. The sockeye broodstock collection program has two primary objectives: (1) to capture an adequate number of adult sockeye salmon in a manner that provides a representative subset of the entire Cedar River sockeye population and (2) to avoid and minimize any potential detrimental impacts the program may have on naturally reproducing salmonids in the Cedar River. The City is not aware of any definitive information demonstrating that ongoing broodstock collection activities at the interim facilities have had significant detrimental impacts on salmonid reproduction in the Cedar River. However, past experience with the prototype sockeye hatchery program has demonstrated the need for a thoughtful and well-founded approach to broodstock collection.

The City believes that the potential risks associated with installation, operation and removal of the interim and long-term broodstock collection facilities can be minimized and avoided through the development of rigorous broodstock collection protocol and implementation of improved broodstock collection practices beginning in Year 1 of the HCP. As part of the HCP, the City will commit $200,000 specifically earmarked for research to support the development and implementation of effective sockeye broodstock collection facilities and practices to minimize the risk of detrimental effects on naturally reproducing salmonids in the Cedar River.

As with the instream flow management regime, potential incidental impacts of the proposed mitigation measures for the migration barrier at the Landsburg Dam are expected to be more than offset by the broad array benefits provided to all Group #8 species by the HCP as a whole.

Direct Take

The primary activities under the HCP that may result in disturbance, and possibly take or the equivalent of take, of Group #8 species include (1) management of river flows and (2) operation of fish passage facilities at Landsburg, and (3) operation of the broodstock collection facilities for the sockeye mitigation program. Once Group #8 species have access to the municipal watershed, activities under the HCP that may result in disturbance, and possibly take or the equivalent of take, of Group #8 species will include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2)restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

Although the HCP instream flow regime is designed to reduce the likelihood of mortality of incubating eggs and alevins during winter flood events, some level of redd scour and related mortalities during incubation are a normal part of salmon life history. Because of the constrained condition of the Cedar River and the fact that the Masonry Dam has limited storage capacity and only captures runoff from the uppermost 43 percent of the basin, water management under the HCP will not eliminate all flood flows. Peak flow management practices are not expected to be affected by implementation of the HCP. Egg to fry mortality in the river during very large flood events can be substantial, varying with the magnitude of peak flows during incubation. Any such death, direct injury, or disturbance would not constitute take under the ESA, as the measures included in the

HCP do not exacerbate these natural impacts.

Rapid reductions in stream flows due natural causes and the City's water management activities on the Cedar River can potentially strand and kill fish. Downramping prescriptions, which constrain the rate at which the City may reduce stream flows as a result of its water management practices, are expected to avoid and minimize risks associated with stranding to levels that would occur under natural, unregulated conditions. Any residual risk of stranding that might occur would by offset by the array of benefits provided by the HCP to Group #8 species as a whole.

As a result of handling and/or structures, it is also possible that injury or death of a small number of fish each year could occur during operation of the fish passage facilities at the Landsburg Diversion Dam and the broodstock collection facilities for the sockeye mitigation program. This small potential level of take, however, will be more than offset by the conservation and mitigation value of the facilities themselves along with other measures included in the HCP.

Within the municipal watershed, the likelihood of direct take occurring at a scale that may compromise the viability of Group #8 species populations is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Group #8 species habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which greatly reduces the risk of mortality from public fishing; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of City activities is expected to be very low in any given year.

Population-level Effects

The City believes that the potential for disturbance and take as described above does not constitute a threat to Group #8 species. On the contrary, the City believes that the substantial measures in this HCP for the protection of Group 8 species and their habitats, implementation of an extensive monitoring and research program, and the incorporation of an adaptive management strategy will result in a substantial net population benefit for these species. The City believes that these measures will provide sufficient mitigation for any potential negative impacts of the City's operations on chinook, and coho salmon and steelhead trout during the term of the HCP.

Other Effects

The Ballard Locks have been identified as a significant source of mortality to emigrating anadromous salmonids. The HCP provides funds to support implementation of passage improvement measures currently under consideration by the ACOE. The ACOE estimates that full implementation of these measures will substantially increase passage survival (Army Corps of Engineers 1997). The increased survival of smolts passing through the Ballard Locks will increase the productivity of anadromous stocks within the Cedar River and throughout the Lake Washington Basin.

The HCP contributes funds for fish passage improvements and improvements to the salt-water drain at the locks (or other measures to conserve freshwater). The saltwater drain is designed to help manage and reduce the accumulation of salt water that passes into Lake Union during normal operation of the locks. This system uses a considerable amount of freshwater to manage saltwater intrusion. These improvements are expected to save approximately 6,000 acre-feet of fresh water each year, which could then be allocated for other beneficial uses, such as to improve fish passage flows at the locks.

One of the major objectives of the City's mitigation plan for sockeye salmon is to contribute to the development of a viable tribal and sport fishery in Lake Washington. As described under the sockeye salmon effects section, the HCP has the potential for the greatly increased adult sockeye returns available for harvest. The potential problems associated with a mixed-species fishery for sockeye (see Section 4.3.2) are not considered a concern for coho salmon and steelhead trout because significant numbers of adult fish are not present in Lake Washington during the period in which sockeye salmon harvests are conducted. Some portion of the chinook run is present in the lake during the sockeye harvest. However, many chinook enter the lake after the period during which sockeye harvests are traditionally conducted. Harvest reports from past sockeye sport fisheries in Lake Washington indicate that very few, if any, chinook have been harvested. In addition, gear restrictions and mandatory release requirements can be imposed to further limit the effects of any incidental chinook capture.

Group #9 - Bald Eagle

Introduction

Bald eagles are commonly present in the Cedar River Municipal Watershed as transients or as migrants during spring and fall seasons, but no nests have been documented within the watershed, and no communal winter roost sites have been identified. Especially during the spring and fall, both adult and juvenile bald eagles are regularly observed perched in trees adjacent to several of the larger lakes in the watershed, particularly Chester Morse Lake, Masonry Pool, Rattlesnake Lake, and Walsh Lake and along the mainstem channels of the Cedar and Rex rivers. Potential key nesting habitat for bald eagles typically includes mature, late successional, and old-growth forests with large trees and snags that are typically located within 1 mile of water bodies that support an adequate prey base. Bald eagle winter roost site selection is thought to depend more on protective landforms and availability of coniferous forest than on proximity to water. Key habitat for foraging includes rivers, lakes, and other aquatic habitats.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any bald eagles that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury to, or death of, any bald eagle resulting from silvicultural treatments, road management, or other operational activities is expected to be low under the HCP, as is the likelihood of disturbance to any actively nesting eagles. However, any such death, direct injury, or disturbance leading to such injury or death would constitute take under the ESA.

Long-term benefits are expected to accrue to the bald eagle, especially through protection of mature, late successional, and old-growth forest, and the recruitment of additional mature and late-successional forest over time. A net gain of potential bald eagle habitat (for nesting, roosting, and foraging) is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to bald eagles through:

(1) protection of all existing key habitat in reserve status, including all mature, late successional, and old-growth forests that could be used for nesting, all other forest that could be used for roosting, and all river, lake, and other aquatic habitats that could be used for foraging; (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and the likelihood of disturbing nesting or roosting activities; (3) natural maturation of second-growth forests into mature and late-successional seral stages, increasing the availability of potential nest, roost, and perch sites; (4) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests; (5) retention, creation, and recruitment of large snags and large trees with broken tops during silvicultural treatments, also increasing the availability of potential nest, roost, and perch sites; (6) protection and improvement of water quality and other habitat conditions for prey species through measures to reduce sediment loading to streams; (7) passage of all native anadromous fish species above the Landsburg Diversion Dam, when the fish ladders are constructed; (8) changes in management of instream flows under the HCP and other flow-related measures that will improve conditions for fish that are prey of bald eagles; (9) removal of 38 percent of watershed roads, reducing the potential for disturbance to nesting or roosting eagles; (10) monitoring and research; and (11) protection of nesting pairs and communal roosts from human disturbance.

The bald eagle could be negatively affected by road management or other operational activities in watershed forests, especially in mature to old-growth forest, as well as by silvicultural treatments and restoration activities in younger second-growth forest. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of tree canopy or specific nest, roost, or perch trees) or through disturbance. Bald eagles can also be negatively affected by management activities that contribute sediment to streams (e.g., timber harvest, road construction, maintenance and use), thereby reducing water quality and potentially affecting populations of prey fish.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the bald eagle are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the municipal watershed, all forest outside limited developed areas is protected through reserve status. As a result, all key forest habitat for the bald eagle within the municipal watershed (i.e. mature to old-growth forest), as well as other potential forest habitat, is protected. All key aquatic habitats are also protected by protection of adjacent forest and by other measures in the HCP.

Major habitat effects on the bald eagle are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests or with aquatic and riparian habitats. Although old-growth forest, by definition, will not increase in extent under the HCP, substantial increases in the quantity and quality of mature and late-successional coniferous forest habitat for the bald eagle are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range, than under current conditions.

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, with greater overall potential for utilization by bald eagles. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

In addition, under the HCP, some potential bald eagle habitat in the municipal watershed is expected to benefit from management actions, such as ecological thinning and restoration, that are intended to produce mature and late-successional forest habitat characteristics in second-growth forests (Section 4.2.2).

The HCP also includes management actions intended to restore and enhance aquatic and riparian habitats. These actions are intended to improve fish habitat, thereby also improving foraging conditions for bald eagles over time. Stream bank stabilization projects, placement of large woody debris, a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas is expected to help accelerate (1) the restoration of natural aquatic and riparian ecosystem functioning and (2) the development of mature or late-successional forest characteristics in younger seral-stage forests in riparian areas (Section 4.2.2).

Silvicultural treatments in riparian areas may result in short-term negative impacts on streamside habitat and/or water quality. No commercial timber harvest will occur in the watershed, however, and, in order to eliminate or minimize any short-term impacts to bald eagle habitat, mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones. One important set of constraints is that during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams and no tree removal that has the potential to reduce streambank stability will be allowed within 25 ft of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines is expected to help reduce the rate of sediment loading to aquatic systems, and help maintain and improve water quality.

Road construction, repair, maintenance, and decommissioning can all impact stream and riparian areas. The HCP includes a comprehensive suite of Watershed Assessment Prescriptions and other management guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with roads, however. Following these prescriptions and guidelines, along with the program to improve many roads and to decommission about 38 percent of existing roads (Section 4.2.2), will reduce the rate of sediment loading to aquatic systems and maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads are adjacent to streambanks, but improved road maintenance under the HCP will help mitigate those impacts.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance to, and possibly the equivalent of take of, bald eagles that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian and instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of disturbing any actively nesting or roosting bald eagles in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active bald eagle nest sites or roost sites from human disturbance, partly through the use of site evaluations and interdisciplinary teams prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because disturbance during nesting and foraging can adversely affect bald eagles, the restriction of public access into the Cedar River Municipal Watershed is expected to provide benefits for foraging, nesting, and roosting bald eagles (should eagles eventually nest or communally roost in the watershed). In order to protect eagles that may nest within the municipal watershed or groups of eagles that may use the watershed for foraging, the City will not conduct silvicultural treatments or construct roads within 0.5 mile of a known active bald eagle nest site between January 1 and August 15 or within 0.25 mile of a known active bald eagle nest site at other times of the year, or within 0.25 miles of an active communal roosting site (Section 4.2.2).

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of any bald eagles resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low.

Population-level Effects

Population-level effects on the bald eagle are, in general, as described for other species addressed by the HCP that are associated with mature, late-successional, and old-growth forest, and for those species associated with aquatic and riparian habitats. Protection in reserve status of all key forested habitat will, over time, result in a forested landscape similar to that which would be present naturally. Protection and restoration of aquatic and riparian habitats adjacent to rivers and streams will improve conditions for the dispersal and movement of organisms dependent on aquatic and riparian habitats. The increase in habitat connectivity and maturation of second-growth forest is expected to benefit the bald eagle population by providing potential nesting, roosting, and foraging habitat throughout the landscape of the Cedar River Municipal Watershed and improving conditions for prey. Other measures in the HCP that will improve habitat for fish that are prey of bald eagles or otherwise increase prey populations or availability are described below under “Other effects.”

The City believes that the HCP will have an overall positive effect on the regional bald eagle population.

Other Effects

Two groups of measures will benefit bald eagles by improving habitat conditions for fish that are prey of bald eagles or by otherwise increasing prey populations. Increased production of anadromous fish will mean increased availability of live prey, increased production of salmon will mean increased availability of carcasses, and construction of fish passage facilities at the Landsburg Diversion Dam will extend the availability of live anadromous fish and salmon carcasses into the municipal watershed. The HCP provides for the passage of all native species of anadromous fish upstream of the Landsburg Diversion Dam into a 12.5-mile reach of the mainstem of the Cedar River and into additional smaller tributaries, substantially adding to spawning and rearing habitat, and increased production of sockeye salmon, downstream of Landsburg, through operation of a hatchery (Section 4.3.2).

Improvements in instream flows under the HCP will increase habitat capacity of the Cedar River, flow downramping protection under the HCP will reduce mortality of juvenile fish, funding for habitat protection and restoration downstream of Landsburg will increase habitat quality and quantity, and funding for improvements at the Ballard Locks will increase survival of smolts passing from Lake Washington to Puget Sound (Section 4.4.2).

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for the bald eagle are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #13 – Harlequin Duck

Introduction

Harlequin ducks are known to be present during breeding season in the Cedar River Municipal Watershed on the mainstem Cedar River to at least an elevation of 2,100 ft, and one major tributary downstream of Cedar Falls, and to successfully breed occasionally. Harlequins winter on salt water and nest along fast-moving streams and rivers, placing their nests on the ground in dense vegetation, in piles of woody debris, in undercut stream banks, between rocks, and in hollow trees or tree cavities (Section 3.6). Potential key habitat for the harlequin duck during the breeding season, used for nesting and rearing of young birds, are fast-flowing rivers and streams and associated bank-side vegetation, especially within mature, late-successional, and old-growth forests.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any harlequin ducks that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of, any harlequin ducks resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting harlequin duck pairs. However, any such death, direct injury, or disturbance of harlequin ducks leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Long-term benefits are expected to accrue to the harlequin duck, especially through protection of all stream and riparian habitat and all mature, late successional, and old-growth forest in reserve status, as well as the recruitment of additional mature and late-successional forest over time. The HCP is expected to result in both short- and long-term benefits to the harlequin duck through: (1) protection of all key habitat (streams and associated riparian habitat); (2) elimination of timber harvest for commercial purposes within the watershed reducing the overall level of habitat disturbance and the likelihood of disturbing nesting or foraging activities; (3) protection of all existing forested habitat in reserve forest status, allowing the restoration of natural function in riparian areas; (4) natural maturation of second-growth forests into mature and late-successional seral stages, potentially recruiting increased amounts of large woody debris that may serve as loafing and nesting sites and improving stream habitat function; (5) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, potentially hastening the development of large woody debris in riparian areas; (6) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying large woody debris which may serve as loafing sites in streams and nesting sites on banks; (7) stream restoration and bank stabilization projects; (8) road improvements and improved road maintenance, reducing sediment loading to streams; (9) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (10) removal of 38 percent of watershed roads, reducing the risk of disturbance to nesting ducks and reducing sediment loading to streams; and (11) monitoring and research.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for harlequin ducks are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for the harlequin duck within the municipal watershed (fast-flowing streams, especially where associated with mature, late-successional and old-growth forests, and streamside habitat) is in reserve status. In addition, silvicultural activities are restricted within 50 feet of streams to minimize the potential for habitat impacts or disturbance to key wildlife species, including harlequin ducks.

Major habitat effects on the harlequin duck are similar, in general, to those described for other species addressed by the HCP that are closely associated with streams and riparian habitats. All key habitat as well as potential habitats are protected. Protection of and improvements in water quality and streamside habitat are of particular importance for nesting and foraging harlequin ducks.

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, with greater overall potential for utilization by harlequin ducks. In order to estimate how the relative amount of older forest age classes will change in “riparian” forest over the 50-year term of HCP, “riparian” zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP includes management actions designed to help restore and enhance aquatic and riparian habitats. Stream bank stabilization projects, placement of large woody debris (LWD), a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas are expected to help (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Other provisions in the HCP, including, road decommissioning (removal), road improvements, improved road maintenance, and limitations on activities near streams, will also foster reestablishment of naturally functioning hydrologic regimes within the landscape of the Cedar River Watershed. Restoration of a naturally functioning aquatic ecosystem will benefit the harlequin duck over the long term. However, over the short term, these management interventions may cause some localized decline in habitat function. Site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in the watershed to ensure that habitat for harlequin ducks will be minimally impacted.

Silvicultural treatments in riparian areas may result in negative impacts on streamside habitat and/or water quality. Such impacts may occur if vegetation canopy cover is reduced to an extent that leads to increased rates of soil erosion or increased solar heating of stream water. No commercial timber harvest will occur in the watershed, however, and, in order to eliminate or minimize any short-term impacts to harlequin duck habitat, mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones. One important set of constraints is that during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams and no tree removal that has the potential to reduce streambank stability will be allowed within 25 ft of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will reduce the rate of sediment loading to aquatic systems, and help maintain and improve water quality.

Road construction, repair, maintenance, and decommissioning can all affect stream and riparian areas. The Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) are intended to minimize the probability of erosion and mass wasting associated with roads. Following these prescriptions and guidelines, along with implementing the program to improve and decommission roads (Section 4.2.2), will reduce the rate of sediment loading to aquatic systems and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads come near streambanks, but improved road maintenance under the HCP will help mitigate those impacts.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of harlequin ducks in the watershed include any operations that involve human activities on roads or in suitable habitat. Such activities include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian and instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of disturbing any actively nesting harlequin duck pairs in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of harlequin duck habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall level of disturbance; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, reducing potential disturbance during nesting; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of any harlequin ducks as a result of silvicultural treatments, road management, or other operational activities is expected to be very low. An occasional harlequin duck nest might be destroyed inadvertently as a result of management actions in streamside habitats, but such impacts will likely be rare.

Population-level Effects

Overall, the population effects on the harlequin duck population are expected to be positive. Key stream and adjacent riparian habitat will be protected and improve in quality over the term of the HCP. Continued low levels of human activity in the watershed will minimize the potential for disturbance to nesting pairs. In addition, the landscape connectivity afforded both fish and wildlife using the Aquatic and Riparian Ecosystem in the municipal watershed will also benefit harlequin ducks by increasing potential foraging habitat and food availability, as well as by providing restored and more mature streamside vegetation that should increase the availability of nest sites. The increase of potential foraging, nesting, and brooding habitat in the Cedar River Municipal Watershed provided by the HCP will substantially augment the efforts of state and federal agencies and other organizations to conserve stream, riparian, and forested habitat in the region and especially in the vicinity of the Cedar River watershed. Such efforts are of particular significance in view of the consistently increasing pressure from urbanization and other types of development that is expanding eastward from the Seattle/Tacoma metropolitan areas.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for harlequin ducks are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #14 – Great Blue Heron

Introduction

The great blue heron is present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date. Great blue herons nest in large coniferous or deciduous trees, typically near water, and feed along the edges of lakes, ponds, streams, and wetlands (Section 3.5.6). Great blue herons typically use habitats below the Pacific silver fir zone, at lower elevations, and may sometimes forage many miles from their nesting areas. Potential key habitat for this species in the municipal watershed includes aquatic and riparian habitats, and secondary habitat includes older seral upland forest, which may be used for nesting.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any great blue herons that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury to, or death of, any great blue herons resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting great blue heron pairs. However, any such death, direct injury, or disturbance of great blue herons leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, great blue herons are similar to those described for other species addressed by the HCP that are closely associated with aquatic and riparian habitats. Long-term benefits are expected to accrue to the great blue heron, especially through protection of all streams, open water, wetlands, and riparian habitat and all mature, late successional, and old-growth forest in reserve status, as well as by the recruitment of additional mature and late-successional forest over time. Protection of, and improvements in, water quality (e.g., reduced sediment and lower temperature) and streamside habitat are of particular importance to support foraging and reproduction for this species.

A net gain in the quality and quantity of key and secondary habitat for the great blue heron is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to great blue herons that may use the watershed through: (1) protection of all key aquatic and riparian habitat, including streams, lakes, ponds, wetlands, and riparian forest to support reproduction and foraging; (2) protection of all old growth and recruitment of a substantial amount of mature and late-successional forest over time, increasing the availability of nesting structures (tall trees and snags); (3) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of disturbance, both to habitat and to nesting birds; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests, improving forest and riparian habitat conditions; (5) stream habitat restoration projects, reestablishing more natural stream function and potentially increasing the availability of aquatic prey species; (6) streambank stabilization projects to reduce sediment input to streams; (7) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams; (8) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (9) overall improvements in water quality; (10) removal of 38 percent of watershed roads, reducing the potential for human disturbance; and (11) monitoring and research.

Great blue herons could be negatively affected by silvicultural treatments, road management, or other operational activities in streams and in riparian or upland forested areas. Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat or water quality (e.g., removal of overstory vegetation, increased stream temperature). Great blue herons could also be negatively affected on a short-term basis by any management actions that contribute sediment to streams (e.g., stream restoration projects, silvicultural treatments in riparian areas, and road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for great blue herons are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for the great blue heron within the municipal watershed (aquatic and riparian habitats) is in reserve status. In addition, protection in reserve status of all forested areas of the watershed will result in increased availability of nesting trees for this species.

Major habitat effects on great blue herons are similar, in general, to those described for other species addressed by the HCP that are closely associated with aquatic and riparian ecosystems. Protection of, and improvements in, water quality and streamside habitat are of particular importance for foraging and reproduction in this species. Also important are (1) elimination of timber harvest for commercial purposes within the watershed, (2) stream and riparian restoration projects, (3) reduction of sediment loading to streams, and (4) gradual development of mature, functional riparian forests.

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature and late-successional forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus potentially benefiting great blue herons through population increases of fish and amphibian prey species. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data, and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to help restore and/or enhance aquatic and riparian habitats. Stream bank stabilization, placement of large woody debris, stream bank revegetation, restoration planting and thinning, and ecological thinning in riparian areas are all expected to contribute to accelerated reestablishment of more natural aquatic and riparian ecosystem functions. The reestablishment of more natural aquatic ecosystem function, combined with the development of additional mature and late-successional characteristics in younger second-growth forests, especially in streamside riparian areas, will reestablish a more naturally functioning forest ecosystem throughout the watershed landscape, thereby improving habitat quality and availability for prey species. In addition, more potential great blue heron nest sites will become available as tall trees persist and continue to develop near aquatic habitats.

Some silvicultural treatments in riparian areas could result in short-term negative impacts on streamside habitat and/or water quality. Such impacts may occur, for example, if reduced canopy cover leads to increased solar heating of stream water, or to increased rates of soil erosion. The following measures included in the HCP, however, should eliminate or minimize any short-term impacts of such management activities on habitat for great blue herons or their aquatic prey: (1) no harvest for commercial purposes in riparian or other areas, (2) restriction of the use of mechanical equipment and cutting of trees within 50 feet of streams, and (3) the use of interdisciplinary teams to evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones. As a result, potential impacts to habitat or water quality resulting from removal of vegetative cover will be virtually eliminated. One important set of constraints is that, during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams, no tree removal that has the potential to reduce streambank stability will be allowed, and no tree removal will be allowed within 25 ft of any stream. Also, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas. Following these prescriptions will reduce the rate of sediment loading to aquatic systems, and help maintain high water quality.

Road repair, maintenance, and decommissioning can all impact stream and riparian areas. The comprehensive suite of Watershed Assessment Prescriptions (appendix 16) and other management guidelines (Section 4.2.2), however, are also intended to minimize the probability of erosion and mass wasting associated with roads. Implementing these prescriptions and guidelines, along with the program to improve and decommission roads (Section 4.2.2), will reduce the rate of sediment loading to streams and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads come near streambanks, but improved road maintenance and a lower level of use under the HCP than what occurred historically with commercial timber harvest will help mitigate those impacts.

Both the hydrologic regimes of, and habitat conditions within, many wetlands and other aquatic habitats in the municipal watershed have likely been affected to some degree by past timber harvest, especially removal of all trees near wetlands. This observation indicates that an opportunity exists to improve hydrologic and other habitat conditions, contributing to restoration of the more natural conditions that existed prior to harvest.

By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to open wetland systems, retain forested wetlands, and protect hydrologic recharge areas. Conservation measures of this type will allow wetland communities to maintain and/or reestablish, over time, more naturally functioning hydrologic regimes as part of a naturally functioning forest ecosystem similar to what existed in the watershed before the twentieth century. Any changes in the hydrologic regimes of wetland communities affected by the HCP will be the result of natural processes of forest succession.

Habitat effects related to mature, late-successional, and old-growth forest are generally as described for other species addressed by the HCP that are associated with those habitats. Although old-growth forest (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for great blue herons, especially in riparian corridors, are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section

4.2.2).

Silvicultural treatments including (1) restoration planting of about 1,400 acres, (2) restoration thinning of about 11,000 acres, and (3) ecological thinning of about 2,000 acres, are expected to make habitat conditions more suitable in some second-growth forest by increasing the number of suitable nest trees and by maintaining or improving stream temperatures through better shade conditions over the long term. In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range and all stream corridors, than under current conditions.

As described for the common loon (Group #4) and in Section 4.5.6, operation of the reservoir over the last decade or two, which has entailed higher operating elevations in the spring and summer, has affected and is continuing to affect wetlands of the Rex and Cedar river deltas. This kind of effect on wetlands and adjacent forest is characteristic of reservoirs in general, because of large fluctuations in water levels that can vary from year to year. The City does not expect, although it is possible, that significantly more reduction in the total area of sedge wetlands around Chester Morse Lake will occur, but changes in forest and other vegetation (including willow thickets) around the reservoir, especially in the deltas, can be expected to continue to change as effects on these habitats lag the changes in reservoir operation that initiated the most recent, ongoing shift of vegetative communities. In the near term, further loss of mature trees along the reservoir margin would potentially reduce the availability of nesting sites, although no great blue herons have been known to nest in this area. Operation of Chester Morse Lake and the Masonry Pool during the term of the HCP will be similar to that which occurred in recent years, however, the wetlands and lakeside forests are probably on the way to reaching a new dynamic equilibrium with the current reservoir operating regime over the long term. Natural maturation of riparian forest and silvicultural intervention to accelerate development of natural riparian forest functions should, over the long term, lead to an overall improvement of conditions for potential nesting around the reservoir compared to current and near-term future conditions.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of great blue herons that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of disturbance to any actively nesting great blue herons in the watershed, however, is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of great blue heron habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term. In addition, the City will manage operational activities to minimize disturbance in the vicinity of active rookeries that might decrease nesting success.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of great blue herons as a result of silvicultural treatments, road management, or other operational activities is expected to be very low. While an occasional nest could be destroyed inadvertently as a result of management actions near riparian or aquatic habitats, this is very unlikely because of the high degree of visibility of heron nests (often in colonies), and because site evaluations will be conducted prior to intervention.

Population-level Effects

Population-level effects on the great blue heron are, in general, as described for other species addressed in the HCP that are closely associated with aquatic and riparian habitats. Under the HCP, all key aquatic and riparian habitat will be protected and, overall, is expected to improve in quality over time. Water quality will also improve over time as a result of a reduction of sediment input to aquatic habitats through habitat restoration, improved road maintenance, road improvement projects, substantial road decommissioning, and a reduced level of heavy road use under a policy of no commercial timber harvest. Improvements in water quality and aquatic habitat will likely result in population increases of great blue heron prey populations of fish and amphibians. Any short-term, local impacts to great blue herons resulting from restoration activities in aquatic and riparian areas will be more than offset by long-term, landscape-level benefits. In addition, measures in the HCP that reduce human activity levels will protect any nests in the watershed from human disturbance, increasing the potential for nesting success.

Protection in reserve status of all aquatic and riparian habitats, as well as upland forest, will also improve habitat connectivity, thereby facilitating dispersal and movement of species dependent on aquatic and riparian habitats, including prey of the great blue heron. The substantial degree of habitat protection and water quality and habitat improvement provided under the HCP should thus benefit any nesting great blue herons that may occur in the Cedar River Municipal Watershed. In addition, increases in mature and late-successional forest habitat, especially where closely associated with aquatic systems, should increase the availability of potential nesting areas (with large trees) within the watershed landscape. Overall, the City expects that population-level effects on the great blue heron will be positive.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the great blue heron are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #15 – Osprey

Introduction

Ospreys have been documented to be present and breeding on a consistent basis in the Cedar River Municipal Watershed for at least the past three decades and were likely present prior to this period. Successfully breeding pairs have been documented at several different nest sites within the watershed during recent years. Potential key nesting habitat for ospreys in the watershed includes mature, late successional, and old-growth forests, especially stands providing snags and large trees within a short distance of water bodies that support an adequate prey base (fish). Snags within the reservoir drawdown zone also provide a limited number of potential nesting and perching sites. Potential key foraging habitat includes lakes, the reservoir, and larger rivers and streams.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any ospreys that may nest in the municipal watershed. The likelihood of direct injury to, or death of, any ospreys resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting osprey pairs. However, any such death, direct injury, or disturbance of ospreys leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to the osprey are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests and with aquatic and riparian habitats. Long-term benefits are expected to accrue to the osprey, especially through protection of mature, late-successional, and old-growth forest in reserve status, protection of riparian corridors through reserve status, and the recruitment of additional mature and late-successional forest in the watershed over time by natural processes and by active silvicultural intervention. A net gain of potential nesting habitat for ospreys is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to ospreys that nest and forage in the watershed through: (1) protection in reserve status of all key aquatic and riparian habitat (including lakeshore); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and the likelihood of disturbing nesting activities; (3) protection of all old-growth forest and recruitment of substantial mature and late-successional forest over time, increasing the availability of suitable nesting trees and perch sites; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) retention, creation, and recruitment of large snags through silvicultural treatments, maintaining and increasing the availability of potential nesting and perching sites; (6) protection and improvement of water quality and other habitat conditions for prey species through measures to reduce sediment loading to streams; (7) stream habitat restoration projects, potentially resulting in increased availability of prey fish; (8) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams; (9) passage of all native anadromous fish species above the Landsburg Diversion Dam, when the fish ladders are constructed; (10) changes in management of instream flows under the HCP and other flow-related measures that will improve conditions for fish that are prey of osprey; (11) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and

(12) protection of nesting pairs from human disturbance.

Ospreys could be negatively affected by silvicultural treatments, road management, or other operational activities, especially in riparian areas and upland forests near open water bodies. Such effects could be direct (e.g., through physical injury to or death of individuals) or indirect, through influences on habitat or behavior, such as direct destruction of active nests, removal of potential nest trees, alteration of habitat structure, or disturbance leading to nest abandonment. Ospreys can also be negatively affected by management activities (such as silvicultural treatments and road construction, maintenance, and use) that contribute sediment to streams, thereby reducing water quality and potentially affecting populations of prey fish.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the osprey are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

The general habitat requirements of the osprey and the bald eagle (Group #9) are very similar, with the exception that eagles use stream corridors more extensively for foraging, rely on carrion seasonally as a food resource, and roost communally during winter. Therefore, the beneficial and detrimental effects of the HCP on habitat are considered generally to be the same or similar for ospreys as for bald eagles.

Because no commercial timber harvest will be conducted in the municipal watershed, all forests outside limited developed areas are in reserve status. As a result, all key habitat (lakes and streams for foraging and mature to old-growth forest for nesting), as well as potential habitat, for the osprey within the municipal watershed is protected.

Major habitat effects on the osprey are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests and with aquatic and riparian habitats. Although old-growth forest (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for the osprey are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape than under current conditions.

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, with greater overall potential for utilization by ospreys. In order to estimate how the relative amount of older forest age classes will change in “riparian” forest over the 50-year term of HCP, “riparian” zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

In addition, under the HCP, some potential osprey habitat in the municipal watershed is expected to benefit from management actions (ecological thinning and restoration) intended to produce mature and late-successional forest habitat characteristics in second-growth forests (Section 4.2.2).

The HCP also includes management actions intended to restore and enhance aquatic and riparian habitats. These actions are intended to improve fish habitat, thereby also improving foraging conditions for ospreys over time. Stream bank stabilization projects, placement of large woody debris, a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas is expected to help accelerate (1) the restoration of natural aquatic and riparian ecosystem functioning and (2) the development of mature or late-successional forest characteristics in younger seral-stage forests in riparian areas (Section 4.2.2).

Silvicultural treatments in riparian areas may result in short-term negative impacts on streamside habitat and/or water quality. No commercial timber harvest will occur in the watershed, however, and, in order to eliminate or minimize any short-term impacts to osprey habitat, mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones. One important set of constraints is that during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams and no tree removal with the potential to reduce streambank stability will be allowed within 25 feet of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions and other management guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines is expected to help reduce the rate of sediment loading to aquatic systems, and help maintain and improve water quality.

Road construction, repair, maintenance, and decommissioning can all impact stream and riparian areas. The HCP includes a comprehensive suite of Watershed Assessment Prescriptions and other management guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with roads, however. Following these prescriptions and guidelines, along with the program to improve many roads and to decommission about 38 percent of existing roads (Section 4.2.2), will reduce the rate of sediment loading to aquatic systems and maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads are adjacent to streambanks, but improved road maintenance under the HCP will help mitigate those impacts.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance to, and possibly the equivalent of take of, ospreys that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following:

(1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian and instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of disturbing any actively nesting ospreys in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active osprey nest sites from human disturbance, partly through the use of site evaluations and interdisciplinary teams prior to silvicultural or road management activities, and through management of operational activities to minimize disturbance in the vicinity of active osprey nest trees; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities, and thus the chance of disturbance of nesting pairs; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term. If identified, no active or historically active nest trees will be cut, except in unique circumstances when human safety considerations or the protection of facilities in limited developed areas are of substantial or regulatory concern.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of any ospreys as a result of silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

Population-level effects on the osprey are, in general, as described for other species addressed by the HCP that are associated with mature, late-successional, and old-growth forest, with the addition of this species' closer association with aquatic habitats for foraging. Under the HCP, all key forested and aquatic habitat will be protected and improved in quality over time. In addition, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP, as no additional commercial harvest will be conducted. The total amount of late-seral forest habitat (over 80 years old) is expected to increase by a factor of nearly five. Protection in reserve status of all key riparian, aquatic, and forested habitat will create a system of forested corridors adjacent to rivers and streams for the dispersal and movement of organisms dependent on aquatic and riparian habitats, as well as large areas of older forest in uplands interspersed between stream systems. The increase in habitat connectivity and maturation of second-growth forest is expected to benefit the osprey population by providing potential nesting and foraging habitat throughout the landscape of the Cedar River Municipal Watershed.

Other Effects

Two groups of measures will benefit osprey by improving habitat conditions for fish that are prey of osprey or by otherwise increasing prey populations. Increased production of anadromous fish will mean increased availability of prey, and construction of fish passage facilities at the Landsburg Diversion Dam will extend the availability of live anadromous fish into the municipal watershed. The HCP provides for the passage of all native species of anadromous fish upstream of the Landsburg Diversion Dam into a 12.5-mile reach of the mainstem of the Cedar River and into additional smaller tributaries, substantially adding to spawning and rearing habitat, and increased production of sockeye salmon downstream of Landsburg through operation of a hatchery (Section 4.3.2).

Improvements in instream flows under the HCP will increase habitat capacity of the Cedar River, flow downramping protection under the HCP will reduce mortality of juvenile fish, funding for habitat protection and restoration downstream of Landsburg will increase habitat quality and quantity, and funding for improvements at the Ballard Locks will increase survival of smolts passing from Lake Washington to Puget Sound (Section 4.4.2).

If fish populations in the reservoir were to be affected by the changed instream flow regime under the HCP, the prey base for ospreys using the reservoir could be affected. However, such changes are expected to be minor and offset by improvements in rearing and spawning habitats in tributaries to the reservoir.

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the osprey are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #16 – Willow Flycatcher

Introduction

The willow flycatcher is present and is known to breed in the Cedar River Municipal Watershed. Potential key habitat for the willow flycatcher in the municipal watershed includes ponds, wetlands, riparian areas, persistent shrub communities, natural forest openings, and meadow complexes, primarily within the western hemlock zone, at lower elevations. The flycatchers will use very small wetlands or wet shrubby areas included in conifer forests, but mid- to late-seral forests themselves provide only “adequate” habitat (Smith et al. 1997). They also use the grass-forb and open canopy stages of forest succession, including clearcuts (Smith et al. 1997).

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any willow flycatchers that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any willow flycatchers resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting willow flycatcher pairs. However, any such death, direct injury, or disturbance of willow flycatchers leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to willow flycatchers that may use the watershed, primarily through: (1) protection through reserve status of all key stream, pond, and wetland habitat, all wetland complexes (includes forested area), all persistent shrub communities, and all riparian habitat; (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and the likelihood of disturbing nesting activities; (3) restoration and enhancement of aquatic and riparian habitats (restoration planting, restoration thinning, and ecological thinning in riparian areas) designed to help accelerate the development of a naturally functioning aquatic and riparian ecosystem; (4) removal of 38 percent of watershed roads, reducing the level of human disturbance; (5) monitoring and research; (6) protection of known nesting pairs from human disturbance; and (7) closure of the watershed to unsupervised public access, reducing potential disturbance near nests.

The willow flycatcher could be negatively affected by silvicultural treatments, road management, or other operational activities in or near key habitat (e.g., wetlands and riparian areas). Such effects could be direct (e.g., through destruction of active nests or injury to individuals) or indirect, through influences on habitat (e.g., removal of overstory) or disturbance. The loss of early seral habitat created artificially by commercial timber harvest could reduce the carrying capacity of the watershed for willow flycatchers, although the future landscape will develop into one more similar to the natural landscape to which this species is adapted.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the willow flycatcher are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas are in reserve status. As a result, all key habitat for the willow flycatcher within the municipal watershed is protected through reserve status. No appreciable changes in acreage of potential key habitat for willow flycatchers will occur under the HCP, but the quality of some habitats may improve, and the habitats may develop more natural characteristics as forest adjacent to open habitats matures. In addition, overall habitat quality for the willow flycatcher is expected to improve through the decrease in human activity throughout the watershed, through the protection of naturally open habitats whenever watershed operations are conducted nearby, and through active intervention to help restore natural habitat function and quality. Some short-term and long-terms gains in the quality of wetlands and some other types of open habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest adjacent to these habitats, and silvicultural intervention. Silvicultural treatments designed to help restore natural riparian habitat functions could result in an increased diversity, and possibly abundance, of insect prey for willow flycatchers.

Willow flycatchers also forage in some early seral forest habitats. As a consequence of eliminating timber harvest for commercial purposes, however, the overall amount of early seral forest habitat in the watershed is expected to decrease over the term of the HCP. Early seral forest habitat will be created largely by natural processes, such as windstorms and disease, and several decades from now is likely to be in patches smaller than those present today. The overall landscape in the municipal watershed, however, will be more similar to the natural landscape to which the willow flycatcher is adapted within this region. It should be noted also that considerable amounts of early seral forest habitat created by commercial timber harvest will likely be available in many areas adjacent to the watershed.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance to, and possibly the equivalent of take of, willow flycatchers that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbing any actively nesting willow flycatcher pairs in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active willow flycatcher nest sites from human disturbance, partly through the use of site evaluations and interdisciplinary teams prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any willow flycatchers resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

It is possible that the projected decrease in the acreage of early seral-stage habitats in the municipal watershed over the 50-year HCP term will reduce the carrying capacity of the watershed for the willow flycatcher. Availability of key habitat (wetlands, riparian areas, persistent shrub communities, and meadow complexes) will not change appreciably, although habitat quality should increase. Because considerable areas of clearcuts can be expected to be available on nearby private timberlands, it is unlikely that the elimination of commercial timber harvest in the watershed will have a negative effect on regional populations of this species, particularly in view of the measures in the HCP to reduce human disturbance levels and the development of a more natural landscape. Rather, the

50-year commitments in the HCP should produce an overall population benefit for the willow flycatcher in the long term. Given that about 65 percent of the 90,546-acre municipal watershed is below an elevation of 3,000 ft and that a more natural habitat distribution will develop across the watershed landscape during the term of the HCP, it may be that the municipal watershed is particularly important for willow flycatchers on a regional basis, especially in view of the current and expected high rate of development of lands at lower elevations in the Puget Sound region.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the willow flycatcher are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #25 – Northern Water Shrew, Masked Shrew

Introduction

Both the northern water shrew and masked shrew are present in the Cedar River Municipal Watershed. The masked shrew occurs at all elevations in the Cascades in riparian and other forest types, as well as alder and willow thickets, and prefers moist conditions with abundant plant cover, thick leaf litter, and decaying logs (Kurta 1995; Johnson and Cassidy 1997). The northern water shrew is associated with cold, clear water in small streams, ponds, and forested wetlands with abundant cover (Johnson and Cassidy 1997). Potential key habitat for both species in the municipal watershed is considered to include streams, ponds, wetlands, and riparian areas, and in addition for the masked shrew, mature, late-successional, and old-growth forest.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect the two species of shrews in Group #25 that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury to, or death of, any Group #25 shrews resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury of Group #25 shrews would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the northern water shrew and masked shrew are generally as described for other species addressed by this HCP that are closely associated with streams, wetlands, riparian habitats, and mature, late successional, and old-growth forest. Long-term benefits are expected to accrue to the Group #25 species, especially through protection in reserve status of all wetlands, streams, and riparian habitat, and all mature, late successional, and old-growth forest, as well as the recruitment of additional mature and late-successional forest over time. The HCP is expected to result in both short- and long-term benefits to the Group #25 shrews through: (1) protection of all key streamside and wetland habitat; (2) protection of all existing forested habitat in reserve forest status, facilitating dispersal of individuals of both species, providing key habitat for masked shrews, and serving to protect all streams, ponds, and wetlands; (3) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and the likelihood of disturbing individuals during breeding and non-breeding seasons; (4) natural maturation of second-growth forests into mature and late-successional seral stages, potentially promoting conditions which would facilitate dispersal for both species and improving habitat for masked shrew; (5) stream restoration and bank stabilization projects, improving streamside cover and potentially improving water quality; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (8) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, also improving habitat conditions on the forest floor (long term) and facilitating dispersal; (9) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying organic debris to the forest floor on both a short- and long-term basis; (10) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; and (11) monitoring and research, with monitoring of benthic invertebrates of particular relevance for northern water shrew .

Group #25 species are susceptible to impacts from silvicultural treatments, road management, or and other activities in riparian areas, and operations that deliver sediment to streams. Such impacts could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory). Group #25 species could also be negatively affected by management activities that contribute sediment to streams (stream habitat restoration projects, silvicultural treatments in riparian areas, road construction, maintenance, use, and decommissioning), thereby reducing water quality.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the northern water shrew and masked shrew are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forest outside limited developed areas, is in reserve status. As a result, all key habitat for the Group #25 shrews within the municipal watershed (streams, ponds, wetlands, riparian habitat, and mature, late-successional and old-growth forests) is in reserve status. In addition, silvicultural activities are restricted within 50 feet of streams to minimize the potential for habitat impacts or disturbance to key wildlife species, including harlequin ducks.

Major habitat effects on the Group #25 shrews are similar, in general, to those described for other species addressed by the HCP that are associated with aquatic and riparian habitats and with mature, late successional, and old-growth forest. Protection of, and improvements in, water quality and aquatic habitat are of particular importance for the northern water shrew. Protection in reserve status of all forested areas of the watershed, including riparian corridors, will facilitate dispersal for both of these species.

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, with greater overall potential for utilization by these shrews. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to help restore and enhance aquatic and riparian habitats, including measures that will improve habitat conditions for invertebrate prey of Group #25 shrews. Stream bank stabilization projects, placement of large woody debris (LWD), a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas are expected to help (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Other provisions in the HCP, including, road decommissioning (removal), road improvements, improved road maintenance, and limitations on activities near streams, will also foster reestablishment of naturally functioning hydrologic regimes within the landscape of the Cedar River Watershed. Restoration of a naturally functioning aquatic ecosystem will benefit the Group #25 shrews over the long term. However, over the short term, these management interventions may cause some localized decline in habitat function. Site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in the watershed to ensure that habitat for Group #25 shrews will be minimally impacted.

Silvicultural treatments in riparian areas may result in negative impacts on streamside habitat and/or water quality. Such impacts may occur if vegetation canopy cover is reduced to an extent that leads to increased rates of soil erosion or increased solar heating of stream water. No commercial timber harvest will occur in the watershed, however, and, in order to eliminate or minimize any short-term impacts to habitat of Group #25 shrews, mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones. One important set of constraints is that during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams and no tree removal that has the potential to reduce streambank stability will be allowed within 25 ft of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will reduce the rate of sediment loading to aquatic systems, and help maintain and improve water quality.

Road construction, repair, maintenance, and decommissioning can all affect stream and riparian areas. The Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) are intended to minimize the probability of erosion and mass wasting associated with roads. Following these prescriptions and guidelines, along with the program to improve and decommission roads (Section 4.2.2), will reduce the rate of sediment loading to aquatic systems and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads are adjacent to streambanks, but improved road maintenance under the HCP will help mitigate those impacts.

Major habitat effects on Group #25 shrews are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests or with aquatic and riparian habitats. Although old-growth forest, by definition, will not increase in extent under the HCP, substantial increases in the quantity and quality of mature and late-successional coniferous forest that is key habitat for the masked shrew and dispersal habitat for the northern water shrew are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range, than under current conditions.

In addition, under the HCP, some potential key habitat for masked shrew and dispersal habitat for the water shrew in the municipal watershed is expected to benefit from management actions, such as ecological thinning and restoration, that are intended to produce mature and late-successional forest habitat characteristics in second-growth forests (Section 4.2.2). To minimize local, short-term habitat impacts of silvicultural activities in upland forests, the HCP also includes management guidelines (Section 4.2.2).

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in direct take of Group #25 shrews in the watershed include any operations that involve human activities on roads or in suitable habitat. Such activities include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian and instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research. Occasionally, dispersing individuals of these shrew species might be injured or killed inadvertently by management activities in upland or riparian areas, or by vehicles on watershed roads.

The likelihood of direct take occurring at a level which may compromise the viability of any Group #25 species populations in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Group #25 species habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing shrews; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road construction, maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of silvicultural treatments, road management, or other operational activities in riparian areas is expected to be very low in any given year. Occasionally, dispersing individuals of these shrew species might be injured or killed inadvertently by management activities in upland or riparian areas, or by vehicles on watershed roads. Masked shrews, which occur in more upland forest habitats than do northern water shrews, might occasionally be injured or killed by management actions in the upland parts of the watershed, but such impacts would be more than offset by long-term habitat improvements.

Population-level Effects

Population-level effects on the masked shrew and northern water shrew populations are, in general, as described for other species addressed by the HCP that are associated with streams and riparian habitats and with mature, late successional, and old-growth forest. Key stream, wetland, pond, riparian, and upland forest habitat will be protected and improved in quality. Any short-term, local impacts to these species from restoration activities in riparian or other areas will be more than offset by long-term, landscape-level benefits. Increases in mature and late-successional forest habitat will facilitate dispersal of these species within the watershed, and allow the watershed to serve as a population source for Group #25 species in the region. The City believes that the HCP will have an overall positive effect on the regional Group #25 shrew populations.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for harlequin ducks are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #29 – Pacific Lamprey, River Lamprey

Introduction

Pacific and river lampreys are widely distributed along the Pacific Coast. While these species are generally considered to be anadromous, some landlocked populations of Pacific lampreys are known to exist (Wydoski and Whitney 1979; ODFW 1996). The life cycles of the anadromous river and Pacific lampreys involve spawning in coastal rivers or streams and extended rearing in freshwater habitat prior to migration to sea.

No comprehensive surveys to determine the presence or absence of Pacific or river lamprey have been conducted within the Cedar River Watershed and no incidental observations of either species have been documented to date upstream of Landsburg. River lamprey have been observed in the Cedar River system downstream of Landsburg and Pacific lamprey have been observed at the Ballard Locks. There has been one report of a dead Pacific lamprey found below Landsburg Dam. It is possible that both species are currently able to pass above the Landsburg Diversion Dam, as a variety of lamprey species are known to pass beyond barriers that other fishes cannot pass. For the purposes of this effects analysis, the City assumes that both species are in the Cedar River system and will pass above Landsburg when the fish ladders are in place; however, the number of lamprey, if any, that will pass above Landsburg is uncertain.

Both of these lamprey species enter coastal rivers and streams to spawn. Adults may spend extended time in freshwater prior to spawning without feeding. Juvenile lampreys, called ammocoetes, live in depositional areas containing fine material for extended periods prior to migrating to the ocean. The quality of stream habitat for spawning lampreys depends on water temperature, water quality, and habitat complexity, which in turn depends, in part, on the condition of riparian vegetation. Potential key habitat for these species includes low- to moderate-gradient streams with small-sized gravel for spawning and sandy or muddy bottom depositional areas with slow to moderate velocities for rearing, along with riparian areas associated with these streams within the municipal watershed.

The combination of mitigation and minimization measures committed to in the HCP for watershed management is expected to protect lamprey within the municipal watershed (Section 4.2.2). Additional benefits will be provided by the instream flow regime (Section 4.4.2), funding for protection and restoration of habit downstream of Landsburg (Section 4.4.2), and construction of fish passage facilities at Landsburg (Section 4.3.2). The likelihood of direct injury to, or death of, any lamprey resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. Some lamprey larvae, however, could be injured or killed during cleaning operations for the water intake forebay at Landsburg or by impingement on the water intake screens. Any such death or direct injury of lamprey would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The mitigation and minimization measures committed to in the HCP are expected to maintain the natural processes important for creating and maintaining habitat for lamprey in the watershed. The HCP is expected to result in short- and long-term benefits to lamprey as compared to the current conditions by implementing or providing:

(1) construction of fish passage and protection facilities at the Landsburg Diversion Dam;

(2) implementation of guaranteed and supplemental instream flows, protecting and providing habitat in the Cedar River below the Masonry Dam;

(3) funding for habitat protection and restoration downstream of Landsburg;

(4) funding to improve survival of adults passing through the Ballard Locks to Puget Sound;

(5) adaptive management of river flows, though the Cedar River Instream Flow Oversight Commission;

(6) protection of all key habitat in the municipal watershed (streams and associated riparian habitat between lower Cedar Falls and Landsburg);

(7) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance;

(8) protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with streams and helping to restore natural ecological functions in riparian forests;

(9) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests;

(10) stream restoration projects, which are expected to improve microhabitat conditions in many reaches;

(11) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats;

(12) guidelines and prescriptions designed to reduce anthropogenic sediment production during watershed management activities; and

(13) monitoring and research.

Either lamprey species could be negatively affected by impingement on water intake screens at Landsburg, cleaning of the forebay at the Landsburg water supply intake, silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect streams in the lower municipal watershed. Such effects could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Lamprey could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and road decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Pacific and river lamprey are detailed in the sections 4.2.2, 4.3.2, 4.4.2, and Section 4.5.6, and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Passage above the Landsburg Diversion Dam will provide improved access for Pacific and river lampreys to approximately 17 miles of stream habitat (mainstem and tributary) that will be protected and restored under the Watershed Management Mitigation and Conservation Strategies (Section 4.2.2). Several tributary streams enter the Cedar River between Lower Cedar Falls and Landsburg that provide low-gradient habitat conducive to lamprey spawning and larval rearing. Improved access is expected to provide the opportunity for increased long-term natural production of these species in the municipal watershed and result in an overall net increase in habitat available to anadromous lampreys. While it is presently possible that some individuals ascend the diversion dam, the installation of fish passage facilities is expected to improve access and increase the number of lamprey that may reach habitat as far up the Cedar River as lower Cedar Falls. Lampreys are known to ascend fish ladders built for salmon in the Columbia River (Fitzpatrick et al. 1996).

The HCP includes additional provisions that will enhance conditions in the Cedar River for Pacific and river lamprey. These provisions include: (1) proposed guaranteed flows and change of flow compliance point (Section 4.4.2); (2) flow downramping standards to protect juvenile fish from stranding (Section 4.4.2); (3) funding for habitat restoration projects, potentially including construction of groundwater-fed spawning channels and/or the purchase or protection of lands near the river downstream of Landsburg (Section 4.4.2); (4) construction of fish passage and protection facilities at the Landsburg Diversion Dam; and (5) watershed management mitigation and conservation measures that would benefit Pacific and river lamprey once fish passage is restored. These measures are expected to provide immediate protection of Pacific and river lamprey habitat and provide opportunity for increased production in the basin.

Habitat Effects Related to Instream Flow Management

Instream flow regimes under the HCP will further protect Pacific and river lamprey by providing assurances that flows throughout the majority of the reach between Lake Washington and Lower Cedar Falls would be equal to or greater than the levels provided by the existing WDOE IRPP recommended flows for most of the year (Section 4.4). Because Pacific or river lamprey spawn in winter and spring, the elements of the instream flow regime designed to protect the redds of salmon and steelhead that spawn in shallower areas near the river margin from dewatering will also afford protection to any lamprey eggs and larvae that may occur in these areas.

In addition, as part of the proposed instream flow management regime, the compliance point of stream flow will be moved approximately 20 miles upstream near the Landsburg Diversion Dam (Section 4.4). Because of this change, flows will remain higher downstream of Landsburg as a result of groundwater and surface water inputs that occur downstream of the measurement point. The change in the location of the measurement point will also allow flows to fluctuate in a more natural manner in the lower river.

The City is anticipating no alterations in its flood management practices as a result of the HCP. Consequently, the City anticipates little or no change in the magnitude, frequency, duration, or timing of peak flow events. Channel forming processes associated with these peak flows serve to maintain silt and sand laden backwaters and quiet eddies near the stream margins or in off-channel areas, habitat typically used by larval lampreys of both species for rearing (Wydoski and Whitney 1979).

Larval Pacific lamprey remain in the stream environment for from 4 to 6 or 7 years before beginning their transformation to the parasitic adult stage (Close et al. 1995). The length of the river lamprey larval period is unknown (Scott and Crossman; 1979). This long freshwater larval period is of particular concern with regard to instream flows and facility operations. During the larval phase, lamprey may move from place to place within the same mud habitat or migrate downstream to another area of the stream (Close et al. 1995). The mechanisms that cue larvae to relocate and the rate at which they can respond to these cues are poorly understood, but larvae are known to respond to low oxygen levels by leaving their burrows (Potter 1980; Hardistry and Potter 1971).

Habitat Effects Related to Funding for Downstream Habitat

The lower Cedar River downstream of the Municipal Watershed has been severely impacted by urbanization and other development, channel modifications, and riparian zone disturbance (King County 1998). It is likely that the confined nature of much of this reach has resulted in a significant loss of backwaters and quiet eddies with areas of mud and silt substrate suitable for lamprey larvae rearing. Mainstem and side-channel habitat quantity and quality have been reduced substantially compared to original conditions in the lower river, largely by land management actions beyond the control and responsibility of the City.

The HCP provides $4.6 million for habitat protection and improvement downstream of Landsburg, which could include construction of groundwater-fed spawning channels and the protection and/or purchase of lands adjacent to the river or its tributaries. New groundwater-fed channels and connected ponds would result in benefits to both Pacific lamprey and river lamprey. These areas would provide perennial habitat protected from channel scour associated with peak flows in the main channel of the Cedar River.

Habitat Effects Related to Mitigation for the Landsburg Diversion Dam

Insofar as Pacific or river lampreys have difficulty crossing the Landsburg Diversion Dam when migrating upstream, construction of fish passage facilities at Landsburg will substantially increase the availability of protected, high quality habitat for spawning adults and larvae. Passage over the Landsburg Diversion Dam would increase river miles of mainstem habitat available to lamprey by 55 percent, and, according to the Washington stream catalog, an additional 17 stream miles of habitat (mainstem and tributary) would become available overall. Given the ability of lampreys to ascend barriers, even more than this 17 stream miles may be accessible to Pacific and river lampreys.

Habitat Effects Related to Land Management in the Municipal Watershed

The effects of past land management in the municipal watershed have included (1) removal of riparian forest during timber harvest, reducing shading, the supply of food (invertebrates) to streams, and recruitment of large woody debris; and (2) construction and use of hundreds of miles of forest roads, which has increased sediment loading to streams through erosion and mass wasting (landslides). The current, disturbed condition of the majority of aquatic and riparian habitats in the municipal watershed presents opportunities for habitat rehabilitation and, over the long term, restoration of the natural ecological functions of the aquatic/riparian ecosystem.

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for Pacific or river lamprey within the municipal watershed (i.e., streams and associated riparian habitat in the lower watershed) is protected through reserve status. In addition, protection in reserve status of *all* forested areas of the watershed will decrease the likelihood of land management activities adversely affecting Pacific or river lamprey. In the short term, these species will benefit by increased levels of habitat protection and by active intervention to increase habitat complexity, such as through projects to add large woody debris to streams deficient in habitat structure, which would create pools that could be used by larvae. In the long term, Pacific and river lamprey will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements, such as pools, that are important to these species.

The City believes that instream habitat improvement and rehabilitation must be accompanied by upslope protection and restoration that will reduce impacts of upslope conditions or activities on stream habitat. For example, efforts to stabilize stream banks or add large woody debris to streams may not be effective in the long run if road failures occur that result in large inputs of coarse sediment to streams upstream of such projects. Thus, these kinds of activities will be coordinated under the HCP.

While reduction of anthropogenic sediment input to streams could reduce the amount of artificially created habitat for lamprey larvae, which use mud and fine sediment, actions to bring these inputs to more natural levels would help restore an aquatic/riparian ecosystem more similar to that to which Pacific and river lamprey are adapted. Furthermore, such restoration efforts should serve to improve the quality of habitat for spawning adults.

Short-term and long-term gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams in the lower municipal watershed, as well as protecting all wetlands, and their recharge areas, associated with streams. Maturation of protected forest in riparian forests near streams will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, creation of more pools, increases in food production for fish, and cooler water temperatures.

The HCP also includes active intervention designed to improve and help restore aquatic and riparian habitats, including stream bank stabilization projects; placement of large woody debris (LWD); a stream bank revegetation program; a program of restoration planting, restoration thinning, and ecological thinning in riparian areas; a program to eliminate, modify, or replace stream-crossing culverts that could impede the passage of lamprey using tributaries, restoring habitat connectivity and continuity; a program to eliminate, modify, or replace stream-crossing culverts that are inadequate for passing peak storm flows, reducing the chance of failure and resulting excessive sediment deposition in downstream habitat; programs to improve problem roads and the maintenance of roads that can affect streams, in both cases to reduce sediment loading to streams associated with erosion and mass wasting; and a program to decommission (remove) about 38 percent of forest roads, further reducing sediment loading to streams.

Collectively, these conservation and mitigation measures should (1) help restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Although restoration of a more naturally functioning aquatic ecosystem will benefit Pacific and river lamprey over the long term, some of these management interventions may cause some localized, short-term decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion, or disturbance of soils that could result in erosion and sediment release into streams.

Because, no harvest for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to undertaking such activities in riparian areas will also help minimize any such impacts on Pacific and river lamprey. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitat for Pacific and river lamprey.

Because many of the types of habitat rehabilitation and restoration measures included in the HCP are experimental, monitoring within the context of adaptive management is essential to the long-term success of these efforts (Section 4.5.7). The HCP includes two types of monitoring relevant to these efforts (Section 4.5.4): (1) long-term monitoring of stream habitat quality, to detect trends, and (2) monitoring of specific aquatic and riparian restoration projects, to provide feedback on the adequacy of project designs. Interdisciplinary teams will be involved in the design and monitoring of restoration projects.

Disturbance Effects and Direct Take

Operation of facilities has inherent potential to affect lamprey that may pass near such facilities or use nearby habitats. The City acknowledges that limited information exists on specific habitats used by larval lamprey in the Cedar River Basin and the rate at which larval lamprey can adjust to changes in river stage. Maintaining stream flows over silt and sand deposits associated with backwaters and off-channel areas could minimize the need of larvae to relocate. To provide additional flexibility in managing stream flows for the benefit of fish, including lamprey, the Instream Flow Agreement (Appendix 27) provides the opportunity for the Cedar River Instream Flow Oversight Commission to advise the City in managing available flows that are over and above guaranteed levels. Once Pacific and river lamprey are able to cross the Landsburg Diversion Dam during upstream migration, if they cannot do so now, any potential effects of management of the municipal watershed would apply to these species.

Disturbance effects could thus occur under the HCP in three ways: (1) through operation of the Landsburg diversion facilities, (2) through management of instream flow levels, and (3) through land management in the municipal watershed.

Disturbance Effects Related to Operation of Landsburg Diversion Facilities

Fine sediments accumulate in the concrete-lined forebay adjacent to the Landsburg Diversion Dam that is associated with the water intake, and this material must be removed annually in order to maintain proper facility operation and ensure drinking water quality. The process of removing this material requires lowering the water elevation at Landsburg Dam, and thus the level of the ponded inundation zone upstream, and draining the forebay. This is done at a maximum rate of stage change in river flow during both the forebay draining and refill operations of +/-0.25 feet per hour. The entire operation is normally completed in 48 hours. During cleaning operations, accumulated sediment is mechanically removed and any larval lampreys that have not left the forebay before draining would be destroyed. Losses, if any, would be influenced by the number and behavior of larval lamprey using the forebay area. It should be noted, however, that any lampreys using sediments in the forebay would be using artificially created habitat that would not be present were the facilities absent.

Also, during normal operation, inundation from the Landsburg Dam typically extends upriver for approximately 3000 ft, the reach within which silt and other fine materials settle out on the channel bottom, creating habitat for larval lamprey. The portion of this reach still retaining run-of-the-river flow (during and after downramping) may provide refuge for larval lamprey displaced from substrates exposed along the river margin during the forebay cleaning process, and this habitat may also add to the amount to fine sediment habitat available naturally for Pacific and river lamprey. Should lamprey larvae be present within this reach during cleaning, the City believes that losses from desiccation may be minimal, because of the short period of time and the time of year the substrate would be subject to exposure. Forebay cleaning typically occurs in February or March, when air and water temperatures are relatively cool and precipitation is received frequently. Since juvenile lamprey may be present year around, this timing reduces the risk to the juveniles compared to warmer and drier periods of the year.

Some lamprey larvae could also be injured as a result of impingement on the water intake screens at Landsburg. Improvements for fish protection, however, include new screens designed to minimize such impacts (Section 4.3.2).

Because of the installation of new fish screens committed to in the HCP and the habitat conditions discussed above that are related specifically to the Landsburg Diversion Dam, the City does not believe that disturbance to, direct injury to, or death of individuals as a result of the City's water supply operation will have any effects on Pacific or river lamprey with population-level consequences.

Disturbance Effects Related to Instream Flows

Rapid downramping of stream flows in the mainstem of the Cedar River as a result of City water supply and hydroelectric operations could strand Pacific and river lamprey larvae in shallow areas, particularly along stream margins, potentially resulting in death of some individuals from high temperature or dehydration, to the extent that those individuals could not move back into flowing water. The HCP will moderate the rate at which instantaneous stream flow could be reduced by the operations of the City's water supply and storage facilities. This moderation would decrease the risk of stranding larval lamprey, as well as fry and juveniles of other species (see Section 4.4.2). A recent analysis of the frequency and magnitude of instream flow changes on the Cedar River suggests that significant downramping events can now occur quite frequently during normal operations (Section 3.5.10). Prior to the HCP, no formal downramping criteria were used to guide flow control operations.

Because of the above mitigation and minimization measures committed to in the HCP, the City believes the likelihood of disturbance to, direct injury to, or death of individuals as a result of flow downramping operations is expected to be very low in any given year.

Disturbance Effects Related to Land Management in the Municipal Watershed

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of Pacific and river lamprey that may occur in the municipal watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use. It should be noted that only a portion of each of the above activities will occur within the lower municipal watershed.

The likelihood of direct take of Pacific and river lamprey from land management activities is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Pacific and river lamprey habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential disturbance overall; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individual Pacific or river lamprey as a result of silvicultural treatments, road management, or other operational activities in streams and associated riparian areas is expected to be very low.

Population-level Effects

For several reasons, the City believes that the HCP will have an overall positive effect on Pacific and river lamprey populations over the long term. The following measures included in the HCP should have positive impacts on populations of Pacific or river lamprey: (1) higher guaranteed instream flows, and flexibility to manage supplemental flows to benefit anadromous species; (2) downramping controls on instream flows, to reduce the chance of stranding; (3) improved access to high quality habitat above Landsburg; and (4) funding for habitat protection and improvement in the Cedar River Basin below Landsburg. While some losses of lampreys may occur during annual forebay cleaning, the extensive habitat available to lamprey in the Cedar River from Lake Washington to lower Cedar Falls (34 miles of stream) makes it unlikely that the losses will be significant to the population of either Pacific or river lamprey.

The HCP also provides a number of distinct benefits to Pacific and river lamprey as part of the Watershed Management Mitigation and Conservation Strategies (Section 4.2), including protection of key habitat through reserve status, improvements and substantial decommissioning of forest roads, and restoration of stream and riparian habitats over the long term to more natural conditions (see above). Any short-term, local impacts to Pacific and river lamprey from these restoration activities in streams and riparian areas will be more than offset by long-term, landscape-level benefits. Increases in the quantity and quality of accessible habitat, in both stream and riparian areas, will benefit Pacific and river lamprey populations in the municipal watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Pacific or river lamprey are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #30 – Kokanee

Introduction

Kokanee, the land-locked form of sockeye salmon, typically occur in deep, cool freshwater lakes. Adults spawn in tributaries to these lakes, and fry return, upon emergence, to mature over a period of about 4 years (Section 3.6.2). Their spawning requirements are similar to those of sockeye salmon, except that, because they are smaller fish, kokanee prefer relatively smaller-sized gravels for spawning. Some kokanee in Lake Washington have been known to spawn in gravel along parts of the lakeshore.

Kokanee have recently been documented in Walsh Lake, and spawning activity has been confirmed in Webster Creek, the main tributary to Walsh Lake (Appendix 23). It is unknown whether this population is native to the lake or is the result of plant(s) sometime during the last several decades. Although kokanee were not collected during a 1977 University of Washington fish survey (Congelton et al. 1977) and were not mentioned in water quality reports from the 1920s, the sampling methods in these efforts may not have been satisfactory to support a conclusion that kokanee were absent at those times.

The quality of stream habitat for spawning kokanee depends on water temperature, water quality, and habitat complexity, including availability of pools, substrate structure, and cover (e.g., woody debris). Such habitat conditions depend, at least in part, on the condition of riparian vegetation and the extent of sediment loading from anthropogenic sources. Potential key habitat for kokanee in the municipal watershed include Walsh Lake and its tributaries, as well as riparian habitat associated with the lake and its tributaries.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any kokanee within the municipal watershed. The likelihood of direct injury to, or death of, any kokanee resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. Any death or direct injury of kokanee would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The mitigation and minimization measures committed to in the HCP are expected to maintain the natural processes important for creating and maintaining habitat for kokanee in the watershed. The HCP is expected to result in short- and long-term benefits to kokanee as compared to the current conditions by implementing: (1) protection of all key habitat (Walsh Lake and its tributaries, and associated riparian habitat); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance; (3) protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with the Walsh Lake and its tributaries; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) stream restoration projects, which are expected to improve microhabitat conditions within the Walsh Lake subbasin; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research.

Kokanee could be negatively affected by silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect Walsh Lake or its tributaries. Such effects could be direct (e.g., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Kokanee could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the kokanee are detailed in the Section 4.2.2 and Section 4.5.6, and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Lands within the upper portion of the Walsh Lake Basin, including land around and above the lake, are owned completely by the City. Any effects of the HCP on kokanee habitat within the municipal watershed would be associated with land management. The effects of past land management in the municipal watershed have included: (1) removal of riparian forest during timber harvest, reducing shading, the supply of food (invertebrates) to streams, and recruitment of large woody debris; (2) construction and use of hundreds of miles of forest roads, which has increased sediment loading to streams through erosion and mass wasting (landslides); and particularly within the Walsh Lake Basin, (3) a history of homesteading and the existence of a mining and manufacturing community (Taylor) within the basin, which impacted forest and riparian vegetation, and water quality in the area (prior to City acquisition of the land). The current, disturbed condition of the majority of aquatic and riparian habitats in the municipal watershed presents opportunities for habitat rehabilitation and, over the long term, restoration of the natural ecological functions of the aquatic/riparian ecosystem.

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for kokanee within the municipal watershed (i.e., Walsh Lake and its tributaries, along with associated riparian habitat) is protected through reserve status. In addition, protection in reserve status of *all* forested areas of the watershed will decrease the likelihood of land management activities adversely affecting kokanee. In the short term, kokanee will benefit by increased levels of habitat protection and by active intervention to increase habitat complexity, such as streambank stabilization projects to reduce the frequency of bank failures. In the long term, kokanee will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements that are important to kokanee, including clean gravels for spawning.

The City believes that instream habitat improvement and rehabilitation must be accompanied by upslope protection and restoration that will reduce impacts of upslope conditions or activities on stream habitat. For example, efforts to stabilize stream banks or add large woody debris to streams may not be effective in the long run if road failures occur that result in large inputs of coarse sediment to streams upstream of such projects. Thus, these kinds of activities will be coordinated under the HCP.

Short-term and long-terms gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams and Walsh Lake, as well as protecting all wetlands, and their recharge areas, associated with streams. In addition, maturation of protected forest in riparian forests near streams and the Walsh Lake wetland complex will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, increases in food production for fish, and cooler water temperatures. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus benefiting kokanee in the Walsh Lake Basin.

The HCP also includes management actions designed to improve and help restore aquatic and riparian habitats, including stream bank stabilization projects; placement of large woody debris (LWD); a stream bank revegetation program; a program of restoration planting, restoration thinning, and ecological thinning in riparian areas; a program to eliminate, modify, or replace stream-crossing culverts that could impede the passage of kokanee using tributaries, restoring habitat connectivity and continuity; a program to eliminate, modify, or replace stream-crossing culverts that are inadequate for passing peak storm flows, reducing the chance of failure and resulting sediment deposition in downstream habitat; programs to improve problem roads and the maintenance of roads that can affect streams, in both cases to reduce sediment loading to streams associated with erosion and mass wasting; and a program to decommission (remove) about 38 percent of forest roads, further reducing sediment loading to streams.

Collectively, these conservation and mitigation measures should (1) help restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Although restoration of a more naturally functioning aquatic ecosystem will benefit kokanee over the long term, some of these management interventions may cause some localized, short-term decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion, or disturbance of soils that could result in erosion and sediment release into streams.

Because, no harvest for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to undertaking such activities in riparian areas will also help minimize any impacts on kokanee. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. These prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitat for kokanee.

Because many of the types of habitat rehabilitation and restoration measures included in the HCP are experimental, monitoring within the context of adaptive management is essential to the long-term success of these efforts (Section 4.5.7). The HCP includes two types of monitoring relevant to these efforts (Section 4.5.4): (1) long-term monitoring of stream habitat quality, to detect trends, and (2) monitoring of specific aquatic and riparian restoration projects, to provide feedback on the adequacy of project designs. Interdisciplinary teams will be involved in the design and monitoring of restoration projects.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of kokanee that occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use. It should be noted that only a small portion of each of the above activities will occur within the Walsh Lake subbasin.

The likelihood of direct take of kokanee resulting from land management activities is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of kokanee habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential mortality from fishing; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of silvicultural treatments, road management, or other operational activities in riparian areas is expected to be very low in any given year. The restriction of public access into the municipal watershed will provide benefits for kokanee by reducing potential disturbance and direct take that might result from fishing, although it is likely that trespassers fishing in Walsh Lake annually take a few kokanee.

Population-level Effects

The HCP provides a number of distinct benefits to kokanee as part of the Watershed Management Mitigation and Conservation Strategies (Section 4.2), including protection of key habitat through reserve status, improvements and substantial decommissioning of forest roads, and restoration of stream and riparian habitats over the long term to more natural conditions (see above). Any short-term, local impacts to kokanee from these restoration activities in streams and riparian areas will be more than offset by long-term, landscape-level benefits. Habitats are managed to protect all life history stages of kokanee. Increases in the quantity and quality of accessible habitat, in both stream and riparian areas, will benefit the kokanee population in the municipal watershed. Thus, the

City believes that the HCP will have an overall positive effect on the watershed kokanee population over the long term.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for kokanee are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #31 – Sea-run Coastal Cutthroat Trout

Introduction

Sea-run cutthroat trout are not found in the Cedar River Municipal Watershed above the Landsburg Diversion Dam, although resident cutthroat are present in high numbers within the watershed below the Lower Cedar Falls. Additionally, it is not known what proportion of the Cedar River cutthroat trout population downstream of the Landsburg Diversion Dam is the anadromous sea-run cutthroat trout. There are no records indicating that sea-run cutthroat trout use the fish ladder at the Ballard Locks. However, large cutthroat trout have been observed in the Cedar River downstream of the Landsburg Diversion Dam, which suggests that some fish may have an anadromous or potentially adfluvial life history.

In general, adult sea-run cutthroat trout tend to spawn in the extreme upper reaches of small streams, ascending above the areas utilized by other anadromous salmonids. For this reason, it is likely that anadromous cutthroat at one time, prior to the time the Cedar River was re-routed into Lake Washington, ascended into stream basins between Landsburg and Lower Cedar Falls (e.g., the Williams Creek, Rock Creek, and Steele Creek subbasins). These subbasins are now dominated by stream-resident cutthroat trout, suggesting that accessible reaches may have been used by sea-run cutthroat trout prior to construction of the Landsburg Dam. The quality of stream habitat for spawning cutthroat depends on water temperature, water quality, and habitat complexity, which in turn depend, at least in part, on the condition of riparian vegetation. Potential key habitat in the municipal watershed for sea-run cutthroat trout includes all habitat currently used by resident cutthroat trout that is located below natural barriers to upstream migration (Map 7). Thus, key habitat includes streams in the lower municipal watershed and their associated riparian habitat. As described below, habitat in the Cedar River below Landsburg that is influenced by City management of instream flows may also be important.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect sea-run cutthroat trout within the municipal watershed (Section 4.2.2). Additional benefits will be provided by the instream flow regime (Section 4.4.2), funding for protection and restoration of habit downstream of Landsburg (Section 4.4.2), and construction of fish passage facilities at Landsburg (Section 4.3.2). The likelihood of direct injury to, or death of, any sea-run cutthroat trout resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, although some fry or juvenile sea-run cutthroat trout could be stranded during flow downramping events, and some juveniles be injured by impingement on the water intake screens at Landsburg, should any spawning occur above Landsburg. Any such death or direct injury of sea-run cutthroat trout would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The mitigation and minimization measures committed to in the HCP are expected to maintain the natural processes important for creating and maintaining habitat for sea-run cutthroat trout in the municipal watershed and downstream, to the extent the City can influence downstream habitat. The HCP is expected to result in short- and long-term benefits to sea-run cutthroat trout as compared to the current conditions by implementing or providing:

(1) construction of fish passage and protection facilities at the Landsburg Diversion Dam;

(2) implementation of guaranteed and supplemental instream flows, protecting and providing habitat in the Cedar River below the Masonry Dam and including protection of redds;

(3) protection of juveniles fish from stranding during flow downramping events;

(4) funding for habitat protection and restoration downstream of Landsburg;

(5) funding to improve survival of smolts passing through the Ballard Locks to Puget Sound;

(6) adaptive management of river flows, though the Cedar River Instream Flow Oversight Commission;

(7) protection of all key habitat in the municipal watershed (streams and associated riparian habitat between Lower Cedar Falls and Landsburg);

(8) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance;

(9) protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with streams and helping to restore natural ecological functions in riparian forests;

(10) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests;

(11) stream restoration projects, which are expected to improve microhabitat conditions in many reaches;

(12) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats;

(13) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and

(14) monitoring and research.

Sea-run cutthroat trout could be negatively affected by impingement on water intake screens at Landsburg (after fish ladders begin operating), management of instream flows, silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect streams or riparian habitats in the municipal watershed (also after fish ladders begin operating). Such effects could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Sea-run cutthroat trout could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and road decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for sea-run cutthroat trout are detailed in the sections 4.2.2, 4.3.2, 4.4.2, and Section 4.5.6, and summarized in tables 4.6-2 and 4.6-4

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

If there are currently sea-run cutthroat trout in the Cedar River, they can be expected to colonize the habitat above the Landsburg Diversion Dam after fish passage facilities are provided under the HCP. Access to the upstream habitat will contribute significant benefits for sea-run cutthroat trout if other factors outside the watershed do not limit the population. Anadromous sea-run cutthroat will have access to the mainstem Cedar River below Lower Cedar Falls and the lower portions of Rock, Williams, and Steele Creek sub-basins. Juveniles typically rear for about one year in their small, natal streams, then move into larger streams for several years before emigrating to salt water.

It is most likely that sea-run cutthroat trout would spawn and rear in tributaries to the Cedar River, not the mainstem, but some juveniles could utilize the mainstem. General field observations indicate that rainbow trout strongly predominate in the mainstem Cedar within the municipal watershed at present, with a ratio of about 99 rainbow to 1 cutthroat observed during trapping in the 1970s (Casne 1975). The mainstem would be used for migration by all adults and smolts, however, and it could be used by a small number of adults for spawning and by some juveniles for rearing. Construction of fish passage facilities at Landsburg will substantially increase the availability of protected, high quality habitat for spawning adults and rearing juveniles.

The primary provisions in the HCP that will enhance conditions in the Cedar River Basin for sea-run cutthroat trout include: (1) proposed guaranteed flows and change of the flow compliance point (Section 4.4.2); (2) flow downramping standards to protect juvenile fish from stranding (Section 4.4.2); (3) funding for habitat protection and restoration projects, potentially including groundwater-fed spawning channels and the protection and/or purchase of lands near the river downstream of Landsburg (Section 4.4.2); (4) construction of fish passage and protection facilities at the Landsburg Diversion Dam; and (5) watershed management mitigation and conservation measures that would benefit any sea-run cutthroat trout present in the municipal watershed once fish passage is restored. These measures are expected to provide immediate protection of sea-run cutthroat trout habitat and provide opportunity for increased production in the basin.

Habitat Effects Related to Instream Flow Management

The instream flow regime under the HCP will protect any sea-run cutthroat trout in the mainstem Cedar River by providing assurances that flows throughout the majority of the reach between Lake Washington and Lower Cedar Falls would be equal to or greater than the levels provided by the existing WDOE IRPP recommended flows for most of the year (Section 4.4.2). Insofar as any sea-run cutthroat trout may spawn in the mainstem Cedar River, the elements of the instream flow regime designed to protect the redds of salmon and steelhead that spawn in shallower areas near the river margin from dewatering will also afford protection to any sea-run cutthroat trout redds that may occur in these mainstem areas, particularly because sea-run cutthroat trout spawning broadly overlaps with the spawning period for steelhead (Wydoski and Whitney 1979). Continuation of the steelhead redd monitoring program under the HCP will provide information that can be used to establish flow regimes that protect incubating steelhead, as done currently, and would be expected to offer similar protection to anadromous (and resident) cutthroat trout.

In addition, as part of the proposed instream flow management regime, the compliance point of stream flow will be moved approximately 20 miles upstream near the Landsburg Diversion Dam (Section 4.4). Because of this change, flows will remain higher downstream of Landsburg as a result of the groundwater and surface water inputs that occur downstream of the measurement point. The change in the location of the measurement point will also allow flows to fluctuate in a more natural manner in the lower river.

The City is anticipating no alterations in its flood management practices as a result of the HCP. Consequently, the City anticipates little or no change in the magnitude, frequency, duration, or timing of peak flow events. Channel forming processes associated with these peak flows serve to maintain habitat that could be used by sea-run cutthroat trout, although most adults and juveniles would more likely use smaller tributaries that are still vulnerable to land management activities.

Habitat Effects Related to Funding for Downstream Habitat

The lower Cedar River downstream of the Municipal Watershed has been severely impacted by urbanization and other development, channel modifications, and riparian zone disturbance (King County 1998). Mainstem and side-channel habitat quantity and quality have been reduced substantially compared to original conditions in the lower river largely by land management actions beyond the control and responsibility of the City.

The HCP provides $4.6 million for habitat protection and improvement downstream of Landsburg, which could potentially include construction of groundwater-fed spawning channels and the protection and/or purchase of lands adjacent to the river or its tributaries, which should benefit sea-run cutthroat trout. New groundwater-fed side channels would provide perennial habitat protected from channel scour associated with peak flows in the main channel of the Cedar River, and some could be used by sea-run cutthroat trout.

Habitat Effects Related to Mitigation for the Landsburg Diversion Dam

When the fish passage facilities are constructed at Landsburg, expected to be in HCP year 3, these facilities will provide access to approximately 17 miles of mainstem and tributary stream habitat that will be protected and restored under the Watershed Management Mitigation and Conservation Strategies included in the HCP (Section 4.2.2). Accessible miles of mainstem habitat will be increased by 55 percent, and at least 5 miles of new, highly protected tributary habitat would be also available. The several tributary streams that enter the Cedar River between Lower Cedar Falls and Landsburg have high-quality habitat conducive to sea-run cutthroat trout spawning and rearing. Improved access is expected to provide the opportunity for increased long-term natural production of sea-run cutthroat trout in the municipal watershed, if they are present, and result in an overall net increase in habitat available to anadromous sea-run cutthroat trout.

It should be noted, however, that the tributaries of the mainstem Cedar in the lower part of the municipal watershed are currently occupied by large numbers of resident cutthroat trout, some rainbow trout, and hybrids in some areas, which will compete with any sea-run cutthroat trout that enter the municipal watershed. It should also be noted that, if the cumulative impact of the HCP program results in large numbers of anadromous salmon within the municipal watershed, the resulting influx of marine-derived nutrients would enhance stream productivity and provide more favorable conditions for growth and survival of species like anadromous cutthroat that rear in the lower Cedar River or tributary streams in the municipal watershed for some portion of their lives. Resident salmonid populations will undoubtedly re-equilibrate with the dynamic ecosystem conditions resulting from reintroduction of anadromous species to the municipal watershed.

Habitat Effects Related to Land Management in the Municipal Watershed

The effects of past land management in the municipal watershed have included (1) removal of riparian forest during timber harvest, reducing shading, the supply of food (invertebrates) to streams, and recruitment of large woody debris; and (2) construction and use of hundreds of miles of forest roads, which has increased sediment loading to streams through erosion and mass wasting (landslides). The current, disturbed condition of the majority of aquatic and riparian habitats in the municipal watershed presents opportunities for habitat rehabilitation and, over the long term, restoration of the natural ecological functions of the aquatic/riparian ecosystem.

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat for sea-run cutthroat trout within the municipal watershed (i.e., streams and associated riparian habitat in the lower watershed) is protected through reserve status. In addition, protection in reserve status of *all* forested areas of the watershed will decrease the likelihood of land management activities adversely affecting sea-run cutthroat trout. In the short term, sea-run cutthroat trout will benefit by increased levels of habitat protection and by active intervention to increase habitat complexity, such as through projects to add large woody debris to streams deficient in habitat structure. In the long term, sea-run cutthroat trout will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements that are important to this species, such as woody debris that provides cover and creates pools.

The City believes that instream habitat improvement and rehabilitation must be accompanied by upslope protection and restoration that will reduce impacts of upslope conditions or activities on stream habitat. For example, efforts to stabilize stream banks or add large woody debris to streams may not be effective in the long run if road failures occur that result in large inputs of coarse sediment to streams upstream of such projects. Thus, these kinds of activities will be coordinated under the HCP.

Short-term and long-terms gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams in the lower municipal watershed, as well as protecting all wetlands, and their recharge areas, associated with streams. In addition, maturation of protected forest in riparian forests near streams will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, creation of more pools, increases in food production for fish, and cooler water temperatures.

The HCP also includes management actions designed to improve and help restore aquatic and riparian habitats, including stream bank stabilization projects; placement of large woody debris (LWD); a stream bank revegetation program; a program of restoration planting, restoration thinning, and ecological thinning in riparian areas; a program to eliminate, modify, or replace stream-crossing culverts that could impede the passage of sea-run cutthroat trout using tributaries, restoring habitat connectivity and continuity; a program to eliminate, modify, or replace stream-crossing culverts that are inadequate for passing peak storm flows, reducing the chance of failure and resulting excessive sediment deposition in downstream habitat; programs to improve problem roads and the maintenance of roads that can affect streams, in both cases to reduce sediment loading to streams associated with erosion and mass wasting; and a program to decommission (remove) about 38 percent of forest roads, further reducing sediment loading to streams.

Collectively, these conservation and mitigation measures should (1) help restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Although restoration of a more naturally functioning aquatic ecosystem will benefit sea-run cutthroat trout over the long term, some of these management interventions may cause some localized, short-term decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion, or disturbance of soils that could result in erosion and sediment release into streams.

Because, no harvest for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to undertaking such activities in riparian areas will also help minimize any such impacts on sea-run cutthroat trout. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitats for sea-run cutthroat trout.

Because many of the types of habitat rehabilitation and restoration measures included in the HCP are experimental, monitoring within the context of adaptive management is essential to the long term success of these efforts (Section 4.5.7). The HCP includes two types of monitoring relevant to these efforts (Section 4.5.4): (1) long-term monitoring of stream habitat quality, to detect trends, and (2) monitoring of specific aquatic and riparian restoration projects, to provide feedback on the adequacy of project designs. Interdisciplinary teams will be involved in the design and monitoring of restoration projects.

Disturbance Effects and Direct Take

Juvenile sea-run cutthroat trout are vulnerable to stranding during events in which river stage decreases rapidly, and all adults moving upstream and juveniles or smolts moving downstream must cross the Landsburg Diversion Dam and pass the water supply intake. Once fish ladders are operational and sea-run cutthroat trout are able to cross the Landsburg Diversion Dam during upstream migration, any potential effects of management of the municipal watershed would apply to this species. Thus, disturbance effects could occur under the HCP in three ways: (1) through operation of the Landsburg diversion facilities, (2) through management of instream flow levels, and (3) through land management in the municipal watershed.

Disturbance Effects Related to Operation of Landsburg Diversion Facilities

Some sea-run cutthroat trout fry or juveniles could be injured as a result of impingement on the water intake screens at Landsburg, or crossing the Landsburg Diversion Dam moving downstream. Improvements for fish protection, however, include new intake screens and modifications to the dam designed to minimize such impacts (Section 4.3.2). Because of the new fish screens and dam modifications committed to in the HCP, the City does not believe that disturbance to, direct injury to, or death of individuals as a result of operation of the Landsburg facilities will have any effects with population-level consequences.

Disturbance Effects Related to Instream Flows

Rapid downramping of stream flows in the mainstem of the Cedar River as a result of City water supply and hydroelectric operations could strand sea-run cutthroat trout fry or juveniles in shallow areas, particularly along stream margins, potentially resulting in death of some individuals from high temperature or dehydration, to the extent that the small fish could not reenter flowing water. The HCP will moderate the rate at which instantaneous stream flow could be reduced by the operations of the City’s water supply and storage facilities. This moderation should substantially decrease the risk of stranding sea-run cutthroat trout as compared to the risk under current operations (see Section 4.4.2). A recent analysis of the frequency and magnitude of instream flow changes on the Cedar River suggests that significant downramping events can occur quite frequently during normal operations (Section 3.5.10). Prior to the HCP, no formal downramping criteria were used to guide flow control operations.

Because of the downramping protections committed to in the HCP, and because few small juvenile sea-run cutthroat trout are expected to be present in the mainstem Cedar River, the City believes the likelihood of disturbance to, direct injury to, or death of individuals as a result of flow downramping operations is expected to be very low in any given year.

Disturbance Effects Related to Land Management in the Municipal Watershed

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of sea-run cutthroat trout that may occur in the municipal watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use. It should be noted that only a portion of each of the above activities will occur within the lower municipal watershed.

The likelihood of direct take of sea-run cutthroat trout from land management activities is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of sea-run cutthroat trout habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential disturbance overall and substantially reduces fishing mortality; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individual sea-run cutthroat trout as a result of silvicultural treatments, road management, or other operational activities in streams and associated riparian areas is expected to be very low.

Population-level Effects

For several reasons, the City believes that, over the long term, the HCP will have an overall positive effect on any sea-run cutthroat trout population that may exist. Higher guaranteed flows, downramping controls, improved access to high quality habitat above Landsburg, and habitat improvement and protection projects in the lower Cedar River watershed should have positive impacts on the populations of sea-run cutthroat trout. The HCP provides a number of distinct benefits to sea-run cutthroat trout as part of the Watershed Management Mitigation and Conservation Strategies (Section 4.2), including protection of key habitat through reserve status, improvements and substantial decommissioning of forest roads, and restoration of stream and riparian habitats over the long term to more natural conditions (see above). Any short-term, local impacts to sea-run cutthroat trout from these restoration activities in streams and riparian areas will be more than offset by long-term, landscape-level benefits. Increases in the quantity and quality of accessible habitat, in both stream and riparian areas, will benefit any sea-run cutthroat trout population in the municipal watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for sea-run cutthroat trout are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #32 – Tailed Frog, Pacific Giant Salamander, Cascade Torrent Salamander

Introduction

The tailed frog and Pacific giant salamander are widely distributed and known to breed in the Cedar River Municipal Watershed. No comprehensive surveys to determine the presence or absence of the Cascade torrent salamander have been conducted in the municipal watershed and no incidental observations of this species have been documented to date. It is also significant to note that the watershed is outside the known range of the Cascade torrent salamander (Leonard et al. 1993; Corkran and Thoms 1996).

Each of the amphibians in species Group #32 is dependent on aquatic and riparian ecosystems during at least one or more phases of its life cycle, although specific habitat requirements do vary somewhat among the three species. All three species deposit their eggs in free water, typically in streams, and their larval forms rear in the stream environment, as long as 5 to 6 years at higher elevations in the case of the Pacific giant salamander (Leonard et al. 1993). Adults of each of the three species are typically found in cold, clear streams (rocky substrates particularly for tailed frogs), but also utilize terrestrial environments. In contrast to the other two species, especially the tailed frog, Pacific giant salamanders can be found in mountain lakes. Adult Cascade torrent salamanders are usually found in or near cold, clear streams, seepages, waterfall splash zones, and in seepages in talus slopes (Leonard et al. 1993) and of the three species, appears to be the species most consistently associated with free water as adults. Adult tailed frogs feed in both streams and adjacent forest habitats and adult Pacific giant salamanders forage in cool, moist coniferous forest habitats, especially in the vicinity of free water (Leonard et al. 1993). Water temperature (especially for the Cascade torrent salamander) and the absence, or minimum levels, of fine sediment (especially for the tailed frog) are important aspects of habitat quality for these amphibian species in Group #32.

Potential key habitat for the tailed frog, Pacific giant salamander, and Cascade torrent salamander (if present) in the municipal watershed includes streams, mountain lakes, seepages, riparian areas, and talus/felsenmeer slopes, especially in mature, late-successional, and old-growth forests (particularly in headwater stream basins). Younger seral-stage forest, especially in areas associated with streams, is considered important as secondary habitat.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any individuals of Group #32 species that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any individuals of Group #32 species resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury of individuals of Group #32 species would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, Group #32 species are similar to those described for other species addressed by the HCP that are closely associated with aquatic and riparian habitats. Long-term benefits are expected to accrue to all of the amphibian species in Group #32, especially through protection of all streams, open water, and riparian habitat and all mature, late successional, and old-growth forest in reserve status, as well as, by the recruitment of additional mature and late-successional forest over time. All key non-forested habitat, talus/felsenmeer slopes (especially those including seepages) will also be protected within reserve forest. In addition, secondary habitat, younger seral-stage forest, will also be protected in reserve status. Protection of, and improvements in, water quality (e.g., reduced sediment, lower temperature) and streamside habitat are of particular importance to support foraging and reproductive behaviors of these species.

A net gain of potential habitat for Group #32 species is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to Group #32 species that may use the watershed through: (1) protection of all key aquatic and riparian habitat including streams, lakes, ponds, seepages, and headwalls to support reproductive and foraging behaviors; (2) protection of all key non-forested habitat (talus/felsenmeer slopes) as inclusions within reserve forest, also to support reproductive and foraging behaviors; (3) protection of all old growth and recruitment of a substantial amount of mature and late-successional forest over time, maintaining or lowering stream temperatures and facilitating dispersal; (4) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance; (5) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests, improving forest and riparian habitat conditions (especially aquatic and terrestrial temperature regimes); (6) stream habitat restoration projects, reestablishing more natural stream function; (7) streambank stabilization projects to reduce sediment input to streams; (8) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams; (9) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (10) overall improvements in water quality; (11) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; and (12) monitoring and research.

Group #32 species could be negatively affected by silvicultural treatments, road management, or other operational activities in streams and in riparian or upland forested areas. Such effects could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory vegetation, increased stream temperature). Group #32 species could also be negatively affected on a short-term basis by management actions that contribute sediment to streams (e.g., stream restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Group #32 species are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including 13,889 acres of old-growth forest, are in reserve status. As a result, all key aquatic and riparian habitat (streams, lakes, ponds, seepages, especially where associated with late-successional and old-growth forest) and all key non-forested habitat (talus/felsenmeer slopes) for Group #32 species within the municipal watershed is protected in reserve status. All secondary and potential habitat is also protected in reserve status. In addition, protection in reserve status of all streams, as well as all forested areas of the watershed, will facilitate dispersal throughout suitable habitat in both aquatic and terrestrial ecosystems over the entire watershed landscape for all three of the amphibians in Group #32. In addition, silvicultural activities (heavy equipment, tree cutting) are restricted within 50 ft of streams and during any operations near special habitats (e.g., talus/felsenmeer slopes) activity will be restricted within a 200-foot zone to minimize the potential for habitat impacts or disturbance to key wildlife species, including Group #32 species, especially the Cascade torrent salamander.

Major habitat effects on Group #32 species are similar, in general, to those described for other species addressed by the HCP that are closely associated with aquatic and riparian ecosystems, especially in late-successional and old-growth forests. Although old growth (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for Group #32 species, especially in riparian corridors, are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). Silvicultural treatments including: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; and (3) ecological thinning of about 2,000 acres is expected to make habitat conditions more suitable in some second-growth forest by improving moisture regimes on the forest floor (e.g., increasing organic debris) and either maintaining cold stream temperatures or by improving shade conditions to reduce stream temperatures over the long term. In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range and all stream corridors, than under current conditions.

In addition to aquatic, riparian, and certain forested habitats used by Group #32 species, the Cascade torrent salamander also utilizes seepages in non-forested talus/felsenmeeer slopes. The Cascade torrent salamander is thus also expected to benefit from management actions designed to protect, restore, or enhance these habitats. All vegetated talus/felsenmeer (329 acres) and non-vegetated talus/felsenmeer (1,189 acres) slopes, most of which are surrounded by reserve forest or are adjacent to key aquatic and riparian habitat, are protected in reserve status.

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus benefiting amphibians in species Group #32. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft (on Type I-III waters), 150 ft (on Type IV waters), and 100 ft (on Type V waters) were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to help restore and/or enhance aquatic and riparian habitats. Stream bank stabilization, placement of large woody debris, stream bank re-vegetation, restoration planting and thinning, and ecological thinning in riparian areas are all expected to contribute to accelerating the reestablishment of more natural aquatic and riparian ecosystem functions. The reestasblishment of more natural aquatic ecosystem function, combined with the development of additional mature and late-successional characteristics in younger second-growth forests, especially in streamside riparian areas, will reestablish a more naturally functioning forest ecosystem throughout the watershed landscape that will improve habitat quality and availability, as well as the potential for dispersal, for the three amphibian species in Group #32.

Silvicultural treatments in riparian areas may result in short-term negative impacts on streamside habitat and/or water quality. Such impacts may occur if reduced canopy cover leads to increased solar heating of stream water, or to increased rates of soil erosion. However, no harvest for commercial purposes will occur in riparian areas, the use of mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones, in order to eliminate or minimize any short-term impacts to habitat of Group #32 species. As a result, potential impacts to habitat or water quality resulting from removal of vegetative cover will be virtually eliminated. In addition, during restoration or ecological thinning activities, no tree removal that has the potential to reduce streambank stability will be allowed within 25 feet of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas. Following these prescriptions will reduce the rate of sediment loading to aquatic systems, and help maintain high water quality.

Road repair, maintenance, and decommissioning can all impact stream and riparian areas. The comprehensive suite of Watershed Assessment Prescriptions are, however, intended to minimize the probability of erosion and mass wasting associated with roads. Implementing these prescriptions, along with the program to improve and decommission roads (Section 4.2.2), will reduce the rate of sediment loading to streams and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads come near streambanks, but improved road maintenance under the HCP will help mitigate those impacts.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of Group #32 amphibians that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) monitoring and research. Occasionally, individual amphibians of this group may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

The likelihood of direct take occurring at a level that may compromise the viability of any Group #32 species populations in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Group #32 species habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing salamanders; and (5) removal of 38 percent of forest roads which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, the likelihood of disturbance to, direct injury to, or death of individuals of Group #32 species as a result of silvicultural treatments, road management, or other operational activities is expected to be very low. An occasional individual might be injured inadvertently as a result of management actions in riparian areas or occasionally by vehicle traffic on watershed roads.

Population-level Effects

Population-level effects on Group #32 amphibian species are, in general, as described for other species addressed by the HCP that are associated with streams and riparian habitats, especially in mature, late-successional, and old-growth forest. Under the HCP, all key aquatic, riparian, and non-forested (talus/felsenmeer) habitat, including headwall basins, will be protected and improved in quality over time. Water quality will also be improved over time as a result of habitat restoration and road maintenance and decommissioning programs intended to reduce sediment input to aquatic systems. Any short-term, local impacts to these species resulting from restoration activities in aquatic and riparian areas will be more than offset by long-term, landscape-level benefits. In addition, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five.

Protection in reserve status of all aquatic and riparian habitats and talus/felsenmeer slopes, as well as upland forest, will improve habitat connectivity, thereby facilitating dispersal and movement of organisms dependent on aquatic and riparian habitats, including the three amphibian species in Group #32. The substantial degree of habitat protection and water quality and habitat improvement provided under the HCP should thus benefit any populations of the species that may occur in the Cedar River Municipal Watershed. In addition, increases in mature and late-successional forest habitat, especially where closely associated with aquatic systems, will facilitate dispersal of these species throughout the watershed landscape and possibly, over the long term, enable the municipal watershed to serve to connect with other populations of Group #32 species in the immediate region.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Group #32 species are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #33 – Long-Toed Salamander, Roughskin Newt, Northwestern Salamander, Western Toad, Northern Red-Legged Frog, Cascades Frog, Oregon Spotted Frog, Western Pond Turtle

Introduction

The northwestern salamander, long-toed salamander, roughskin newt, western toad, northern red-legged frog, and Cascades frog are widely distributed and known to breed in the Cedar River Municipal Watershed. No comprehensive surveys to determine the presence or absence of the Oregon spotted frog and western pond turtle have been conducted in the Cedar River Municipal Watershed, and no incidental observations of these species have been documented to date. Members of this species group require and/or use a wide range of habitat types, ranging from open, non-forested wetlands to closed-canopy forest habitat types (Table 4.2-3). Habitat associations are described in detail in Section 3.6 for all eight species (seven amphibians, one reptile) in Group #33 and are summarized below. The common name of the northern red-legged frog and the Oregon spotted frog, in particular, as given above may be indicated simply as the red-legged frog and the spotted frog, respectively, in some reference materials. Other names in common usage may also vary among these species as included in a variety of information sources.

Species	Elevation Range	Primary Habitats	Secondary Habitats	Important Habitat Elements
Long-toed salamander	All	Adults use forests, meadows; breed in seasonal wetlands, pond edges, slow streams		Rocks and logs in forest
Roughskin newt	All	Adults use mesophytic conifer or hardwood forests and open valleys, or breeding habitat; breed in lakes, ponds, sluggish streams		Moist forest floor conditions, decayed logs; older forests; vegetation near breeding habitat
Northwestern salamander	All	Adults use humid coniferous forests; breed in ponds, lakes, and slow streams		Older forests

Species	Elevation Range	Primary Habitats	Secondary Habitats	Important Habitat Elements
Western toad	All	Adults use moist areas with dense cover; breed in springs, ponds, shallow areas of lakes, marshes, and slow-moving streams		Damp woody debris
Northern red-legged frog	Below 2,800 ft	Adults use moist and riparian forests; breed in marshes, bogs, ponds, lakes, springs, and slow streams		Mature and older forests, cool water temperature (thus riparian forest cover)
Cascades frog	Above 2,600 ft	Adults use breeding habitat and nearby forest; breed in small water bodies, including areas in sphagnum bogs and forested swamps	Forests away from water	Closed canopy forest, large woody debris
Oregon spotted frog	All	Marshy ponds, wetlands with emergent vegetation, lakes, and streams	Adults also use riparian forests and dense shrubs in riparian areas	Forested areas are potential refugia
Western pond turtle (unlikely to occur in the municipal watershed)	Below 1,000 ft	Uses marshes, sloughs, moderately deep ponds, slow-moving rivers and streams, as well as meadows and forests	Rapid-flowing, clear, cold, rock and gravel streams; land up to 1,600 ft from water, for hibernation	Submerged logs and floating vegetation for resting sites; muddy bottoms for hibernation

Potential key habitat for Group #33 species in the municipal watershed includes lakes, ponds, springs, emergent wetlands, sphagnum bogs, forested swamps, and slow-moving streams, as well as riparian habitat, conifer and hardwood forest, and meadows. For certain species in this group, potential key upland habitat also includes habitat elements typically present in mature, late-successional, and old-growth forest, such as decaying coarse woody debris and moist conditions on the forest floor. Forest is primary habitat for some species and dispersal habitat for others, and rapid-flowing streams may be used by some species in the group as secondary habitat.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Group #33 species that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury to, or death of, any individuals of Group #33 species resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury of individuals of Group #33 species would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Direct and indirect effects of operational activities on, and the long-term benefits to, the Group #33 species are similar to those described for other species addressed by the HCP that are associated with aquatic and riparian habitats, and for species associated with forest habitats. The HCP is expected to result in both short- and long-term benefits to Group #33 species that may use the watershed through: (1) protection of all key and secondary habitats (streams, ponds, lakes, and wetlands, riparian habitat, meadows, and forest); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and protecting forest habitats that could be used as primary habitat by some species or for dispersal by others; (3) protection of all old growth and recruitment of a substantial amount of mature and late-successional forest over time, facilitating dispersal and providing improved habitat conditions for those species that prefer conditions typically existing in late-seral forests; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests in some areas; (5) stream restoration projects; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research.

Group #33 species could be negatively affected by silvicultural treatments, road management, or other operational activities in riparian or upland areas. Such effects could be direct (e.g., through direct injury to, or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory vegetation, elevated water temperature). Group #33 species could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Group #33 species are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside developed areas, including all aquatic and riparian ecosystem elements and all forest outside limited developed areas, are in reserve status. As a result, all key and secondary habitat for Group #33 species within the municipal watershed (i.e., streams, ponds, lakes, and wetlands, riparian habitat, meadows, and forest) is protected through reserve status. In addition, protection in reserve status of all forested areas of the watershed will facilitate dispersal by these species. As a whole, Group #33 species clearly depend on a naturally functioning complex of aquatic, riparian, and upland forest habitats.

Both the hydrologic regimes of, and habitat conditions within, many wetlands in the municipal watershed have likely been affected to some degree by past timber harvest, especially where virtually all trees were removed adjacent to lakes, ponds, wetlands, or streams. In such cases, an opportunity exists to improve hydrologic and other habitat conditions, contributing to reestablishment of the more natural conditions that existed prior to harvest.

Short-term and long-term gains in the quality of wetland, stream, and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to open wetland systems, retain forested wetlands, and protect hydrologic recharge areas. Conservation measures of this type will allow wetland communities to maintain and/or reestablish, over time, more naturally functioning hydrologic regimes as part of a naturally functioning forest ecosystem similar to what existed in the watershed before the twentieth century. Therefore, any changes in the hydrologic regimes of wetland communities affected by the HCP will be the result of natural processes of forest succession. In addition, maturation of protected forest in riparian forests near streams will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole. In order to estimate how the relative amount of older forest age classes will change in “riparian” forest over the 50-year term of HCP, “riparian” zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

Protection of upland forest through reserve status under the HCP will also provide short-term and long-term gains in the quality of upland habitats as a result of the natural maturation of younger seral-stage forests. Habitat effects related to mature, late-successional, and old-growth forest are, generally, as described for species addressed by the HCP that are associated with those habitats. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). Development of riparian and upland forest into mature and late-successional seral stages will promote microclimatic conditions that will facilitate overland dispersal of Group #33 species, and result in increased abundance of key habitat elements, such as large woody debris, important to some species in Group #33.

The HCP includes management actions designed to improve and help restore aquatic, riparian, and upland forest habitats. Stream bank stabilization projects, placement of large woody debris (LWD), a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas are expected to help (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests, especially in riparian areas. Restoration of a more naturally functioning aquatic ecosystem benefits Group #33 species over the long term. Over the short term, however, these management interventions may cause some localized decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion.

Because, no harvest of timber for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to initiating such activities in riparian areas will also help minimize any such impacts on Group #33 species. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. Following these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitats for all species in Group #33. One important set of constraints is that during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams and no tree removal that has the potential to reduce streambank stability will be allowed within 25 ft of any stream.

Improvement in upland forest habitat will benefit all species in Group #33 that use upland forest as primary habitat, and it will improve conditions during dispersal for all eight species. Overall, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by year 2050, a near fivefold increase over current conditions for these three seral stages in total and a fiftyfold increase in mature and late-successional forest (Section 4.2.2).

Under the HCP, upland forest habitat is also expected to benefit from management actions (e.g., ecological thinning and restoration thinning) intended to accelerate development of mature and late-successional forest habitat characteristics in some areas of previously harvested forest. Although silvicultural intervention to develop late-successional forest characteristics will benefit Group #33 species over the long term by recruiting important habitat elements, such as coarse woody debris, and by providing better microsites to facilitate dispersal, over the short term these management actions may cause some temporary, local impacts. As mitigation, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in key habitat to ensure that habitat for Group #39 species is only minimally impacted.

Forest management and management activities associated with forest roads (including road construction, repair, maintenance, and decommissioning) can, if not done properly, impact wetlands and streams through erosion and mass wasting that increases sediment loads and decreases water quality. Because no harvest for commercial purposes will occur in the municipal watershed, however, any potential impacts associated with commercial timber harvest are eliminated. The HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with roads. Implementing these prescriptions and guidelines, along with the programs to improve roads and to decommission about 38 percent of watershed roads, will reduce the rate of sediment loading to aquatic systems and help maintain high water quality. Although it is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads are adjacent to streambanks, improved road maintenance under the HCP, as well as the expected low level of road use, will help mitigate those impacts.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of Group #33 species that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about

11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of direct take occurring at a level that may compromise the viability of Group #33 species populations is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Group #33 species habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing amphibians or reptiles; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term. Occasionally, dispersing individuals might be injured or killed inadvertently by management activities in upland or riparian areas, or by vehicles on watershed roads.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of silvicultural treatments, road management, or other operational activities in riparian areas is expected to be very low in any given year.

Population-level Effects

Overall, population-level effects on the Group #33 species are, generally, as described for other species addressed by the HCP that are associated with streams, riparian habitats, and upland forest. Key riparian, aquatic, and upland forest habitat will be protected and improved in quality. Any short-term, local impacts to these species from restoration activities in streams, riparian areas, or upland forests will be more than offset by long-term, landscape-level benefits. Increases in the quantity and quality of mature and late-successional forest habitat, in both riparian and upland areas, will benefit populations of Group #33 species by providing improved key habitat for some species and by facilitating the movement and dispersal of individuals of all species throughout the Cedar River Municipal Watershed and, potentially, by facilitating movement between the municipal watershed and adjacent watersheds to the north and south. Thus, overall population-level effects should be positive for Group #33 species.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Group #33 are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #34 – Van Dyke's Salamander

Introduction

No comprehensive surveys to determine the presence or absence of Van Dyke's salamander have been conducted in the Cedar River Municipal Watershed, and no incidental observations of this species have been documented to date. Van Dyke's salamander is found only in Washington State, with scattered, widely spaced populations known primarily from the Olympic Mountains, the southern Cascades to the northern extent of Mt. Ranier, and the Willapa Hills (including Long Island) up to an elevation of 3,600 ft (Leonard et al. 1993). However, the Cedar River watershed is included within the potential range of this species as it is defined for the Northwest Forest Plan -- Survey and Manage requirements (Jones 1998; USDA 1994). Van Dyke's salamander may be sympatric with the red-backed salamander in the Washington Cascades (Nussbaum et al. 1983) (please see Group #35, red-backed salamander). Although typically grouped as a Woodland Salamander, Van Dyke's salamander, with the possible exception of Dunn's salamander, is considered to be the most closely related to water of these woodland species (Leonard et al. 1993). Because the Van Dyke's salamander demonstrates an apparent affinity for water (provides suitable moisture regimes in the terrestrial environment), it is classed as an "aquatic/riparian" species under the HCP, however, the species' association with terrestrial habitats (mature to old-growth forest key habitat) and similarities to late-successional and old-growth dependent species groups addressed in the HCP is also emphasized.

Potential key habitat for Van Dyke's salamander in the municipal watershed includes seeps, streamside and waterfall splash zones in riparian areas, montane lakes, and streamside talus/felsenmeer slopes, particularly in mature, late successional, and old-growth forest that typically, and most consistently, accumulates substantial quantities of decaying logs, leaf litter, bark piles, and other debris on the forest floor. The moisture regimes typically maintained in certain riparian (streamside) habitats, organic debris on the forest floor in older forest, and in many talus/felsenmeer slopes, especially those closely associated with streams, provide suitable foraging, breeding, and hiding cover for Van Dyke's salamanders. Only two nests have been documented: one was located under a moss-covered stone, the other inside a large Douglas-fir log near a creek (Leonard et al. 1993).

In addition, this species may also be found in other habitats, including talus slopes, rock outcrops, and other seral-stages of coniferous forest, even substantial distances from streams, if site conditions (aspect, shading) maintain adequate microclimate regimes (moisture and temperature levels). Within the municipal watershed, these habitat types (some talus/felsenmeer slopes, rock outcrops, younger forest) are considered of secondary importance for the Van Dyke's salamander.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Van Dyke's salamanders that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any Van Dyke's salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Long-term benefits are expected to accrue to the Van Dyke's salamander, especially through protection of all streams, open water, and riparian habitat and all mature, late successional, and old-growth forest in reserve status, as well as, the recruitment of additional mature and late-successional forest over time. All key non-forested habitat associated with aquatic systems, including talus/felsenmeer slopes will also be protected within reserve forest. In addition, secondary habitat (additional talus/felsenmeer slopes, rock outcrops, other seral-stage forest) will also be protected in reserve status. A net gain of potential Van Dyke's salamander habitat is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to the Van Dyke's salamander through: (1) protection of all key habitat in riparian stream corridors, including headwalls and inner gorges; (2) protection of all existing key forested habitat in reserve forest status, facilitating dispersal; (3) protection of all key non-forested habitat (talus/felsenmeer slopes, open water) as inclusions within reserve forest; (4) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance; (5) natural maturation of second-growth forests into mature and late-successional seral stages, potentially recruiting increased amounts of organic debris to the forest floor and improving habitat function; (6) stream restoration and bank stabilization projects, improving streamside cover; (7) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams; (8) guidelines and prescriptions designed to reduce sediment production during watershed management activities, reducing potential impacts to aquatic habitats; (9) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, also improving habitat conditions on the forest floor (long term) and facilitating dispersal; (10) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying organic debris to the forest floor on both a short- and long-term basis; (11) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; (12) protection of secondary habitat (other talus/felsenmeer slopes, rock outcrops, earlier seral-stage forest) as inclusions within reserve forest; and (13) monitoring and research.

Van Dyke's salamanders could be negatively impacted by silvicultural treatments, road management, or other activities especially in riparian areas and in the vicinity of talus/felsenmeer slopes. Such impacts could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory, shade reduction). Van Dyke's salamanders could also be impacted by management activities that contribute sediment to streams (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the Van Dyke's salamander are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (seeps, riparian (streamside) corridors, and talus/felsenmeer slopes, especially where associated with mature, late-successional and old-growth forests, for the Van Dyke's salamander within the municipal watershed is in reserve status. In addition, secondary habitat, including other talus/felsenmeer slopes, rock outcrops, and other seral-stage forest is also protected in reserve status. Protection in reserve status of all forested areas of the watershed, including riparian corridors, will also facilitate dispersal for this species. In addition, silvicultural activities (heavy equipment, tree cutting) are restricted within 50 ft of streams and during any operations near special habitats (e.g., talus/felsenmeer slopes or rock outcrops) activity will be restricted within a 200-foot zone to minimize the potential for habitat impacts or disturbance to key wildlife species, including Van Dyke's salamander

Major habitat effects on Van Dyke's salamander are similar, in general, to those described for other species addressed by the HCP that are associated with mature, late-successional and old-growth forests, except that this salamander is more closely associated with, and/or dependent upon, water to create suitable microhabitats than most of the other species associated with older forest environments. Although old growth (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for Van Dyke's salamander are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). Silvicultural treatments including: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; and (3) ecological thinning of about 2,000 acres, are expected to make habitat conditions more suitable in some second-growth forest by improving moisture regimes (increasing shade) and providing additional habitat structure (large woody debris) on the forest floor over the long term. In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range and all stream corridors, than under current conditions.

In addition to forested habitats, Van Dyke's salamanders also utilize open, non-forested talus/felsenmeeer slopes and rock outcrops. The Van Dyke's salamander is thus also expected to benefit from management actions designed to protect, restore, or enhance these habitats. All vegetated talus/felsenmeer (329 acres) and non-vegetated talus/felsenmeer (1,189 acres) slopes, and rock outcrops, most of which are surrounded by or are adjacent to key forested habitat, are protected in reserve status. And, similar to the case for the red-backed salamander (Group #35), only 4,708 acres (less than 7 percent) of key forested habitat will be above 4,000 feet, only slightly beyond the documented extent of the Van Dyke's salamander's elevation range (3,600 feet).

Short-term and long-term gains in the quality and/or quantity of aquatic and riparian habitats are expected under the HCP as a result of the natural development of mature forest in riparian areas. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus benefiting Van Dyke's salamander. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft (on Type I-III waters), 150 ft (on Type IV waters), and 100 ft (on Type V waters) were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to help restore and/or enhance aquatic and riparian habitats. Stream bank stabilization, placement of large woody debris, stream bank re-vegetation, restoration planting and thinning, and ecological thinning in riparian areas are all expected to contribute to accelerating the reestablishment of more natural aquatic and riparian ecosystem functions. The reestasblishment of more natural aquatic ecosystem function, combined with the development of additional mature and late-successional characteristics in younger second-growth forests, especially in streamside riparian areas, will reestablish a more naturally functioning forest ecosystem throughout the watershed landscape that will improve habitat quality and availability, as well as the potential for dispersal, for the Van Dyke's salamander.

Silvicultural treatments in riparian areas may result in short-term negative impacts on streamside habitat and/or water quality. However, no timber harvest for commercial purposes will occur in the watershed, mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones, in order to eliminate or minimize any short-term impacts to habitat of Van Dyke's salamander. During restoration or ecological thinning procedures, no tree removal with the potential to reduce streambank stability will occur within 25 feet of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas. This will reduce the rate of sediment loading to aquatic systems and help maintain high water quality.

Road repair, maintenance, and decommissioning can all impact stream and riparian areas. The comprehensive suite of Watershed Assessment Prescriptions are, however, intended to minimize the probability of erosion and mass wasting associated with roads. Following these prescriptions and guidelines, along with the program to improve and decommission about 38 percent of existing roads (Section 4.2.2), will reduce the rate of sediment loading to streams and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads are adjacent to streambanks, but improved road maintenance under the HCP will help mitigate those impacts.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in direct take of Van Dyke's salamanders in the watershed include any operations that involve human activities on roads or in suitable habitat. Such activities include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) riparian and instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) monitoring and research.

Occasionally, individual Van Dyke's salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

The likelihood of direct take occurring at a level which may compromise the viability of any Van Dyke's salamander populations that may occur in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Van Dyke's salamander habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing salamanders; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any Van Dyke's salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low in any given year, although occasionally, individual Van Dyke's salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

Population-level Effects

Population-level effects on the Van Dyke's salamander are, in general, as described for other species addressed by the HCP that are associated with mature, late-successional, and old-growth forest, with the exception of their closer association with water. Under the HCP, all key riparian, aquatic, forested, and non-forested habitat will be protected and improved in quality over time. In addition, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five. Protection in reserve status of all riparian, as well as upland forest, will improve habitat connectivity, thereby facilitating dispersal and movement of organisms dependent on riparian habitats, including Van Dyke's salamander. This substantial degree of protection complies with the principal management recommendation of WDW (1991) for Van Dyke's salamander, and should thus benefit any populations of the species that may occur in the Cedar River Municipal Watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Van Dyke's salamander are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #37 – Papillose Taildropper, Fender's Soliperlan

Stonefly, Carabid Beetles (*Bembidion gordoni*, *B. stillaguamish*, *Nebria kincaidi*, *N. gebleri cascadensis*, *N. paradisi*, *Pterostichus johnsoni*)

Introduction

No comprehensive surveys to determine the presence or absence of the papillose taildropper, Fender's soliperlan stonefly, or any of the six species of carabid beetles included in Group #37 have been conducted in the municipal watershed, and no incidental observations of these species have been documented to date. Habitat associations of these eight species are not well understood, but all are believed to occur typically in association with streams and streamside habitats.

Papillose taildroppers appear to be strongly associated with riparian vegetation in most coniferous forests, but also may occur in moist situations in non-forest habitats and in upland forests (Section 3.6). Under the Northwest Forest Plan, the papillose taildropper is estimated to have a 50 percent chance that sufficient habitat will be provided so as to maintain well distributed, interacting populations of this species across its range on federal lands in the next 100 years, and a 10 percent chance of extirpation (Frest and Johannes (1993).

Fender's soliperlan stoneflies occur in cool, fast-flowing, well oxygenated rocky streams (Nelson 1996) as well as seeps, and are sensitive to changes in riparian zones that can raise stream temperature. All six species of carabid beetles are associated with mountain streams. *Bembidion gordoni* is associated with fast-flowing streams (Bergdahl 1996), and *Nebria kincaidi* and *N. paradisi* occur along small, high-elevation (subalpine) streams (Bergdahl 1996). *N. gebleri cascadensis* is associated with streams and streamside habitats most elevations (Bergdahl 1996), and *Pterostichus johnsoni* is dependent on streams and found in headwaters of wall-based channels and in steep, wet, unstable sand-mud-scree slopes (Bergdahl 1996). *B. stillaguamish*, widespread and likely to occur in the municipal watershed, is found along the margins of fairly large mid-elevation streams, often on stabilized sand/gravel bars, and in streamside vegetation with sandy soil, often at the margins of large pools (Bergdahl 1996; Bergdahl 1996, 1997; Bergdahl, J., Northwest Biodiversity Center, June 19, 1998, personal communication)

Potential key habitat in the municipal watershed for all eight species in Group #37 includes streams, streamside areas, and riparian habitat over a broad elevation range, as well as upland forest for papillose taildropper.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any of the Group #37 species that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury to, or death of, any Group #37 species resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP in any given year. However, any such death or direct injury of Group #37 species would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to Group #37 species that may occur in the watershed through: (1) protection through reserve status of all key stream habitat, streamside forest, and riparian habitat; (2) elimination of timber harvest for commercial purposes within the municipal watershed, reducing the overall level of habitat disturbance and protecting upland forest habitat that could be used as primary habitat by the papillose taildropper or for dispersal by the other seven species; (3) protection of all old growth and recruitment of a substantial amount of mature and late-successional forest over time, facilitating dispersal and creating more microsites with the moisture regimes preferred by the papillose taildropper; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests, increasing the abundance of sites suitable for papillose taildropper; (5) stream restoration projects; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (8) funding for optional species and sensitive habitat surveys (Section 4.5.5), which can be used to increase understanding of these species; (9) development of a species-habitat relations model (Section 4.5.5), which can better define habitat needs of these species; and (10) the flexibility to alter mitigation in response to better understanding of the habitat relationships of these species through the adaptive management program (Section 4.5.7).

Group #37 species could be negatively affected by silvicultural treatments, road management, or other activities in riparian areas. Such effects could be direct (e.g., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory). Group #37 species could also be negatively affected by management activities that contribute sediment to streams (timber harvest, road construction, maintenance, and use), thereby reducing water quality.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Group #37 species are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key habitat (streams and riparian areas) for the Group #37 species within the municipal watershed is in reserve status. In addition, protection in reserve status of all forested areas of the watershed will protect all key upland habitat for the papillose taildropper and will facilitate overland dispersal of all eight species; activities that could impact aquatic habitat are restricted near water bodies; and silvicultural treatments in riparian and upland forest will be conducted in many areas previously harvested to restore natural ecological functions and to develop characteristics of late-successional forest habitat.

Major habitat effects on and benefits to Group #37 species are generally as described for other species associated with stream and riparian habitats. All key habitat, as well as secondary and potential habitats, are protected; over time, habitat quality and conditions for dispersal should improve substantially. Protection of and improvements in water quality and streamside habitat are of particular importance for species in Group #37.

Short-term and long-terms gains in the quality of wetland and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian corridors. In order to estimate how the relative amount of older forest age classes will change in "riparian" forest over the 50-year term of HCP, "riparian" zones of 300 ft on Type I-III waters, 150 ft on Type IV waters, and 100 ft on Type V waters were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase. Development of young forest into mature and late-successional seral stages in such areas will help restore a more naturally functioning riparian/aquatic ecosystem, thus potentially benefiting these three species.

The HCP also includes management actions designed to help restore streams and riparian habitats. Streambank stabilization projects, placement of large woody debris, and a stream bank re-vegetation program should benefit all eight species in Group #37 by improving stream and streamside habitats. In addition, a program of restoration planting, restoration thinning, and ecological thinning in riparian areas should also benefit all eight species by helping to accelerate the restoration of natural aquatic and riparian ecosystem functioning and the development of mature or late-successional characteristics in younger second-growth forests in riparian areas.

Forest management and management activities associated with forest roads (including road construction, repair, maintenance, and decommissioning) can, if not done properly, impact streams through erosion and mass wasting that increases sediment loads and decreases water quality. Because no harvest for commercial purposes will occur in the municipal watershed, however, any potential impacts associated with commercial timber harvest are eliminated. Silvicultural treatments near streams and riparian areas, however, could result in some short-term, negative impacts on water quality if not properly conducted.

Silvicultural treatments in riparian areas may result in short-term negative impacts on streamside habitat and/or water quality. No commercial timber harvest will occur in the watershed, however, and, in order to eliminate or minimize any short-term impacts to habitat of Group #37 species, mechanical equipment and cutting of trees are restricted within 50 feet of streams, and interdisciplinary teams will evaluate and plan silvicultural and operational projects in any key habitat, especially within riparian zones. One important set of constraints is that during restoration or ecological thinning activities, no mechanized equipment will be allowed within 50 ft of streams and no tree removal that has the potential to reduce streambank stability will be allowed within 25 ft of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with road systems and silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems, and will help maintain high water quality in potential habitats for all eight species in Group # 37.

Improvement in upland forest habitat will benefit the papillose taildropper as an improvement in potential key habitat and the other seven species as an improvement in dispersal habitat. Overall, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by year 2050, a near fivefold increase over current conditions for these three seral stages in total and a fiftyfold increase in mature and late-successional forest (Section

4.2.2).

Under the HCP, upland forest habitat is also expected to benefit from management actions (e.g., ecological thinning and restoration thinning) intended to accelerate development of mature and late-successional forest habitat characteristics in some areas of previously harvested forest, creating more microsites that could be used by the papillose taildropper and generally improving conditions for dispersal for all these invertebrate species. Although silvicultural intervention to develop late-successional forest characteristics will benefit Group #37 species over the long term, over the short term these management actions may cause some temporary, local impacts. As mitigation, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in key habitats to ensure that habitat for Group #39 species is only minimally impacted.

Road repair, maintenance, and decommissioning can all impact aquatic and riparian areas. The HCP includes a comprehensive suite of Watershed Assessment Prescriptions and other management guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with roads. Following these prescriptions and guidelines, along with implementing the program to improve and decommission roads (Section 4.2.2), will reduce the rate of sediment loading to aquatic systems, and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads come near streambanks, but several conservation and mitigation measures included in the HCP will help mitigate those impacts. These measures include removal (decommissioning) of about 38 percent of the road system, substantial reengineering (improvement) of other roads, improved road maintenance, and the highly reduced level of road use under the HCP as compared to past levels of use incurred as a result of commercial timber harvest.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of Group #37 invertebrates that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of direct take occurring at a level which may compromise the viability of Group #37 species populations in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP:
(1) interdisciplinary team site evaluations prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules;
(4) the City’s policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing Group #37 species; and (5) removal of 38 percent of forest roads, which will reduce the potential for

take related to road maintenance, improvement, and use over the long term. Occasionally, dispersing individuals from Group #37 species (especially papillose taildroppers) might be killed or injured by such activities in riparian or upland areas, or by vehicles on watershed roads.

Because of specific mitigation and minimization measures committed to in the HCP, the likelihood of disturbance to, direct injury to, or death of any Group #37 individuals as a result of silvicultural treatments, road management, or other operational activities is expected to be very low in any given year.

Population-level Effects

Because the extent of understanding of the ecology of Group #37 species is limited, and because none of these species has been documented as present in the municipal watershed, population-level effects for these species cannot be specified with any certainty. The conservation and mitigation measures included in the HCP, however, because they provide substantial protection and improved conditions with respect to all key habitat in the municipal watershed, should have a beneficial effect on populations of any of these species that may occur in the watershed. Any short-term, local impacts to these species from restoration activities in or near streams and riparian areas will be more than offset by long-term, landscape-level benefits. Protection in reserve status of all riparian areas, as well as increases in mature and late-successional forest habitat, will benefit populations of Group #37 species by facilitating the movement and dispersal of individuals throughout the municipal watershed, and the municipal watershed could serve as a population source for other areas in the future. Thus, the overall population-level effects should be positive for those species that may be present in the municipal watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Group #37 species are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #38 – Beller’s Ground Beetle, Hatch’s Click Beetle, Long-Horned Leaf Beetle

Introduction

The presence of Beller’s ground beetle has been documented recently in the Cedar River Municipal Watershed. No comprehensive surveys to determine the presence or absence of the Hatch’s click beetle and the long-horned leaf beetle have been conducted in the municipal watershed, and no incidental observations of these two species have been documented to date. The Beller’s ground beetle and the Hatch’s click beetle are closely associated with, and may be restricted to, sphagnum bogs and sphagnum wetlands below 3,000 ft elevation (Section 3.5.6). Beller’s ground beetle was documented in two sphagnum bog-like wetlands at the east end of Chester Morse Lake, south of Little Mountain. Adult Beller’s ground beetles are typically found near open water and larvae are aquatic; larvae of Hatch’s click beetles are often found near bog margins, above the water line. Similar to Beller’s ground beetle and Hatch’s click beetle, the long-horned leaf beetle inhabits low-elevation sphagnum bogs, but can also be found in a variety of other types of wetlands, with adults located typically near open water and larvae using submerged portions of aquatic plants (Section 3.5.6). Potential key habitat in the municipal watershed includes sphagnum bogs and other wetlands (including open water), as well as associated riparian habitats important to protection of the wetland environment.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Group #38 beetle species that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury to, or death of, any Group #38 beetles resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low under the HCP. However, any such death or direct injury of Group #38 beetles would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to any Group #38 beetles that may occur in the watershed through: (1) protection of all key habitat (sphagnum bogs, other wetland types and associated open water and riparian habitat); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and any potential effects on wetlands, recharge areas, and water bodies; (3) protection of all old growth and recruitment of substantial mature and late-successional forest over time, facilitating dispersal between wetland systems; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests, increasing levels of protection for adjacent wetland systems; (5) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to wetland systems; (6) guidelines and prescriptions designed to reduce sediment production during watershed management activities; (7) funding for optional species and sensitive habitat surveys (Section 4.5.5), which can be used to increase understanding of these species; (8) development of a species-habitat relation model (Section 4.5.5), which can better define habitat needs of these species; and (9) the flexibility to alter mitigation in response to better understanding of the habitat relationships of these species through the adaptive management program (Section 4.5.7).

Group #38 species could be negatively affected by silvicultural treatments, road management, or other operational activities near sphagnum bogs and other wetlands. Such impacts could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory). Group #38 species could also be impacted by management activities that contribute sediment to wetlands (e.g., silvicultural treatments near wetlands or riparian areas, or road maintenance, use, and decommissioning).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Group #38 species are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas are in reserve status. This includes the only known bog-like wetlands in the watershed, which are south of Little Mountain, as well as all other types of wetland systems and associated open water. As a result, all key habitat for Group #38 species within the municipal watershed (sphagnum bogs, other wetlands, and associated riparian habitat) is in reserve status. In addition, protection in reserve status of all forested areas of the watershed will facilitate overland dispersal for these species.

Some short-term and long-term gains in the quality of wetland habitats are expected under the HCP as a result of the natural development of mature forest in the vicinity of wetlands. Development into mature and late-successional forest helps restore a more naturally functioning ecosystem, thus benefiting Group #38 species. As discussed above under Group #33, the hydrologic regimes of wetland communities may change as a result of forest succession, but wetland hydrology should approach more natural, pre-disturbance conditions, and all recharge areas of bog-like and other wetland types are protected under the HCP.

Silvicultural treatments and the use, repair, maintenance, and decommissioning of forest roads can, in some circumstances, impact wetlands through the removal of vegetative cover and/or through erosion and mass wasting, increasing sediment loading to wetlands and decreasing water quality. Because no commercial timber harvest will occur in the watershed, however, any impacts associated with the removal of vegetative cover will be largely eliminated or short term in nature. In addition, the HCP includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other management guidelines (Section 4.2.2) that are intended to minimize the potential for erosion and mass wasting associated with silvicultural treatments in riparian areas, and to minimize the probability of erosion and mass wasting associated with road use, repair, maintenance, and decommissioning. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems, including wetlands, and help maintain high water quality.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of Group #38 species that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) those instream habitat restoration projects, if any, that may affect wetlands; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (8) routine road use; and (9) some types of monitoring and research.

The likelihood of disturbance to, direct injury to, or death of any Group #38 individuals as a result of management actions in the vicinity of wetlands and associated riparian areas is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of Group #38 species habitat prior to silvicultural or road management activities near wetlands or in riparian habitat; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access to the

Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing beetles; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Population-level Effects

Overall, population-level effects on the Group #38 beetle species are generally as described for other species addressed by the HCP that are closely associated with wetland or riparian habitats. Key wetland and riparian habitat, as well as all associated upland habitat that protects recharge areas or could be used for dispersal, will be protected in reserve status. Any short-term, local impacts to these species from restoration activities near wetlands or in riparian areas will be more than offset by long-term, landscape-level benefits. Protection in reserve status of all wetlands and associated riparian habitat, and increases in mature and late-successional forest habitat will benefit regional populations of Group #38 species by facilitating the movement and dispersal of individuals throughout the Cedar River Municipal Watershed and, potentially, by facilitating movement between the municipal watershed and adjacent watersheds to the north and south. Overall, the City expects that population-level effects on the three Group #38 beetle species will be positive.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Group #38 species are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #39 – Carabid Beetles (*Omus dejeanii, Bembidion viator, Bradycellus fenderi*)

Introduction

Omus dejeanii has been documented to be present and breeding in the Cedar River Municipal Watershed. No comprehensive surveys to determine the presence or absence of *Bembidion viator* and *Bradycellus fenderi* have been conducted in the municipal watershed, and no incidental observations of these two species have been documented to date. Habitat associations of these three species are not well understood, but all three species occur at lower elevations. *Omus dejeanii* is known to occur in swamps, forests, forest glades, and along stream banks (Section 3.6), *Bembidion viator* to occur in swamps, bogs, and forested marshes, and *Bradycellus fenderi* to occur in swamps, forested marshes, and foothill streamside zones (Bergdahl 1996, 1997; Bergdahl, J., Northwest Biodiversity Center, June 19, 1998, personal communication).

Potential key habitats for these three species in the municipal watershed are low-elevation swamps, forested wetlands, riparian areas, and forest. Low-elevation forest is considered to be secondary habitat for *Bembidion viator* and *Bradycellus fender*i, and would be used primarily for dispersal.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Group #39 species that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any Group #39 beetles resulting from silvicultural treatments, road management, or other operational activities is expected to be very low in any given year under the HCP. However, any such death or direct injury of Group #39 beetles would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to Group #39 species through: (1) protection through reserve status of all key wetland habitat and riparian habitat; (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and protecting forest habitats that could be used as primary habitat by *Omus dejeanii* or for dispersal by the other two carabid species; (3) protection of all old growth and recruitment of substantial mature and late-successional forest over time (including large areas at low elevation), facilitating dispersal and increasing habitat quality for *Omus dejeanii*; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to wetlands; (6) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research.

Group #39 species could be negatively affected by silvicultural treatments, road management, or other operational activities in low-elevation forests and a variety of wetlands. Such effects could be direct (e.g., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory). Group #39 species could also be negatively affected by management activities that contribute sediment to wetlands (e.g., stream habitat restoration projects and silvicultural treatments near wetlands or in riparian areas, or road maintenance, use, and decommissioning), thereby affecting water quality.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for Group #39 species are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside developed areas, including all key habitat and secondary habitat for Group #39 species, are in reserve status. In addition, protection in reserve status of all forested areas of the watershed will facilitate overland dispersal of these species, activities that could impact aquatic habitat are restricted near water bodies, and silvicultural treatments in riparian and upland forest will be conducted in many areas previously harvested to restore natural ecological functions and to develop characteristics of late-successional forest habitat.

Short-term and long-terms gains in the quality of wetland and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. Development of young second-growth forest into mature and late-successional seral stages in riparian areas will help restore a more naturally functioning aquatic ecosystem, thus potentially benefiting these three species. In order to estimate how the relative amount of older forest age classes will change in “riparian” forest over the 50-year term of HCP, “riparian” zones of 300 ft (on Type I-III waters), 150 ft (on Type IV waters), and 100 ft (on Type V waters) were established using GIS data and acreage for forest age classes under current and future predicted conditions were calculated. Currently, only 16 percent of the 15,160 acres of forest within this riparian zone is over 80 years old (mature, late-successional, or old growth), while at the end of the HCP term (year 2050) 85 percent will be more than 80 years old, a near fivefold increase.

The HCP also includes management actions designed to help restore wetland and riparian habitats. Streambank stabilization projects, placement of large woody debris, and a stream bank re-vegetation program should benefit *Omus dejeanii* by improving streamside habitats, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas should benefit all three species by helping to accelerate the reestablishment of natural aquatic and riparian ecosystem functioning and the development of mature or late-successional characteristics in younger second-growth forests in riparian areas.

Forest management and management activities associated with forest roads (including road construction, repair, maintenance, and decommissioning) can, if not done properly, impact wetlands and streams through erosion and mass wasting that increases sediment loads and decreases water quality. Because no harvest for commercial purposes will occur in the municipal watershed, however, any potential impacts associated with commercial timber harvest are eliminated. Silvicultural treatments near streams and riparian areas, however, could result in some short-term, negative impacts on water quality if not properly conducted.

During restoration or ecological thinning activities, no tree removal that has the potential to reduce streambank stability will be allowed within 25 feet of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with road systems and silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems, and will help maintain high water quality in potential habitats for all three species of carabid beetles in Group #39. Expected changes in the hydrologic regimes of wetland communities resulting from forest succession are discussed above under Group #33.

Improvement in upland forest habitat, including embedded forest openings and glades, will benefit *Omus dejeanii* as an improvement in potential key habitat and the other two species as an improvement in dispersal habitat. Overall, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by year 2050, a near fivefold increase over current conditions for these three seral stages in total and a fiftyfold increase in mature and late-successional forest (Section 4.2.2). Because the vast majority of the lower-elevation forest in the watershed was harvested in the early twentieth century, most of the mature and late-successional forest habitat in year 2050 will develop at low elevations, where the second-growth is currently older than in most other parts of the watershed (Section 4.2.2). At elevations below 3,000 ft elevation at year 2050, mature and late-successional forest is projected to total 47,988 acres, a forty-one-fold increase over current conditions, and mature, late-successional, and old-growth forest is projected to total 50,563 acres.

Under the HCP, upland forest habitat is also expected to benefit from management actions (e.g., ecological thinning and restoration thinning) intended to accelerate development of mature and late-successional forest habitat characteristics in some areas of previously harvested forest. Although silvicultural intervention to develop late-successional forest characteristics will benefit Group #39 species over the long term, over the short term these management actions may cause some temporary, local impacts. As mitigation, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions to ensure that habitat for Group #39 species is only minimally impacted.

Road repair, maintenance, and decommissioning can all impact aquatic and riparian areas. The HCP includes a comprehensive suite of Watershed Assessment Prescriptions and other management guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with roads. Implementing these prescriptions and guidelines, along with the program to improve and decommission roads (Section 4.2.2), will reduce the rate of sediment loading to aquatic systems, and help maintain high water quality. It is inevitable that ongoing road use and maintenance will continue to produce some level of sedimentation and retard succession of riparian vegetation where roads come near streambanks, but several conservation and mitigation measures included in the HCP will help mitigate those impacts. These measures include removal (decommissioning) of about 38 percent of the road system, substantial reengineering (improvement) of other roads, improved road maintenance, and a highly reduced level of road use under the HCP as compared to past levels of use related to commercial timber harvest.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of Group #39 species that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of direct injury or death occurring at a level that may compromise the viability of Group #39 species populations is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations in key habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing beetles; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term. Occasionally, however, dispersing individuals might be injured or killed inadvertently by management activities in upland or riparian areas, or vehicles on watershed roads.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of any individuals of Group #39 species as a result of silvicultural treatments, road management, or other operational activities in the watershed is expected to be very low in any given year.

Population-level Effects

Because even a general understanding of the ecology of Group #39 species is limited, and because only one of these species has been documented as present in the municipal watershed, population-level effects for these species cannot be specified with any certainty. The conservation and mitigation measures included in the HCP, however, because they provide substantial protection and improved conditions with respect to all key habitat in the municipal watershed, should have a beneficial effect on populations of any of these species that may occur in the watershed. Any short-term, local impacts to these species from restoration activities near wetlands and in or near riparian areas will be more than offset by long-term, landscape-level benefits. Protection in reserve status of all riparian areas, as well as increases in mature and late-successional forest habitat, will benefit populations of Group #39 species by facilitating the movement and dispersal of individuals throughout the municipal watershed, and the municipal watershed could serve as a population source in the future. Thus, the overall population-level effects should be positive for those species that may be present in the municipal watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for Group #39 species are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #40 – Snail (*Valvata mergella*)

Introduction

Valvata mergella is an aquatic snail whose only known population in North America occurs at Paradise Lake in Snohomish County, Washington. This species was observed in the Pacific Northwest and Alaska in the 1800s, but had not been recorded this century until it was confirmed in Paradise Lake in September 1995 (Richter 1995). No comprehensive surveys to determine the presence or absence of *V. mergella* have been conducted in the municipal watershed and no incidental observations of this species have been documented to date. Potential key habitat for *V. mergella* in the municipal watershed may be present in lakes (or ponds) with a muddy bottom and well oxygenated water. Given the lack of information on the habitat associations of *V. mergella*, the City also assumes that this species may use some other types of water bodies, including some streams.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any *V. mergella* that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any *V. mergella* resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury of *V. mergella* would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to the *V. mergella* through: (1) protection in reserve status of all key riparian habitat (including lakeshore), along with all lakes and ponds; (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and any potential effects on water bodies; (3) protection of all old growth and recruitment of a substantial amount of mature and late-successional forest over time, potentially promoting the reestablishment of natural functioning in streams, lakes, and ponds; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) stream restoration projects; (6) road improvements and substantial decommissioning, and improved road maintenance, reducing sediment loading to streams; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research.

V. mergella could be negatively affected by silvicultural treatments, road management, or other operational activities, especially those conducted in close proximity to lakes and streams. Although direct effects (direct injury to or death of individuals) would be unlikely, indirect effects, through influences on habitat, particularly water quality, might occur (e.g., excessive sediment or nutrient input).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the *V. mergella* are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all key habitat of *V. mergella*, are protected in reserve status. In addition, activities that could impact aquatic habitat are restricted near water bodies, and silvicultural treatments in riparian forest will be conducted in many areas of previously harvested riparian forest in order to restore natural ecological functions.

Short-term and long-terms gains in the quality of aquatic and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. Development of forest into mature and late-successional seral stages in such areas will help restore a more naturally functioning aquatic ecosystem, thus potentially benefiting this species. The HCP also includes management actions designed to help restore and enhance stream and riparian habitats. Stream bank stabilization projects, placement of large woody debris, a stream bank re-vegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas are all expected to help accelerate the restoration of natural aquatic and riparian ecosystem functioning and the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Restoration of a more naturally functioning aquatic ecosystem potentially benefits *V. mergella*, if the species occurs in the municipal watershed.

Silvicultural treatments and management activities associated with forest roads (including road construction, repair, maintenance, and decommissioning) can impact reservoirs, lakes, ponds, and streams through erosion and mass wasting that increases sediment loads and decreases water quality. Because no harvest for commercial purposes will occur in the municipal watershed, however, any potential impacts associated with commercial timber harvest are largely eliminated. During restoration or ecological thinning activities, no tree removal is allowed that has the potential to reduce streambank stability, and no tree removal will be allowed within 25 feet of any stream. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (Appendix 16) and other guidelines (Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with road systems and silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitat for *V. mergella*.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of *V. mergella* that may occur in the watershed include any operations that involve human activities on roads or near suitable habitat such as the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

The likelihood of direct take occurring at a level that may compromise the viability of any *V. mergella* populations in the watershed is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of *V. mergella* habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall level of habitat disturbance; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of the mitigation and minimization measures included in the HCP, the likelihood of disturbance to, direct injury to, or death of any *V. mergella* as a result of silvicultural treatments, road management, or other operational activities is expected to be extremely low. Because pertinent information regarding the ecology of *V. mergella* is lacking, the potential effects of water supply operations on a *V. mergella* population, if it were to exist in the reservoir system, are unknown.

Population-level Effects

Because pertinent information regarding the ecology of *V. mergella* is severely lacking, population-level effects for this species cannot be specified with any certainty. The conservation and mitigation measures included in the HCP, however, because they provide substantial protection and improved conditions with respect to all key habitats in the municipal watershed, should have a beneficial effect on any populations of this species that may occur in the watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) could provide information important to conserving *V. mergella*, if this species is discovered to be present in the municipal watershed. The adaptive management program descirbed in Section 4.5.7 could then be used to determine if the mitigation and minimization strategies for *V. mergella* are achieving their conservation objectives and could facilitate adjustments needed to make the strategies better achieve these objectives.

SPECIAL HABITATS

Group #10 – Peregrine Falcon

Introduction

No comprehensive surveys to determine the presence or absence of peregrine falcons have been conducted in the Cedar River Municipal Watershed and no incidental observations of this species have been documented to date. However, a nest has recently been documented within a few miles of the northern watershed boundary. Potential key habitat for peregrine falcons in the Cedar River Municipal Watershed includes cliffs and rock outcrops (potential nesting habitat), as well as natural open habitats (grass-forb meadows and persistent shrub communities) and open wetlands (palustrine emergent and palustrine scrub-shrub) used for foraging.

Certain kinds of human disturbance near nesting peregrines can influence nesting success. Significantly, because the primary function of the Cedar River Watershed is to supply drinking water to the City of Seattle and the surrounding region, the types and extent of human activities conducted within the municipal watershed differ substantially from those taking place on many nearby lands, especially those areas open to commercial timber harvest and/or a wide variety of public recreational activities.

No change in the amount of potential peregrine falcon habitat is expected over the 50-year term of the HCP, although the quality of many open habitats should increase as a consequence of placing all surrounding forest in reserve status. The HCP is expected to result in both short- and long-term benefits to peregrine falcons through: (1) protection through reserve status of all cliff and rock outcrop features, potentially used for nesting; (2) protection through reserve status of all natural open habitats used for foraging (e.g., meadows, persistent shrub, and wetlands) in the watershed; (3) elimination of timber harvest for commercial purposes within the watershed, reducing levels of human disturbance associated with log haul; (4) removal of 38 percent of watershed roads, reducing human disturbance related to all types of road use; (5) monitoring and research; and (6) protection of nesting pairs from human disturbance, as well as continued closure of the watershed to unsupervised public access.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any peregrine falcons that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any peregrine falcons resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low under the HCP, as is the likelihood of disturbance to any actively nesting peregrine falcon pairs. However, any such death, direct injury, or disturbance leading to injury or death would constitute an impact equivalent to take as applied to those species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect. (The peregrine was recently delisted, but could be listed again at some time in the future.)

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the peregrine falcon are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas are in reserve status. As a result, all key habitat (cliffs, rock outcrops, natural open habitats, and nonforested [open] wetlands) for the peregrine falcon within the municipal watershed is in reserve status. No changes in acreage of potential key habitat for the peregrine falcon will occur under the HCP, although the overall quality of many open habitats that could be used for foraging should increase as a consequence of placing all surrounding forest in reserve status. In addition, both foraging and nesting habitat quality for the peregrine falcon is expected to improve through the decrease in human activity throughout the watershed.

Disturbance Effects

The primary activities that may result in disturbance, and possibly take, of peregrine falcons in the watershed under the HCP include any operations that involve human activities on roads or in or near suitable foraging or nesting habitat when in use, including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years, with the potential for more removal later; (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbance to any actively nesting peregrine falcon pair in the watershed, however, is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of active peregrine falcon nest sites from human disturbance; (2) elimination of commercial logging activities (including log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the municipal watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term. In addition, as for other species addressed in the HCP that utilize special habitats, during watershed operations near any cliffs and rock outcrops a 200-foot zone, in which activities will be restricted, will be established to minimize the potential for habitat impacts or disturbance to peregrine falcons. And, should this species eventually nest within the municipal watershed, the City will not harvest or cut trees or construct roads within 0.5 mile of a known active peregrine nest site between March 1 and July 31 or within 0.25 mile at other times of the year.

Direct Take

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any peregrine falcon resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low.

Population-level Effects

The HCP protects all potential nesting and foraging habitat for peregrine falcons in the municipal watershed, including all cliffs, rock outcrops, natural open habitats, and open wetlands. The 90,546-acre municipal watershed is also contiguous with other protected lands, especially to the north, that are included within the federal late-successional reserve system. Falcons have recently nested just north of the municipal watershed, and this unusual extent of contiguous protected habitat and landscape connectivity may encourage falcons to reestablish within the watershed and thereby contribute to the continued recovery of the peregrine falcon population on a regional level.

Other Effects

If peregrine falcon reproductive activity is documented within the Cedar River Municipal Watershed, nests will be monitored to provide information that can be used to develop guidelines to minimize disturbance. The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for the peregrine falcon are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #11 – Grizzly Bear

Introduction

No comprehensive survey has been conducted to determine the presence or absence of grizzly bears in the Cedar River Municipal Watershed, and no incidental observations have been confirmed to date. In addition, despite the fact that grizzly bears are relatively easy to identify by sight and/or field evidence, the species has not been detected in the watershed, despite extensive field activity. Therefore, it is unlikely that grizzly bears are presently breeding or denning in the Cedar River Municipal Watershed on any consistent basis. However, the southernmost portion of the North Cascades Ecosystem Recovery Zone is located approximately 3 linear miles north of the eastern portion of the Cedar River watershed and highly reliable grizzly bear sightings have occurred both north and south of the watershed during the last ten years. Therefore, although no reliable observations of this type of activity have been documented in the watershed, a reasonable possibility exists that individual grizzly bears may occasionally use the municipal watershed as a travel or dispersal corridor.

Grizzly bears typically establish large home ranges that may include up to 1,500 square miles and are also known to disperse over long distances. The relative size of the municipal watershed (141 square miles) compared with potential home range size would suggest that the watershed, in itself, would be unlikely to support resident grizzly bears (might be included in a home range) and might more adequately meet the requirements of dispersing individuals, serving as a dispersal corridor connecting larger blocks of suitable habitat. Both resident and dispersing bears utilize a wide variety of habitats, ranging from open, non-forested types to older, closed canopy forest, on a seasonal basis. Although both resident and dispersing bears might, at times, utilize the majority of forested and non-forested habitat types over the entire elevation range within the watershed, potential key habitats present in the Cedar River Watershed are considered to include upland meadows, talus, persistent shrub communities, emergent wetlands, riparian areas, and closed canopy forest, especially mature to old-growth forest stages. Other habitat types present in the watershed are considered secondary.

Human disturbance (e.g., vehicle traffic, recreational activities) has been identified as a major factor influencing the suitability and use of habitat by grizzly bears. The availability of core areas, comprised of habitat that is more than 0.3 miles from open roads, motorized trails, or high-use hiking trails, and measures of road density have been used recently by federal agencies to evaluate and compare the potential suitability, relative to human disturbance, of habitat for the grizzly bear on a seasonal basis. Significantly, because the primary function of the Cedar River Watershed is to supply drinking water to the City of Seattle and the surrounding region, the types and extent of human activities conducted within the municipal watershed differ substantially from those taking place on many nearby lands, especially those areas open to commercial timber harvest and/or a wide variety of public recreational activities.

Therefore, the most significant factors associated with the Cedar River Municipal Watershed relative to protection of the grizzly bear in the Washington Cascades are 1) the fact that the municipal watershed is located in the central Washington Cascades within a potential dispersal corridor between the Recovery Zone and several areas of protected habitat to the south (e.g., Mt. Rainier National Park) which may play a significant role in linking important areas of grizzly bear habitat within the region; (2) the substantially lower level (and type) of human disturbance occurring within the watershed relative to surrounding areas; and (3) the protection of all key habitats.

The combination of mitigation and minimization measures committed to in the HCP protects any grizzly bears that may occur in the municipal watershed. The likelihood of direct injury or death of any grizzly bear resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low under the HCP, as is the likelihood of disturbance to any actively denning individual or adult bear with offspring. However, any such death, direct injury, or disturbance leading to such injury or death would constitute take under the ESA.

A net gain of potential grizzly bear habitat (foraging, denning, and dispersal) and reduction in the effects of human disturbance is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to grizzly bears through: (1) elimination of timber harvest for commercial purposes within the watershed, virtually eliminating large scale habitat impacts and substantially reducing disturbance resulting from road use; (2) removal of 38 percent of watershed roads, thereby providing additional core habitat and reducing disturbance levels; (3) continued closure of the municipal watershed to unsupervised public access, thus essentially eliminating disturbance resulting from recreational activity; (4) protection of all non-forested key habitats; (5) protection of all existing old-growth forest which also serves to protect inclusions of non-forested key habitat; (6) natural maturation of second-growth forests into mature and late-successional seral stages, thus reestablishing more natural ecosystem function; (7) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (8) protection of denning bears from human disturbance; and (9) monitoring and research.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the grizzly bear are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests outside developed areas, including all 13,889 acres of old-growth forest, are in reserve status,. As a result, all key habitat (upland meadows, talus, persistent shrub communities, emergent wetlands, riparian areas, and closed canopy forest, especially mature to old-growth forest stages), as well as secondary habitat, for the grizzly bear within the municipal watershed is in reserve status.

The HCP protects all forested and non-forested habitat, outside limited developed areas, in the watershed, thereby protecting all potential key habitat, as well as other secondary and potential habitat for the grizzly bear in the Cedar River Municipal Watershed. A majority of this habitat is found within the spotted owl Critical Habitat Unit (CHU) in the higher elevation, eastern portion of the watershed. Protection of key habitat in the CHU is also of primary significance because the CHU is the most remote and least roaded part of the watershed. Also, because of its proximity to the Alpine Lakes Wilderness Area, the CHU is the area of the watershed most likely to be occupied by colonizing grizzly bears or traversed by dispersing or transient individuals.

The HCP also benefits grizzly bears through the restoration and/or development of certain key habitats in the municipal watershed. The HCP is expected to result in short- and long-term benefits to grizzly bears through: (1) natural maturation of second-growth forests into mature and late-successional seral stages, especially in aquatic buffers and riparian areas; (2) management actions designed to restore more-natural functioning in riparian ecosystems; and (3) management actions designed to accelerate the development of mature, late-successional, and old-growth characteristics in second-growth forests.

Grizzly bears are omnivorous and opportunistic foragers, including vegetation, live prey, and carrion in their regular diet. Ungulates, including elk and deer, typically comprise a substantial portion of the grizzly bear diet (either live or as carrion). Both elk and black-tailed deer populations are present in the watershed and, although their habitat use patterns differ, they both utilize a range of open habitats (for foraging) and closed forests (for cover). High levels of commercial timber harvest create an artificially high abundance of herbaceous and shrub forage as compared with more natural systems, and ungulate populations typically respond accordingly. However, because a major focus of the HCP is the protection of old-growth dependent species and the protection and restoration of naturally functioning, late-successional and old-growth dominated ecosystems, ungulate populations favored in early successional stage forests, in general, will not sustain the relatively high numbers of animals present in recent years within the previously harvested areas of the watershed.

Despite a decrease in early seral stage forest habitat, especially in the upper watershed, both elk and deer populations will continue to exist under the HCP management regime and will re-equilibrate with the maturing forest landscape, presumably at some lower population level. This particular aspect of habitat maturation on ungulate populations will not especially favor the grizzly bear, because types of open habitat other than harvest units are limited in the watershed. However, future habitat conditions, and resultant wildlife populations, within the watershed will be more similar to those expected in the unharvested, native coniferous forest ecosystems to which the grizzly bear is adapted. Also, despite the decrease of early- and mid-seral forest habitat within the watershed over time, much of the land adjacent to the watershed, especially to the south and east, will continue, presumably, to be managed as commercial timberland. Under this type of land management regime early- and mid-seral forest habitats, as well as relatively higher numbers of ungulates as a prey base, will be available to grizzly bears well within their potential home range.

Disturbance Effects

Grizzly bears require areas substantially free from human disturbance, especially during denning periods. Areas more than 0.3 mile from a road are termed "core" habitat (see below) and are considered most important for these bears (Interagency Grizzly Bear Committee 1994). Unsupervised public access to the municipal watershed is not allowed except within the Rattlesnake Lake Recreation Area and below the water supply intake at Landsburg on the western administrative boundary. Therefore, recreational activities (e.g., hiking, motor and trail bikes, camping) are restricted within the watershed. Some hiking trails, including a section of the Pacific Crest Trail at the eastern end of the watershed, currently exist or are planned for development along selected sections of the watershed boundary. No recreational trails are currently present or planned within the interior of the municipal watershed. In addition, all road access points to the municipal watershed are gated (locked) at the administrative boundary and access is by permit only.

Since no commercial timber harvest will be conducted within the municipal watershed and virtually all log hauling will be eliminated, road use and traffic levels will be significantly different from that incurred on commercial forest transportation systems and recreational lands. The types of traffic on the watershed transportation system will result primarily from: 1) road maintenance and limited construction activities for road improvements and decommissioning; (2) silivicultural treatment projects (3) surveillance activities related to drinking water protection; (4) research and monitoring projects; and (5) other routine operational activities. With the exception of routine road maintenance, limited road construction and silvicultural projects, and in some cases, operational activities, light vehicle traffic will predominate. Many roads, especially at higher elevations and in more remote areas of the watershed will receive minimum vehicle trips in most years. Most vehicle traffic will, in all probability, be confined to major roads, road systems, and sampling routes most directly associated with operating the water supply system.

A conservative, preliminary analysis estimating the availability of core habitat available within the watershed, which considered all watershed roads (not differentiated by activity level) and all habitat types (open water excluded), indicates that a total of 6,554 acres of core habitat, in 51 individual blocks, currently exists within the watershed. The individual blocks of core habitat included in this total range in size from less than one acre to more than 2,000 acres. The four largest individual blocks of contiguous core habitat within the watershed, totaling 5,061 acres (77 percent), are located mostly in the CHU. These four blocks of core habitat contain 2,038, 1,616, 960, and 447 acres and are located in the areas of Mt. Baldy/Abiel Peak/Tinkham Peak on the northern boundary, Findley Lake, Meadow Mountain, and Goat Mountain, respectively. The remaining

1,493 acres (23 percent) of habitat greater than 0.3 miles from a road, contained in 47 smaller blocks, is scattered throughout other areas of the watershed, but no single block is greater than 200 acres in size.

Under the HCP, after projected road removal is completed, a total of 12,975 acres of core habitat (67 individual blocks), representing an increase of 6,421 acres (98 percent increase) from current conditions, will exist by the end of the 50-year HCP term. In fact, most of the substantial increase of core habitat will be realized during the first two decades of the HCP, solely as a result of an aggressive road-decommissioning program. The individual blocks of core habitat included in this projected total will range in size from less than one acre to more than 3,000 acres. The five largest individual blocks of contiguous core habitat, totaling 8,353 acres (64 percent of total) will, as before, be mostly located within the CHU. This acreage will consist of large blocks containing 3,001, 2,418, 1,221, 932, and 781 acres. The increases in core habitat will accrue primarily to the large blocks of contiguous core habitat in the same areas as indicated above with the addition of one unit in the upper Taylor Creek Basin. This analysis of projected core habitat indicates that each of the original existing blocks of core habitat will increase in area under the HCP and a fifth block of core habitat greater than 500 acres in size will be created. An additional 4,622 acres of habitat (36 percent of total) greater than 0.3 miles from a road will be present, distributed in other areas of the watershed, including six individual blocks, each greater than 300 acres in size.

The amounts of core habitat potentially available to grizzly bears within the Cedar River Municipal Watershed under current conditions and as expected under the HCP, as presented immediately above, are considered conservative estimates. All roads in the watershed were considered “open” and not differentiated as to type and level of use for the analyses, nor were they classified by seasonal usage. Therefore, since the maximum amount of road was used in the analyses, the area estimates represent the minimum amount of core habitat that would be available to grizzly bears within the watershed during any given season or year. Because many roads, especially at higher elevations and in more remote areas of the watershed, are not driveable or, will in all probability receive a minimum number of vehicle trips in most years, they could be classified as “impassable” or “restricted” and considered as part of core habitat. In such case, the estimates of core habitat for both current and future conditions under the HCP would increase substantially.

Thus, the primary activities under the HCP that may result in disturbance, and possibly of take, of grizzly bears that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat, and include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later; (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year after year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) some types of research and monitoring.

However, the likelihood of disturbance to any actively denning grizzly bears in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and avoidance of silvicultural treatments, road management, and other operational activities within 1.0 mile of active grizzly bear dens from October 1 to

May 30 and within 0.25 mile during the rest of the year; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which reduces potential mortality or injury from motor-vehicle collisions and reduces the ability of poachers and trespassers to harass or harm bears; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement and use over the long term. Road removal, particularly in the upper municipal watershed (within the CHU), and closure of roads to public use is important for three reasons – (1) bears are potentially more likely to occur in the upper municipal watershed, (2) the greatest amount of existing core habitat occurs in the upper municipal watershed, and (3) the greatest opportunity to produce additional core habitat through selective road decommissioning also occurs in the upper municipal watershed.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of any grizzly bears resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Direct Take

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to or death of any grizzly bear resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low.

Population-level Effects

The HCP maintains and, over time, substantially increases both the total number and size of many individual, large blocks of core habitat within the watershed, especially within the CHU. Although blocks of core habitat will be distributed throughout the watershed, the largest blocks of contiguous core habitat will be located within the CHU in the eastern section. All elements of grizzly bear key habitat will be available within the CHU and within these larger blocks of core habitat, in particular. In addition, several blocks of contiguous core habitat within the CHU will also be contiguous with other blocks of habitat to the north, east, and south of the watershed, including lands in the federal Late-Successional Reserve (LSR) system. This landscape connectivity may benefit the grizzly bear population on a more regional level by facilitating movement and dispersal of individuals between the municipal watershed and other watersheds to the north, east, and south (especially the Alpine Lakes Wilderness Area to the north).

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the grizzly bear are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives. If grizzly bear dens are discovered within the Cedar River Municipal Watershed, they will be monitored to provide information that can be used to develop guidelines to minimize disturbance.

Group #12 – Gray Wolf

Introduction

No comprehensive surveys have been conducted to determine the presence or absence of gray wolves in the Cedar River Municipal Watershed, and no incidental observations have been confirmed to date. In addition, because the species is relatively easy to identify by sight and/or by calls, and yet has not been detected despite extensive field activity, it is unlikely that gray wolves are present in the Cedar River Municipal Watershed on any consistent basis. However, this assessment does not negate the possibility that individuals may occasionally use the municipal watershed as a travel or dispersal corridor. Gray wolves typically have large home ranges and utilize a wide variety of habitats ranging from open, non-forested types to older, closed canopy forest, as long as an adequate ungulate prey base is present and human activity is low. Den sites have been observed in sandy soils in river bottomlands, in hollow logs and hollow trees typically present in late-successional and old-growth forests, and in caves. Potential key habitats present in the Cedar River Watershed include rock outcrops, upland meadows, persistent shrub communities, riparian areas, and old-growth forests. Secondary habitats include other forested areas, which could be used for cover or dispersal.

Human disturbance (e.g., vehicle traffic, recreational activities) has been identified as a major factor influencing the suitability and use of habitat by gray wolves. Measures of road density have been used recently by federal agencies to evaluate and compare the potential suitability, relative to human disturbance, of habitat for the gray wolf and security habitat is considered to be areas with a density of open roads less than 1 mi/mi^2. Significantly, because the primary function of the Cedar River Watershed is to supply drinking water to the City of Seattle and the surrounding region, the types and extent of human activities conducted within the municipal watershed differ substantially from those taking place on many nearby lands, especially those areas open to commercial timber harvest and/or a wide variety of public recreational activities.

Although the overall density of "open" roads is 4.2 mi/mi^2 now and will be about 2.7 mi/mi^2 after the road decommissioning plan has been completed after about HCP year 20, the relatively low level of human use of most municipal watershed roads compared to other watersheds may result in many areas of the municipal watershed effectively serving as security habitat. This may particularly be the case in the CHU, in the easternmost portion of the watershed, where road density will be lowest and road use will likely be the least.

The most significant factors associated with the Cedar River Municipal Watershed relative to protection of the gray wolf in the Washington Cascades are 1) the fact that the municipal watershed is located in a potential zone of recolonization, and is a potential dispersal corridor between the population in the North Cascades and several areas of protected habitat to the south (e.g., Mt. Rainier National Park) which may play a significant role in linking important areas of wolf habitat within the region; (2) the substantially lower level (and type) of human disturbance occurring within the watershed relative to surrounding areas; and (3) the protection of all key habitats.

The combination of mitigation and minimization measures committed to in the HCP protects any gray wolves that may occur in the municipal watershed. The likelihood of direct injury or death of any gray wolf resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low under the

HCP, as is the likelihood of disturbance to any actively denning individual or adult wolf with offspring. However, any such death, direct injury, or disturbance leading to such injury or death would constitute take under the ESA.

Under the HCP, all key habitat will be protected, a net gain of gray wolf security habitat may occur over the 50-year term as a result of extensive road decommissioning, and a reduction in the effects of human disturbance is also expected. The HCP is expected to result in both short- and long-term benefits to gray wolves through: (1) elimination of timber harvest for commercial purposes within the watershed, virtually eliminating large scale habitat impacts and substantially reducing disturbance resulting from road use; (2) removal of 38 percent of watershed roads, thereby providing additional security habitat and reducing disturbance levels; (3) continued closure of the municipal watershed to unsupervised public access, thus essentially eliminating disturbance resulting from recreational activity; (4) protection of denning wolves from human disturbance; (5) protection of all non-forested key habitats; (6) protection of all existing old-growth forest, which provides denning sites and also serves to protect inclusions of non-forested key habitat; (7) natural maturation of second-growth forests into mature and late-successional seral stages, thus reestablishing more natural ecosystem function and providing more denning sites; (8) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; and (9) monitoring and research.

As a consequence of the elimination of timber harvest for commercial purposes, however, the ungulate populations in the watershed are expected to decrease over the term of the HCP. As no early seral forest habitat will be created by other than natural processes, the amount of early seral habitat, and the herbaceous/shrub forage supply for ungulates, will decrease. Insofar as wolves depend on an ungulate prey base, the capacity of the watershed to support wolves may diminish over time, unless the reduced human disturbance level is more important than the reduced prey base. Two additional considerations are (1) that the overall watershed landscape will be more similar to the natural landscape to which wolves in the region are adapted, and (2) considerable early seral forest habitat is being created by commercial timber operations on land adjacent to the watershed, supporting populations of ungulates that are likely larger than those present prior to commercial timber harvest in the region.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the gray wolf are detailed in Section 4.2.2 of the HCP and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests outside developed areas, including all 13,889 acres of old-growth forest, are in reserve status,. As a result, all key habitat for the gray wolf (rock outcrops, upland meadows, persistent shrub communities, riparian areas, and old-growth forest) within the municipal watershed is in reserve status, as well as all secondary habitat outside limited developed areas. The amount of security habitat may increase as road densities, thus human activities related to roads, are reduced over time.

The majority of the key habitat for wolves is found within the spotted owl CHU in the higher elevation, eastern portion of the watershed. Protection of key habitat in the CHU is also of primary significance to the gray wolf because the CHU is the most remote and least roaded part of the watershed (see effects analysis for Group #11, grizzly bear). Also, because of its proximity to the Alpine Lakes Wilderness Area, the CHU is the area of the watershed most likely to be occupied by colonizing gray wolves or traversed by dispersing or transient individuals.

The HCP will also benefit wolves through the restoration and/or development of certain potential key habitats for gray wolves in the municipal watershed. The proposed HCP is expected to result in short- and long-term benefits to gray wolves through: (1) natural maturation of second-growth forests into mature and late-successional seral stages, providing additional den sites and potentially better foraging conditions for ungulates than mid-seral forest; (2) management actions designed to restore a more naturally functioning forest ecosystem; and (3) management actions designed to accelerate the development of mature, late-successional, and old-growth characteristics in second-growth forests.

Gray wolves are carnivorous predators that typically rely on ungulates (elk and deer) as a primary component of their diet and require adequate populations of these species within their range in order to sustain healthy packs and a viable population. Both elk and black-tailed deer populations are present in the watershed. Although patterns of habitat use differ, both species use a range of open habitats for foraging and closed-canopy forest, and/or dense understory vegetation for cover. High levels of commercial timber harvest create an artificially high abundance of herbaceous and shrub forage for deer and elk as compared with more natural systems, and ungulate populations typically respond accordingly.

Because a major focus of the HCP is the protection of old-growth dependent species and the protection and restoration of naturally functioning, late-successional and old-growth dominated ecosystems, however, ungulate populations favored in early-successional stage forests, in general, will not sustain the relatively high numbers of animals present in recent years within the previously harvested areas of the watershed.

Despite a decrease in early-seral stage habitat, especially in the upper watershed, both elk and deer populations will continue to exist under the HCP management regime and will re-equilibrate with the maturing forest landscape, presumably at some lower population level. Because types of open habitat other than harvest units are limited in the watershed, this particular effect of forest habitat maturation on ungulate populations will not especially favor the gray wolf. Several considerations, however counteract this reduction in prey base: (1) that the overall watershed landscape will become, over the term of the

HCP, more similar to the natural landscape and prey availability to which wolves in the region were adapted, and (2) considerable early seral forest habitat is being created by commercial timber operations on land adjacent to the watershed, supporting populations of ungulates that are likely larger than those present prior to commercial timber harvest in the region. Considering the large home range of wolf packs and the high availability of ungulate prey in areas adjacent to the watershed, it is possible that the reduction of early seral habitat within the watershed may be less important to future wolf populations than the reduction in road density, decrease in human activity on roads, potential increase in the amount of security habitat, and potential increase in denning sites during the term of the HCP.

Disturbance Effects

Gray wolves require areas away from human disturbance, especially during reproductive (denning) periods. Wolves avoid areas with greater than approximately 1 mi/mi^2 of *open* roads (Mladenoff et al. 1995); as described above, habitat with these characteristics is considered to be "security habitat." Uses of forest roads and trails in this region that could most impact wolves include recreational activities and log haul for commercial timber harvest, and potential impacts on wolves are dependent on the level of these activities. When the levels of these types of human activities are very low, an "open" road may be treated by wolves as a closed road, effectively increasing the potential for habitat in an area to serve as security habitat.

Unsupervised public access to the municipal watershed is not allowed except within the Rattlesnake Lake Recreation Area and below the water supply intake at Landsburg on the western administrative boundary. Therefore, recreational activities (e.g., hiking, motor and trail bikes, camping) are restricted within the watershed. Some hiking trails, including a section of the Pacific Crest Trail at the eastern end of the watershed, currently exist or are planned for development along selected sections of the watershed boundary. No recreational trails are currently present or planned within the interior of the municipal watershed. In addition, all road access points to the municipal watershed are gated (locked) at the administrative boundary and access is by permit only.

Since no commercial timber harvest will be conducted within the municipal watershed under the HCP, and virtually all log hauling will be eliminated, road use and traffic levels will be significantly different from that incurred on commercial forest transportation systems and recreational lands. The types of traffic on the watershed transportation system will result primarily from: 1) road maintenance and limited construction activities for road improvements and decommissioning; (2) silvicultural treatment projects (3) surveillance activities related to drinking water protection; (4) research and monitoring projects; and (5) other routine operational activities. With the exception of routine road maintenance, limited road construction and silvicultural projects, and in some cases, operational activities, light vehicle traffic will predominate. Many roads, especially at higher elevations and in more remote areas of the watershed, will receive very few vehicle trips in most years. Most vehicle traffic will, in all probability, be confined to major roads, road systems, and sampling routes most directly associated with operating the water supply system.

While only a few areas of the watershed may qualify in the future as security habitat for wolves when only road density is considered, the relatively minor use of many roads, particularly in the CHU, is likely to allow certain areas to serve as security habitat. In addition, large blocks of habitat at least 0.3 miles from roads will increase substantially under the HCP as a result of the road-decommissioning program (see the effects analysis for Group #11, grizzly bear).

The primary activities under the HCP that may result in disturbance, and possibly take, of gray wolves that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat, and include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year after year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) some types of research and monitoring.

The likelihood of disturbance to any actively denning gray wolves in the watershed is, however, expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and avoidance of silvicultural treatments, road management, and other operational activities within 1.0 mile of active gray wolf dens from March 1 to July 31 and within 0.25 mile during the rest of the year; (2) restriction of activities near any known rendezvous sites and development of a mitigation plan with the Services for any wolves discovered in the watershed; (3) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (4) compliance with Washington Forest Practice Rules; (5) the City’s policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which reduces potential mortality or injury from motor-vehicle collisions and also reduces the ability of poachers and trespassers to harass or harm wolves; and (6) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term. Road removal, particularly in the upper municipal watershed (within the CHU), and closure of roads to public use is important for three reasons – (1) wolves are potentially more likely to occur in the upper municipal watershed, (2) security habitat is more likely to be present in the upper watershed, and (3) the greatest opportunity to produce security habitat through selective road decommissioning also occurs in the upper municipal watershed.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any gray wolves resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Direct Take

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any gray wolf resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low.

Population-level Effects

The HCP creates a large block of older forest in the CHU. This block is contiguous with lands to the north, east, and south of the watershed at its upper (eastern) end, including lands within the federal Late-successional Reserve system (LSR). This landscape connectivity may benefit the gray wolf population on a more regional level by facilitating movement and dispersal of individuals between the municipal watershed and other watersheds to the north, east, and south (especially the Alpine Lakes Wilderness Area to the north).

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for the gray wolf are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives. If gray wolf dens are discovered within the Cedar River Municipal Watershed, they will be monitored to provide information that can be used to develop guidelines to minimize disturbance.

Group #21 – Band-tailed Pigeon

Introduction

Band-tailed pigeons are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted and no nests or breeding activity have been documented to date. Key habitats for band-tailed pigeons are considered to be mineral springs and low-elevation coniferous and mixed forests, but no mineral springs are known to exist in the municipal watershed. Band-tailed pigeons nest in trees and use a variety of open and forested habitats for foraging, including natural meadows, small patches of early-seral forest (grass-forb-shrub and open canopy stages), and mixed deciduous and conifer forest. Closed-canopy conifer and conifer/hardwood forest are preferred for nesting, and band-tailed pigeons are known to travel long distances to mineral springs and foraging areas. Band-tailed pigeons forage in smaller patches of early-seral forest habitat that are near closed canopy forest, but appear to avoid old growth.

The band-tailed pigeon could be negatively affected by silvicultural treatments, road management, or other operational activities, especially in low- to mid-elevation forests in the watershed. Such effects could be both direct (e.g., through destruction of an active nest caused by silvicultural treatment activities) or indirect, through disturbance or influences on habitat (e.g., removal of overstory).

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any band-tailed pigeons that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any band-tailed pigeons resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting band-tailed pigeon pairs. However, any such death, direct injury, or disturbance of band-tailed pigeons leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in long-term benefits to band-tailed pigeons through: (1) protection of any mineral springs, if discovered; (2) protection through reserve status of all natural open habitat used for foraging (e.g., meadows, persistent shrub, and wetlands) in the watershed; (3) elimination of timber harvest for commercial purposes in the watershed, reducing the level of habitat disturbance and the likelihood of disturbance of nesting activities; (4) silvicultural treatments in riparian and upland second-growth forests, insofar as such treatments result in the increased production of fruits used by band-tailed pigeons; (5) development, through forest maturation and natural disturbances, of a landscape more similar to the natural landscape to which the band-tailed pigeon is adapted; (6) monitoring and research; and (7) closure of the watershed to unsupervised public access, reducing potential disturbance near nests or direct mortality as a result of hunting.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for band-tailed pigeons are described in Section 4.2.2 and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all forests outside limited developed areas are in reserve status. As a result, all key habitat (mineral springs, if any exist, and low-elevation coniferous and mixed forests) for the band-tailed pigeon within the municipal watershed is in reserve status.

Although no mineral springs (a key habitat type) have been identified in the watershed, the HCP calls for the protection of any mineral spring discovered during the term of the HCP. All natural open habitat used for foraging (e.g., meadows, persistent shrub, and mapped wetlands) in the watershed is protected through reserve status. Silvicultural treatments in riparian and upland second-growth forests will be designed to develop more extensive shrub layers, and should, in some cases, result in the increased production of fruits used by band-tailed pigeons, including red elderberry, *Sambucus racemosa*, and huckleberry (*Vaccinium*) species.

Band-tailed pigeons also forage in habitats affected by human activities, including early-seral forest that is in small patches near forest edges. As a consequence of the elimination of timber harvest for commercial purposes, however, the overall amount of early-seral forest habitat in the watershed is expected to decrease over the term of the HCP. Early-seral forest habitat will be created largely by natural processes, such as windstorms and disease, and several decades from now is likely to be in patches smaller than those present today.

It is not clear what effect the change in forest age distribution in the municipal watershed during the term of the HCP will have on band-tailed pigeons, but considerable early-seral forest habitat is being created by commercial timber operations on land adjacent to the watershed. The fact that band-tiled pigeons fly long distances to forage may make such nearby habitat useful to pairs nesting in the municipal watershed, if early-seral forest is important. In addition, the overall landscape in the municipal watershed will be more similar to the natural landscape to which band-tailed pigeons in the region are adapted.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in disturbance, and possibly the equivalent of take, of band-tailed pigeons that may occur in the watershed include any operations that involve human activities on roads or in suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

However, the likelihood of disturbance to any actively nesting band-tailed pigeons in the watershed is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) elimination of timber harvest for commercial purposes in the watershed, reducing overall habitat disturbance and log hauling on roads; (2) interdisciplinary team site evaluations and protection of known, active band-tailed pigeon nest sites from human disturbance prior to silvicultural or road management activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any band-tailed pigeons resulting from silvicultural treatments, road management, or other operational activities is expected to be very low. Nonetheless, occasional nests might be damaged inadvertently as a result of silvicultural treatments or other management actions.

Population-level Effects

No significant population-level effects are expected. The net effect of forest habitat changes on band-tailed pigeons is not known. Reductions of early-seral habitat may be offset to some extent by silvicultural treatments that increase shrubs that produce fruit eaten by band-tailed pigeons. Because nests are hard to find, some nesting pairs could be disturbed during silvicultural treatments, despite site evaluations by interdisciplinary teams. This relatively minor risk of disturbance should be more than countered, however, by protection of any mineral springs and known nests, and, most significantly, by elimination of the major source of potential nesting disturbance in the area: commercial timber harvest.

Other Effects

The monitoring and research program committed to in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for band-tailed pigeons are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #22 – Rufous Hummingbird, Western Bluebird

Introduction

The rufous hummingbird is common throughout the Cedar River Municipal Watershed. The western bluebird is known to occur only occasionally in the watershed, and no breeding activity has been observed. Potential key habitat for the rufous hummingbird in the municipal watershed is natural open habitat (meadows, persistent shrub communities, and meadow complexes), some open wetlands (palustrine emergent and scrub-shrub), open riparian habitats, and other areas where nectar-producing flowers of preferred species are available. Rufous hummingbirds also use early seral-stage forest (grass-forb-shrub and open canopy stages) and secondarily use some other types of conifer forest where forage plants are present.

Potential key habitat for the insectivorous western bluebird in the municipal watershed is natural open habitat (meadows and persistent shrub communities), open wetlands (palustrine emergent and scrub-shrub), open riparian habitats, and natural forest openings and other forest clearings, particularly where snags are present. Western bluebirds nest in holes, using abandoned woodpecker holes in snags in burned areas or nest boxes placed at forest edges or in other open areas. Western bluebirds also use some early seral-stage forest (grass-forb-shrub and open canopy stages) and some other types of open conifer forest.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any rufous hummingbirds or western bluebirds that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any rufous hummingbirds or western bluebirds resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting pairs of these species. However, any such death, direct injury, or disturbance of rufous hummingbirds or western bluebirds leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to rufous hummingbirds and western bluebirds that may use the watershed primarily through: (1) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and the likelihood of disturbing nesting activities; (2) protection through reserve status of all natural open habitats used for foraging (e.g., meadows, persistent shrub, and wetlands) in the watershed; (3) silvicultural treatments in riparian and upland second-growth forests, insofar as these treatments result in creation and recruitment of snags that could provide nest sites for western bluebirds and development of shrub layers that could provide foraging opportunities for hummingbirds; (4) protection of known nesting pairs from human disturbance; (5) removal of 38 percent of watershed roads, reducing the level of human disturbance; (6) monitoring and research; and (7) closure of the watershed to unsupervised public access, reducing potential disturbance near nests.

Rufous hummingbirds and western bluebirds could be negatively affected by silvicultural treatments, road management, or other operational activities in or near habitats used by either species. Such effects could be direct (e.g., destruction of active nests) or indirect, through influences on habitat (e.g., removal of vegetation) or disturbance. The loss of early seral habitat created artificially by commercial timber harvest could reduce the carrying capacity of the watershed for the rufous hummingbird, and possibly for the western bluebird, although the future landscape will develop into one more similar to the natural landscape to which these species are adapted.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for rufous hummingbirds and western bluebirds are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas are in reserve status. As a result, all key habitat (natural open habitats) for the rufous hummingbird within the municipal watershed is protected through reserve status. No appreciable changes in acreage of potential key habitat for these species will occur under the HCP, however the quality of some habitats may improve, and the habitats may develop more natural characteristics as forest adjacent to open habitats matures. In addition, overall habitat quality for the rufous hummingbird and western bluebird is expected to improve through the decrease in human activity throughout the watershed, through the protection of natural open habitats whenever watershed operations are conducted nearby, and through active intervention to help restore natural habitat function and quality.

Silvicultural treatments in riparian and upland second-growth forests will be designed to develop a more extensive shrub layer and to create and recruit snags. In some cases, these treatments should result in increased numbers of flower-producing plants that hummingbirds may use for foraging and snags near open areas that western bluebirds may use for nesting.

Both rufous hummingbirds and western bluebirds also forage in habitats affected by human activities, including some early seral forest. As a consequence of the eliminating timber harvest for commercial purposes, however, the overall amount of early seral forest habitat in the watershed is expected to decrease over the term of the HCP. Early seral forest habitat will be created largely by natural processes, such as windstorms and disease, and several decades from now is likely to be in patches smaller than those present today. The overall landscape in the municipal watershed, however, will be more similar to the natural landscape to which these species adapted within this region. It should be noted that considerable amounts of early seral forest habitat created by commercial timber harvest will likely be available in many areas adjacent to the watershed, and that the amount of early seral forest habitat available in the region has not been a major factor in recent declines of these species, nor is it likely to be in the future.

Disturbance Effects and Direct Take

The primary activities that may result in disturbance to, and possibly the equivalent of take of, rufous hummingbirds in the watershed under the HCP include any operations that involve human activities on roads or in or near suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbance to any actively nesting rufous hummingbirds or western bluebirds in the watershed, however, is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active rufous hummingbird and western bluebird nest sites from human disturbance, partly through the use of site evaluations and interdisciplinary teams prior to silvicultural activities near potential nesting areas; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any rufous hummingbirds or western bluebirds resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

It is possible that the projected decrease in the acreage of early seral-stage habitats in the municipal watershed over the 50-year HCP term may reduce the carrying capacity of the watershed for one or both of these species. Several measures included in the HCP, however, may offset some or all of the potential effect of reduction in foraging habitat on populations of these species.

Because western bluebirds are considered to be an incidental species in the watershed, and because loss of snags is known to be one factor that has reduced regional populations of this species, efforts to create and recruit snags near open areas may offset the reduction in early seral forest habitat. Likewise, efforts to increase development of understory shrubs in second-growth conifer forest may offset, at least to some extent, loss of early seral forest habitat for rufous hummingbirds. Because the amount of early seral forest habitat is unlikely to be limiting to these species at this time, and because considerable areas of clearcuts can be expected to be available on nearby private timberlands, it is unlikely that the elimination of commercial timber harvest in the watershed will have a negative effect on regional populations of either species, particularly in view of the measures in the HCP to reduce human disturbance levels and the development of a more natural landscape.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for rufous hummingbirds and western bluebirds are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #23 – Golden Eagle, Merlin

Introduction

Golden eagles are present in the Cedar River Municipal Watershed only intermittently as transients and migrants, most often observed above high-elevation ridges. Merlins are present in the watershed, but no comprehensive surveys have been conducted, and no nests or breeding activity have been documented to date. Both species forage in open areas and nest on cliffs and in trees near forest openings. Golden eagles nest in large trees in old-growth forests; merlins also use tree cavities. Merlins in the Cascade Mountains are found at higher elevations, from the Pacific silver fir zone up, using forest edges and meadows along the Cascade crest (Smith et al. 1997). Cliffs and rock outcrops, natural open upland habitats (grass-forb meadows and persistent shrub communities), open wetlands (palustrine emergent and palustrine scrub-shrub wetlands), and large trees are potential key habitats for these species in the Cedar River Municipal Watershed, with high-elevation forests also representing key habitat for merlins. The golden eagle also forages in early seral forest habitats, and the merlin may do so as well.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any golden eagles and merlins that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any golden eagles or merlins resulting from silvicultural treatments, road management, or other operational activities is expected to be extremely low under the HCP, as is the likelihood of disturbance to any actively nesting golden eagle or merlin pairs. However, any such death, direct injury, or disturbance leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect..

The HCP is expected to result in both short- and long-term benefits to golden eagles and merlins that may occur in the watershed primarily through: (1) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance and the likelihood of disturbing nesting activities; (2) protection through reserve status of all cliffs and rock outcrops potentially used for nesting; (3) protection through reserve status of all existing old-growth forest that may be used for nesting, or, at higher elevation, for foraging by merlins; (4) protection through reserve status of all natural open habitats used by either species for foraging (e.g., meadows, persistent shrub, and wetlands) in the watershed; (5) natural maturation of second-growth forests into mature and late-successional seral stages that could provide trees used for nesting or improve habit for foraging merlins; (5) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, potentially increasing the number and quality of nesting trees for both species; (6) protection of known nesting pairs from human disturbance; (7) removal of 38 percent of watershed roads, reducing the level of human disturbance; (8) closure of the watershed to unsupervised public access, reducing potential disturbance near nests; and (8) monitoring and research.

Golden eagles and merlins could be negatively affected by silvicultural treatments, road management, or other operational activities in or near habitats used by either species. Such effects could be direct (e.g., destruction of active nests) or indirect, through influences on habitat (e.g., removal of vegetation or snags) or disturbance. The loss of early seral habitat created artificially by commercial timber harvest could reduce the carrying capacity of the watershed for the golden eagle, and possibly for the merlin, although the future landscape will develop into one more similar to the natural landscape to which these species are adapted.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for golden eagles and merlins are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (cliffs, rock outcrops, natural open habitats, and mature to old-growth forest) for golden eagles and merlins that may occur in the municipal watershed is in reserve status. The acreage of mature, late-successional, and old-growth forest will increase by nearly a factor of five under the HCP, and the quality of some open habitats may improve and develop more natural characteristics as forest adjacent to open habitats matures. In addition, overall habitat quality for the golden eagle and merlin is expected to improve through the decrease in human activity throughout the watershed, through the protection of natural open habitats whenever watershed operations are conducted nearby, and through active intervention to help restore natural habitat function and quality. Silvicultural treatments in second-growth forests near open habitats will be designed to foster development of larger trees and snags, which could be used for nesting by either species.

Golden eagles, and possibly merlins, also forage in some open, early seral forest, with merlins potentially using such habitats primarily near forest edges. As a consequence of the eliminating timber harvest for commercial purposes, however, the overall amount of early seral forest habitat in the watershed is expected to decrease over the term of the HCP. Early seral forest habitat will be created largely by natural processes, such as windstorms and disease, and several decades from now is likely to be in patches smaller than those present today. The overall landscape in the municipal watershed, however, will be more similar to the natural landscape to which these species adapted within this region. It should be noted that considerable amounts of early seral forest habitat created by commercial timber harvest will likely occur in many areas adjacent to the watershed, which would be available to such wide-ranging foragers as golden eagles and merlin.

Disturbance Effects and Direct Take

The primary activities that may result in disturbance, and possibly the equivalent of take of, golden eagles and merlins in the watershed under the HCP include any operations that involve human activities on roads or in or near suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later);

(5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbance to any actively nesting golden eagles or merlins in the watershed, however, is expected to be very low and short-term in nature because of the specific mitigation and minimization measures committed to in the HCP: (1) protection of known active golden eagle and merlin nest sites from human disturbance, partly through the use of site evaluations and interdisciplinary teams prior to silvicultural activities near potential nesting areas; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall levels of habitat disturbance and human activities; (3) compliance with Washington Forest Practice Rules; (4). the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any golden eagles or merlins resulting from silvicultural treatments, road management, or other operational activities is expected to be very low.

Population-level Effects

The protection of all forest outside limited developed areas in reserve status, the protection and potential improvement of all key open habitats, silvicultural activities designed to develop large trees and snags (for nesting), and the overall level of protection from human disturbance afforded by the HCP should all provide population benefits for the golden eagle and the merlin. It is possible that the projected decrease in the acreage of early seral-stage habitats in the municipal watershed over the 50-year term may reduce the carrying capacity of the watershed for golden eagles and, possibly, for merlins.

This potential loss of early seral forest habitat, however, would be offset by the measures described above and the development of a more natural landscape habitat distribution under the HCP, one more similar to that for which both species are adapted. In addition, considerable areas of clearcuts can be expected to occur on nearby private timberlands available to such wide-ranging foragers. Thus, it is unlikely that the elimination of commercial timber harvest in the watershed will have a negative effect on regional populations of either species, and the mitigation and conservation measures in the HCP, taken as a whole, may provide an overall positive population effect.

Other Effects

The monitoring and research program committed to in the HCP (Section 4.5) will, through adaptive management (Section 4.5.7), be used to determine if the mitigation and minimization strategies for merlins and golden eagles are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #24 – Black Swift

Introduction

Black swifts are present in the Cedar River Municipal Watershed, but no comprehensive surveys have been conducted, and no nests or breeding activity have been documented to date. Potential key habitat for black swifts in the municipal watershed includes cliffs, rock outcrops, headwalls and inner gorges, waterfalls on streams, and mature, late-successional, and old-growth forests, especially in riparian areas. Black swifts commonly nest on steep cliffs or behind waterfalls. They are aerial feeders that forage widely above the forest canopy or over open areas, such as wetlands and meadows.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any black swifts that may nest in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any black swifts resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively nesting pairs of this species. However, any such death, direct injury, or disturbance of black swifts leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

The HCP is expected to result in both short- and long-term benefits to black swifts that may use the watershed primarily through: (1) protection in reserve status of known cliffs and rock outcrops that may be used for nesting in the watershed; (2) restoration and enhancement of aquatic and riparian habitats (restoration planting, restoration and ecological thinning in riparian areas) designed to help accelerate the development of a naturally functioning aquatic and riparian ecosystem and the development of mature or late-successional forest characteristics in riparian areas; (3) protection of all natural open habitats (e.g., meadows, persistent shrub, and wetlands) used for foraging in the watershed, primarily through protection by inclusion in surrounding forest that is in reserve status; (4) protection of all existing old-growth forest; (5) natural maturation of second-growth forests into mature and late-successional seral stages; (6) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas; (7) removal of 38 percent of watershed roads, reducing potential disturbance near any nesting areas; (8) elimination of timber harvest for commercial purposes within the watershed, reducing the level of human activity potentially near nesting areas; (9) monitoring and research; and (10) protection of nesting pairs and colonies from human disturbance.

Black swifts could be negatively affected by silvicultural treatments, road management, or other operational activities in or near key habitat (e.g., riparian areas, waterfalls, large trees, and cliffs). Such effects could be direct (e.g., through injury to individuals) or indirect, through influences on habitat or disturbance.

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for black swifts are described in Section 4.2.2 and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial Effects and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas are in reserve status. As a result, all key habitat (cliffs, rock outcrops, headwalls and inner gorges, waterfalls on streams, and mature to old-growth forests) for the black swift within the municipal watershed is in reserve status.

Besides the protection of all potential key habitats listed, the silvicultural treatments and road management activities committed to in the HCP are expected to significantly restore and enhance potential key habitat in riparian areas and in mature to late-successional forest. Increases in the quantity and quality of mature and late-successional coniferous forest habitat are expected over the 50-year term of the HCP as a result of natural maturation of all second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in second-growth in some areas, both potentially increasing the abundance and diversity of insects on which swifts may feed. Measures to protect and restore stream, wetland, and riparian habitats should similarly improve the ability of such areas to produce insect prey for swifts.

Disturbance Effects and Direct Take

The primary activities that may result in disturbance, and possibly the equivalent of take, of black swifts in the watershed under the HCP include any operations that involve human activities on roads near nesting areas or in or near suitable habitat including the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (7) routine road use.

The likelihood of disturbance to any actively nesting black swifts in the watershed is expected to be very low and short-term in nature, however, because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations prior to undertaking management activities in key habitat to ensure that habitat for black swifts is not degraded, to minimize direct impacts to individual black swifts that may be present, and to ensure that any breeding swifts are not disturbed; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing the overall level of human disturbance that could potentially affect nesting or foraging; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access (including no access for hunting) to the Cedar River Municipal Watershed, which further minimizes the risk of disturbance to nesting pairs and other resident or transient birds; and (5) removal of 38 percent of forest roads, which will reduce the amount of disturbance related to road maintenance, improvement, and use over the long term.

Because of the specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any individual black swifts resulting from silvicultural treatments, road management, or other operational activities in the watershed is extremely low.

Population-level Effects

Black swifts will benefit from any habitat improvements that increase the availability of insect prey, but the population-level effects of any such change cannot be predicted. Protection of any nesting pairs and colonies from human disturbance, could have a positive population effect on the black swift.

Other Effects

The monitoring and research program committed to in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for black swifts are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #35 – Western Redback Salamander

Introduction

The western red-backed salamander is present and breeding in the Cedar River Municipal Watershed. Potential key habitat for this salamander in the watershed includes talus/felsenmeer slopes, rock outcrops, and dense coniferous forest, particularly forest that has accumulated substantial quantities of decaying logs, leaf litter, bark piles, and other debris on the forest floor, as is more typically and consistently present in mature, late-successional, and old-growth forest. The presence of organic debris on the forest floor in older forest and the moist environment of many talus/felsenmeer slopes and rock outcrops provides foraging and hiding cover for red-backed salamanders, as well as suitable microclimate conditions for egg deposition below the substrate surface. Other seral-stage coniferous forest, including riparian forest (especially streamside areas), is considered of secondary importance.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any western red-backed salamanders that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any western red-backed salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP. However, any such death or direct injury of western red-backed salamanders would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term "take" applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Long-term benefits are expected to accrue to the western red-backed salamander, especially through protection of mature, late successional, and old-growth forest in reserve status and the recruitment of additional mature and late-successional forest over time. All key non-forested habitat (talus/felsenmeer slopes and rock outcrops) will also be protected within reserve forest. A net gain of potential western red-backed salamander habitat is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to the western red-backed salamander through: (1) protection of all existing key forested habitat in reserve forest status; (2) protection of all key non-forested habitat (talus/felsenmeer slopes, rock outcrops) as inclusions within reserve forest; (3) elimination of timber harvest for commercial purposes within the watershed; (4) natural maturation of second-growth forests into mature and late-successional seral stages, potentially recruiting increased amounts of organic debris to the forest floor and improving habitat function; (5) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, also improving habitat conditions on the forest floor (long term); (6) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying organic debris to the forest floor on both a short- and long-term basis; (7) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; (8) protection of secondary habitats including younger, closed canopy forest and riparian stream corridors in reserve status; and (9) monitoring and research.

The western red-backed salamander could be negatively affected by silvicultural treatments, road management, or other operational activities, especially in or adjacent to key habitat. Such effects could be direct (e.g., through injury to individuals) or indirect, through influences on habitat (e.g., disturbance of cover objects or removal of tree canopy).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures for the western red-backed salamander are described in Section 4.2.2 and summarized in tables 4.6-2, 4.6-3, and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all 13,889 acres of old-growth forest, are in reserve status. As a result, all key habitat (mature, late-successional, and old-growth forest, talus/felsenmeer slopes, rock outcrops), as well as all secondary habitat, for the western red-backed salamander within the municipal watershed is protected in reserve status.

Major habitat effects on the western red-backed salamander are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests. Although old growth (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for the western red-backed salamander are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a five-fold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape, including the entire elevation range, than under current conditions. And, only 4,708 acres (less than 7 percent) of key forested habitat will be above 4,000 feet, beyond the documented extent of the western red-backed salamander's elevation range.

In addition to forested habitats, western red-backed salamanders also utilize open, non-forested talus/felsenmeeer slopes and rock outcrops. The western red-backed salamander is thus also expected to benefit from management actions designed to protect, restore, or enhance these habitats. All vegetated talus/felsenmeer (329 acres) and non-vegetated talus/felsenmeer (1,189 acres) slopes, and rock outcrops, most of which are surrounded by or are adjacent to key forested habitat, are protected in reserve status. In addition, during watershed operations near any talus/felsenmeer slopes or rock outcrops a 200-foot zone, in which activities will be restricted, will be established to minimize the potential for habitat impacts or disturbance to western red-backed salamanders.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in direct take of western red-backed salamanders in the watershed include any operations that involve human activities on roads or in suitable habitat. Such activities include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) monitoring and research. Occasionally, individual red-backed salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

The likelihood of direct take occurring at a level that may compromise the viability of western red-backed salamander populations in the watershed is expected to be very low, due to the specific mitigation and minimization measures committed to in the HCP: (1) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing impacts to key forest habitat and essentially eliminating the chance of mortality associated with log hauling; (2) interdisciplinary team site evaluations prior to silvicultural or road management activities; (3) compliance with Washington Forest Practice Rules; (4) the City’s policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing salamanders; and (5) removal of 38 percent of forest roads which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of direct injury to, or death of, any western red-backed salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low in any given year, although occasionally, individual western red-backed salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

Population-level Effects

Population-level effects on the western red-backed salamander are, in general, as described for other species addressed by the HCP that are associated with late-successional and old-growth forest. Under the HCP, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early- or mid-seral forest habitat (less than 50 years old) will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early-seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five.

Mitigation and minimization measures in the HCP create a linear system of protected forested corridors adjacent to streams for the dispersal and movement of organisms dependent on riparian habitats, as well as large areas of older forest in upland areas between stream systems. This increased acreage of preferred forest habitat and landscape connectivity will benefit populations of western red-backed salamanders by increasing the overall habitat carrying capacity of the municipal watershed, thereby potentially increasing populations and also by facilitating the movement or dispersal of individuals between patches of available habitat throughout the Cedar River Municipal Watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the western red-backed salamander are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

Group #36 – Larch Mountain Salamander

Introduction

No comprehensive surveys to determine the presence or absence of Larch Mountain salamanders have been conducted in the Cedar River Municipal Watershed, and no incidental observations of this species have been documented to date. The Larch Mountain salamander is generally considered to be one of the rarest amphibians in Washington State, and until recently, was thought to be confined to reaches of the Columbia Gorge of the Oregon and Washington Cascades (Leonard et al. 1993). Recently, however, several Larch Mountain salamander populations have been found near Mt. St. Helens and Mt. Rainier to an elevation of 3,400 feet (Leonard et al. 1993). In addition to several other Cascade locations, the species has also been documented recently in the Green River watershed adjacent to (south of) the Cedar River drainage (Foster Wheeler Environmental field survey data, 1998). Also, the Cedar River watershed is included within the potential range of this species as it is defined for the Northwest Forest Plan -- Survey and Manage requirements (Crisafulli 1998). This Woodland Salamander, although requiring moist microclimate conditions, is almost never associated with free water. Potential key habitat for this salamander in the watershed includes mature, late-successional, and old-growth coniferous forests, particularly those forests with rocky substrates and/or including talus/felsenmeer slopes with organic debris incorporated.

The combination of mitigation and minimization measures committed to in the HCP is expected to protect any Larch Mountain salamanders that may occur in the Cedar River Municipal Watershed. The likelihood of direct injury or death of any Larch Mountain salamanders resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, as is the likelihood of disturbance to any actively breeding individuals of this species. However, any such death, direct injury, or disturbance of Larch Mountain salamanders leading to such injury or death would constitute an impact equivalent to take as applied to species listed under the ESA. Note that the term “take” applies only to those species listed under the ESA as endangered, or threatened if the respective Service publishes a rule to that effect.

Long-term benefits are expected to accrue to the Larch Mountain salamander, especially through protection of mature, late successional, and old-growth forest in reserve status and the recruitment of additional mature and late-successional forest over time. All key non-forested habitat (talus/felsenmeer slopes) will also be protected within reserve forest. A net gain of potential Larch Mountain salamander habitat is expected over the 50-year term of the HCP. The HCP is expected to result in both short- and long-term benefits to the Larch Mountain salamander through: (1) protection of all existing key forested habitat in reserve forest status; (2) protection of all key non-forested habitat (talus/felsenmeer slopes) as inclusions within reserve forest; (3) elimination of timber harvest for commercial purposes within the watershed; (4) natural maturation of second-growth forests into mature and late-successional seral stages, potentially recruiting increased amounts of organic debris to the forest floor, thereby improving habitat function and facilitating dispersal; (5) silvicultural treatments designed to accelerate the development of mature, late-successional, and old-growth structural characteristics in second-growth forests in some areas, also improving habitat conditions on the forest floor (long term); (6) retention, creation, and recruitment of logs and large snags during silvicultural treatments, supplying organic debris to the forest floor on both a short- and long-term basis; (7) removal of 38 percent of watershed roads, reducing the risk of direct injury or death as a result of road use; (8) protection of secondary habitats including younger, closed canopy forest and riparian stream corridors in reserve status; and (9) monitoring and research.

Larch Mountain salamanders could be negatively affected by silvicultural treatments, road management, or other operational activities, especially in or near key habitat (mature to old-growth forest, especially with talus/felsenmeer slopes incorporated). Such effects could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., microclimate changes as a result of the removal of overstory vegetation).

Pertinent Mitigation and Minimization Measures

Mitigation and minimization measures pertinent to Larch Mountain salamander are described in Section 4.2.2 and summarized in tables 4.6-2 and 4.6-4.

Primary Beneficial and Detrimental Effects of the HCP

Habitat Effects

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all 13,889 acres of old-growth forest, all vegetated talus/felsenmeer (329 acres), and non-vegetated talus/felsenmeer (1,189 acres) are in reserve status. As a result, all key habitat (mature, late-successional, and old-growth forest, especially with talus/felsenmeer slopes incorporated), as well as all secondary habitat, for the Larch Mountain salamander within the municipal watershed is in reserve status. It is significant to note that protection in reserve status of all forested areas of the watershed, including riparian corridors, will facilitate dispersal for this species. In addition, during any operations near talus/felsenmeer slopes or rock outcrops, activity will be restricted within a 200-foot zone to minimize the potential for habitat impacts or disturbance to key wildlife species, including the Larch Mountain salamander.

Major habitat effects on the Larch Mountain salamander are similar, in general, to those described for other species addressed by the HCP that are associated with late-successional and old-growth forests, as well as for those associated with special habitats (e.g., talus/felsenmeer slopes). Although the acreage of talus/felsenmeer and old growth (by definition) will not increase in extent under the HCP, substantial increases in the quantity of mature and late-successional coniferous forest habitat for the Larch Mountain salamander are expected over the 50-year term of the HCP as a result of natural maturation of second-growth forests (a long-term habitat gain) and silvicultural intervention designed to accelerate development of older forest characteristics in some areas of second-growth forest. Solely as a result of natural forest maturation, approximately 34,932 acres of mature forest, 23,918 acres of late-successional forest, and 13,889 acres of old-growth forest are projected to exist in the watershed by the year 2050, representing nearly a fivefold increase in combined mature, late-successional, and old-growth forest as compared with current conditions (Section 4.2.2). In addition, by the end of the HCP term, older forest habitat will be more evenly distributed throughout the watershed landscape than under current conditions.

Under the HCP, some potential salamander habitat in the watershed is expected to benefit from management actions (ecological thinning and restoration thinning) intended to accelerate the development of mature and late-successional characteristics in second-growth forests. Development of late-successional and old-growth characteristics in younger second-growth forests is expected to benefit Larch Mountain salamanders over the long term. Silvicultural treatments including: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; and (3) ecological thinning of about 2,000 acres, are expected to make habitat conditions more suitable in some second-growth forest by improving moisture regimes (increasing shade) and providing additional habitat structure (large woody debris) on the forest floor over the long term. However, over the short term, these management actions may cause some localized decline in habitat function. As partial mitigation, site evaluations will be conducted by an interdisciplinary team prior to undertaking management actions in the watershed to ensure that habitat for Larch Mountain salamanders is minimally impacted.

Disturbance Effects and Direct Take

The primary activities under the HCP that may result in direct take of Larch Mountain salamanders in the watershed include any operations that involve human activities on roads or in suitable habitat. Such activities include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (5) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (6) improvement of about 4 to 10 miles of road per year (occasionally more in some years); (7) routine road use; and (8) monitoring and research. Occasionally, individual Larch Mountain salamanders may be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

The likelihood of direct take occurring at a level that may compromise the viability of

Larch Mountain salamander populations in the watershed is expected to be very low, due to the specific mitigation and minimization measures committed to in the HCP: (1) elimination of commercial logging activities (including virtually all log hauling) from the watershed, reducing impacts to key forest habitat and essentially eliminating the chance of mortality associated with log hauling; (2) interdisciplinary team site evaluations prior to silvicultural or road management activities; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which further minimizes the risk of injury or death of dispersing salamanders; and (5) removal of 38 percent of forest roads which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed above, the likelihood of disturbance to, direct injury to, or death of any Larch Mountain salamanders as a result of silvicultural treatments, road management, or other operational activities is expected to be very low in any given year. However, individual Larch Mountain salamanders may occasionally be injured or killed inadvertently by vehicles when they attempt to cross watershed roads while dispersing.

Population-level Effects

Population-level effects on the Larch Mountain salamander are, in general, as described for other species addressed by the HCP that are associated with mature, late-successional, and old-growth forest, with the addition of this species' closer association with rocky substrates and vegetated talus/felsenmeer slopes. Under the HCP, all key forested and non-forested habitat will be protected and improved in quality over time. In addition, the current substantial amount of watershed forest in fragmented condition will mostly be replaced by large blocks of older forest habitat, interrupted only by natural openings, roads, and limited areas of development. By HCP year 50, no early or mid-seral forest habitat less than 50 years old will remain in the watershed, except for that resulting from natural events (e.g., fire, wind, disease, insect infestation); forest now in early seral stages as a result of recent commercial logging will mature over the term of the HCP, and no additional commercial harvest will be conducted. The total amount of late-seral habitat (over 80 years old) is expected to increase by a factor of nearly five. Protection in reserve status of all forested areas will improve habitat connectivity, thereby facilitating dispersal and movement of organisms dependent on forested habitats, as well as species (such as the Larch Mountain salamander) which use forested habitats for dispersal between patches of suitable non-forested habitat. This substantial degree of protection complies with the principal management recommendation of WDFW (1997) for Larch Mountain salamander, and should thus benefit any populations of the species that may occur in the Cedar River Municipal Watershed.

Other Effects

The monitoring and research program included in the HCP (Section 4.5) will, through adaptive management, be used to determine if the mitigation and minimization strategies for the Larch Mountain salamander are achieving their conservation objectives and facilitate adjustments needed to make the strategies better achieve these objectives.

DETERMINATION OF NET BENEFIT

As indicated in the summaries of effects presented above, the City believes that the HCP clearly provides a net benefit for all 83 species addressed by the HCP. The determination of whether or not a net benefit would be provided under the HCP was made by comparing operations and habitat conditions projected under the HCP with operations and habitat conditions at the time of implementation (for a more general discussion of this issue related to the Watershed Management Mitigation and Conservation Strategies, see Section 4.2.2). For the great majority of species addressed, the benefits of the HCP are clear, because one or more of the following will occur under the HCP:

- Improvement in habitat *quality* though changes in operations (e.g., improved instream flows), restoration or rehabilitation projects (e.g., stream, riparian, and upland forest restoration within the watershed), reduction of human disturbance levels (by removal of about 38 percent of the watershed road system), or protection (though inclusion in reserve status of all old-growth forest and all second-growth forest, which will develop over time into mature and late-successional forest);
- An increase in *quantity* of available habitat (recruitment of new habitat) by increased connectivity (e.g., for fish by providing passage facilities at Landsburg or replacing culverts that block passage upstream within the watershed, or for wildlife dependent on older seral forest by a commitment not to harvest timber for commercial purposes), habitat development (e.g., through forest succession that will result in more acreage of late-seral forest in the watershed), or creation of new habitat (e.g., construction of side channels for fish in the floodplain downstream of Landsburg);
- Reductions of *impacts* on individuals (e.g., establishment of flow downramping limits and the commitment not to harvest timber for commercial purposes)
- Protection against *disturbance* (e.g., restrictions on activities near breeding sites during sensitive periods of the life cycle, such as near northern goshawks nests or gray wolf dens) and control of watershed access (reducing general human disturbance, public access for hunting or fishing, and poaching);
- Projects that will improve *survival* of individuals (e.g., improved survival of smolts thought the Ballard Locks through funding of smolt slides and freshwater water conservation); and
- Direct *population enhancement* (e.g., by the sockeye hatchery, or by emergency supplementation for chinook, coho, or steelhead, if warranted).

As discussed in Section 4.2.2, the benefit for several species may not be as obvious as for the majority. Bull trout and, to a much lesser extent, pygmy whitefish and common loons are predicted to experience minor, but potentially negative incremental impacts of changes in reservoir operations that will result from managing instream flows to increase benefits for anadromous fish species (see Section 4.5.6; Appendix 38). However, other habitat protection and restoration programs should provide positive benefits for these species that should counter the negative effects over time (4.2.2). Riparian areas around the reservoir and streams used by these species will be protected and restored (section 4.2.2), including areas in which bull trout and pygmy whitefish spawn and rear. The commitment not to harvest timber for commercial purposes and the removal of about 38 percent of forest roads under the HCP should provide major benefits for all three species. The Cedar Permanent Dead Storage Project could have adverse impacts on any of these three species if implemented, but the potential for such impacts will be carefully evaluated over a period of 5 years, mitigation will be developed if that project is implemented (Section 4.5.6), and implementation would require amendment of the HCP and incidental take permit (see Appendix 1, Section 12.2).

Upland species that utilize forest openings, such as clearcuts, wetlands, and meadows, might not benefit as much under the HCP as those using older seral forest. Under the HCP, no early seral forest will be generated by commercial timber harvest. Rather, early seral forest will be largely by natural processes and disturbances, such as windstorms and fires. Nesting habitat for golden eagles, for example, will be protected under the HCP, but, to the extent that this species uses recently harvested areas for foraging, then foraging habitat will decrease over time.

However, it is very important to note that the landscape pattern of forest seral stages under the HCP will be nearer to that present in the natural landscape prior to European settlement, and silvicultural intervention for forest habitat restoration (section 4.2.2) will be designed to produce a forest ecosystem that functions more like a natural system than the overall forest does today. Because of this more natural pattern of forest age classes and ecosystem function, the City believes that a net benefit will accrue even to those species that use open habitats that are decreased in extent by elimination of logging, particularly considering that timber harvest expected in adjacent areas will create large areas of early seral habitat in artificially high amounts.

Habitat for the band-tailed pigeon may not improve, as the amount of mixed coniferous and deciduous should not change much, and the total area of forest openings created by commercial timber harvest will decrease. Because the overall level of forest protection is much greater than was the case in the past, however, and the level of human disturbance will be lower, and this species should experience an overall benefit.

Effects on species not known to be present in the watershed are speculative, and will depend on the presence of these species in the municipal watershed in the future and the habitats that they prefer. The natural open-habitat types believed to be used by grizzly bear and gray wolf will be protected, habitat connectivity among habitat patches will be improved as the proportion of late-seral forest increases over time, more potential denning sites will be available as more mature and late-successional forest develops, and, most importantly, removal of about 38 percent of forest roads and continued closure of the watershed to the public should provide a substantial reduction in human disturbance level and increase in usable habitat for these species. To the extent these species use Special Habitats for foraging, then available habitat will not be increased, although, by being embedded in maturing forest, meadow communities should improve in quality over time. If any of these two species also use later seral forest in the watershed for foraging or denning, then available habitat will be increased. In addition, dens of gray wolves and grizzly bears, if found, will be protected while in use (Section 4.2.2).

While the populations of ungulates on which wolves (if they were to be present in the watershed) and other large carnivores would prey are expected to decrease under the HCP, these populations should reach levels more characteristic of natural landscapes than would be the case for intensively harvested forests. Furthermore, as argued above, the ecosystems in the watershed under the HCP will function more like ecosystems influenced only by natural disturbances. Finally, the absence of competition with hunters under current watershed management should make relatively more prey animals available, and the relatively low level of human disturbance within the currently closed watershed (Section 4.2.2) should increase foraging success.

Some species within the Lake Washington Basin, both those addressed by the HCP and others not addressed, could be adversely affected by measures in the HCP. For example, construction of fish passage facilities at Landsburg will result in the recolonization by anadromous species of areas that have only resident fish today. Because the river between Landsburg and lower Cedar Falls was used by the same anadromous species prior to construction of the Landsburg Diversion Dam, however, the City considers such effects to be acceptable.

Finally, naturally reproducing salmonids could be adversely affected by sockeye produced from the interim or replacement hatchery. However, several arguments indicate that such effects should be minor (Section 4.3.4).

- Agreement on clear objectives regarding impacts, a comprehensive monitoring program, and adaptive management designed to meet these objectives should combine to keep risks low;
- The City expects that the numbers of adult sockeye will be regulated (by harvest) within appropriate escapement goals by the fisheries co-managers (WDFW and the Tribe);
- The City expects that the fry-production targets will be set by the fisheries co-managers appropriate to the system carrying capacity;
- Hatchery fry are expected to have a lower incidence of IHN virus than naturally produced fry;
- Spawning interference should not be a significant problem, because of differences in life history characteristics and run timing of the species involved, because these species naturally occur together, and because escapement levels is expected to be regulated by the fisheries managers so that sockeye will not be superabundant on spawning areas.

In summary, the City believes that all of the species addressed in the HCP will experience a net benefit from the HCP compared to current conditions and operations. A benefit should accrue immediately after the HCP is implemented for all species, with the possible exception of bull trout and, to a much lesser extent pygmy whitefish and common loons, which will be affected in a minor fashion by *changes* in reservoir operations from current. However, habitat protection and improvements in the municipal watershed should soon produce a net benefit for these species as well.

5. IMPLEMENTATION OF THE HABITAT CONSERVATION PLAN

Chapter 5 Contents

5.1 Introduction to Plan Implementation

Implementation of the City's HCP will be governed by a formal HCP Implementation Agreement (Appendix 1) and two related agreements, an Instream Flow Agreement (Appendix 27) and a Landsburg Mitigation Agreement (Appendix 28). These agreements define roles, responsibilities, and commitments of the various signatory parties; establish schedules and funding for activities; and describe oversight, decision-making, and related issues.

The HCP and the Implementation Agreement are complementary to each other. As described in Chapter 2, together the HCP and Implementation Agreement fulfill the requirements of the Endangered Species Act for issuance of an incidental take permit for listed and unlisted species that are addressed by the HCP. The HCP Implementation Agreement will be signed by the City, USFWS, and NMFS.

In addition to the general provisions described above for all three agreements, the Implementation Agreement describes how unforeseen circumstances will be handled should they occur, how the plan may be amended, and how compliance activities will be conducted. The Implementation Agreement also incorporates the federal No Surprises Policy for HCPs, pursuant to a final rule published February 23, 1998 (see Chapter 2).

The Instream Flow Agreement is expected to be signed by the City, USFWS, NMFS, WDFW, and WDOE, with the ACOE potentially signing later. The City and Services hope that it may also eventually be signed by the Muckleshoot Indian Tribe, which has been involved in the development of the HCP and the Instream Flow Agreement. The Instream Flow Agreement describes commitments by the City for minimum instream flows; goals for supplementation of minimum flows; operation of a multi-agency instream flow commission; and water conservation improvements at the Ballard Locks that would provide improved survival of juvenile fish passing out to sea through the locks. The Instream Flow Agreement is largely intended to resolve issues about river flows related to a variety of interests, other than the ESA, of the different signatory parties.

The Landsburg Mitigation Agreement is expected be signed by the City, USFWS, NMFS, and WDFW. The City and Services hope that it may also eventually be signed by the Muckleshoot Indian Tribe, which has been involved in the development of the HCP and the Landsburg Mitigation Agreement. The Landsburg Mitigation Agreement covers mitigation for the blockage to anadromous fish posed by the Landsburg Diversion Dam, where the City diverts water for municipal and industrial supply. The Landsburg Mitigation Agreement is largely intended to resolve issues related to state law about blockages to fish passage.

The remainder of Chapter 5 generally describes the timing and duration of the HCP, funding and handling of costs, oversight, and adaptive management. Adaptive management is an integral part of the HCP and is an important feature of the extensive research and monitoring program described in Section 4.5.

5.2 Duration and Timing of HCP

5.2.1 Term

The term of the HCP is approximately 50 years. Because of uncertainty with respect to the actual date of implementation, the initial term may be slightly longer. It will run forty nine (49) years beyond the end of HCP year 1 of the schedule of activities described in this HCP. HCP year 1 is defined as the period from the effective date of the Implementation Agreement until the end of the first full calendar year following that date. For example, if the Implementation Agreement becomes effective in January of 2000, HCP year 1 will run from January of 2000 through December of 2001. HCP year 2 and all succeeding HCP years will coincide with the calendar years that follow the end of HCP year 1.

5.2.2 Schedule

The schedules for various activities in the HCP are given in Chapter 4 for the specific conservation and mitigation strategies (sections 4.2-4.4), and for the monitoring and research program (Section 4.5). A Little more than half of the total funding for the HCP is expected to be spent in the first decade (Table 5.3-2), largely because of the need to complete important restoration projects early and conduct key studies at the beginning of the plan's term.

Approximately three-fourths of the capital project costs are scheduled to be spent in the first decade (Table 5.3-2). The fish passage facilities, sockeye hatchery, and nearly half of the watershed restoration projects are scheduled for completion in the first decade.

Approximately half of the monitoring and research funds are scheduled to be spent in the first decade (Table 5.3-2). The Cedar Dead Storage Project Evaluation, several sockeye research studies, the accretion inflow study in the lower Cedar River, early species surveys, and watershed habitat research and model development are all scheduled for completion in the first decade.

5.3 Funding

5.3.1 General Funding Provisions

The City will fully fund its commitments made in the HCP, subject to the overall cost cap established for the HCP. The funding commitments are described in detail in Chapter 4 and summarized in Table 5.3-2 below. Funding will be from sources at the City's discretion, including, but not limited to, revenues from the sale of water, timber (if from the Cedar River Municipal Watershed, consistent with the conservation and mitigation measures described in Chapter 4), and land, and from outside sources, such as grants or contributions.

The City and the agencies that are signatories to HCP Implementation Agreement and related agreements will strive to achieve an efficient and effective use of funds to accomplish the goals, objectives, and elements of the HCP within the overall cost cap and within established fund transfer limitations, as described below. The City agrees to make available for mitigation and monitoring the full amount of money specified in the HCP, regardless of whether or not cost savings are achieved on individual elements of the HCP. The City is under no obligation to exceed the total funding commitment in the HCP.

5.3.2 Flexibility to Reallocate Funds Among Elements of the HCP

The City recognizes that changes in the allocation of funds among different elements of the HCP may be required during implementation. For example, some experimental projects may not prove effective, and may need to be changed. For some major projects, such as the sockeye hatchery, the project may be significantly modified or an alternative strategy may be followed. In addition, some elements may cost more or less to accomplish than is allocated. In order to allow flexibility in implementation to address such situations, the HCP includes provisions to transfer funds among elements of the HCP, or to new elements that may be added in the future. Such changes will be made subject to the overall cost cap for the HCP and a set of constraints designed to retain the overall integrity of the conservation objectives of the HCP.

To retain the integrity of the HCP but also allow flexibility, eight specific subdivisions of HCP activities, called Cost Categories, have been identified (Table 5.3-1), within which funds can be transferred. These Cost Categories are treated the same as the overall cost cap for the HCP, in that each is also capped. That is, the City commits to fully fund each of those Cost Categories, but will not exceed the total (cost cap) for each, and cannot transfer funds *among* the different Cost Categories without a plan amendment, as described below. In addition, unless the City specifically agrees otherwise, funds are not transferable between operating and capital project elements of the HCP. This provision is important because of the City’s need to plan its financial commitments and the differential effect of capital versus operational activities on annual costs.

As further described in the Implementation Agreement, the City will have the authority to make minor transfers of funds among activities *within* a Cost Category in order to accomplish elements of the HCP, as long as such transfers do not reduce the City’s ability to accomplish the agreed-upon elements of the HCP and do not compromise the overall purposes and objectives of the HCP. Significant transfers of funds will be subject to approval of the signatories to the Implementation Agreement or related agreements, as appropriate.

Table 5.3-1. Cost categories for the HCP.

Cost Category [1]	Approvals
Watershed Management	Signatories to the Implementation Agreement
Instream Flow Management	Signatories to the Instream Flow Agreement
Mitigation for chinook, coho, and steelhead	Signatories to the Landsburg Mitigation Agreement
Mitigation for sockeye [2]	Signatories to the Landsburg Mitigation Agreement
Watershed research and monitoring	Signatories to the Implementation Agreement
Instream flow research and monitoring	Signatories to the Instream Flow Agreement
Chinook, coho, and steelhead research and monitoring	Signatories to the Landsburg Mitigation Agreement
Sockeye research and monitoring	Signatories to the Landsburg Mitigation Agreement

[1] Approvals required, by category, for funding commitments encompassed by the referenced agreement.

[2] As provided in the Landsburg Mitigation Agreement (Appendix 28) and Section 4.3.2 of the HCP, *both* funding for habitat protection and restoration in the Cedar River Basin below Landsburg *and* any savings from the construction or operation of the replacement sockeye hatchery may be used for fish habitat acquisition, restoration, or enhancement in the Lake Washington Basin for any or all anadromous fish species.

In order to most effectively achieve the overall conservation objectives of the HCP, additional flexibility may be needed to transfer funds among, not just within, Cost Categories. The transfer of funds between the Cost Categories listed and described above will require an amendment to the HCP, and may require approval of parties to the Instream Flow Agreement or Landsburg Mitigation Agreement if the activities involved are covered by one of those agreements.

5.3.3 Adjustment for Inflation or Deflation

All cost estimates and commitments in the HCP are given in 1996 dollars. These figures will be annually adjusted in a standard manner for inflation or deflation.

Table 5.3.2. Summary of funding commitments in HCP (in nearest thousands of 1996 dollars).

YEARS:	CIP/ O&M[2]	Total 50-yr.	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50
WATERSHED MANAGEMENT																	
Road improvements and maintenance	**TOTAL**	**$15,518.00**	**$693.60**	**$693.60**	**$693.60**	**$693.60**	**$693.60**	**$530.00**	**$530.00**	**$530.00**	**$530.00**	**$530.00**	**$2,112.50**	**$2,112.50**	**$1,725.00**	**$1,725.00**	**$1,725.00**
Road decommissioning	CIP	**$5,000.00**	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$250.00	$1,250.00	$1,250.00	$0.00	$0.00	$0.00
Road improvements	CIP	**$7,250.00**	$350.00	$350.00	$350.00	$350.00	$350.00	$200.00	$200.00	$200.00	$200.00	$200.00	$562.50	$562.50	$1,125.00	$1,125.00	$1,125.00
Road maintenance	O&M	**$3,268.00**	$93.60	$93.60	$93.60	$93.60	$93.60	$80.00	$80.00	$80.00	$80.00	$80.00	$300.00	$300.00	$600.00	$600.00	$600.00
Stream and riparian restoration	**TOTAL**	**$4,404.99**	**$186.38**	**$186.38**	**$186.38**	**$186.38**	**$186.38**	**$186.38**	**$186.38**	**$186.38**	**$117.00**	**$117.00**	**$585.00**	**$349.71**	**$581.76**	**$581.76**	**$581.76**
Large woody debris replacement in streams	CIP	**$975.00**	$12.50	$12.50	$12.50	$12.50	$12.50	$12.50	$12.50	$12.50	$46.88	$46.88	$234.38	$105.70	$147.06	$147.06	$147.06
Bank stabilization	CIP	**$756.00**	$19.75	$19.75	$19.75	$19.75	$19.75	$19.75	$19.75	$19.75	$19.75	$19.75	$98.75	$71.51	$129.41	$129.41	$129.41
Bank revegetation	CIP	**$212.00**	$6.63	$6.63	$6.63	$6.63	$6.63	$6.63	$6.63	$6.63	$6.63	$6.63	$33.13	$19.10	$31.18	$31.18	$31.18
Conifer under-planting	CIP	**$212.00**	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$31.25	$19.43	$32.94	$32.94	$32.94
Restoration thinning	CIP	**$180.00**	$5.63	$5.63	$5.63	$5.63	$5.63	$5.63	$5.63	$5.63	$5.63	$5.63	$28.13	$16.21	$26.47	$26.47	$26.47
Stream crossing projects to pass peak flows	CIP	**$850.00**	$15.63	$15.63	$15.63	$15.63	$15.63	$15.63	$15.63	$15.63	$15.63	$15.63	$78.13	$86.21	$176.47	$176.47	$176.47
Stream crossing projects for fish passage	CIP	**$1,220.00**	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$120.00	$16.25	$16.25	$81.25	$31.54	$38.24	$38.24	$38.24
Upland reserve forest restoration	**TOTAL**	**$3,920.00**	**$242.38**	**$242.38**	**$242.38**	**$242.38**	**$242.38**	**$242.38**	**$242.38**	**$242.38**	**$179.88**	**$179.88**	**$930.63**	**$117.10**	**$191.18**	**$191.18**	**$191.18**
Restoration thinning	CIP	**$2,620.00**	$201.75	$201.75	$201.75	$201.75	$201.75	$201.75	$201.75	$201.75	$139.25	$139.25	$727.50	$0.00	$0.00	$0.00	$0.00
Ecological thinning	CIP	**$1,000.00**	$31.25	$31.25	$31.25	$31.25	$31.25	$31.25	$31.25	$31.25	$31.25	$31.25	$156.25	$90.07	$147.06	$147.06	$147.06
Restoration planting	CIP	**$300.00**	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$46.88	$27.02	$44.12	$44.12	$44.12
TOTAL WATERSHED		**$23,843.00**	**$1,122.35**	**$1,122.35**	**$1,122.35**	**$1,122.35**	**$1,122.35**	**$958.75**	**$958.75**	**$958.75**	**$826.88**	**$826.88**	**$3,628.13**	**$2,579.30**	**$2,497.94**	**$2,497.94**	**$2,497.94**
LANDSBURG MITIGATION																	
Chinook, coho, steelhead mitigation	**TOTAL**	**$9,481.00**	**$591.00**	**$2,500.00**	**$3,025.00**	**$705.00**	**$140.00**	**$140.00**	**$140.00**	**$140.00**	**$50.00**	**$50.00**	**$250.00**	**$250.00**	**$500.00**	**$500.00**	**$500.00**
Interim chinook, coho, steelhead mitigation	O&M	**$720.00**	$90.00	$90.00	$90.00	$90.00	$90.00	$90.00	$90.00	$90.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Construction of intake screens	CIP	**$2,859.00**	$246.00	$1,182.00	$1,182.00	$249.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Construction of fish ladders	CIP	**$2,011.00**	$172.00	$832.00	$832.00	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Construction of downstream passage	CIP	**$958.00**	$83.00	$396.00	$396.00	$83.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Operation of passage facilities	O&M	**$2,350.00**	$0.00	$0.00	$0.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$50.00	$250.00	$250.00	$500.00	$500.00	$500.00
Contingency fund for fish passage facilities	CIP	**$583.00**	$0.00	$0.00	$525.00	$58.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Sockeye mitigation	**TOTAL**	**$22,734.00**	**$737.00**	**$674.00**	**$575.00**	**$3,538.00**	**$3,710.00**	**$300.00**	**$300.00**	**$300.00**	**$300.00**	**$300.00**	**$1,500.00**	**$1,500.00**	**$3,000.00**	**$3,000.00**	**$3,000.00**
Interim sockeye mitigation	CIP	**$1,024.00**	$128.00	$256.00	$256.00	$256.00	$128.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Hatchery construction	CIP	**$7,678.00**	$477.00	$318.00	$319.00	$3,282.00	$3,282.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Operation of replacement hatchery	O&M	**$13,800.00**	$0.00	$0.00	$0.00	$0.00	$300.00	$300.00	$300.00	$300.00	$300.00	$300.00	$1,500.00	$1,500.00	$3,000.00	$3,000.00	$3,000.00
Supplementation guidelines	CIP	**$32.00**	$32.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Broodstock collection solutions & monitoring	CIP	**$200.00**	$100.00	$100.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Downstream habitat: all species	TOTAL (CIP)	**$1,637.00**	$0.00	$98.00	$147.00	$1,392.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
TOTAL LANDSBURG MITIGATION		**$33,852.00**	**$1,328.00**	**$3,272.00**	**$3,747.00**	**$5,635.00**	**$3,850.00**	**$440.00**	**$440.00**	**$440.00**	**$350.00**	**$350.00**	**$1,750.00**	**$1,750.00**	**$3,500.00**	**$3,500.00**	**$3,500.00**

YEARS:	CIP/ O&M[2]	Total 50-yr.	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50
INSTREAM FLOWS																	
Powerhouse improvements	**TOTAL**	**$600.00**	**$350.00**	**$0.00**	**$250.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Emergency bypass	CIP	**$350.00**	$350.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tailrace rack	CIP	**$250.00**	$0.00	$0.00	$250.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Locks improvements[3]	**TOTAL**	**$1,875.00**	**$875.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$1,000.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Smolt passage improvements	CIP	**$625.00**	$625.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Freshwater conservation	CIP	**$1,250.00**	$250.00	$0.00	$0.00	$0.00	$0.00	$1,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Conservation messages for fish	**TOTAL (O&M)**	**$1,500.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$150.00**	**$150.00**	**$300.00**	**$300.00**	**$300.00**
Downstream Habitat	**TOTAL**	**$3,270.00**	**$0.00**	**$1,270.00**	**$1,000.00**	**$1,000.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Downstream habitat protection & restoration	CIP	**$3,000.00**	$0.00	$1,000.00	$1,000.00	$1,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Walsh Lake restoration	CIP	**$270.00**	$0.00	$270.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
TOTAL INSTREAM FLOWS		**$7,245.00**	**$1,255.00**	**$1,300.00**	**$1,280.00**	**$1,030.00**	**$30.00**	**$1,030.00**	**$30.00**	**$30.00**	**$30.00**	**$30.00**	**$150.00**	**$150.00**	**$300.00**	**$300.00**	**$300.00**
RESEARCH AND MONITORING																	
Instream flow monitoring and research	**TOTAL**	**$3,409.15**	**$391.94**	**$407.04**	**$339.04**	**$318.04**	**$197.04**	**$162.51**	**$132.51**	**$132.51**	**$86.51**	**$86.51**	**$196.15**	**$137.05**	**$274.10**	**$274.10**	**$274.10**
Existing stream gage at Cedar Falls	O&M	**$246.15**	$0.00	$0.00	$0.00	$0.00	$0.00	$5.47	$5.47	$5.47	$5.47	$5.47	$27.35	$27.35	$54.70	$54.70	$54.70
Existing stream gages below Landsburg	O&M	**$547.00**	$10.94	$10.94	$10.94	$10.94	$10.94	$10.94	$10.94	$10.94	$10.94	$10.94	$54.70	$54.70	$109.40	$109.40	$109.40
New stream gage above Powerhouse	O&M	**$525.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$41.00	$11.00	$11.00	$11.00	$11.00	$55.00	$55.00	$110.00	$110.00	$110.00
New gage at Renton	O&M	**$121.00**	$30.00	$9.10	$9.10	$9.10	$9.10	$9.10	$9.10	$9.10	$9.10	$9.10	$9.10	$0.00	$0.00	$0.00	$0.00
Temporary gages in lower river (2)	O&M	**$130.00**	$30.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00	$0.00	$0.00	$0.00	$0.00
Switching criteria study	O&M	**$200.00**	$50.00	$50.00	$50.00	$50.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Steelhead redd monitoring	O&M	**$240.00**	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$30.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Chinook studies	O&M	**$1,000.00**	$241.00	$257.00	$189.00	$168.00	$97.00	$16.00	$16.00	$16.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Accretion flow study	O&M	**$400.00**	$0.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$0.00	$0.00	$0.00	$0.00
Passage of chinook, coho, steelhead above Landsburg	**TOTAL**	**245.00**	**70.00**	**0.00**	**0.00**	**65.00**	**5.00**	**5.00**	**5.00**	**15.00**	**5.00**	**15.00**	**35.00**	**15.00**	**10.00**	**0.00**	**0.00**
Counts at Landsburg fish ladders	O&M	**110.00**	0.00	0.00	0.00	50.00	5.00	5.00	5.00	5.00	5.00	5.00	25.00	5.00	0.00	0.00	0.00
Landsburg intake screen evaluation	O&M	**15.00**	0.00	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drinking water quality monitoring	O&M	**120.00**	70.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	10.00	10.00	10.00	10.00	0.00	0.00
Sockeye monitoring and research	**TOTAL**	**$3,473.00**	**$200.00**	**$175.00**	**$175.00**	**$175.00**	**$124.00**	**$124.00**	**$124.00**	**$124.00**	**$99.00**	**$99.00**	**$234.00**	**$60.00**	**$750.00**	**$190.00**	**$820.00**
Fry condition at release	O&M	**$92.00**	$0.00	$0.00	$0.00	$0.00	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	$10.00	$10.00	$20.00	$20.00	$20.00
Fry marking and evaluation	O&M	**$320.00**	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$0.00	$0.00	$0.00	$0.00	$80.00	$0.00	$80.00
Fry trapping and counting	O&M	**$560.00**	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$0.00	$0.00	$0.00	$0.00	$140.00	$0.00	$140.00
Fish health	O&M	**$620.00**	$0.00	$0.00	$0.00	$0.00	$20.00	$20.00	$20.00	$20.00	$20.00	$20.00	$70.00	$50.00	$140.00	$100.00	$140.00
Short-term fry rearing	O&M	**$65.00**	$35.00	$10.00	$10.00	$10.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lake Washington plankton studies (year-round)	O&M	**$480.00**	$40.00	$40.00	$40.00	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$160.00	$0.00	$160.00
Lake plankton studies (spring)	O&M	**$56.00**	$0.00	$0.00	$0.00	$0.00	$7.00	$7.00	$7.00	$7.00	$7.00	$7.00	$14.00	$0.00	$0.00	$0.00	$0.00

YEARS:	CIP/ O&M[2]	Total 50-yr.	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50
Adult survival, distribution, homing studies	O&M	**$800.00**	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$40.00	$80.00	$0.00	$120.00	$40.00	$160.00
Phenotypic and genetic studies of adults	O&M	**$480.00**	$30.00	$30.00	$30.00	$30.00	$0.00	$0.00	$0.00	$0.00	$30.00	$30.00	$60.00	$0.00	$90.00	$30.00	$120.00
Watershed aquatic monitoring and research	**TOTAL**	**$2,729.00**	**$134.50**	**$237.50**	**$212.50**	**$308.50**	**$148.50**	**$148.50**	**$172.50**	**$157.50**	**$52.50**	**$124.50**	**$369.50**	**$246.50**	**$220.00**	**$98.00**	**$98.00**
Two-year experimental stream monitoring[4]	O&M	**$0.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Long-term stream monitoring	O&M	**$459.00**	$0.00	$0.00	$0.00	$54.00	$26.00	$26.00	$50.00	$23.00	$0.00	$47.00	$70.00	$47.00	$70.00	$23.00	$23.00
Aquatic restoration monitoring	O&M	**$875.00**	$0.00	$0.00	$0.00	$25.00	$25.00	$25.00	$50.00	$50.00	$50.00	$50.00	$250.00	$150.00	$100.00	$50.00	$50.00
Bull trout - adult surveys (weir)	O&M	**$350.00**	$50.00	$50.00	$50.00	$50.00	$25.00	$25.00	$0.00	$0.00	$0.00	$25.00	$25.00	$25.00	$25.00	$0.00	$0.00
Bull trout - adult surveys (spawning)	O&M	**$280.00**	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bull trout - fry/juvenile surveys	O&M	**$280.00**	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bull trout -stream telemetry studies[5]	O&M	**$120.00**	$0.00	$60.00	$0.00	$60.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bull trout -lake telemetry studies[6]	O&M	**$70.00**	$0.00	$0.00	$35.00	$35.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bull trout - stream distribution	O&M	**$60.00**	$12.00	$0.00	$0.00	$12.00	$0.00	$0.00	$0.00	$12.00	$0.00	$0.00	$12.00	$12.00	$0.00	$0.00	$0.00
Bull trout - redd inundation study	O&M	**$110.00**	$0.00	$55.00	$55.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Common loon monitoring	O&M	**$125.00**	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$2.50	$12.50	$12.50	$25.00	$25.00	$25.00
Watershed terrestrial monitoring and research	**TOTAL**	**$2,630.01**	**$85.63**	**$85.63**	**$156.67**	**$131.67**	**$181.67**	**$119.17**	**$154.17**	**$104.17**	**$81.04**	**$81.04**	**$248.34**	**$200.83**	**$373.33**	**$299.23**	**$327.43**
Assessment of expanded forest stand data	O&M	**$75.00**	$10.00	$10.00	$10.00	$10.00	$10.00	$5.00	$5.00	$5.00	$5.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00
Assessment of expanded forest attribute data	O&M	**$75.00**	$10.00	$10.00	$10.00	$10.00	$10.00	$5.00	$5.00	$5.00	$5.00	$5.00	$0.00	$0.00	$0.00	$0.00	$0.00
Augmentation of forest habitat inventory	O&M	**$75.00**	$15.00	$15.00	$15.00	$15.00	$15.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Long-term forest habitat inventory (including old-growth classification and field verification)	O&M	**$525.02**	$15.00	$15.00	$24.38	$24.38	$24.38	$21.88	$21.88	$21.88	$21.88	$21.88	$42.50	$37.50	$75.00	$75.00	$82.50
Habitat restoration - riparian forest development	O&M	**$335.00**	$0.00	$0.00	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$10.71	$10.71	$53.57	$37.50	$75.00	$62.50	$50.00
Habitat restoration - upland forest development	O&M	**$335.00**	$0.00	$0.00	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$10.71	$10.71	$53.57	$37.50	$75.00	$62.50	$50.00
Marbled murrelet - survey, old growth	O&M	**$75.00**	$0.00	$0.00	$25.00	$25.00	$25.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Marbled murrelet - baseline survey, second growth	O&M	**$150.00**	$0.00	$0.00	$0.00	$0.00	$25.00	$50.00	$50.00	$25.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Marbled murrelet - long term surveys	O&M	**$100.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$50.00	$0.00	$50.00
Marbled murrelet - experimental habitat study	O&M	**$185.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$10.00	$10.00	$10.00	$10.00	$40.00	$40.00	$10.00	$25.00	$30.00
Spotted owl - baseline survey[7]	O&M	**$75.00**	$0.00	$0.00	$25.00	$0.00	$25.00	$0.00	$25.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Spotted owl - site center survey	O&M	**$75.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$15.00	$10.00	$25.00	$12.50	$12.50
Optional species/habitat surveys	O&M	**$150.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$4.17	$4.17	$20.83	$20.83	$33.33	$35.90	$30.77
Data/GIS compatibility	O&M	**$150.00**	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$6.25	$3.57	$3.57	$17.86	$12.50	$25.00	$20.83	$16.67
Forest habitat modeling	O&M	**$75.00**	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$9.38	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Species-habitat relations modeling	O&M	**$175.00**	$20.00	$20.00	$20.00	$20.00	$20.00	$10.00	$10.00	$10.00	$10.00	$10.00	$5.00	$5.00	$5.00	$5.00	$5.00
Cedar permanent dead storage project evaluation	**TOTAL**	**$1,445.00**	**$225.50**	**$265.50**	**$365.50**	**$405.50**	**$153.00**	**$30.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

YEARS:	CIP/ O&M[2]	Total 50-yr.	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50
Engineering, water quality, and economic studies	CIP	**$700.00**	$140.00	$140.00	$140.00	$140.00	$140.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bull trout - spawning impedance (passage plan)	CIP	**$65.00**	$13.00	$13.00	$13.00	$13.00	$13.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bull trout - spawning impedance (delta modeling)	CIP	**$290.00**	$72.50	$72.50	$72.50	$72.50	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Pygmy whitefish/rainbow trout studies	CIP	**$280.00**	$0.00	$0.00	$140.00	$140.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Delta plant community monitoring[5]	CIP	**$80.00**	$0.00	$40.00	$0.00	$40.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Common loon nesting habitat monitoring	CIP	**$30.00**	$0.00	$0.00	$0.00	$0.00	$0.00	$30.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
MONITORING & RESEARCH TOTAL		**$13,931.16**	**$1,107.57**	**$1,170.67**	**$1,248.71**	**$1,403.71**	**$809.21**	**$589.18**	**$588.18**	**$533.18**	**$324.05**	**$406.05**	**$1,082.99**	**$659.38**	**$1,627.43**	**$861.33**	**$1,519.53**
GRAND TOTAL		**$78,871.16**	**$4,812.92**	**$6,865.02**	**$7,398.06**	**$9,191.06**	**$5,811.56**	**$3,017.93**	**$2,016.93**	**$1,961.93**	**$1,530.93**	**$1,612.93**	**$6,611.11**	**$5,138.68**	**$7,925.37**	**$7,159.27**	**$7,817.48**
TOTAL CIP		$44,747.00	$3,717.25	$5,746.25	$6,301.25	$7,929.25	$4,591.75	$1,908.75	$878.75	$878.75	$746.88	$746.88	$3,328.13	$2,279.30	$1,897.94	$1,897.94	$1,897.94
TOTAL O&M		$34,124.16	$1,095.67	$1,118.77	$1,096.81	$1,261.81	$1,219.81	$1,109.18	$1,138.18	$1,083.18	$784.05	$866.05	$3,282.99	$2,859.38	$6,027.43	$5,261.33	$5,919.53

[1] Approximate timing of activities and expenditures. May vary for specific activities. Please see text in Chapter 4 for details.
[2] CIP: Capital Improvement Project; O&M: Operations and Maintenance (operating expenses).
[3] Project likely to be delayed, depending on ACOE schedule and other factors.
[4] Completed.
[5] Any 2 years within HCP years 2-7.
[6] Within HCP years 3-9.
[7] HCP years 3-10.

5.4 Oversight of HCP Implementation

Significant attention has been given to HCPs in recent years. One concern expressed by the public and scientists has been that there is little opportunity for the public or outside scientists to be involved in the development and implementation of such plans. Because of the long-term nature of many HCPs, there is keen interest in determining how such plans are functioning with respect to their objectives. The City recognized the need for such involvement during development of the HCP, and held a number of workshops with outside scientists (Section 3.3.4), as well as an extensive public outreach program (Revised Cedar River Watershed HCP EA/Final EIS, Section 1.7). In response to comments from the scientists and the public, the City made a variety of substantial changes to the draft HCP and incorporate elements of several of the alternatives evaluated in the EA/EIS into the this final HCP.

In addition, the City recognizes the need for the signatories to the Implementation Agreement and related agreements to be involved in implementation of the HCP, as well as the public and outside scientists. The City will establish an overall HCP Oversight Committee, and later subcommittees or groups as needed, that will serve to advise the City during implementation of the HCP. Each signatory to the Implementation Agreement or to either of the two related agreements, and the Muckleshoot Indian Tribe, will have one designated member on the HCP Oversight Committee. King County will have one advisory representative on the HCP Oversight Committee, contingent on the County’s written endorsement of the HCP.

After consulting with the various parties to the Implementation Agreement and related agreements, the City will appoint additional advisory members to the HCP Oversight Committee to effect broad representation during the implementation process. Included will be outside scientists and representatives of the general public, other public agencies, and interest groups, including environmental groups, and fish advocacy groups, as well as one representative with knowledge of forest science. The City will chair the HCP Oversight Committee, as well as any subcommittees and work groups that may be established, and will provide administrative support. The HCP Oversight Committee will meet at least annually, but may adopt a reduced meeting frequency after the first decade.

As described in the Implementation Agreement (Appendix 1), the HCP Oversight Committee’s function will be to advise the City concerning HCP implementation. It will serve as a forum for: (i) communication regarding implementation of the HCP; (ii) identification of issues that need discussion and resolution; and (iii) periodic review of HCP progress. The Oversight Committee is advisory to the City and cannot override the decisions or actions taken under the Instream Flow Agreement or Landsburg Mitigation Agreement.

The City, in consultation with the HCP Oversight Committee, may also establish subcommittees or *ad hoc* advisory working groups as needed for specific projects or issues. Such subcommittees and working groups will be advisory to the City, and the City will determine membership and administrative rules for them, after consulting with the HCP Oversight Committee. The HCP Oversight Committee will coordinate any subcommittees and the work groups that are established. The City will establish, convene and chair all such groups, and will provide administrative support.

Pursuant to the two related agreements, the City will also establish the following commission and committee:

- *Cedar River Instream Flow Oversight Commission*. This commission, established by the Instream Flow Agreement (Appendix 27), will oversee instream flow decisions, as well as instream flow monitoring and research. Membership will include all signatories to the Instream Flow Agreement and the Muckleshoot Indian Tribe, as well as King County in an advisory capacity if the County provides a written endorsement of the HCP.

- *Cedar River Anadromous Fish Committee*. This committee, established by the Landsburg Mitigation Agreement (Appendix 28), will advise the City regarding implementation of anadromous fish mitigation, including anadromous fish monitoring and research. Membership will include one representative each for the four signatories to the Landsburg Mitigation Agreement, the Muckleshoot Indian Tribe, and King County, if the County provides a written endorsement of the HCP. In addition, the there will be one representative of the parties that were signatory to the June 11, 9999, Notice of Appeal of the Final EIS, and three other stakeholders selected by unanimous agreement of the Parties to the Landsburg Mitigation Agreement..

The functioning of the various implementation committees is further described in the Implementation Agreement and related agreements (appendices 1, 27, and 28).

5.5 Adaptive Management

5.5.1 Schedule for Development of Specific Applications of Adaptive Management

The City will develop written approaches for the application of adaptive management to the environmental events and the three specific HCP issues described in Section 4.5.7 in the section entitled "Specific Applications of Adaptive Management for Changed Circumstances." The approaches for adaptive management related to two of the specific applications cannot be developed until particular project plans are completed for those activities, because such plans will affect the choice of criteria and monitoring needs. However, the adaptive management plan for the flow accretion study, which will be initiated with implementation of the HCP, can be developed concurrent with development of the accretion flow study design and initial implementation of the study. The City will develop written approaches for the application of adaptive management according to the following schedule:

(1) Accretion Flows. By the end of HCP Year 3.

(2) Landsburg Fish Passage. One year prior to initiation of passage of adult chinook or coho salmon, or steelhead trout, above the Landsburg Diversion Dam.

(3) Sockeye Hatchery Operation. One year prior to initial operation of the replacement sockeye hatchery, and prior to the final decision to construct the hatchery.

Formal written approaches will not be developed for those cases where adaptive management is used simply as a general tool for adaptively responding to new information or understanding, or for changed circumstances related to environmental events (Section 4.5.7). Decisions about effectiveness and changes to mitigation or conservation strategies will be based on the conservation objectives of the relevant mitigation or conservation strategies. Such cases of the general application of adaptive management are expected to include experimental projects for watershed restoration (Section 4.2); adaptive changes in the allocation of “discretionary water” and other decisions regarding instream flow management handled under the provisions of the Instream Flow Agreement (Section 4.4 and Appendix 27); operation of other oversight committees that are involved in real-time decisions and project planning, review of progress, and adjustments to the plan (Section 5.4); the ability to transfer funds among elements of the HCP, or to new elements, but within limits to ensure that the integrity of the plan is maintained (Section 5.3.2); the flexibility to alter mitigation and conservation strategies in response to new information or a change in status of species addressed in the HCP; and minor modifications to the HCP under provisions of the Implementation Agreement (Appendix 1, § 12.1).

5.5.2 Limits to City Commitments

The Implementation Agreement (Appendix 1) specifies how funding or other commitments of resources will be treated regarding any additional mitigation developed under adaptive management during implementation of the HCP. Except as specified above under the subsection entitled “Specific Applications of Adaptive Management for Changed Circumstances,” application of adaptive management in this HCP is subject to the overall cost constraints described in Section 5.3.1, and §§ 7.4 and 9.1 of Appendix 1. For remaining cases, funding and commitment of resources will be derived from within the plan’s overall, agreed-upon funding and resource commitments, or from sources other than the City, unless the City otherwise agrees.

6. ALTERNATIVES TO HCP THAT WOULD AVOID TAKE

Chapter 6 Contents

6.1 Introduction

A detailed discussion of the full range of alternatives considered for the HCP can be found in the Cedar River Watershed Revised EA/Final EIS. However, to meet requirements for an HCP under Section 10 of the ESA (see Section 2.3.2 of the HCP), a brief discussion is included here of alternatives to the HCP that would avoid take. This chapter provides an explanation of why these alternatives are not acceptable for City operations in the Cedar River Watershed in lieu of an incidental take permit based on the HCP. Alternatives that would avoid take are organized according to the three major components of the HCP: watershed management, mitigation for blockage to anadromous fish at the Landsburg Diversion Dam (anadromous fish mitigation), and instream flows.

Under these “No Take” alternatives to the HCP, the City of Seattle would not seek incidental take permits from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service for species listed as endangered, or species listed as threatened for which a take prohibition was in place under section 4(d) of the ESA. The City of Seattle would not implement an HCP to comply with the ESA or address currently unlisted species or threatened species for which no final 4(d) rule existed. Instead, City operations on the Cedar River and in the Cedar River Municipal Watershed would be conducted to avoid take of the species known to occur in the municipal watershed that are now listed under ESA as threatened with an existing final 4(d) rule (northern spotted owl, marbled murrelet, bald eagle, and bull trout); endangered (gray wolf), should they be found to occur in the watershed; or threatened with an existing final 4(d) rule (grizzly bear), should they be found to occur in the watershed.

City operations would be regulated by the federal government on a case-by-case basis as any additional species became listed under the ESA or additional final 4(d) rules were promulgated.

Uncertainty regarding compliance with the ESA is one of the dominant features common to the No Take alternatives described for all three components of the HCP. This uncertainty would continue over time. Requirements could stiffen, more species could be listed, or requirements could relax with changes in federal policy. As a result, the City of Seattle would need to respond as appropriate to these changes and take precautions to ensure regulatory compliance when guidance was lacking.

6.2 No Take Option for Watershed Management

In order to avoid take from watershed management activities, the City of Seattle would achieve compliance with the ESA by not conducting timber harvest activities, building roads, or conducting other land management operations within or near existing and potential habitat for listed species in a manner that would result in take of these species. Based on knowledge of the habitat associations and distribution of listed species in the municipal watershed (Section 3.5), it is likely that some timber harvest could be conducted in most of the previously harvested stands in the lower watershed, and in some parts of the upper watershed. No harvest would likely be conducted within old-growth forest. However, the City’s ability to plan timber harvest would be uncertain and would depend on the locations and activities of individuals of listed species. These locations and activities are likely to change over time, and future harvest would become more restricted if populations of these species in the municipal watershed were to increase.

This No Take option differs from the “No Action” alternative described in the Revised EA/Final EIS in that the No Take option likely could allow more timber harvest in some areas of the watershed, but harvest under the No Take option would be more uncertain. The No Take option differs from the four other alternatives analyzed in the Revised EA/Final EIS in that it would allow more timber harvest, not include commitment to an Ecological Reserve, and not include such measures as ecological thinning, restoration thinning, restoration planting, an increased level of road decommissioning and stabilization, and the variety of stream, riparian and upland restoration projects included in the HCP alternative. These activities would not take place under the No Take option.

Therefore, the No Take option for watershed management would not provide as much improvement in habitat over time, overall, for species addressed in the HCP as the HCP does. Furthermore, the No Take option for watershed management would result in uncertainty in the City’s ability to conduct land management activities necessary to fulfill its obligations to the public for managing the watershed as a municipal water supply. For these reasons, the City is not pursuing the No Take option.

6.3 No Take Option for Anadromous Fish Mitigation

No species of anadromous fish are currently listed as endangered under the ESA or as threatened with a published take prohibition under section 4(d) of the ESA. Thus, the City’s water supply operations that affect anadromous fish species could continue without alteration unless one or more of the species were to become listed under ESA or a final take prohibition were to be published for the threatened chinook salmon. Because sockeye salmon in the Cedar River are from an introduced stock, Cedar River sockeye are not eligible for listing under ESA (Section 3.5.8). One or more of the other anadromous salmonid stocks in the Cedar River could also be listed in the future.

The City does not believe that the existence of the Landsburg Diversion Dam causes take as defined by the ESA (Section 2.3.2), because the Landsburg facilities were in existence prior to initial passage of the ESA in 1973. However, should NMFS be able to show that the existence and operation of the dam causes take for any species that becomes listed, the City would have to develop an HCP and take actions for such species that include provisions to minimize and mitigate the impact of any taking caused by the Landsburg Diversion Dam to the maximum extent practicable. These actions could include construction of facilities at Landsburg to pass chinook salmon, coho salmon, steelhead trout, or sea-run cutthroat trout over the dam, depending on which species were to become listed. Construction of such facilities is part of the HCP and all other alternatives analyzed in the Revised EA/Final EIS except the No Action alternative. No actions regarding sockeye salmon would be required under the No Take option.

This No Take option differs from the No Action alternative analyzed in the Revised EA/Final EIS in that the No Take option would not include mitigation for sockeye. Under the No Action alternative in the Revised EA/Final EIS, a prototype hatchery would continue to be operated for sockeye, but no firm commitments are made to mitigation for other species. Under both the No Take option and the No Action alternative analyzed in the Revised EA/Final EIS, mitigation would be provided to species on a case-by-case basis at the time of listing as endangered or publication of a final 4(d) rule for threatened species. The No Take option differs from the four other four alternatives analyzed in the Revised EA/Final EIS in that it would not include long-term mitigation for sockeye or a commitment to construct facilities to pass chinook, coho, and steelhead over the Landsburg Diversion Dam, regardless of whether any of these species were to be listed.

The No Take option for anadromous fish mitigation would not provide certainty regarding any requirements under the ESA regarding mitigation that might be required for the Landsburg Diversion Dam, and it would not provide the substantial benefits to anadromous fish species that are include in the HCP. For these reasons, the City is not pursuing the No Take option.

6.4 No Take Option for Instream Flows

As noted above in Section 6.3, no species of anadromous fish is currently listed as endangered under the ESA or as threatened with an existing take prohibition under section 4(d) of the ESA. Thus, the City's water supply operations that affect anadromous fish species could continue without alteration unless one or more of the species were to become listed under ESA or unless a 4(d) rule is published for the threatened chinook salmon. As indicated in Section 6.3, sockeye salmon in the Cedar River are not eligible for listing under ESA. Puget Sound chinook salmon have been listed as threatened by NMFS, but no final 4(d) rule has been published. One or more of the other anadromous salmonid stocks could be listed in the future.

The ways in which management of instream flows could cause take are not clear. Regulations define take to include significant habitat modification or degradation, but only where it actually kills or injures wildlife (Section 2.3.2). Such actions as rapid downramping of flows in a manner that strands and kills fish would constitute take, as would entrainment of fish into water intakes.

If a species of anadromous fish were to become listed, the City would have to develop an HCP and take actions for that species that includes provisions to minimize and mitigate the impact of any taking caused by the management of instream flows and water diversion. These actions would likely include downramping limitations for such species and measures to avoid entrainment, such as construction of protective screens on the water intake at Landsburg. The No Take option could also include requirements regarding regulation of instream flows, but the form of those requirement is uncertain. No actions regarding sockeye salmon would be required under the No Take option.

Under the "No Action" alternative described in detail in the Revised EA/Final EIS, instream flows would continue to be managed according to the non-binding instream flows established for the Cedar River by WDOE in 1979 (Section 2.2.5), which provide habitat for all anadromous species but do not include downramping limitations. The HCP alternative provides substantial benefits for all anadromous species compared to the No Action alternative.

Uncertainty regarding compliance with the ESA characterizes the No Take option, because as time goes on requirements could stiffen, requirements could be relaxed, or species potentially affected by instream flows in the Cedar River could be listed. If a final 4(d) rule were to be published for chinook salmon in Puget Sound, the City would be required to manage flows on the river in a manner that would meet the requirements of the ESA for chinook, some of which are not clear at this time. Management of flows in this way could end up being at the expense of other unlisted species of concern, such as sockeye, coho, or steelhead.

In preparing this HCP, the City of Seattle is seeking certainty with respect to its ability to supply water to it customers in the future (Section 2.4). This No take option does not provide such certainty, and it would not provide as many benefits to anadromous fish as the HCP. For both these reasons, this No Take option is not as suitable as the HCP, which both maintains the predictability of the City's water supply operations on the Cedar River and includes instream flow management in the river that will provide benefits to a variety of fish species, including chinook salmon, sockeye salmon, coho salmon, and steelhead trout.

The No Take option for instream flows would not provide certainty regarding future water supply under the ESA, and it would not provide the substantial benefits to anadromous fish species that are included in the HCP. For these reasons, the City is not pursuing the No Take option.

6.5 Conclusions

In general, the No Take options are not as suitable for City operations on the Cedar River Watershed as the HCP proposal. The City of Seattle is responsible for providing a safe, reliable and adequate supply of water to the homes and businesses in the City and, through supply contracts with other jurisdictions, to most of the metropolitan area. This responsibility is accompanied by very high standards for water quality to protect public health and for reliability in meeting a wide range of basic needs, including water for fire protection and for use by many residential and commercial customers. The City is also responsible for providing reliable electric service to residents and businesses in Seattle and adjoining areas. The City is obligated to provide all of these services at a fair and affordable cost. In addition, the City is also responsible for minimizing actual and potential environmental impacts from its operations through very high standards of environmental protection, restoration, and mitigation.

The No Take options would not allow the City to fulfill these obligations to the fullest extent. For example, the HCP commitments for watershed management would provide greater habitat protection and improvements than the No Take option. The No Take option for anadromous fish mitigation would not provide certainty with regard to mitigation for the Landsburg Diversion Dam, and would not provide the substantial benefits to anadromous fish that the HCP does. The No Take option for instream flows would result in an uncertain regulatory climate that would inhibit long-range water supply planning for the region, and that could force management of flows in the river to focus on the needs of individual species as they become listed under the ESA, rather than providing for the needs of all species of anadromous fish as does the HCP. The No Take option for instream flows would not provide the substantial benefits to anadromous fish that the HCP does.

Glossary of Terms

Unless specified otherwise in the text, the following terms and phrases are defined as follows.

Accretion flows	The local inflows to the Cedar River, including tributary and subsurface inflows, downstream of Landsburg Diversion Dam, at which point most of the City's instream flow commitments will be measured.
Adaptive management	As applied in the HCP, the process of adaptive management is defined with three basic elements: (i) an initial operational decision or project design made in the face of uncertainty about the impacts of the action; (ii) monitoring and research to determine impacts of actions; and (iii) changes to operations or project design in response to new information.
Adfluvial	A fish population or stock that rears as adults in a lake and spawns in a river or tributary of a river.
Alevin	A recently hatched juvenile salmonid that has not emerged from the gravel and that still has its yolk sac.
Alluvial soils	Soils deposited by running water.
Anadromous fish	Those species of fish, such as salmon, that hatch and typically rear in freshwater, migrate to the ocean to mature into adults, and return upstream to freshwater rivers, streams, and lakes to spawn.
Aquatic habitat	Bodies of water such as rivers, streams, lakes, and wetlands, as defined.
Bank armoring	Hardening of streambanks to reduce erosion potential using hard (rocks or structures) or soft (biotechnical) engineering techniques.
Bedload	Substrate that is too heavy to stay suspended in water and is transported along the bottom of the stream by bouncing, rolling, or sliding.
Best Management Practices (BMPs)	Methods, measures, or practices designed to reduce adverse impacts, usually applied as a system of practices rather than a single practice.
Biodiversity	Biological diversity; the combination and interactions of genetic diversity, species composition, and ecological diversity in a given place at a given time.
Biological legacies	Features of a previous forest that are retained at timber harvest or left after natural disturbances, including large old-growth or other snags, stumps, live trees, logs, soil communities, hardwood trees, and shrubs.
Blowdown	Trees felled by high wind.
Bog	A hydrologically isolated, low nutrient wetland that receives its water from precipitation only. Bogs typically have no inflow and rarely have outflows, and have specially adapted vegetation such as sphagnum moss, Labrador tea, bog laurel, sundews, and some sedges. Bogs may have an overstory of spruce, hemlock, cedar, or other tree species, and may be associated with open water bodies.

Broodstock	Adult fish used for breeding in a hatchery.
Buffer	A forested, or otherwise undisturbed, strip left or treated differently during silvicultural activities to protect sensitive ecosystems (e.g., streams, wetlands, and old growth) or fish or wildlife habitat. Management activities such as planting or thinning may be allowed in buffers if they are consistent with the conservation objectives for the buffer.
Candidate species, federal	Any species being considered by the Secretary of the Interior or the Secretary of Commerce for listing as a threatened or endangered species under the Endangered Species Act, as amended, but not yet the subject of a proposed rule.
Candidate species, state	A wildlife species that is under review by Washington Department of Fish and Wildlife for possible listing as endangered, threatened, or sensitive when sufficient evidence suggests that its status may meet criteria defined for endangered, threatened, or sensitive in WAC 232-12-297. Candidate species are designated in WDFW Policy POL-M6001.
Canopy	The cover of branches and foliage formed collectively by the crowns of trees or other growth. Also used to describe layers of vegetation or foliage below the top layer of foliage in a forest, as when referring to the multi-layered canopies or multi-storied conditions typical of ecological old-growth forests.
Canopy closure	The degree to which the boles, branches, and foliage (canopy) block penetration of sunlight to the forest floor or obscures the sky; determined from measurements of density (percent closure) taken directly under the canopy.
Carabid (beetle)	Predaceous ground beetles from the family Carabidae, a large family of beetles. Many feed on pest species.
Carrying capacity	The maximum number of organisms that can be sustained in a given area of habitat.
Catastrophic event	A large-scale, high intensity natural or human-caused disturbance that occurs infrequently, such as insect or disease outbreaks, extraordinary flooding, or severe fire, that would require action to protect drinking water quality, protect public safety, and prevent significant damage to natural resources.
Catastrophic salvage	The removal of trees for sale from an area or areas of forest that experienced a catastrophic event.
Cavity tree	A tree or snag with holes or openings caused by fire, rot, or limb breakage, or excavated by birds. Such trees are used for roosting, reproduction, and foraging by birds and mammals.
Cedar River Basin	The entire area that drains into the Cedar River above Lake Washington.

Cedar River Municipal Watershed	An administrative unit of land; the 90,546-acre municipal watershed within the upper part of the Cedar River Basin, upstream from the City's water intake at Landsburg Diversion Dam. It is composed of eight major subbasins and 27 subbasins, 26 of which drain into the Cedar River. It supplies about 2/3 of the drinking water to Seattle Public Utilities' water service area.
Char	Fish in the family Salmonidae that belong to the genus *Salvelinus*. For example, bull trout is a char.
City, the	The City of Seattle.
Clearcut	A silvicultural system and type of regeneration harvest that is widely used in the Pacific Northwest. It involves removal of nearly all standing trees within a given harvest area. This system focuses on promoting regeneration of species that thrive in full sunlight. It is also the most efficient and economical method of harvesting timber. As defined by Forest Practices Rules (1995), "…a harvest method in which the entire stand of trees is removed in one timber harvesting operation. Except as provided in WAC 222-30-110, an area remains clearcut until: It meets the minimum stocking requirements under WAC 222-34-010(2) or 222-34-020(2); and the largest trees qualifying for the minimum stocking levels have survived on the area for five growing seasons or, if not, they have reached an average height of four feet."
Coarse woody debris	Large pieces of wood in forests, including logs (down dead trees), pieces of logs, large branches, stumps, and snags (standing dead trees). Provides valuable habitat for many kinds of animals and contributes significantly to biodiversity of conifer forests.
Commission, the	Cedar River Instream Flow Oversight Commission, to be established as part of the HCP pursuant to the Instream Flow Agreement.
Competitive exclusion	A phase in which the canopy closes and competition among trees becomes intense in a developing stand. Also sometimes called stem exclusion.
Compliance monitoring	Monitoring performed to determine whether HCP programs and elements are implemented as written.
Compliance point	The location(s) in the Cedar River at which measurements are made to assure compliance with instream flow and flow downramping rate requirements.
Component	Refers to one of the four major types of commitment in the HCP: watershed management, anadromous fish mitigation, instream flows, or monitoring and research.
Connectivity	A measure of the extent to which conditions between different areas of similar or related habitat provide for successful movement of fish or wildlife species, supporting populations on a landscape level.

Conservation strategy	A collective set of measures to avoid, minimize, or mitigate the potential take (or equivalent of take) of species addressed by the HCP, or for protecting, rehabilitating, enhancing, or restoring habitats for these species.
Contiguous habitat	Habitat that is distributed continuously or nearly continuously across the landscape.
Critical flows	The minimum instream flows (cfs) maintained in the Cedar River below the Landsburg Diversion Dam to protect habitat conditions for anadromous fish under very adverse and infrequent hydrologic conditions (on average, one-in-ten years). Critical instream flows are lower for most periods of the year than normal flows, which are provided, on average, 9 in 10 years.
Critical habitat	Areas designated under the federal Endangered Species Act, defined as "specific areas with the geographic area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) necessary to the conservation of the species and (II) which may required special management considerations or protection; and . . . specific areas outside the geographic area occupied by the species, at the time it is listed . . . upon a determination . . . that such areas are essential for the conservation of the species."
Critical habitat unit (CHU)	Units of critical habitat; see also "Northern Spotted Owl CHU."
Crown closure	See "Canopy closure."
Cutslope	An over-steepened slope face created by excavating into a hillside, such as during road construction.
Dead storage	The water in Chester Morse Lake below a depth of 1,532 ft, which is the natural gravity outlet of the lake.
Debris flow	A moving mass of rock fragments, soil, and trees, with a high volume of water that can travel at speeds greater than 60 mph and travel long distances down steep confined mountain channels. Debris flows are typically caused by storm events.
Decommissioning	Deconstruction; work on roads no longer to be used that leaves them in a condition suitable to control erosion and maintain water movement. Methods of decommissioning include removal of bridges, culverts, and fills in accordance with WAC 222-24-050.
Dewatering (of redds)	A condition in which water flows are decreased to a level where redds (nests of salmonid eggs) are exposed.
Diameter at breast height (dbh)	The diameter of a tree, including bark, measured 4.5 ft above the ground on the uphill side of the tree and measured in inches.

Discretionary water	As used in the HCP, water volumes or flows that can be provided, at the discretion of the City, to increase instream flows for fish at different times when it is needed, typically as recommended by the Cedar River Instream Flow Oversight Committee.
Dispersal	The movement of juvenile, subadult, or adult animals from one sub-population to another. Individuals may disperse for foraging, breeding, and other reasons.
Distribution (of a species)	The spatial arrangement of individuals of a species within its range.
Disturbance	Significant change in forest structure or composition through natural events (such as fire, flood, wind, earthquake, or disease) or human-caused events (forest management).
Dog-hair stand	An over-stocked, closed-canopy stand with little or no understory vegetation because of a lack of light penetration, and where growth is suppressed. These stands are typically less than 30 years old, but can be older.
Downramping	Reductions in instream flows as a result of changes in water or hydroelectric facility operations, most often expressed as a rate of drop of river water elevation in inches per hour.
Early seral – grass-forb stage	Very recently harvested or disturbed forest habitat characterized by dominance of grasses and other non-woody vegetation, defined in this HCP as such habitat that is 0-9 years of age. Tree seedlings are present, but not dominant, and shrubs can be present.
Early seral – open canopy stage	Recently harvested or disturbed forest habitat dominated by young trees (saplings) and shrubs, defined in this HCP as such habitat that is 10-29 years of age. Canopy closure is typically less than 60%.
Ecological thinning	As used in this HCP, the experimental silvicultural practice of cutting, damaging, or otherwise killing some trees from some areas of older, overstocked, second-growth forest (typically over 30 years old). The intent of ecological thinning is to encourage development of the habitat structure and heterogeneity typical of late-successional and old-growth stands, characterized by a high level of vertical and horizontal stand structure, and to improve habitat quality for wildlife. It is expected that techniques will include variable-density thinning to create openings, develop a variety of tree diameter classes, develop understory vegetation, and recruit desired species; and creating snags and logs by uprooting trees, felling trees, topping trees, injecting trees with decay-producing fungus, and other methods. Ecological thinning does not have any commercial objectives. However, in those cases in which an excess of woody material is generated by felling trees, trees may be removed from the thinning site and may be sold or used in restoration projects on other sites. See Figure G-1.a for illustration.
Ecosystem	A natural system composed of component organisms interacting with their environment.

Ecosystem management	A strategy or plan to provide for the needs of organisms associated with an ecosystem, typically focusing on habitat management.
Edge habitat	An area where different ecological communities meet or where different successional stages or vegetative conditions within communities come together. Also, as used in the context of instream flows, that portion of a stream nearest to the wetted margins of the active stream channel.
Effective habitat	Habitat that provides all components necessary for the survival of a specific population.
Effectiveness monitoring	Monitoring to determine whether implemented HCP conservation strategies result in anticipated habitat conditions or effects on species.
Element	A feature of a component. For example, a fish ladder would be an element of the anadromous fish mitigation component.
Emergent surfaces	Those portions of objects that protrude above the surface of the water (e.g., logs). May be important for some species as an egress from the water.
Emergent vegetation	Aquatic plants that are only partially submerged, and are typically rooted in the aquatic environment with the majority of photosynthesis occurring above the surface of the water (e.g., cattails).
Endangered species, federal	A designation as defined in Section 3 of the federal Endangered Species Act for a species in danger of extinction throughout all or a significant portion of its range.
Endangered species, state	A wildlife species native to the State of Washington that is seriously threatened with extinction throughout all or a significant part of its range within the state. State endangered species are legally designated in WAC 232-12-014 and defined in WAC 232-12-297 Section 2.4.
Enhancement	An improvement of a structural or functional attribute that may or may not restore the original linkages to other parts of the ecosystem [based on Kaufmann].
Entrainment	To draw in and transport by the flow of a fluid. For example, some fish are likely entrained into the penstocks of the Cedar Falls Powerhouse through the intake structure.
Environmental Assessment (EA)	A formal document prepared under the National Environmental Policy Act to assess the effects that a particular action will have on the environment.
Environmental Impact Statement (EIS)	A document prepared under the State Environmental Policy Act to systematically analyze the effects that site-specific activities will have on the environment.
Escapement	The number of adult fish returning to spawn after harvest. Escapement goals are often established by fisheries managers.

Even-aged forest	A forest with minimal differences in age, generally less than 10 years, between trees.
Felsenmeer	Broken and fragmented rock, often in angular blocks, formed on gentle mountain slopes through weathering processes, particularly freezing and thawing.
Firm block (of water)	As part of the instream flow regime, a specified volume of water (2,500 acre-feet) that the City would provide, as a commitment, between June 17 and August 4 in most normal years to supplement the required minimum instream flows in a manner that benefits anadromous fish.
Fish ladder	A structure typically used to allow passage of adult fish upstream over barriers that block their migration.
Fish screens	Screens installed on water intakes to reduce juvenile and adult fish entrainment and injury from impingement.
Fish weir	A fence or enclosure set in a waterway for blocking fish passage or capturing fish.
Flow stable mode	An operational mode for a hydroelectric project that maintains stable flow downstream of the project, such that the project does not peak (fluctuate flow) with electrical load (demand).
Forest succession	The sequential change in composition, abundance, and patterns of species that occurs as a forest matures after an event in which most of the trees are removed. The sequence of biological communities in a succession is called a sere, and the communities are called seral stages.
Fry	A free-swimming, juvenile salmonid that has recently emerged from the gravel and has fully absorbed its yolk sac.
Geographic Information System (GIS)	A computer system for collecting, storing, retrieving, transforming, displaying, and analyzing spatial or geographic data, accomplished by linking areas or map features with associated attributes for a particular set of purposes, including the production of a variety of maps and analyses.
Glacial moraine	As used in the HCP, a deposit of sediment at the advancing front edge of a glacier. A glacial moraine is deposited wherever a glacier pauses, marking the farthest extent of the end of the advance, and is often crescent shaped. Sediment may also be deposited laterally.
Green tree	A living and growing tree.
Habitat	The sum total of environmental conditions of a specific place occupied by plant or animal species or a population of such species. A species may require or use more than one type of habitat to complete its life cycle.

Habitat conservation plan (HCP)	As defined under Section 10 of the federal Endangered Species Act, a plan required for issuance of an incidental take permit for a listed species. Called "conservation plans" under the Act, HCPs can address multiple species, both listed and unlisted, and can be long term. HCPs provide for the conservation of the species addressed, and provide certainty for permit applicants through an implementation agreement between the Secretary of the Interior or Secretary of Commerce and a non-federal entity.
Half-pounder	Steelhead that grow to an average weight of one-half pound during their initial ocean residence.
Harm	A form of take under the federal ESA; defined in federal regulations as an act that actually kills or injures wildlife. Such acts may include significant habitat modification or degradation that actually kill wildlife by significantly impairing essential behavioral patterns, such as breeding, feeding, or sheltering (50 CFR 17.3).
HCP year 1	That period of time through the end of the first full calendar year following the effective date of the HCP.
Headwall	Very steep, concave portions of the headwaters of a stream, including tops of rock ledges and areas of a basin that are usually wet and unstable.
Headwaters	The source of a stream or stream system.
High-normal flows	The high part of the normal minimum instream flow curve, for flows in the Cedar River below the Landsburg Diversion Dam, during the period between October 8 and December 31 for some normal years. The applicability of this curve in any given year is based upon storage and hydrologic conditions prevailing each fall and is determined by specific flow-switching criteria and procedures. High-normal flows are intended to provide more beneficial habitat conditions for anadromous fish in the fall than low-normal flows or critical flows.
Hydroacoustic surveys	A method for underwater assessment of fish using an echolocater (device that uses sound to locate objects).
Hydrograph	Graphical relationship of stream discharge (rate of flow) plotted against time.
Hydrologic	Pertaining to the cycling, movement, distribution, and properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.
Hydrologic maturity	The state of forest vegetation whereby vegetative water usage and the effect of forest on hydrology are similar to that of unharvested forest vegetation. As defined in the HCP, hydrologically mature vegetation has a canopy closure of 70 percent or more, and a diameter (dbh) of 9 inches or more.

Implementation Agreement	A part of the application for an incidental take permit for an approved HCP, an agreement that specifies the terms and conditions, resources, schedule of activities, and expectations for the parties to the agreement.
Implementation monitoring	Compliance monitoring; monitoring to determine whether the HCP conservation strategies are implemented as written.
Incidental take	As defined by the Endangered Species Act, the taking of federally listed animal species, if the taking is incidental to, and not the purpose of, carrying out otherwise lawful activities. See also "Take."
Incidental Take Permit	A permit issued by the U.S. Fish and Wildlife Service or National Marine Fisheries Service to a non-federal entity that allows the incidental take of a threatened or endangered species; requires the permittee to carry out specified actions that minimize and mitigate the impacts of the incidental take to the maximum extent practicable, and in a manner that does not appreciably reduce the likelihood of survival or recovery of the species in the wild.
Infectious Hematopoietic Necrosis Virus (IHNV)	A viral pathogen present in nearly all populations of sockeye salmon, and some populations of steelhead trout and chinook salmon, that causes the potentially fatal disease Infectious Hematopoietic Necrosis.
Inner gorges	Deeply incised stream channels with steep side slopes, with high mass-wasting hazard (landslide potential).
Intakes	Structures through which water from the reservoir or river are taken into the City's hydroelectric generation and water supplies facilities; includes the penstocks and the Howell-Bunger valve.
Interior forest conditions	Forest conditions that are largely not affected by edge effects, which occur where large openings abut the forest. Edge effects that are know to occur in some areas include penetration of light and wind, temperature changes, and increased predator activity. Interior forest condition are achieved at sufficient distance from an edge so that edge effects are minimal.
Inundation	The condition whereby shorelines, streams, or vegetation are flooded by elevated water levels. When the inundating waters cover an area that had flowing water, such as the lower reach of a stream above a lake, inundation can result in increased sedimentation and decreased oxygen levels within the substrate.
Iteroparous	In general, applies to species in which individuals breed more than once in their lifetimes. Applies to salmonids that can survive initial spawning to spawn again in subsequent seasons. Resident trout and many individual anadromous steelhead trout are iteroparous, whereas salmon are semelparous (spawning only once).
Kelt	A maiden salmonid that survives its first spawning and returns to the sea.
Key habitat	Habitat that is utilized by and often required for a species for breeding or rearing or both.

Lake	A body of open water greater than 20 acres in area and at least 6.6 ft deep at low water.
Lake Washington Basin	The entire area draining into Lake Washington. Also known as the Lake Washington Watershed.
Landsburg Diversion Dam	Low dam at the site of the diversion for uptake of drinking water operated by Seattle Public Utilities, located at River Mile 21.8 of the Cedar River. As a run-of-the-river dam, it does not create a significant impoundment of water upstream. Also referred to as Landsburg Dam.
Landsburg Drainage Subbasin	The 79,951 acres of land within the hydrographic basin of the Cedar River Watershed that drains into the Cedar River above the Landsburg Diversion Dam. The City owns all but 499 acres of this subbasin.
Landscape	A large regional unit of land that typically includes a mosaic of biological communities.
Large woody debris (LWD)	Large pieces of wood in or partially in stream channels, including logs, pieces of logs, root wads of trees, and other large chunks of wood. LWD provides streambed and bank stability and habitat complexity. Often called coarse woody debris when within forests.
Late-successional forest	Forest in the later stages of forest succession; the sequential change in composition, abundance, and patterns of species that occurs as a forest matures. As used in the HCP, refers to conifer forests 120-189 years of age. Characterized by increasing biodiversity and forest structure, such as a number of canopy layers, large amounts of coarse woody debris, light gaps (canopy openings), and developed understory vegetation.
Lentic systems	Standing waters, such as lakes, ponds, and some wetlands.
Listed wildlife species, federal	Under the federal Endangered Species Act, species, or sub-unit of a species, formally listed in the Federal Register as endangered or threatened by the Secretary of the Interior or the Secretary of Commerce. A listing refers to the species or sub-unit by scientific and common name and specifies over what portion of its range it is endangered or threatened.
Listed wildlife species, state	Wildlife species that are classified as endangered, threatened, or sensitive under Washington State law. Defined in WAC 232-12-297.
Littoral zone	The shallow region of a lake or pond, to a depth of about 3 ft, which may have highly productive emergent macrophytes (large plants) that utilize the resources of both the terrestrial and aquatic habitats.
Live-box traps	A holding pen used in conjunction with fish traps; the trap captures the fish and the live-box holds them until removal.
Log	A down tree, or tree segment, lying on or near the ground. Logs provide valuable habitat for wildlife. Also, a segment of a harvested tree that may be suitable for lumber and other products.
Lotic systems	Flowing waters such as streams and rivers.

Lower municipal watershed	That area of the Cedar River Municipal Watershed generally west and south of Cedar Falls which largely drains to the mainstem of the Cedar River downstream of Masonry Dam.
Low-normal flows	The low part of the normal minimum instream flow curve, for flows in the Cedar River below the Landsburg Diversion Dam, during the period between October 8 and December 31 for some normal years. The applicability of this curve in any given year is based upon storage and hydrologic conditions prevailing each fall and is determined by specific flow-switching criteria and procedures. Low-normal flows are intended to provide more beneficial habitat conditions for anadromous fish in the fall than critical flows.
Mainstem	The primary stream channel of a river into which tributaries flow, extending from the mouth of the river to its furthest headwater.
Management prescriptions	A set of procedures designed to accomplish a specific management objective.
Marbled murrelet	*Brachyramphus marmoratus*. A Pacific seabird that typically nests in mature or old-growth forests within 50 miles of the marine environment; listed as a federal and state threatened species.
Mass wasting	Landslide; dislodgment and downslope transport of a single block of soil, rock, and vegetation resulting from the interaction of water and gravity on slopes. Occurs naturally in forested environments, but can be caused and made worse by disturbances such as poorly constructed forest roads.
Mature Forest	Forest that is entering later stages of forest succession. As used in the HCP, refers to conifer forests 80-119 years of age. While less so than late-successional forest, mature forest is characterized by increasing biodiversity and forest structure, such as a number of canopy layers, large amounts of coarse woody debris, light gaps (canopy openings), and developed understory vegetation.
Mid seral – closed canopy stage	Forest that is in the middle stage of a sere, or sequences of ecological communities in a forest succession. As used in the HCP, refs to conifer forest that is 30-79 years of age, in which the forest canopy is relatively closed, allowing little light penetration and understory development.
Mitigation	Methods of reducing adverse impacts of a project by (1) limiting the degree or magnitude of the action and its implementation; (2) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (3) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or, (4) compensating for the impact by replacing or providing substitute resources or environments.

Monitor species	Taxa of potential concern; a term frequently used to describe status, but not a legal designation; species native to the state of Washington that: (1) were at one time classified as endangered, threatened, or sensitive; (2) require habitat that has limited availability during some portion of its life cycle; (3) are indicators of environmental quality; (4) require further field investigations to determine population status; (5) have unresolved taxonomy which may bear upon their status classification; (6) may be competing with and impacting other species of concern; or (7) have significant popular appeal.
Monitoring	The process of collecting information to evaluate if objectives and anticipated results of a management plan are being realized or if implementation is proceeding as planned. This may include assessing the effects upon a species' habitat or non-organic components of the watershed, such as accretion flows.
Moraine	See "Glacial moraine."
National Environmental Policy Act (NEPA)	A law passed in 1969 that requires all federal agencies to consider and analyze all significant environmental impacts of any action proposed by those agencies, to inform and involve the public in the agency's decision-making process, and to consider the environmental impacts in the agency's decision-making process.
National Marine Fisheries Service (NMFS)	A branch of the National Oceanic and Atmospheric Administration, Department of Commerce, which is the listing authority for marine mammals and anadromous fish under the Endangered Species Act.
Native species	Any wildlife species naturally occurring in a specific area of Washington for purposes of breeding, resting, or foraging, excluding introduced species not found historically in this state; defined by WAC 232-12-297.
Natural Heritage Program	A Washington Department of Natural Resources program that identifies, selects, and nominates outstanding natural areas in Washington State; also, oversees state listing of plants.
New forestry	Timber harvest methods that are intended to sustain the ecological functions of the forest by carrying over key elements (biological legacies) of the previous forest, including live trees, snags, down wood, and other ecologically important elements of the mature forest; developed as an alternative to traditional industrial clearcut harvesting.
Non-firm block (of water)	As part of the instream flow regime, a specified volume of water (3,500 acre feet) that the City would provide, as a goal, between June 17 and August 4 in most normal years to supplement the required minimum instream flows in a manner that benefits anadromous fish.
Non-native species	Those animal and plant species that were not originally in a specific geographic area, but have been introduced, either intentionally or unintentionally, by humans.

Normal flows	The minimum instream flows (cfs) maintained in the Cedar River below the Landsburg Diversion Dam to provide beneficial habitat conditions for anadromous fish under other than conditions triggering critical flows. Normal instream flows, whcich are provided, on average, nine-in-ten years, are higher for most periods of the year than critical flows. During the fall there are two normal flow regimes, high normal and low normal, which are provided under different hydrologic conditions.
Northern spotted owl	*Strix occidentalis caurina*. A medium-sized, dark brown owl native to the Pacific coastal region that primarily nests and lives in old-growth forest; federally listed as a threatened species and listed as endangered by Washington State.
Northern Spotted Owl Critical Habitat Unit (CHU)	Area designated by the USFWS in 1991 (Fed. Reg. Vol. 57, Pp. 1796-1838) to protect remaining critical late-successional and old-growth forest habitat (and other areas) for the northern spotted owl and to reduce fragmentation. One of these units, WA-33, overlaps 22,845 acres of habitat in the eastern portion of the Cedar River Municipal Watershed.
Northern spotted owl site center	The location of status 1, 2 or 3 northern spotted owls, based on the definitions from WAC 222-16-010 (see Appendix 24).
Occupied marbled murrelet site	Areas used by marbled murrelets for nesting, as defined in WAC 222-16-010 (see Appendix 24).
Old-growth conditions	Conditions in older conifer forest stands, with vertical and horizontal structural attributes sufficient to maintain some or all of the ecological functions of natural "ecological old-growth" forest, which is typically at least 200 years old and often much older.
Old-growth forest	As used in the HCP, native unharvested conifer forest in the Cedar River Municipal Watershed that is at least 190 years of age, but which does not necessarily exhibit "ecological old-growth" conditions.
Open water bodies	All lakes and ponds of any size without forest canopy above.
Out-migrant	A juvenile fish that is migrating from one rearing environment to another.
Overlay analysis	The process of stacking digital representations of various spatial data on top of each other so that each position in the area covered can be analyzed and evaluated in terms of these combined data.
Palustrine emergent wetlands	Palustrine wetlands characterized by erect, rooted, herbaceous hydrophytes (plants adapted to water or waterlogged soils), excluding mosses and lichens, which are present for most of the growing season in most years. Includes wetlands often referred to as marshes and wet meadows.
Palustrine forested wetlands	Palustrine wetlands characterized by woody vegetation that is 20 ft tall or taller (trees).

Palustrine scrub-shrub wetlands	Palustrine wetlands dominated by woody vegetation less than 20 ft tall (shrubs and shrubby trees).
Palustrine wetlands	Freshwater (non-marine) wetlands dominated by trees, shrubs, persistent emergents, or emergent mosses or lichens, and wetlands lacking vegetation that have an area of less than 20 acres and are no deeper than 6 ft; palustrine wetlands include marshes, swamps, bogs, and fens.
Parr	A juvenile salmonid rearing in fresh water at the stage at which it has developed parr marks before it reaches the smolt or sub-adult stage.
Parr marks	The vertical markings on a juvenile salmonid.
Pelagic zone	The open, mid-column zone in a body of water that is not associated with shoreline or shallow depths.
Penstocks	Large pipes that carry water from Masonry Dam to the Cedar Falls Powerhouse, for operation of hydroelectric turbines.
Persistent emergent vegetation	Erect, rooted, herbaceous vascular plants that may be temporarily to permanently flooded at the base but do not tolerate prolonged inundation of the entire plant, and that normally remain standing at least until the beginning of the next growing season.
Pole	A young tree, from the time its lower branches begin to die until the time the rate of crown growth begins to slow and crown expansion is noticeable. For the classification system used in the HCP, includes trees from 5.01 to 11.0 inches dbh.
Polygon	A GIS term for a multi-sided figure that has area and which represents a habitat unit, man-made structure, or other spatial entity on a map.
Pond	A body of open water from 0.5 to 20 acres in area and at least 6.6 ft deep at low water.
Preservation	The maintenance of intact ecosystems [based on Kaufmann].
Probable maximum flood (PMF)	A flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the drainage basin under study.
Profundal zone	In a body of water, the deeper sediment bottom that is free of vegetation.
Proposed threatened or endangered species, federal	Species formally proposed in the Federal Register by the Secretary of Interior or the Secretary of Commerce for listing as threatened or endangered under the federal Endangered Species Act; not a final designation.
Puncheon, wood	A drainage structure constructed of wood, usually logs, placed beneath the surface of a road in two or more layers (first perpendicular to the road, then longitudinally) to facilitate the passage of water under the road, while supporting the road and traffic.

Rain-on-snow zone	The area where several times during the winter the snowpack is partially or completely melted during warm periods and/or rainstorms.
Rattlesnake Lake Viewshed	Rattlesnake Lake and the land immediately surrounding, including Rattlesnake Ledge, that has been set aside for public usage.
Reach	See "Stream reach."
Rearing habitat	Areas in rivers, streams, ponds, or lakes, where juvenile salmon and trout find food and shelter to live and grow.
Redd	A salmonid fish's nest, which is created by excavating a shallow pit in gravel where eggs are buried for incubation.
Regeneration harvest	A general term for silvicultural systems that involve removal of most trees within a harvest area for the purpose of stand regeneration. (Regeneration harvest systems return the stand to an early stage of forest succession.) Such systems are commonly used for commercial timber harvest in the Pacific Northwest and include clearcutting, shelterwood harvest, seed tree harvest, and retention harvest (see definition).
Rehabilitation	Making an ecological system useful again in terms of its original functions [based on Kaufmann].
Remote sensing	Information acquired by indirect means, such as by satellite or airplane.
Reservoir	As used in the HCP, the Chester Morse Lake/Masonry Pool complex; also referred to as the reservoir complex.
Restoration planting	Planting of native trees, shrubs, and other plants to encourage development of habitat structure and heterogeneity, to improve habitat conditions for fish and wildlife, and to accelerate development of old-growth conditions or riparian forest function in previously harvested second growth.
Restoration thinning	As used in this HCP, a silvicultural intervention strategy applied in areas of young (usually 10 to 30 year-old) over-stocked forest with the intent of increasing biological diversity and wildlife habitat potential, accelerating the development of mature forest characteristics, and minimizing the amount of time a stand remains in the stem exclusion stage (a stage characterized by minimal light penetration and low biological diversity). This strategy protects water quality by reducing the risk of large scale catastrophic damage to the watershed (primarily through development of windfirmness and increased resistance to insect attack, which is exacerbated by the stress on intense competition among trees). Techniques for restoration thinning include cutting, girdling, or otherwise killing some trees in variable density thinning patterns, retaining a mix of species that is characteristic of natural site conditions, and leaving small gaps or openings characteristic of naturally regenerated forests that result from small natural disturbances such as wind or disease. See Figure G-1.b for illustration.

Revised Code of Washington (RCW)	A revised, consolidated, and codified form and arrangement of all the laws of the state that are of a general and permanent nature.
Riparian habitat	Habitat along lakes, rivers, and streams where the vegetation and microclimate are influenced by year-round or seasonal water and associated high water tables.
Riparian zone	A zone adjacent to lakes, ponds, rivers, and streams where the microclimate, soil, and vegetation are typically, although not always, influenced by surface water and associated groundwater; this area forms an interface between the aquatic environments and adjacent terrestrial habitats and includes riparian habitat. Wetlands may or may not be located within this zone, and vegetation in a riparian zone may or may not include true riparian habitat.
River mile (RM)	Statue mile as measured along the center line of a river. River miles (RM) are measured upstream from the mouth of a river (e.g., RM 18.5), but can also used as a discrete measure of distance in a river or stream (e.g., 1-3 river miles).
Rotation	The number of years required to grow a stand to a desired size or maturity before harvest. Rotation age is the typical age of a stand at harvest in a particular harvest management regime.
Salmonids	Fish species belonging to the family Salmonidae, including trout, salmon, char, and whitefish species.
Sapling	A young tree which is no longer a seedling but not yet a pole. As used in the HCP, trees from 2.01 to 5.0 inches dbh.
Scour	The erosion of stream bed and/or banks caused by flood water in a river or stream.
Screw traps	A mechanism for trapping juvenile fish, usually downstream migrants, by which the fish are pulled into a live box by a large screw mechanism that turns by the force of the water.
Second-growth	Forest stands in the process of regrowth after an earlier cutting or disturbance.
Semelparous	In general, applies to species in which individuals breed only once in their lifetimes. Applies to salmonids that die after spawning, such as do all of the Pacific salmon species.
Sensitive soil	Soils with moderate or high flood hazard potential, or slow or very slow drainage rates, or that are formed in place (organics), or that are alluvial soils.
Sensitive species, state	A wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of its range within the state without cooperative management or the removal of threats. Sensitive species are legally designated in WAC 232-12-011 and defined in WAC 232-12-297 Section 2.6.

Seral stage	A particular stage (ecological community) in a sere, or pattern of succession. As used in the HCP, applies to forest succession
Sidecast	Excavated material that has been moved to the side and deposited within the limits of construction for a road or landing (for collecting logs during timber harvest), or that has been dumped over the side and outside the limits of construction. Sidecasting results in over-steepened slopes that, in very steep terrain, can cause slope instability and failure under certain conditions.
Silviculture	The theory and practice of controlling the establishment, composition, growth, and quality of forest stands in order to achieve management objectives. Includes such actions as thinning, planting, fertilizing, and pruning.
Slope	A measure of the steepness of terrain, equal to the tangent of the angle of the average slope surface with the horizontal, expressed in percent. A 100 percent slope has an angle with the horizontal of 45 degrees, a 70% slope has an angle of 35 degrees, and a 30 percent slope has an angle of 17 degrees.
Smolt	The life stage of a juvenile salmon when it migrates to saltwater, involving physiological changes that adapt an individual for the change from fresh to salt water.
Snag	A standing dead tree.
Species	A unit of the biological classification system (taxonomic system) below the level of genus; a group of individual plants or animals (including subspecies and populations) that have common attributes and are capable of interbreeding. The federal Endangered Species Act defines species to include subspecies and any “distinct population segment” or “evolutionarily significant unit” of any species.
Species of concern	As used in the HCP, any species addressed by the HCP and whose conservation strategies are taken into account by the HCP.
Species of concern, federal	An unofficial status designation given a species which appears to be in jeopardy, but for which insufficient information exists to support listing.
Species of concern, state	Those species listed as state endangered, state threatened, state sensitive, or state candidate, as well as species listed or proposed for listing by the Secretary of Interior or Secretary of Commerce.
Species of greatest concern	As used in the HCP, 14 species addressed by the HCP that are currently listed under the Endangered Species Act or otherwise are believed to be at significant risk in the region.
Stand (forest stand)	A group of trees that possess sufficient uniformity in composition, structure, age, spatial arrangement, or condition to distinguish them from adjacent groups of trees.

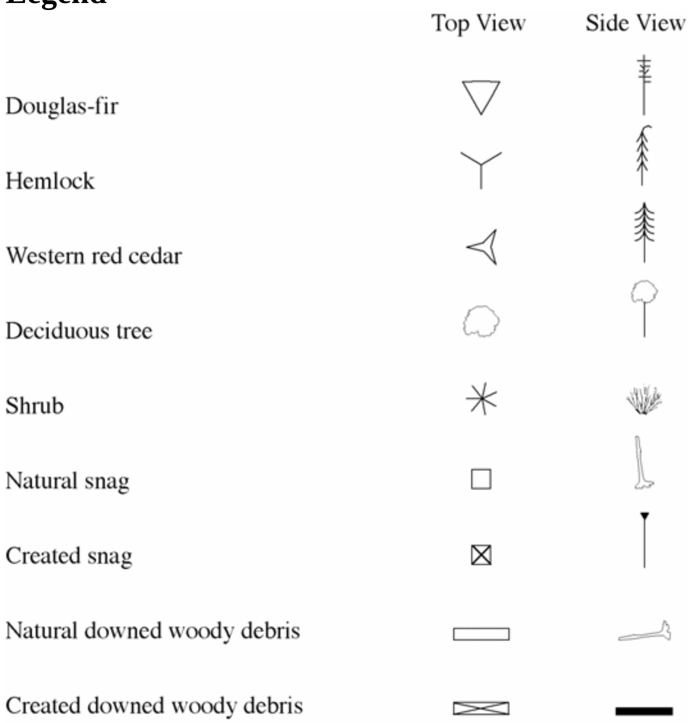
State Environmental Policy Act (SEPA)	The state law that requires all state and local government agencies to consider and analyze the adverse environmental impacts of any action proposed by those agencies, to inform and involve the public in the agency's decision-making process, and to consider the environmental impacts in the agency's decision-making process.
Stock	The group of fish spawning in particular lake(s) or stream(s) at a particular season that to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.
Stream reach	A segment of a stream that has beginning and end points selected for some specific characteristic.
Subnivian	Beneath snow.
Succession	A natural replacement of one plant (and/or animal) community by another over time in the absence of disturbance.
Suitable marbled murrelet habitat	A contiguous forested area containing trees capable of providing nesting opportunities, as defined by WAC 222-16-010 (Appendix 24).
Suitable spotted owl habitat	Forest stands that meet descriptions defined in WAC 222-16-085 (Appendix 24).
Tailrace	A structure and outlet that conveys flow from a hydroelectric turbine to the river.
Tailrace rack (barrier)	A barrier that keeps fish from swimming upstream into a hydroelectric turbine.
Tainter gates	A type of gate with a circular segment for its face, rotating about its center of curvature; commonly used on dams and diversion structures to control the flow of water over and under a spillway.
Take	To harass, harm, pursue, hunt, wound, kill, trap, capture, or collect a federally listed threatened or endangered species, or to attempt to do so (ESA, Section 3[10]). Take is prohibited under federal law, except where authorized. Take may include disturbance of the listed species, nest, or habitat when disturbance is extensive enough to disrupt normal behavioral patterns for the species, although the affected individuals may not actually die. See also "Harm" and "Incidental take."
Talus	An accumulation of rock debris at the base of a cliff or rock formation, typically forming a slope that is often unstable.
Threatened species, federal	A designation as defined in the federal Endangered Species Act for a species that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.
Threatened species, state	A wildlife species native to the state of Washington that is likely to become endangered within the foreseeable future throughout significant portions of its range within the state without cooperative management or the removal of threats. Threatened species are legally designated in WAC 232-12-011and defined in WAC 232-12-297 Section 2.5.

Tribe, the	The Muckleshoot Indian Tribe.
Tributary	A stream that flows into a larger stream or body of water.
Turbidity	A measure of the relative clarity of water, which may be affected by material in suspension in the water.
Turbine	The machine used to convert the energy of water into electrical energy.
Type I-III waters	In the context of the HCP, fish bearing waters. Definition based on WAC 222-16-030.
Type IV waters	Streams without fish that influence Type I-III waters under the state classification system; streams with a well-defined channel, which may be perennial or intermittent. Definition based on WAC 222-16-030.
Type V waters	Streams without fish that influence Type IV waters under the state classification system; includes streams with or without well-defined channels. Definition based on WAC 222-16-030.
Type IX waters	A stream, or potential stream, which has not yet been typed under the state classification system.
U.S. Fish and Wildlife Service (USFWS)	The federal agency that is the listing authority under the Endangered Species Act for plant and animal species other than marine mammals and anadromous fish.
Upper municipal watershed	That area of the Cedar River Municipal Watershed generally east of Cedar Falls which drains to the Chester Morse Lake Basin.
Up-ramping	Increases in instream flows as a result of changes in facility operations, most often expressed as a rate of increase in water elevation in inches per hour.
USGS gage	A streamflow discharge measuring station; records stage, or height, of water, which can then be converted to discharge (cfs) based on stream geometry.
Walsh Lake Diversion Ditch	An approximately 4 mile-long channel constructed in the early 1930s to redirect the drainage waters from Walsh Lake (within the Cedar River Municipal Watershed) to a point in the Cedar River downstream of the Landsburg Diversion Dam and drinking water intake structures. Also referred to as Walsh Lake Ditch or Walsh Ditch.
Washington Administrative Code (WAC)	All current, permanent rules of each state agency, adopted pursuant to chapter 34.05 RCW.
Watershed	A basin contributing water, organic matter, dissolved nutrients, and sediments to a stream, lake, or ocean. As applied in the HCP, used also to refer to the Cedar River Municipal Watershed above the Landsburg Diversion Dam and water intake, some of which does not drain into the Cedar River above the Landsburg water intake.

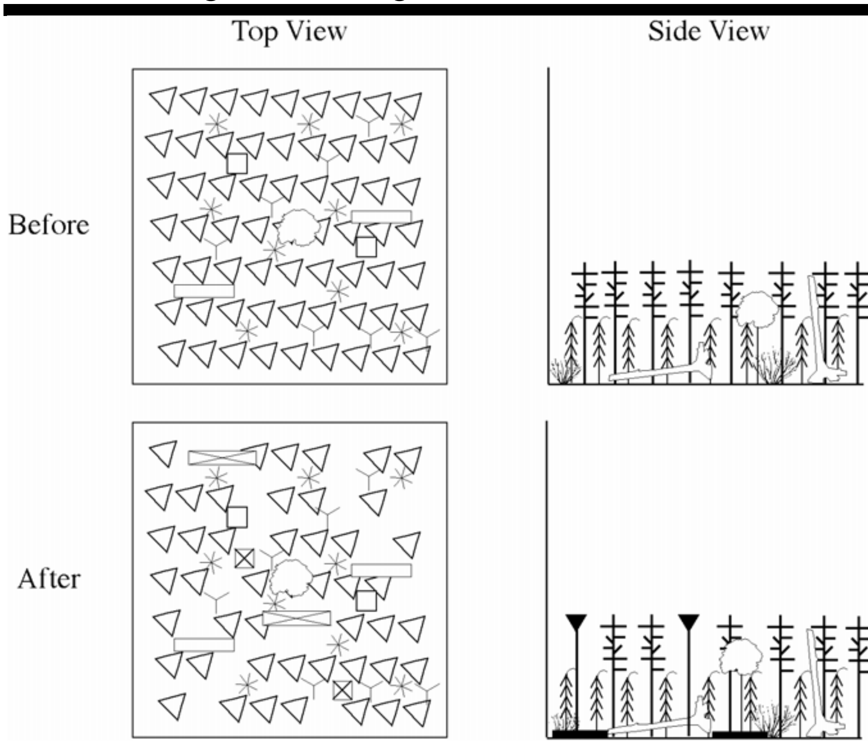
Watershed analysis	A cumulative effects assessment prepared for forest practices in a watershed administrative unit under the Washington State Forest Practices Act with the long-term objective of protecting and restoring public resources and the productive capacity of fish habitat affected by forest management operations; produces prescriptions for future management; completed under WAC 222-22-050 or WAC 222-20-060, with prescriptions selected under WAC 222-22-010.
Watershed ecological reserve	Watershed reserve. Consistent with the City commitment not to harvest timber for commercial purposes within the municipal watershed, all forest within the municipal watershed, outside of developed areas, is sometimes referred to in the HCP as the watershed ecological reserve.
Weighted Usable Area (WUA)	An integrated measure of both habitat quantity and quality for fish as a function of river flow under the IFIM approach (Instream Flow Incremental Methodology), weighted for differences among sampling areas and locations within a habitat type with respect to depth, velocity, substrate, and cover, all attributes that affect the overall quality of habitat for fish. WUA is often calculated for life history aspects, such as spawning, rearing, or holding. WUA typically is zero at zero flow, increases as flows (thus velocity and depth) increase, then decreases from the flow that produces maximum WUA as velocity and depth increase beyond levels preferred by a given species or life stage. Optimum flows under IFIM are considered to be those yielding the maximum WUA, if attainable.
Weir	See “Fish weir.”
Wetland	Land where the water table is usually at or near the surface or the land is covered by shallow water and has one or more of the following attributes: the land supports, at least periodically, predominantly hydrophytic plants (plants adapted to water or waterlogged soil); substrate is predominantly undrained hydric soils; and/or the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season each year.
Wild stocks	In Washington State, a fish stock that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage; can include native or introduced stocks.
Wildlife reserve tree	Defective, dead, damaged, or dying tree which provides habitat for wildlife species dependent on standing trees; defined in WAC 222-16-010.
Yarding	The transport of logs from the point of felling to a collecting point or landing.

Figure G-1. Illustrations of forms of timber harvest and thinning.

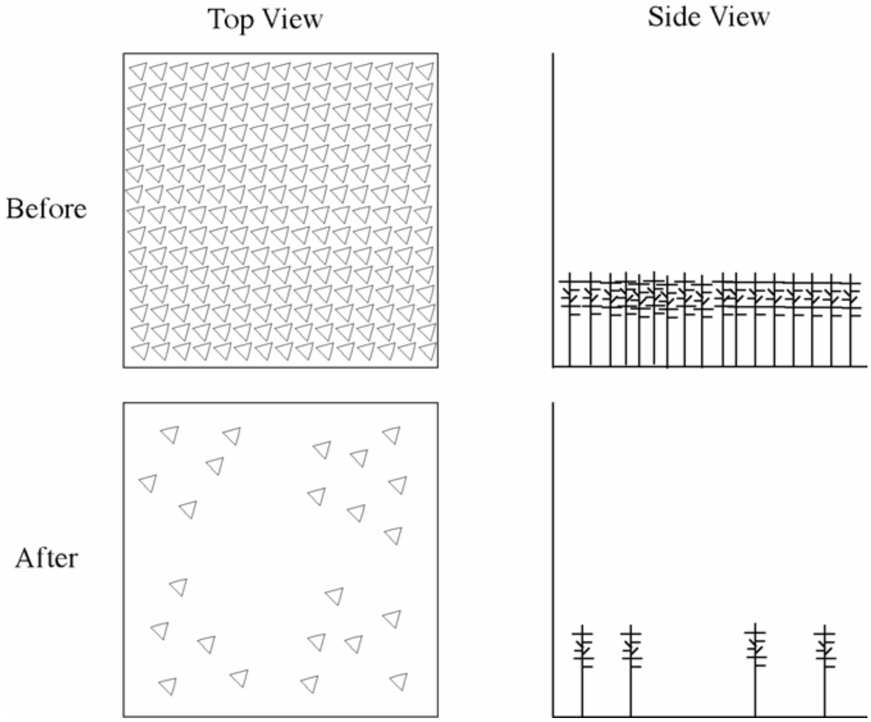
Legend



G-1.a. Ecological thinning.



G-1.b. Restoration thinning.



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