N A T U R A L R E S O U R C E S

FINAL HABITAT CONSERVATION PLAN

September 1997

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Jennifer M. Belcher - Commissioner of Public Lands

Authority

This Plan was approved and adopted by the Board of Natural Resources (Resolution 96-911, November 5, 1996).

Board of Natural Resources

The following individuals were seated on the Board at the time of adoption.

Jennifer Belcher, *Chair, Commissioner of Public Lands*
Judith Billings, *Superintendent of Public Instruction*
David Thorud, *Dean, College of Forest Resources, University of Washington*
Dorothy Duncan, *County Commissioner representing the Forest Board counties*
Bob Nichols, *Executive Policy Division, OFM - designee for Governor Mike Lowry*
James Zuiches, *Dean, College of Agriculture and Home Economics, Washington State University*

Jennifer M. Belcher
Commissioner of Public Lands

September 1997

Dear Reader:

The Washington Department of Natural Resources manages 3 million acres of state lands in trust for common schools, state universities, other public institutions, and county services. About 2.1 million acres are forestlands.

As a prudent trust manager, the department follows all applicable laws, including the Endangered Species Act. Since 1990, when the northern spotted owl was listed as a threatened species, the department has been subject to continually changing requirements for the management of state forest lands, resulting in uncertainty and instability that is expected to increase due to the prospect of additional species being listed as threatened or endangered in the future. At the same time, current regulations don't necessarily provide certainty or stability for the future of the protected species.

The department is charged with preserving the productivity of the trusts in perpetuity, which we believe requires protecting the long-term health of forests and the ecosystem. We therefore began to look for a better way to manage the state's forested trust lands and protect threatened and endangered species. The Endangered Species Act offers such an option through the creation of a habitat conservation plan (HCP), which allows more flexibility in land management activities and innovation in protection of threatened wildlife.

With assistance from wildlife experts, our own silvicultural experts, trust beneficiaries, and the public, I believe the Washington State Department of Natural Resources has developed an HCP that will keep state trust lands at the forefront of excellence in forest land management. At the same time, our HCP will provide certainty, stability, and flexibility to both the trusts and wildlife.

Sincerely,

Jennifer M Belcher

JENNIFER M. BELCHER
Commissioner of Public Lands

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Acronyms

ACRONYMS USED IN THE TEXT OF THE HCP

dbh	Diameter at breast height
DNR	Washington Department of Natural Resources
EIS	Environmental Impact Statement
FEMAT	Forest Ecosystem Management Assessment Team
GIS	Geographic Information System
HCP	Habitat Conservation Plan
NRF	Nesting, roosting, and foraging habitat
OESF	Olympic Experimental State Forest
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
WAC	Washington Administrative Code
WAU	Watershed Administrative Unit

ACRONYMS USED IN CITATIONS

C.F.R.	Code of Federal Regulations
LULC	Land Use/Land Cover (GIS data layer)
MPL	Major Public Lands (GIS data layer)
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PFRT	Peregrine Falcon Recovery Team
PHS	Priority Habitat and Species
U.S.C.	U.S. Code
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
WDF	Washington Department of Fisheries (merged into WDFW in 1994)
WDFW	Washington Department of Fish and Wildlife
WDW	Washington Department of Wildlife (merged into WDFW in 1994)
WFPB	Washington Forest Practices Board
USEPA	U.S. Environmental Protection Agency

ACRONYMS WITH LIMITED USE IN THE TEXT (I.E., ONE TO TWO PAGES)

ESU	Evolutionarily Significant Unit (Chapter III - salmonids and riparian areas)
HAU	Hydrologic Analysis Unit (Chapter IV - riparian conservation strategy)
NAP	Natural Area Preserve (Chapter I - land covered)
NRCA	Natural Resource Conservation Area (Chapter I - land covered)
PFA	Post-fledgling family area (Chapter IV - multispecies conservation strategy)
TFW	Timber/Fish/Wildlife Agreement
WRIA	Water Resource Inventory Area (Chapter I - planning area organization)

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I. Introduction

DNR's Habitat Conservation Plan

The Washington Department of Natural Resources (DNR) has prepared a multi-species Habitat Conservation Plan (HCP) to address state trust land management issues relating to compliance with the federal Endangered Species Act (16 U.S.C. 1531 et seq.). The plan will cover approximately 1.6 million acres of state trust lands managed by DNR within the range of the northern spotted owl.

A habitat conservation plan is a long-term land management plan authorized under the Endangered Species Act to conserve threatened and endangered species. For DNR, it means a plan for state trust lands that allows timber harvesting and other management activities to continue while providing for species conservation as described in the Endangered Species Act. Section 10 of the Endangered Species Act (16 U.S.C. 1539) authorizes a landowner to negotiate a conservation plan with the Secretary of the Interior to minimize and mitigate any impact to threatened and endangered species while conducting lawful activities such as forest practices. The HCP offsets any harm caused to individual listed animals with a plan that promotes conservation of the species as a whole. Incidental take, including the disturbance of habitat of an endangered or threatened species, is allowed within limits defined by an incidental take permit issued by the federal government.

As a trust manager, DNR has unique obligations. (See Chapter II discussion on trust duties.) Briefly, among these are acting with undivided loyalty to the interests of the trusts, recognizing their perpetual nature, managing in a prudent manner, minimizing the risk of loss, and using sound principles that will preserve the productivity of the trusts in perpetuity while striving to provide the most substantial support to the beneficiaries over the long term. An HCP will help meet these trust obligations by providing greater certainty in management, greater stability in harvest levels, and greater flexibility in operations.

According to the Endangered Species Act, the draft HCP is part of an application for incidental take permits and unlisted species agreements that will be submitted to the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for review. The federal agencies will conduct a biological assessment and jeopardy analysis of DNR's HCP to determine whether the proposal complies with the Endangered Species Act. If the permits are issued, they will allow the incidental take on DNR-managed lands of northern spotted owls, marbled murrelets, and other listed upland species, and, on the west side of the Cascade Range, selected other species if they become listed. To minimize and mitigate the impacts of incidental take to the maximum extent practicable, DNR will implement the HCP.

Based on a careful review of the final HCP, Final Environmental Impact Statement, analysis of benefits and impacts to the trusts, results of the analysis by the federal agencies, other appropriate analyses, and public review, the Board of Natural Resources will determine whether to enter into an agreement with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

Species Covered by the HCP

DNR's HCP provides mitigation for incidental take permits for two federally listed species — the northern spotted owl *(Strix occidentalis caurina)* and the marbled murrelet *(Brachyramphus marmoratus)*. The HCP also conserves habitat for unlisted species in western Washington for which DNR is seeking unlisted species agreements. These include western Washington runs of several salmonids, other federal and state candidate species (i.e., species proposed for listing), and other unlsted species west of the Cascade crest. In addition, although DNR does not expect to take any individuals of these species, it is requesting incidental permits for the other upland species listed by the federal government as endangered or threatened within the range of the northern spotted owl. These additional species are the Oregon silverspot butterfly *(Speyeria zerene hippolyta)*, the Aleutian Canada goose *(Branta canadensis leucopareia)*, the peregrine falcon *(Falco peregrinus)*, the bald eagle *(Haliaeetus leucocephalus)*, the gray wolf *(Canis lupus)*, the grizzly bear *(Ursus arctos),* and the Columbian white-tailed deer *(Odocoileus virginianus leucurus)*. (See Chapter III for a discussion of habitat needs of the species covered by the HCP.)

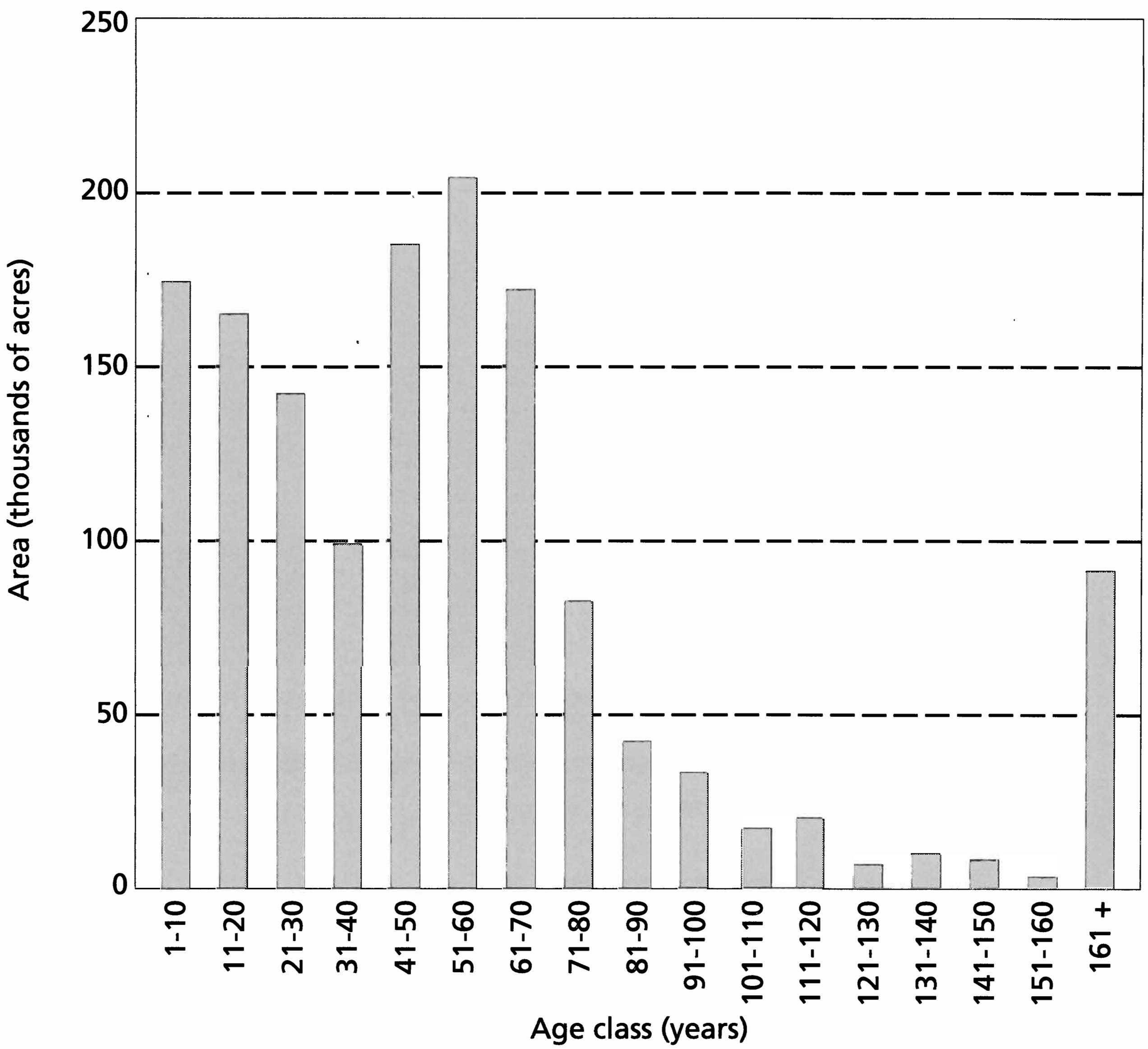
Land Covered by the HCP

In Washington, the range of the northern spotted owl includes all of the western part of the state as well as lands on the east slopes of the Cascade Range. This HCP covers all DNR-managed forest lands within the range of the northern spotted owl, excluding those lands designated as urban or leased for commercial, industrial, or residential purposes and those lands designated as agricultural. All DNR management activities on these lands are covered. The total area of trust lands covered by the HCP is approximately 1,630,000 acres, of which all but about 50,000 acres are forested. These lands range from scattered isolated parcels under 40 acres to large contiguous blocks in excess of 110,000 acres. The conservation strategies apply to lands DNR manages or will manage under the HCP; however, DNR is not precluded from buying, selling, or exchanging such lands as long as the overall integrity of the HCP is maintained. (See the Implementation Agreement for additional information.) Map I.1. shows DNR-managed lands covered by the HCP.

The majority of the forest on DNR-managed lands covered by the HCP is conifer. Less than 10 percent is in hardwood. Most DNR-managed lands have been logged at least once in the last 100 years. For DNR-managed lands covered by the HCP, approximately 1,421,000 acres are in even-aged stands and 155,000 acres are in uneven-aged stands. Map I.2 shows the location of these even-aged and uneven-aged stands. One-fourth of the even-aged stands are 20 years old or less, and more than half are 60 years old or less. Figure I.1. summarizes by age class the acreage of even-aged forests managed by DNR in the HCP area. Currently available information for uneven-aged stands describes the volume or number of trees in each of four size classes. Although most uneven-aged stands have trees in more than one size class, Table I.1 summarizes stands by the dominant size class for each stand.

Figure I.1: DNR-managed HCP lands by age class and area for even-aged stands

(Source: DNR GIS LULC coverage, April 1995)



CURRENT LAND USE

Of the 1,580,000 acres of forested land covered by the HCP, approximately 1,520,000 acres are in timber production. Special uses of forested land on the remaining 60,000 acres include old-growth research areas and gene pool reserves that DNR has deferred from harvest, riparian management zones, and recreation sites.

Table I.1: DNR-managed HCP lands by dominant size class and area for uneven-aged stands

Size class (diameter at breast height in inches)	Acres	Percent of uneven-aged acres
0-6	22,000	14.2
6-9	11,000	7.1
10-18	71,000	45.8
20+	51,000	32.9

ADJACENT OWNERSHIP

Although DNR-managed lands are distributed throughout the plan area, most tend to be adjacent to or near large blocks of federal land along the Cascade and Olympic mountain ranges. The major exception to this pattern is in southwestern Washington, where DNR manages more than 250,000 acres that are not near federal ownership.

DNR-managed lands covered by the HCP are interspersed among a variety of other ownerships as shown in Map I.3. Table I.2 summarizes the approximate acreage held by land owners and managers in the plan area.

Table I.2: Acreage by ownerships in the area covered by the HCP

(Source: DNR GIS MPL coverage, April 1995)

Landowner or manager	Acres	Percent of plan area
Private	9,488,000	44.4
U.S. Forest Service (national forests)	4,463,000	20.9
U.S. Forest Service (wilderness areas)	2,297,000	10.8
National Park Service	1,919,000	9.0
WA Department of Natural Resources	1,777,000[1]	8.3
Tribal lands	1,015,000	4.8
U.S. Department of Defense	123,000	0.6
WA Department of Fish and Wildlife	100,000	0.5
Municipal watersheds	101,000	0.5

Table I.2: Acreage by ownerships in the area covered by the HCP *(continued)*

Landowner or manager	Acres	Percent of plan area
State Parks & Recreation Commission	41,000	0.2
U.S. Fish and Wildlife Service	19,000	0.1
Other state lands	10,000	>0.1
U.S. Bureau of Land Management	5,000	>0.1

[1] Approximately 1,630,000 acres of this total are covered by the HCP.

NATURAL AREA PRESERVES AND NATURAL RESOURCES CONSERVATION AREAS

DNR also manages approximately 66,000 acres of non-trust lands as Natural Area Preserves and Natural Resources Conservation Areas. Natural Area Preserves provide the highest level of protection for excellent examples of unique or typical natural features of Washington. Natural Resources Conservation Areas are established to protect outstanding examples of native ecosystems, habitat for endangered, threatened, and sensitive plants and animals, and scenic landscapes.

Approximately 45,000 acres of these special lands lie within the area covered by the HCP. (See Map I.1.) Some of these lands currently provide habitat in areas identified as important for achieving the conservation objectives of the HCP. It is expected that these lands will continue to provide this habitat into the future because the legislature clearly intended for these special lands to be maintained for future generations. The purpose statement for the legislation that established Natural Area Preserves includes the following: "It is, therefore, the public policy of the state of Washington to secure for the people of present and future generations the benefit of an enduring resource of natural areas by establishing a system of natural area preserves, and to provide for the protection of these natural areas" (RCW 79.70.010). A similar commitment to the future is contained in the findings for the legislation that created Natural Resources Conservation Areas: "There is an increasing and continuing need by the people of Washington for certain areas of the state to be conserved, in rural as well as urban settings, for the benefit of present and future generations" (RCW 79.71.010). Land characteristics identified as worthy of conservation under this legislation include: areas that have high natural system and wildlife values, land or water that has flora or fauna of critical importance, and examples of native ecological communities.

While not subject to the HCP, DNR is given credit for the habitat contributions provided by these lands in terms of meeting the conservation objectives of the HCP. Whether these lands continue to provide such contributions to the conservation objectives, and the remedy if they do not, will be discussed at each of the scheduled comprehensive reviews. (See the Implementation Agreement.) DNR's management of the Natural Area Preserves and Natural Resources Conservation Areas is not expected to increase the level of take for any species covered by the incidental take permit. DNR's management of these lands shall maintain the conservation objectives described in Chapter IV of this HCP. Should an unforeseen circumstance arise that increases the level of take, DNR will follow the process for making a major amendment to the HCP and the Incidental Take Permit as outlined in the Implementation Agreement. Management of Natural Area Preserves and Natural Resources Conservation Areas is not intended to alter DNR's obligations for mitigation as set forth in this HCP.

VEGETATIVE ZONES

Vegetative zones are broad areas that have similar types of vegetation. The HCP area includes land in the eight zones described below. These brief descriptions are followed by Table I.3, which lists selected plant species found in each zone.

Sitka Spruce Zone

Along the Pacific coast and extending inland up river valleys is a narrow band of vegetation where Sitka spruce is considered the climax species. This is the Sitka spruce zone. In most places, it is usually only a few miles wide and occurs where summer fog and drip precipitation are common. The climate in this zone is the mildest of any Washington forest zone. Winter rains are heavy, and snow is infrequent. Trees are tall, and stands are dense. Productivity and biomass are high, and there are relatively few hardwoods. Rain forests of the Olympic National Park are a special type of Sitka spruce zone.

Western Hemlock Zone

The western hemlock zone extends from sea level to 2,000 feet throughout most of Washington. The inland boundary of this zone coincides roughly with the western boundary of the national forests in the Cascade Range. The climax trees are western hemlock, with western redcedar in wetter areas and Douglas fir in drier areas. The forest canopy is dense, tall conifers. This forest zone is the largest in the state and contains some of the most productive and intensely managed forest lands. Most state forest land in western Washington is in this zone. However, because of its extent and accessibility, most of the western hemlock zone has been disturbed, logged, or burned at least once in the past 200 years. As a result, large portions are now dominated by Douglas fir in seral stands or contain mixtures of hardwoods. Even before settlement by Europeans, there were extensive Douglas fir stands, probably the result of old fires. Remnants of these original stands are commonly referred to as old growth. Red alder is a common pioneer species throughout the zone.

Climate in the western hemlock zone is mild, wet, and maritime. Snow is common but not persistent. The Puget Sound lowlands are considered a special type; forest composition is modified by the rain shadow of the Olympic Mountains and gravelly glacial soils.

Another type of western hemlock zone occurs east of the Cascade Range. Extensive stands of western hemlock and western redcedar occur in moist localities and along streams and rivers throughout northeastern Washington, as well as farther east. The trees, understory vegetation, and high precipitation give these inland stands their distinct maritime appearance.

Pacific Silver Fir Zone

The Pacific silver fir zone extends from about 2,000 to 4,000 feet in elevation in Washington. On the west side of the Cascades, it abuts the western hemlock zone at lower elevations and extends upward to the subalpine forest in the Olympic Mountains and Cascade Range. Pacific silver fir community types are also found east of the Cascades. Throughout the zone, the climate is cool and wet, but the growing season is short. It is common in this zone for up to half of the annual precipitation to fall as snow and persist as winter snowpacks for three to seven months. Dense forests consist of tall conifers and patches of shrubby undergrowth. Huckleberry species are common. Douglas fir is also a major component of this zone.

Subalpine Fir/Mountain Hemlock Zone

Subalpine fir/mountain hemlock forests make up the highest forest zone in the Olympics and on both sides of the Cascade Range, extending from about 4,000 feet to the timberline. Mountain hemlock predominates at the lower elevations and is replaced by subalpine fir at higher elevations. The zone ends at the high altitudes in a mosaic of tree groups, glades and meadows. East of the Cascades and in the Okanogan highlands, subalpine fir is associated with Engelmann spruce. Scattered pockets of Engelmann spruce are also found on the eastside of the Olympics and west of the Cascades in the Mt. Baker-Ross Lake area. The subalpine zone is Washington's coolest and wettest forest environment. Forests here are dense and contain short to medium-tall conifers, often with an understory mixture of shrub and herbaceous vegetation.

Alpine Zone

Alpine meadows and high-altitude barrens are found in the Olympics and Cascades above timberlines. This zone lacks timber production potential. Vegetation consists of complex mixtures of forbs, grasses, sedges, and low shrubs. The several types of plant communities on Washington alpine lands are linked to local microclimatic variations of moisture, snowpack duration, and substrate. Winters are cold and long, and summers are brief. Growth, except for spectacular floral displays, is slow.

Grand Fir Zone

An extensive grand fir zone occurs below the subalpine forest in eastern Washington. From a management point of view, the grand fir zone and Douglas fir zone, with which it merges, are usually considered together. However, in an ecological sense, they should be considered separately. The grand fir zone is cooler and wetter than the lower Douglas fir zone, but warmer and with less snow accumulation than subalpine forests.

Douglas Fir Zone

The Douglas fir zone in eastern Washington is particularly dominate in the northern portion of the state. Subtle limitations of temperature and moisture are probably important in separating this zone from the moister grand fir zone and the drier ponderosa pine zone. At lower and drier elevations in Washington, Douglas fir is commonly bordered by a band of ponderosa pine that separates it from shrub steppe and grass communities of the Columbia Basin. Forests in both the grand fir and Douglas fir zones consist of dense medium and tall conifers. Where overstory density permits, understory vegetation may be of extensive brush or grass, depending on soil moisture content.

Ponderosa Pine Zone

The ponderosa pine zone, lowest of the forest zones in eastern Washington, occurs between 2,000 and 4,000 feet elevation. It typically borders the shrub-grassland zone, but in south central Washington, an Oregon white oak community is located between the two.

This zone is the driest of the Washington forest zones. Precipitation is low, especially in summer. Winter precipitation commonly falls as snow, which accumulates as a result of low temperatures. Summer days are hot and summer nights cool. The effective growing season is short and probably moisture-limited. Soil moisture regulates the distribution of understory vegetation, which ranges from brush to grass. The forest consists of dense to open stands of tall trees.

Table I.3: Vegetative zones in the area covered by the HCP

(Source: Franklin and Dyrness 1973)

Vegetative zone	Elevation range (feet)	Average precipitation (inches)	Major tree species	Common shrubs	Herbaceous plants
Sitka spruce	0 - 500	80 - 120	Sitka spruce, western hemlock, western redcedar, Douglas fir, grand fir, Pacific silver fir, red alder	red huckleberry, devil's club, salmonberry	sword fern, Oregon oxalis, false lily-of-the-valley, evergreen violet, Smith's fairybells
Western hemlock	0 - 3,000	60 - 120	Douglas fir, western hemlock, western redcedar, red alder, bigleaf maple	vine maple, Pacific rhododendron, creambush ocean-spray, California hazel, western yew, Pacific dogwood, red huckleberry, Oregon grape, salal, trailing blackberry	deerfoot vanillaleaf, evergreen violet, white trillium, sword fern, twinflower, Pacific peavine, common tarweed, white hawkweed, snow-queen, common beargrass, Oregon iris, western fescue, western coolwort, Hooker's fairybells, wild ginger, ladyfern, deerfern, Oregon oxalis
Pacific silver fir	2,000 - 4,500	80 - 120	Pacific silver fir, western hemlock, noble fir, Douglas fir, western redcedar	vine maple, salal, Oregon grape, red huckleberry, Alaska huckleberry, oval-leaf huckleberry, devil's club	beargrass, twin-flower, bunchberry dogwood, deerfoot vanillaleaf, queencup beadlily, dwarf blackberry, western coolwort, white trillium, ladyfern

Table I.3: Vegetative zones in the area covered by the HCP *(continued)*

Vegetative zone	Elevation range (feet)	Average precipitation (inches)	Major tree species	Common shrubs	Herbaceous plants
Mountain hemlock and subalpine fir	4,000 - 6,000	65 - 110	mountain hemlock, subalpine fir, lodgepole pine, Alaska-cedar	big huckleberry, oval-leaf huckleberry, Cascade azalea, blueleaf huckleberry, rustyleaf	beargrass, one-sided wintergreen, dwarf blackberry, Sitka valerian, evergreen violet, avalanche fawnlily
Alpine	4,000+	60-120		western cassiope, blueleaf huckleberry, red mountain-heath, luetkea	Alaskan clubmoss, mountain hairgrass, American bistort, Sitka valerian, showy sedge, feathery mitrewort, American false hellebore, arctic lupine, fireweed, black alpine sedge, alpine willowweed, slender hawkweed, fanleaf cinquefoil, smallflower paint-brush, western pasqueflower
Grand fir	3,500 - 6,500	25 - 50	grand fir, ponderosa pine, lodgepole pine, western larch, Douglas fir	common snowberry, shineleaf spirea, woods rose, Nootka rose, mallow nine-bark, creambrush oceanspray	pinegrass, north-western sedge, elk sedge, broadleaf arnica, kinnikinnick

Table I.3: Vegetative zones in the area covered by the HCP *(continued)*

Vegetative zone	Elevation range (feet)	Average precipitation (inches)	Major tree species	Common shrubs	Herbaceous plants
Douglas fir	2,000 - 4,500	30-60	Douglas fir, ponderosa pine, lodgepole pine, western larch	baldhip rose, Oregon boxwood, prickly currant, big huckleberry	Columbia brome, sweetscented bed-straw, starry solomonplume, western meadow-rue, heartleaf arnica, sideflower mitre-wort, bigleaf sand-wort, white hawk-weed, twinflower, trail plant, Piper anemone, Lyall anemone, wood violet, white trillium, queencup beadlily, wild ginger, broad-leaf lupine, dwarf blackberry
Ponderosa pine	2,000 - 4,000	15 - 30	ponderosa pine, western juniper, quaking aspen, Oregon white oak	Saskatoon serviceberry, chokecherry, black-hawthorn, cream-bush oceanspray, common snowberry, woods rose, Nootka rose, mallow ninebark, shinyleaf spirea, creeping western barberry, Wyeth buckwheat, snow eriogonum, yellow leafless mistletoe	bluebunch wheat-grass, Idaho fescue, Sandberg's bluegrass, western yarrow, western gromwell, yellow salsify, large-flowered brodiaea, beauty cinquefoil, purple-eyed grass, spreading dogbane, arrowleaf balsam-root, sagebrush, buttercup, low pussy-toes, slender fringe-cup, littleflower collinsia, miner's lettuce, Japanese brome, cheatgrass brome, narrow-leaved montia, smallflower forget-me-not, vernal draba, autumn willowweed, Nuttall's fescue, little tarweed, pink annual phlox, shining chickweed

CLIMATE

Washington's climate is controlled by three factors: (1) location on the windward coast of the Pacific Ocean; (2) the north-south Cascade Range that runs through the center of the state; and (3) the semi-permanent high- and low-pressure regions located over the north Pacific Ocean. These factors combine to produce dramatically different conditions within short distances. The Cascade Range, for instance, blocks the initial thrust of Pacific storms into eastern Washington while protecting western Washington from the polar-continental influence. Thus, western Washington has a marine climate and eastern Washington has a marine-continental climate.

Successive moisture-laden storms move into the Pacific Northwest during late fall, winter, and early spring. They are intercepted first by coastal ranges (the Olympic Mountains and Willapa Hills) and then by the Cascade mountains, leaving most of eastern Washington in a rain shadow with an almost desert-like climate. From late spring to early fall, the Pacific high pressure area moves progressively farther north, weakening storms and limiting rainfall.

Annual precipitation ranges from 75 inches along the coast to 175 inches along the western slopes of the Olympic Mountains and nearly 100 inches in the Willapa Hills. The rain-shadow effect of the Olympic Mountains results in only 16 to 25 inches on the northeast part of the Olympic Peninsula and in parts of the San Juan Islands.

From the Puget Sound lowlands south to the Columbia River, the mean annual precipitation is 40 to 60 inches. Precipitation increases along the west slopes of the Cascades, reaching 120 inches annually in some places. Striking gradations in precipitation totals are also noted on the eastern slopes of the Cascades, decreasing to an annual mean of 12 inches 40 miles from the crest and down to only 8 inches in the southern part of the central basin.

Approximately 80 to 85 percent of the annual precipitation falls between October and April in western Washington. The driest months are typically July and August. Above 2,500 to 3,000 feet, precipitation generally falls as snow from about November through March. Maximum snow accumulations in higher elevations normally occur in the last part of March or early April. Snow above the 5,000-foot level in western Washington may remain into July. Snowfall decreases rapidly on the east slopes of the Cascades as distance east of the crest increases.

The influence of the Pacific Ocean provides generally mild temperatures in western Washington. Winter minimums are 25° to 30° F and maximums are 40° to 45° F. July is the warmest month, with maximum temperatures of 65° to 75° F in the coastal areas and 75° to 80° F inland. Minimum temperatures average near 50° F. Temperatures are more extreme in eastern Washington because of the continental influence. January maximums there average generally between 30° and 40° F and minimums between 15° and 25° F. July maximums average 85° to 90° F and minimums 45° to 55° F.

Prevailing winds are generally southwesterly over the state from late fall to early spring and northwesterly and lighter during the rest of the year.

The most intense storms take place in late fall and early winter. Wind velocities range from 50 to 70 miles per hour or higher along the coast almost every winter. Speeds approaching or exceeding 100 miles per hour have been observed occasionally on coastal ridges. Wind speeds inland are lower during these storms but have been observed at 50 to 60 miles per hour.

Rain usually accompanies lightning storms. Western Washington has 10 to 12 such storms each year, mostly along the western slopes of the Cascades. There are about 25 lightning storms each year in eastern Washington, but they are usually accompanied by less rain. However, an outbreak of "dry lightning" typically occurs two to three times each year in eastern Washington and on rare occasions in western Washington.

In western Washington, the sun shines about 24 percent of the time in December. In July, the figure is typically about 61 percent. In eastern Washington, the sun shines 25 to 30 percent of the time in December and January, but the figure increases to 80 to 85 percent in July and August. Frost-free days in western Washington begin in late April and continue to early November, while in eastern Washington the frost-free period begins in late May and ends in late September.

Organization of the Planning Area

NATURAL SYSTEMS

As discussed earlier in this chapter, DNR-managed lands covered by the HCP include a complex mix of parcel sizes and configurations, vegetation types, and species of concern. To tie the minimization and mitigation more closely to the natural systems and geographic variations in habitat, to gain economies of scale, and to provide greater efficiency in planning, the area covered by the HCP has been divided into nine planning units based on watersheds. (See Map I.4.)

These planning units are delineated by clustering Water Resource Inventory Areas (as defined by the Washington Department of Ecology and commonly referred to as WRIAs) that drain to common water bodies. (See Maps I.5 - I.13.) For example, WRIAs that drain into Grays Harbor and Willapa Bay define the South Coast Planning Unit, WRIAs that drain into the Straits of Juan de Fuca define the Straits Planning Unit. Some planning units are modified to accommodate administrative boundaries; one example is the Olympic Experimental State Forest. Watershed-based boundaries have been recognized in making these adjustments by using Watershed Administrative Unit (as defined by DNR in cooperation with other agencies, tribes, and the public and commonly referred to as WAU) boundaries when possible. There are two exceptions: (1) the boundary separating the Straits and the Olympic Experimental State Forest planning units makes a short deviation due north from near Lake Crescent to the Strait of Juan de Fuca, and (2) the eastern boundary of the three planning units east of the Cascade crest is the eastern boundary of the range of the northern spotted owl. Planning units are named on the basis of where they drain (North Puget Sound) or general location (Klickitat).

The three east-side planning units form the east-side planning area and are included only in the conservation strategies and mitigation for the northern spotted owl and other federally listed species. (The marbled murrelet is not known to cross over the Cascade crest into the east-side planning area, and the unlisted species including salmon are not covered by this HCP in the east-side planning area.) Because of the unique history and role of the Olympic Experimental State Forest Planning Unit, its conservation strategies and mitigation for the spotted owl and riparian areas differ from the other planning units. (See the next subsection for a full explanation.) The remaining planning units west of the Cascade crest are referred to as the west-side planning area. Table I.4 describes major features and acreage of DNR-managed land for each planning unit and planning area.

Table I.4: Major features and acreage of DNR-managed lands by planning unit and planning area

Planning unit name and planning area	Counties and parts of counties containing DNR-managed lands in the area covered by the HCP	Major rivers	Acres of DNR-managed lands covered by the HCP
Chelan (east side)	Chelan and western Okanogan	Wenatchee, Entiat, Stehekin, Twisp, and Methow	15,000
Yakima (east side)	Kittitas and northwestern Yakima	Tieton, Bumping, Naches, Yakima, and Teanaway	81,000
Klickitat (east side)	southwestern Yakima, western Klickitat and southeastern Skamania	White Salmon and Klickitat	132,000
North Puget (west side)	Whatcom, Skagit, Snohomish, northern King, San Juan, and Island	Nooksack, Skagit, Sauk, Stillaguamish, Skykomish, and Snoqualmie	362,000
Straits (west side)	eastern Clallam, eastern Jefferson, and northwestern Mason	Elwha, Dungeness, Dosewallips, Duckabush, Hamma Hamma, and Skokomish	112,000
South Puget (west side)	southern King, Pierce, eastern Thurston, north-central Lewis, Kitsap, and eastern Mason	Cedar, Green, White, Carbon, Puyallup, Nisqually, and Deschutes	144,000
South Coast (west side)	Grays Harbor, western Thurston, Pacific, and western Lewis	Quinault, Humptulips, Chehalis, Hoquiam, Wishkah, Wynoochee, Satsop, Black, Skookumchuck, Newaukum, North, Willapa, and Naselle	234,000
Columbia (west side)	eastern Lewis, southeast Pacific, Wahkiakum, Cowlitz, Clark, and Skamania	Cowlitz, Toutle, Coweeman, Kalama, Lewis, Washougal, Wind, and Grays	286,000
Olympic Experimental State Forest (separate planning area)	western Clallam and western Jefferson	Hoko, Quileute, Soleduck, Calawah, Bogachiel, Hoh, Clearwater, and Queets	264,000

WHY THE OLYMPIC EXPERIMENTAL STATE FOREST PLANNING UNIT IS UNIQUE

The Olympic Experimental State Forest Planning Unit (also referred to as the OESF and the Experimental Forest) is unique among planning units in this HCP because of its experimental nature, integrated approach to management, and planning history. The long-term vision for the Experimental Forest is of a commercial forest in which ecological health is maintained through innovative integration of forest production activities and conservation.

This vision evolved from recommendations of the Commission on Old Growth Alternatives before the listing of the northern spotted owl and marbled murrelet. The Commission's intent was for DNR to avoid management disruptions from future listings and conservation issues by learning to manage for healthy ecosystems that included older forest features. A look back at the Old Growth Commission's original recommendation reveals this visionary nature of the OESF, looking beyond the needs of individual species to the ecological values of old-growth forests as a whole and to the relationships between forest management activities and the complex ecosystem relationships within forests:

> The Commission believes that the ecological values of old-growth forests include but go beyond spotted owl habitat. Scientists are only just beginning to understand the complex ecosystem interrelationships in these forests, and the comparatively lower elevation mature forests remaining on state lands have particularly rich diversity. Forest scientists and managers are increasingly discussing the ability to sustain key elements of ecological diversity within managed commercial forests as an alternative to past approaches. The Commission sees a clear need for further research in this area and a great opportunity to conduct it on state-owned lands. The intent is to experiment with harvest and regeneration methods to enhance habitat characteristics and commodities production. The Commission believes this recommendation may lead to entirely new models of forestry including workable alternatives which balance production with ecology (Commission on Old Growth Alternatives for Washington's Forest Trust Lands 1989 p. 2).

The OESF was included in the 1992 Forest Resource Plan as a "state forest that will be managed separately from other lands in western Washington" (DNR 1992 p. 21). See Chapter II for a discussion of the Forest Resource Plan.

The Experimental Forest's planning history has led to a strategy that differs from the other planning units in both concept and detail by combining conservation, production, research and monitoring, innovative silvicultural techniques, and communication and education in a unified effort. The aim will be to learn how to manage the forest so that habitat conservation and timber production are melded across the landscape, rather than separated into designated areas.

In addition to providing income and other benefits to the trusts, the OESF will help find field-tested solutions to forest management issues related specifically to integrating production and conservation. Through the Experimental Forest, DNR will actively question its knowledge about the relationships between forest ecosystem functions and forest management activities. It will explore these questions through monitoring and research and by sharing knowledge with and seeking insights from other professionals and publics around the world. As the research provides new information, management activities will be adapted accordingly. Ultimately, what is learned in the OESF can be applied where appropriate to other DNR-managed forest lands. (See also Section E of Chapter IV on the OESF Planning Unit.)

The Experimental Forest is included as a planning unit of this HCP in order to fulfill one of the stated purposes of the proposed action:

> To enable DNR to conduct management and research activities within the OESF in areas currently occupied by listed species in order to build new knowledge relevant to trust management obligations and species conservation. (See also the Draft Environmental Impact Statement.)

There are three components of this experiment: (a) habitat conservation strategies based on an experimental concept of an "unzoned" forest, that is, a forest without areas deferred from timber management; (b) a commitment to monitoring, research, and information sharing as the basis for experimental management; and (c) creation of a process for integrating intentional learning with management decision making and course adjustments.

The following points summarize the objectives of the Experimental Forest:

(1) The OESF is DNR's focal point for experimentation. Information gained from the experimentation will be applied to other DNR-managed lands where and when appropriate. DNR will share the information gained with other interested parties in order to ensure that the maximum benefit is achieved through DNR's investment in the Experimental Forest.

(2) In the OESF, DNR will seek to answer questions about integrating conservation and production. DNR will explore the links between management activities and ecological processes and functions at both the landscape and the stand levels.

(3) DNR will acquire knowledge to enhance trust land management through active monitoring, a targeted research effort, and the promotion of cooperative research projects.

(4) Through time, DNR will demonstrate a process by which trust land management activities in the Experimental Forest can respond to new information.

II. Planning Context

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Trust Duties

DNR has unique obligations in managing the lands covered by the HCP because they are trust lands. The majority of these lands were granted under the Enabling Act and the State Constitution when Washington became a state in 1889. The federally granted lands are to support certain designated beneficiaries in perpetuity. The beneficiaries include public institutions such as public schools, state universities, and charitable, educational, penal, and reformatory institutions.

The state also acquired land from several counties after tax foreclosures and tax delinquencies, as well as through purchases and gifts. The legislature has directed that these lands, known as Forest Board lands, be held in trust and administered and protected by DNR as are other state forest lands. There are 21 counties with Forest Board lands; 19 of them have Forest Board lands within the range of the northern spotted owl.

Out of approximately 3 million acres currently managed in these trusts, about 2.1 million are forest lands. (About 1.6 million acres of the forest lands are within the range of the northern spotted owl and are covered by the HCP. See Map II.1.)

A trust is a relationship in which one person, the trustee, holds title to property which it must keep or use for the benefit of another (Bogert 1987). The relationship between the trustee and the beneficiary is a fiduciary relationship, and it requires the trustee to act with strict honesty and candor and solely in the best interests of the beneficiary. A trust includes a trustee (the entity holding the title), one or more beneficiaries (entities receiving the benefits from the assets), and trust assets (the property kept or used for the benefit of the beneficiaries). In the case of Washington's trust responsibility, the trust assets are the trust lands and the permanent funds.

With the state as trustee, the legislature has designated DNR as manager of the federal grant and Forest Board trust lands. Statutorily, DNR consists of the Board of Natural Resources, the Commissioner of Public Lands as administrator, and the Department Supervisor (RCW 43.30.030). The Board of Natural Resources is required, by statute, to establish "policies to insure that the acquisition, management and disposition of lands and resources within the Department's jurisdiction are based on sound principles designed to achieve the maximum effective development and use of such lands and resources consistent with laws applicable thereto" (RCW 43.30.150). The Board is composed of six members: the Commissioner of Public Lands; the Governor (or a designated representative); the Superintendent of Public Instruction; the Dean of the College of Agriculture, Washington State University; the Dean of the College of Forest Resources, University of Washington; and an elected representative from a county that contains Forest Board land.

As a trust manager, DNR follows the common law duties of a trustee, which include: administering the trust in accordance with the provisions that created it; maintaining undivided loyalty to each of the trusts; managing trust assets prudently; making the trust property productive while recognizing the perpetual nature of the trusts; dealing impartially with beneficiaries; and reducing the risk of loss to the trusts. The department must also comply with all laws of general applicability.

Some of the trust duties have been discussed by the courts specifically in the context of federal land grant trusts. By and large, however, Washington courts have not expounded upon the specifics of how the duties applicable to private trustees apply in the specific, and often unique, circumstances facing the state. A court's analysis of these issues would be informed by the specific trust terms found in the State Constitution and Enabling Act as interpreted in court decisions.

In 1984, the Washington State Supreme Court specifically addressed the state trust relationship in County of Skamania v. State of Washington, 102 Wn.2d 127, 685 P.2d 576. The Skamania decision explicitly addresses only two of a trustee's duties. It found that a trustee must act with undivided loyalty to the trust beneficiaries, to the exclusion of all other interests, and manage trust assets prudently. The Court also cited a series of cases in which private trust principles were applied to land grant trusts. While all but one of these cases are from other states with differently worded Enabling Acts, they generally indicate that a state's duty is to strive to obtain the most substantial support possible from the trust property while exercising ordinary prudence and taking necessary precautions for the preservation of the trust estate. This principle has often been generally referred to as the trust mandate. Although the trust mandate has not been more expressly addressed by the Washington courts, DNR strives to produce the most substantial support possible over the long term consistent with all trust duties conveyed on DNR by the state of Washington.

The 1992 Forest Resource Plan (see section later in this chapter for a discussion of the Forest Resource Plan) contains a succinct discussion of the trust mandate and the common law duties of a trustee as interpreted by DNR and approved by the Board. For example, Board policy indicates that all decisions are to be made with the beneficiaries' interest first and foremost in mind. Board policy also indicates prudence includes managing state lands so as to help prevent the listing of additional species as threatened or endangered.

Board policy indicates that DNR is to manage trust assets to ensure healthy forests that will be productive in perpetuity. Board policies also imply that it is important not to foreclose reasonably foreseeable future options for support. For these reasons, it is important to retain the capacity of the forest to sustain its components and biological relationships.

In short, any management plan for trust lands, including this HCP, should be consistent with the principles of trust management. The following excerpt from the Forest Resource Plan's discussion of DNR's interpretation of its duties as a trust manager helps explain how this HCP ties to trust management obligations:

> The Prudent Person Doctrine
> Trust managers are legally required to manage a trust as a prudent person, exercising such care and skill as a person of ordinary prudence would exercise in dealing with his or her own property. In the department's view, this means, among other things, avoiding undue risk, avoiding tortious acts, etc.

The beneficiaries need a predictable timber sales program that can be executed over several years. Constantly changing regulations often add to administrative overhead. Sales prepared under one set of regulations, for example, may be harvested under a different and more stringent set. These changes (between the time of preparation and the time of harvest) cause contract disputes with purchasers and may force the department to modify planning decisions, thus adding to administrative overhead and causing further delays.

The department believes it is in the best interest of the beneficiaries to manage the trusts in a manner that will avoid the type of controversy that has surrounded forest practices in the past few years. These types of controversies (such as the federal listing of the northern spotted owl as a threatened species) usually result in ever more restrictive regulations. In the department's opinion, public concerns regarding wildlife, fisheries and water quality are likely to escalate and may result in more stringent regulations if the public perceives that the department and other public land managers are not considering nontimber resources.

The department believes it is in the best interests of the trust beneficiaries over the long run to:

- Manage state forest land to prevent the listing of additional species as threatened or endangered.
- Prevent public demand for ever-increasing, restrictive regulations of forest practices.
- Avoid the resulting contract disputes and uncertainty (DNR 1992 p. B-1).

This Habitat Conservation Plan is expected to allow DNR to better fulfill its duties as a trust manager by:

(1) providing certainty and stability in complying with the Endangered Species Act while producing substantial long-term income for trust beneficiaries,

(2) allowing more predictable timber sales levels,

(3) ensuring future productivity of trust lands,

(4) keeping options open for future sources of income from trust lands,

(5) increasing management flexibility, and

(6) reducing the risk of loss to the trusts.

The Endangered Species Act

In 1973, Congress passed the Endangered Species Act (16 U.S.C. 1531 et seq.). The stated purposes of the Act 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.

Administration of the Endangered Species Act is overseen by the Secretary of the Interior, with the U.S. Fish and Wildlife Service acting on the Secretary's behalf. The Secretary of Commerce, acting through the National Marine Fisheries Service, is the listing authority for marine mammals and anadromous fish. The Act 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 Act 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 U.S. Fish and Wildlife Service 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 Act (16 U.S.C. 1533(d)), the listing Secretary may apply — and usually has applied — the same prohibitions of activities regarding endangered species to threatened species.

If a plant is listed as endangered, activities that are prohibited 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 and is required to submit a conservation plan 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 Section 10 of the Act (16 U.S.C. 1539(a)(2)(A)), a conservation plan must specify:

(1) the impact which will likely result from such taking;

(2) what steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps;

(3) what alternative actions to such taking the applicant considered and the reasons such alternatives are not being utilized; and

(4) such other measures that the Secretary may require as being necessary or appropriate for purposes of the plan.

The permit can be issued if, "after opportunity for public comment," the Secretary finds that:

(1) the taking will be incidental;

(2) the applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;

(3) the applicant will ensure that adequate funding for the plan will be provided;

(4) the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; and

(5) the measures, if any, required [by the Secretary] will be met (16 U.S.C. 1539(a)(2)(B)).

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 Act (16 U.S.C. 1536(c) and (a)).

The U.S. Fish and Wildlife Service, acting on behalf of the Secretary of the Interior, has listed as threatened two forest-associated species that occur on DNR-managed land covered by this HCP. In July 1990, the northern spotted owl was listed; in October 1992, the marbled murrelet was listed. In addition, the U.S. Fish and Wildlife Service has listed several other species whose habitat occurs within the range of the northern spotted owl. Although the owl's range is the area covered by the HCP, these other listed species do not occur in great number on DNR-managed forest land. These species are the Oregon silverspot butterfly, the Aleutian Canada goose, the bald eagle, the peregrine falcon, the gray wolf, the grizzly bear, and the Columbian white-tailed deer.

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

Since the listings of the spotted owl and the murrelet, the federal government has published draft recovery plans that target conditions on federal and nonfederal lands for ecological recovery of the listed species. The federal government has also proposed a plan to restore viable populations on federal lands. Because these plans affect DNR's HCP, a brief discussion of the federal plans is included here. In addition, the Secretary of the Interior can issue regulations (called 4(d) rules) regarding conservation of listed species on nonfederal lands. Such a rule has been proposed for the spotted owl; because it would affect DNR-managed lands, a brief discussion of that draft 4(d) rule is included as well.

FINAL DRAFT RECOVERY PLAN FOR THE NORTHERN SPOTTED OWL

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 Act'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).

A Draft Recovery Plan for the northern spotted owl was issued in 1992 (USDI 1992a) and revised following the public comment period, but it has yet to receive final approval. As of the approval date of this HCP, the Department of the Interior had not published any further discussion of the Final Draft Recovery Plan, nor had the plan's official status been resolved.

Included in the Final 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). Section A of Chapter IV on spotted owl mitigation contains an explanation of how DNR used the federal recovery team's recommendations in the formulation of DNR's spotted owl conservation strategies.

PRESIDENT'S FOREST PLAN

Because DNR's mitigation for incidental take of spotted owls is designed to complement recovery activities on federal land, a discussion of those activities as proposed in the President's Forest Plan is included here. 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, also known as the President's Forest Plan. The main issue leading to the development of the President's Forest Plan was the future of existing old-growth forests.

Since 1989, numerous lawsuits and several court injunctions have severely restricted new and existing timber sales on lands managed by the U.S. Forest Service and the Bureau of Land Management (USDA and USDI 1994). Federal district courts have ruled that these agencies failed to comply with federal law. In particular, separate court decisions have stated that the U.S. Forest Service 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; Forest Ecosystem Management Assessment Team 1993).

In western Washington, the U.S. Forest Service has jurisdiction over federal lands available for timber harvest. Since 1960, federal legislation has repeatedly directed the U.S. Forest Service 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 and USDI 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 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:

(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 U.S. Forest Service, 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 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.

FEMAT proposed dividing the landscape into different areas according to allowable management activities. They defined two types of reserves: Late successional Reserves and Riparian Reserves. Late successional Reserves encompass old-forest stands, and Riparian Reserves consist of protected-forest zones along rivers, streams, lakes, and wetlands. The Riparian Reserve acts as a buffer between water resources and timber harvest. (For the purposes of this HCP, congressionally reserved areas such as National Parks and Wilderness Areas are considered Late successional Reserves.) Most timber harvesting will occur in the area outside reserves, which is referred to as the Matrix. The forest conditions produced through harvesting are required to meet minimum specifications. Timber harvesting can also occur in Adaptive Management Areas, which are designated to encourage the development and testing of technical and social approaches to achieving desired ecological, economic, and social objectives.

The preferred alternative, known as Option 9, was approved by both the Secretary of the Interior and the Secretary of Agriculture (who oversees the U.S. Forest Service). The Record of Decision for the President's Forest Plan was issued on April 13, 1994, and was to take effect 30 days later. 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 President's Forest Plan was lawful (Seattle Audubon Society v. Lyons 871 F. Supp. 1291, W.D. Wash. 1994). As of the writing of this HCP, the decision is under appeal in the Ninth Circuit. Section A of Chapter IV on spotted owl mitigation discusses how DNR's conservation strategies relate to the President's Forest Plan.

DRAFT 4(D) RULE FOR THE NORTHERN SPOTTED OWL

Section 4(d) of the Endangered Species Act (16 U.S.C. 1533(d)) authorizes the Secretary of the Interior to issue regulations, commonly referred to as 4(d) rules, that are deemed necessary to provide for the conservation of an endangered or threatened species and can be applied on nonfederal lands. 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 President's Forest Plan for federal forest lands (Holthausen et al. 1994, Appendix 1, p. 1).

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 in a few key areas would contributions from nonfederal lands be needed. Therefore, relief from prohibitions on incidental take could be granted in some portions of the spotted owl's range (Federal Register v. 60, no. 33, p. 9484-9485). However, the U.S. Fish and Wildlife Service 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 (Federal Register v. 60, no. 33, p. 9484-9485).

On February 17, 1995, the U.S. Fish and Wildlife Service published a draft 4(d) rule for the northern spotted owl that defines where incidental take restrictions would apply in Washington and California (USDI 1995). The public comment period for the proposed rule ended May 18, 1995.

The proposed 4(d) rule would establish six Special Emphasis Areas in Washington in which incidental take prohibitions would continue to apply. In addition to the lands within the Special Emphasis Areas, any nonfederal lands that fall within a spotted owl circle (see the section in Chapter III on spotted owls for an explanation of owl circles) surrounding a site center located on federal reserves established by the President's Forest Plan (USDA and USDI 1994) would also be subject to take restrictions for two years following adoption of the rule. This provision does not apply to nonfederal lands on the Olympic Peninsula. After two years, the U.S. Fish and Wildlife Service proposes to re-examine the need to maintain habitat on nonfederal lands within federally sited owl circles. All owners of land outside of Special Emphasis Areas 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, some DNR-managed trust lands would be included in every Special Emphasis Area. Those lands would not gain relief from current incidental take prohibitions.

However, the draft 4(d) rule also proposes several types of landowner exemptions and opportunities for other kinds of agreements. As a landowner with holdings of more than 5,000 acres of forest land in every Special Emphasis Area, DNR could adopt a habitat conservation plan authorized under Section 10 of the Endangered Species Act (16 U.S.C. 1539(a)(1)(B)) as an alternative to observing incidental take prohibitions. In fact, DNR had already begun preparation of this HCP prior to the publication of the proposed 4(d) rule. Because of the expectation that many large landowners will provide conservation through habitat conservation plans, the U.S. Fish and Wildlife Service is willing to be more lenient under the 4(d) rule (Federal Register v. 60, no. 33, p. 9485).

REANALYSIS REPORT FOR THE NORTHERN SPOTTED OWL ON THE OLYMPIC PENINSULA

There has been a long-standing concern about the viability of the spotted owl on the Olympic Peninsula because the sub-population there is isolated from sub-populations in the western Washington and Oregon Cascades (Thomas et al. 1990; USDA 1988; USDI 1992a). To obtain supporting information for the development of a 4(d) rule under the Endangered Species Act (see above), the U.S. Fish and Wildlife Service requested the analysis of the most recent information about spotted owls on the peninsula in order to assess whether and where it might be appropriate to relax incidental take restrictions on nonfederal lands. A group of six spotted owl ecologists, known as the Federal

Reanalysis Team, was assembled to review existing data and develop a population model to estimate the importance of contributions of varying amounts of habitat from nonfederal lands to the long-term existence of a spotted owl population on the Olympic Peninsula.

The Federal Reanalysis Team used the most current information available for the Olympic Peninsula on spotted owl habitat, population estimates, and demographic rates to re-examine the recommendations made in the Final Draft Recovery Plan (USDI 1992b). Specifically, the Team used these data in a spatially explicit (i.e., sensitive to location and space) spotted owl population model (McKelvey et al. 1992) to simulate the likelihood of persistence of owls on federal lands under various management scenarios and habitat configurations likely to result from the President's Forest Plan and different levels of contributions from nonfederal lands (Holthausen et al. 1994 p. 6).

The Final Draft Recovery Plan had recommended that nonfederal lands on the western side of the Olympic Peninsula be managed to provide demographic support to the population and to maintain connectivity between the coastal strip of the Olympic National Park and the core of federal land on the peninsula (USDI 1992b p. 103). The Final Draft Recovery Plan had also recommended that habitat and population connectivity between the western Washington Cascade Range and the Olympic Peninsula be re-established by providing habitat for breeding clusters of spotted owls in southwest Washington. The reasoning was that re-establishing population connectivity could reduce the risk of extirpation of the Olympic Peninsula sub-population (USDI 1992b p. 105).

The Federal Reanalysis Team made the following conclusions from its work (Holthausen et al. 1994 p. 1-2):

(1) "It is likely, but not assured that a stable population of owls would be maintained on portions of the Olympic National Forest and the core area of the Olympic National Park in the absence of contribution of habitat from nonfederal lands" (Holthausen et al. 1994 p. 1).

(2) It would be unlikely that spotted owls would be maintained on the western coastal strip of the Olympic National Park without a contribution of habitat from nonfederal lands.

(3) There will probably be fewer areas with high occupancy by owls in the Olympic National Forest and the core area of the Olympic National Park without a contribution of habitat from nonfederal lands.

(4) "Retention of nonfederal habitat could result in a biologically significant contribution to the maintenance of a stable spotted owl population distributed evenly across currently occupied portions of the Olympic Peninsula" (Holthausen et al. 1994 p. 1-2).

(5) Retention of nonfederal habitat, while making a significant contribution to the maintenance of the population, will not fully resolve the uncertainties surrounding the long-term persistence of spotted owls on the Olympic Peninsula.

(6) Retention of nonfederal habitat on the western side of the Olympic Peninsula would likely increase the chances of maintaining a population on the coastal strip of the Olympic National Park.

(7) Nonfederal lands may provide the majority of low-elevation habitat on the peninsula. Low-elevation habitat may be of higher quality than high-elevation habitat.

(8) A habitat connection across southwest Washington as suggested in the Final Draft Recovery Plan would have little effect on the status of the owl population on the peninsula if that population were already stable or nearly stable.

The Federal Reanalysis Team was careful to point out in their report that they used considerable professional judgement when drawing conclusions from the results of their modeling efforts. They emphasized that model results do not represent reality, but instead are "repeatable projections of a set of assumptions" (Holthausen et al. 1994 p. 45). The manner in which DNR used the Reanalysis Team's conclusions in the formulation of its spotted owl conservation strategies is discussed in Section A and Section E of Chapter IV. More specific information regarding the biological basis of the report is in Section A on the spotted owl in Chapter III.

DRAFT RECOVERY PLAN FOR THE MARBLED MURRELET

On August 1, 1995, the U.S. Fish and Wildlife Service announced the availability of the federal Draft Recovery Plan (USDI 1995) and a revised proposal for the designation of critical habitat for the marbled murrelet in Washington, Oregon, and California.

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 Draft Recovery Plan for the Marbled Murrelet 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 draft plan includes information on (a) the biology, including habitat needs, of the species, (b) reasons for population decline and current threats, (c) current management, and (d) recommendations for recovery efforts for Washington, Oregon, and California.

The objectives identified in the Draft Recovery Plan are (a) to stabilize the population at a sustainable level throughout its range, (b) to provide future conditions that support viable, self-sustaining populations, and (c) to gather the scientific information necessary to develop criteria for delisting the species.

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

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

(1) establishing six marbled murrelet conservation zones with specific management strategies for each,

(2) identifying and protecting habitat in each zone through designation of critical habitat or other methods such as habitat conservation plans, and developing management plans for these areas,

(3) monitoring populations and habitat and surveying potential breeding habitat to identify occupied sites,

(4) implementing actions to stabilize and increase the population in the immediate future and increase population growth in the long-term, and

(5) initiating needed research and establishing a regional research coordination body.

PROPOSAL FOR DESIGNATION OF CRITICAL HABITAT FOR THE MARBLED MURRELET

The U.S. Fish and Wildlife Service designates as critical habitat 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 in May 1996 (Federal Register v. 61, no. 102, p. 26255-26320).

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 President's Forest Plan. In areas where federal lands alone were thought to be insufficient to support a well distributed population, an additional 870 thousand acres (approximately) of state (812,200 acres), county (9,100 acres), city (1,000 acres), and private (48,000 acres) lands are identified.

The U.S. Fish and Wildlife Service continues to rely on previously existing regulations to protect the marine environment and did not include any marine environment in the final rule.

The final rule includes the following language regarding areas designated as critical habitat that are within an HCP: "Critical habitat units do not include non-federal lands covered by a legally operative incidental take permit for marbled murrelets issued under section 10(a) of the Act."

Other Wildlife Statutes and Regulations

There are other laws and regulations pertaining to wildlife that are applicable, such as the federal Migratory Birds Treaty Act and the federal Bald and Golden Eagle Protection Act. In addition, the state has statutes and regulations governing wildlife. The Washington Department of Fish and Wildlife oversees state listings of endangered and threatened wildlife. DNR'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. (See the section in this chapter on the Forest Practices Act.)

If the Washington Department of Fish and Wildlife 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 those species designated as threatened, sensitive, or protected are listed under WAC 232-12-011. As of the drafting of this HCP, 24 species are listed as endangered and eight species as protected. The complete regulations governing the state listing, delisting, and management of animal species are given in WAC 232-12-297.

The Washington Department of Fish and Wildlife is charged with writing recovery plans for endangered and threatened species that include target population objectives and an implementation plan for attaining the objectives. Such recovery plans may consider various approaches to meeting the objectives, including regulation. To date, the agency has written three recovery plans, for the snowy plover (*Charadrius alexandrinus*) (WDFW 1995a), the upland sandpiper (*Bartramia longicauda*) (WDFW 1995b), and the pygmy rabbit (*Brachylagus idahoensis*) (WDWF 1995c), none of which affect this HCP. (See Section F of Chapter III and Section G of Chapter IV for discussion of plants in the area covered by the HCP.)

RCW 79.70.030 authorizes DNR 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. As of the drafting of this HCP, the most current list of vascular plants can be found in a report titled Endangered, Threatened & Sensitive Vascular Plants of Washington (DNR 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. (See Section F of Chapter III and Section G of Chapter IV for a discussion of plants in the area covered by the HCP.)

Environmental Laws

In addition to the Endangered Species Act, DNR is required to follow relevant laws of general applicability such as the federal Clean Air Act, the federal Clean Water Act and the state Shorelines Management Act. As part of the process for developing an HCP, DNR is required to adhere to both the National and State Environmental Policy Acts.

NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA, 42 U.S.C. 4321 et seq.) requires full public disclosure and analysis of the environmental impacts of proposed federal actions significantly affecting the quality of the human environment. The issuance of an incidental take permit is a federal action subject to NEPA compliance. Federal actions associated with DNR's proposal involve both the U.S. Fish and Wildlife Service on behalf of the Secretary of the Interior and the National Marine Fisheries Service on behalf of the Secretary of Commerce.

It is important to distinguish between the requirements for an incidental take permit as set forth in the Endangered Species Act (16 U.S.C. 1531 et seq., described earlier in this chapter) and the detailed analysis required under NEPA. To comply with the requirements for an incidental take permit as set forth in the Endangered Species Act, an HCP must explain the potential impacts on federally listed species, the planned measures to minimize and mitigate to the maximum extent practicable those impacts, and other measures as necessary. The HCP must also describe alternatives to the proposed taking and explain why those are not considered feasible. NEPA requires a broader analysis that examines additional environmental impacts of the proposal and considers all reasonable alternatives to the proposed action. As part of the evaluation of reasonable alternatives, the No Action (i.e., no change from current practices) alternative must be analyzed. In this case, the NEPA analysis will compare the effect of issuing the permit to what would occur without the permit (USFWS 1996 p. 45). Please refer to the Draft Environmental Impact Statement for this analysis.

WASHINGTON STATE ENVIRONMENTAL POLICY ACT

The Washington State Environmental Policy Act (SEPA, RCW 43.21C) sets forth requirements for state 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. DNR is complying with these requirements through the Draft Environmental Impact Statement, a thorough public review effort, and a Final Environmental Impact Statement.

ENVIRONMENTAL IMPACT STATEMENTS AND PUBLIC REVIEW

Both SEPA and NEPA allow a state agency to jointly prepare an environmental impact statement (EIS) with a federal agency. 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 an environmental impact statement" (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 (WAC 197-11-640). In order to improve efficiency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and DNR have agreed to serve as joint lead agencies for the environmental review of DNR's HCP. The lead agencies have prepared a Draft EIS pursuant to NEPA regulations (40 C.F.R. 1500-1508) and SEPA regulations (WAC 197-11) to fully evaluate DNR's HCP.

To satisfy both federal and state environmental policy act requirements, the U.S. Fish and Wildlife Service and DNR conducted a joint scoping process for the preparation of the Draft EIS. Agencies, tribes and members of the public submitted comments. The Board of Natural Resources also held a series of special public meetings around the state to hear public input. The results of the public scoping process are described in the Draft EIS.

A period of public review and comment followed issuance of the draft HCP and Draft EIS. Another series of public meetings was held around the state. The lead agencies reviewed the comments and the federal agencies conducted a biological assessment and jeopardy analysis of DNR's HCP. A Final EIS and notice of availability were published in October 1995. The Board of Natural Resources considered all reasonable alternatives, benefits and impacts to the trusts, results of the review by the federal agencies, and public input prior to deciding to adopt DNR's HCP. Please refer to DNR's Draft EIS and Final EIS for further information and analysis of the reasonable alternatives examined.

The State Forest Practices Act

In addition to statutes and regulations discussed in previous sections, as a forest land manager, DNR must comply with the Forest Practices Act, Chapter 76.09 RCW, which regulates forest management activity in Washington. The Forest Practices Act expresses the legislature's recognition of the importance of the forest products industry to Washington while finding it in the public's interest that forests be managed in a manner that protects public resources. The legislative finding and declaration includes the statement: "The legislature hereby finds and declares that the forest land resources are among the most valuable of all resources in the state; . . . that coincident with maintenance of a viable forest products industry, it is important to afford protection to forest soils, fisheries, wildlife, water quantity and quality, air quality, recreation, and scenic beauty" (RCW 76.09.010(1)).

The Forest Practices Act created the Forest Practices Board. One of the Board's duties is to promulgate forest practices regulations necessary to implement the purposes, policies, and provisions of the Forest Practices Act. Rules that relate to water quality protection must also be promulgated by the Department of Ecology. One of the legislative findings for the Forest Practices Act is to afford protection to forest soils and public resources (water, fish, wildlife, and capital improvements of the state or its political subdivisions) (RCW 76.09.010(2)(b)). These rules constitute Chapter 222 WAC, which sets minimum standards for forest practices such as road construction, timber harvesting, precommercial thinning, reforestation, fertilization, and brush control. Also included are rules concerning forest practices and habitat for threatened and endangered species. (See WAC 222-16-050(1)(b) and 222-16-080.)

Habitat conservation plans have a special relationship to the forest practices rule regarding critical habitats. When applications for proposed forest practices are submitted, they are assigned to one of four classes established by rule by the Forest Practices Board. Forest practices classified as Class IV-Special are subject to environmental review under the State Environmental Policy Act, Chapter 43.21 RCW (SEPA). Certain practices on "critical wildlife habitats (state) and critical habitat (federal) of threatened and endangered species" require a Class IV-Special designation (WAC 222-16-050(1)(b), 080). However, such habitats are no longer considered critical if the forest practices are "consistent" with a "conservation plan and permit for a particular species [that has been] approved by the U.S. Fish and Wildlife Service" (WAC 222-16-080(7)(a)). Therefore, additional environmental review under SEPA would not be required.

DNR's Forest Resource Plan

In addition to following statutory regulations, DNR is guided in management of state trust lands by policies established by the Board of Natural Resources. (See RCW 43.30.1150(2).) The Forest Resource Plan, adopted by the Board in 1992, is the major policy document currently providing direction for management of forested trust lands.

The Forest Resource Plan reaffirms DNR's commitment to act as a prudent land manager in order to generate income from state forest land to support schools and other beneficiaries. Policies in the various sections of the plan require DNR to analyze and, if necessary, to modify the impact of its activities on watersheds, wildlife habitat, special ecological features, wetlands, and other natural resources to ensure healthy forests that will be productive for future generations. The plan contains general policies and priorities intended to be interpreted within the context of the whole plan, including the following vision statement:

> The department has a clear purpose in caring for state forest land based on stewardship, innovation, commitment and competence. Department employees manage state forest lands and resources in an exemplary manner. Forest land planning is based on early collaboration with land users, neighbors, governments, tribes and the public, with mutual recognition of obligations and responsibilities. When necessary, the trust beneficiaries are compensated for a variety of uses by public and private sources. The department aggressively markets timber and a wide array of nontimber products. The department uses the most appropriate tools and technology. The department recognizes that assets owned by the trusts include the entire ecosystem and manages each site with the entire

> ecosystem in mind. The requirements for the management of timber and nontimber resources are integrated in landscape planning. Finally, the department recognizes the value of its employees, promotes creative thinking at all levels and accepts risk as an element of decisions (DNR 1992 p.1).

The plan divides policies into four general categories: trust asset management, forest land planning, silviculture, and implementation. Trust asset management policies address issues such as forest land transactions, lands available for timber harvest, harvest levels, marketing of special forest products, forest health, fire protection, financial assumptions, and special ecological features. Forest land planning policies describe the process for converting the plan policies into objectives and on-the-ground activities. Silviculture policies set the "sideboards" for individual site prescriptions and activities that effect the establishment, composition, structure, and growth of state forests. Implementation policies describe public involvement, monitoring, research, and plan modification processes.

The HCP is viewed as the major element for complying with the Forest Resource Plan policy on endangered, threatened, and sensitive species on the 1.6 million acres of DNR-managed land that the HCP covers. This policy states:

> The department will meet the requirements of federal and state laws and other legal requirements that protect endangered, threatened and sensitive species and their habitats. The department will actively participate in efforts to recover and restore endangered and threatened species to the extent that such participation is consistent with trust obligations (DNR 1992 p. 39).

In addition, the HCP provides support and direction for applying other Forest Resource Plan policies in regard to riparian management zones, wetlands, landscape planning, wildlife habitat, silviculture, and the Olympic Experimental State Forest.

The Forest Resource Plan articulates the Board's goals and policies in regard to striving to make the trust lands productive while protecting resources. These goals and policies can be implemented in a variety of ways, of which this HCP is one. The HCP does not revisit fundamental decisions made in the Forest Resource Plan. Therefore, the HCP should not be seen as an alternative to the Forest Resource Plan, but rather as a way of providing more substance and detail to existing policies.

III. Biological Data for Species Covered by the HCP

III. Biological Data for Species Covered by the HCP

A. Northern Spotted Owl

Species Ecology/Literature Review

INTRODUCTION

The northern spotted owl (*Strix occidentals caurina*) occurs in the Pacific coastal region from British Columbia to Marin County, California. Research during the past two decades indicates that spotted owls are strongly associated in much of their range with late successional and old-growth forest habitats. The spotted owl also occurs in some younger forest types where the structural attributes of older forests are present. The U.S. Fish and Wildlife Service listed the spotted owl as a threatened species in June 1990, based on the reduction of the owl's preferred habitat throughout its range (Federal Register v. 55, p. 26114-94). The state of Washington has listed the northern spotted owl as endangered.

The federal Northern Spotted Owl Recovery Team (hereafter referred to as the Recovery Team; for a description of its purposes, see the section in chapter II on the Final Draft Recovery Plan for the Northern Spotted Owl) adopted a modified version of the physiographic provinces described in Franklin and Dyrness (1973) to describe the range of the northern spotted owl. Physiographic provinces are defined by the physical and environmental factors that influence ecological characteristics of the landscape. This section will refer to the Recovery Team provinces for descriptive purposes. (See Map III.1.)

There is a separate discussion on ecology and threats to population for the northern spotted owl on the Olympic Peninsula because a separate conservation strategy is proposed for spotted owls in the Olympic Experimental State Forest Planning Unit on the west side of the Olympic Peninsula and the majority of knowledge of spotted owl ecology and population biology in Washington derives from studies conducted on the Olympic Peninsula. The objectives of that discussion are to review and discuss life history, population ecology, and threats to population persistence of the spotted owl as they relate to its conservation in the Olympic Experimental State Forest.

PHYSICAL CHARACTERISTICS AND BEHAVIOR

The northern spotted owl is a medium-size dark brown owl that has round to elliptical white spots on the head, white mottling on the body and abdomen, and white bars on the tail (Johnsgard 1988). It can be distinguished from other owls by its dark brown eyes surrounded by lighter brown facial disks. It differs from a close relative, the barred owl (*Strix varia*), by the presence of spots on the head and chest as compared to the vertical barring on the chest of barred owls.

Age and Sex Characteristics

Spotted owls have an average life span of eight years (Thomas et al. 1990). Juvenile spotted owls (age one day to five months) can be distinguished from older owls by the presence of pale brown downy feathers (Forsman 1981). As juveniles grow, the amount of down plumage decreases. At approximately five months, juveniles acquire adult-like plumage, but they have white, sharp-tipped tail feathers (Forsman 1981). Subadults between the ages of one and two years retain a downy tuft at the tip of their still-white tail feathers; the tuft is lost sometime after the first year (Moen et al. 1991). Spotted owls are considered adults at 27 months, at which time their tail feathers become rounded and mottled brown.

The easiest way to distinguish males and females is by voice, since their plumage is very similar (Forsman et al. 1984). Male vocalizations are generally lower pitched than female vocalizations. There is also a difference in size, with females being larger than males (reverse sexual dimorphism) (Blakesley et al. 1990 p. 323).

Foraging

Northern spotted owls are adapted to nocturnal hunting through exceptionally good eyesight and hearing and through modified feathers that facilitate silent flight (USDI 1992b p. 18). Spotted owls hunt opportunistically during the day. Typical hunting behavior consists of perching on a branch and locating potential prey by sight or sound, then pouncing on and capturing prey with their talons (USDI 1992b p. 18).

Spotted owls rely on small mammals for most of their diet, although they also eat birds and insects. Significant prey species in terms of biomass (weight) and frequency of capture are flying squirrels (*Glaucomis sabrinus*), wood rats (*Neotoma fuscipies* and *N. cinera*), mice *(Peromyscus* spp.), red tree voles (*Arborimus longicadus*), and rabbits (*Sylvilagus* spp.). Red-back voles (*Clerthrionomys californicus*) can be important south of the Columbia River (Forsman et al. 1984; Thomas et al. 1990; Carey et al. 1992). Two or three small mammal species generally comprise the majority of prey biomass for spotted owls in an area (Solis 1983; Forsman et al. 1984). On the Olympic Peninsula, however, Carey et al. (1992) found that spotted owls depend primarily on flying squirrels. Regional variation in diet is apparently based on habitat and distributional limits of the prey species (Forsman et al. 1984; Thomas et al. 1990, Appendix J; Carey et al. 1992).

Reproduction

Spotted owls form long-term pair bonds. Reproductive activity begins in the late winter when pairs begin to roost together on a regular basis. Commitment to nesting depends on the condition of the female, ability of the male to obtain sufficient food, and availability and abundance of prey. Spotted owls nest in existing structures such as cavities, broken tree tops, or platforms. (See section on habitat characteristics below.) Eggs are laid during early spring. Clutch size in spotted owls is small — one to two eggs is normal. Occasionally a female will lay three eggs. The female incubates the eggs for approximately 30 days, during which time the male's primary responsibility is to provide her with food (Forsman et al. 1984).

Owlets remain in the nest for three to five weeks after hatching (USDI 1992b p. 31). They typically leave before they are able to fly by hopping onto adjacent branches or the ground. Juvenile owls depend on their parents for food until they disperse in September or October. Dispersal of the young signals the end of the reproductive cycle (Gutierrez et al. 1985; Miller and Meslow 1985; Miller 1989). Members of a pair then separate for the winter.

During nesting season, a reproductively active pair of spotted owls defends a functional territory through vocalizations and visual displays. Breeding owls, especially males, are more likely to respond to actual or mimicked owl calls than are non-breeding or single birds (Thomas et al. 1990). A functional territory is the area where habitat conditions are sufficient for survival and reproductive replacement of the pair. Territories are thought to be smaller than home ranges, though the exact relationship is not known (USDI 1992b p. 20).

Nesting Success

Reproductive success for spotted owls varies widely by geographic region and over time (Forsman et al. 1984; Gutierrez et al. 1984; Carey 1985; Franklin et al. 1990; Lutz 1992; LeHaye et al. 1992). Initiation of nesting varies from 40 to 60 percent of pairs (Federal Register, v. 55, p. 7). Success of nesting within a population of sampled individuals can vary from 0 to 100 percent (USDI 1992b p. 31).

Survival

Survival rates for juvenile owls vary, but generally are low (Gutierrez et al. 1985; Miller 1989). Juveniles are vulnerable to predation and starvation during dispersal due to lack of cover when travelling in open areas, inexperience at evading predators, and inexperience in obtaining food (Forsman et al. 1984; Miller 1989). Survival rates for subadults and adults are generally higher than for juveniles. Burnham et al. (1994) summarized survival rates for spotted owls from 11 study sites in California, Oregon, and Washington. Survival rates are estimated from capture/recapture studies of banded animals (Burnham et al. 1987; Lebreton et al. 1992). Estimated mean annual juvenile survival rates for the 11 study areas was 0.258 (standard error[1], se = 0.36) and ranged from 0 to 0.418. Mean annual survival rates for adult spotted owls was 0.844 (se = 0.005) and ranged from 0.821 to 0.868 (Burnham et al. 1994 p. 16).

Home Range

Home range for a species is generally defined as the area used by the animal and to which it exhibits fidelity (USDI 1992b p. 26). Spotted owl home range sizes vary geographically. Median annual home ranges in Washington are largest on the Olympic Peninsula at 14,232 acres (Hanson et al. 1993 p. 19). The Final Draft Recovery Plan reported median annual home ranges in the eastern Cascades and western Cascades provinces as 7,124 acres and 6,657 acres respectively (USDI 1992b p. 27). Hanson et al. (1993) reported median annual home ranges of 6,609 acres and 8,205 acres for the eastern and western Washington Cascades respectively. The smallest observed home range in Washington is 2,969 acres in the western Washington Cascades (Hanson et al. 1993 p. 20).

Gutierrez (in USDI 1992b) summarized the generalizations that can be derived from recent studies about home range characteristics. First, initial observations by Forsman (1980) about the large size of spotted owl home ranges have been confirmed. Second, there is a large degree of overlap between members of the same pair (Forsman et al. 1984; Solis and Gutierrez 1990) and less overlap among adjacent pairs. Carey (1985) speculated that the degree of home range overlap can be affected by forest fragmentation in the landscape. Later research confirmed this hypothesis (Carey et al. 1992). Third, there is much geographic variation in home range size (Thomas et al. 1990; Carey et al. 1992). Fourth, home range size increases as the amount of old-growth forest in the home range decreases

[1] Standard error (se) is a measure of variability. A larger standard error indicates greater variability. Standard error generally decreases with larger sample size.

(Forsman et al. 1984; Carey 1985; Thrailkill and Meslow 1990). Data about the amount of late successional habitat in annual home ranges summarized by Hanson et al. (1993) corroborated this finding for the Olympic Peninsula but not for the western Washington Cascades.

In addition to the above studies on home range characteristics, Lehmkhul and Raphael (1993) found that most measures of spotted owl habitat patterns (total amount, patch size, measures of fragmentation) in home ranges were similar to patterns found in 8,035-acre circles around owl activity centers on the Olympic Peninsula. Measures were less similar for 2,008-acre circles and for 18,080-acre circles. Lehmkhul and Raphael also suggest that 8,035-acre circles contain habitat that is in smaller, more isolated patches than actual home ranges and that circles will more closely approximate home ranges where habitat is distributed across the landscape in regular patterns (Lehmkuhl and Raphael 1993 p. 312).

The variables responsible for geographic differences in home range size are not well understood. Many factors, such as food availability, interspecific competition, and amount and arrangement of suitable habitat, probably contribute to observed variation in home range size (USDI 1992b p. 26).

Dispersal

Juvenile spotted owls must disperse from their parents' home range to establish their own home range and engage in reproductive activity. Adults may also disperse to new home ranges if they have been displaced by logging or by a competing barred owl or if the other member of a pair has died. The dynamics of adult dispersal are much less understood than for juveniles. Successful dispersal of juvenile and displaced adult spotted owls is an important mechanism for recolonizing unoccupied habitat and replacing breeding members of the population, which, in turn, are important for population recovery and maintenance (Thomas et al. 1990 p. 303).

Researchers have used radio telemetry to study patterns of juvenile owl dispersal in Oregon and California. Dispersal generally begins between mid-September and mid-October, and direction of dispersal from the nest area appears to be random (Gutierrez et al. 1985; Miller 1989). Straight-line travel distance for the first autumn was between 9 and 30 miles (Gutierrez et al. 1985; Miller 1989). Guitierrez et al. (in USDI 1992b p. 34) used reobserved banded owls to determine dispersal distance for juveniles that survived to establish their own territories. These distances averaged 4 miles for juvenile males and 12 miles for juvenile females.

Radio-telemetry data for dispersing juveniles in Washington was collected in 1991 and 1992, and comes from three studies, one each on the Olympic Peninsula, the Wenatchee National Forest in the eastern Washington Cascades and the Yakama Indian Reservation. Mean dispersal distance for juveniles on the Olympic Peninsula was 15 miles (number in sample size, $n = 31$, $se = 1.22$), maximum distance 36 miles (Washington Forest Practices Board 1995 p. 23). In the eastern Cascades, mean distance was 15.1 miles ($n = 80$, $se = 1.22$), and maximum distance was 76 miles. On the Yakama Indian Reservation, mean dispersal distance was 22.2 miles ($n = 7$, $se = 5.29$), and maximum dispersal distance was 54 miles (Washington Forest Practices Board 1995 p. 23).

Knowledge of dispersal behavior and habitat is crucial for designing conservation strategies for the spotted owl (Thomas et al. 1990). The distance between areas of suitable nesting, roosting, and foraging habitat should not exceed the distance that most successfully dispersed juveniles are known to have traveled (Thomas et al. 1990). The structure of dispersal habitat is discussed below.

Interspecific Relationships

The spotted owl's main competitor for resources is the barred owl. Barred owls have colonized the Cascade Range and Olympic Mountains in the past 50 years, probably in response to forest fragmentation across the landscape. Barred owls have been reported to be dominant in their interactions with spotted owls and have displaced spotted owls from nests at some sites (USDA 1988; Hamer et al. 1989). Where spotted owls and barred owls co-exist, barred owls reduce the amount of habitat available to spotted owls by using similar structures for nests and pursuing some of the same prey.

Hybridization (breeding between different but related species) is occurring between spotted owls and barred owls. Hamer et al. (1994) reported that a hybrid owl successfully reproduced with a barred owl in at least two breeding seasons. Hybridization appears to be a rare occurrence, given the proportion of known hybrids to known breeding pairs of spotted owls. If hybridization were to become more extensive, however, the genetic integrity of the spotted owl population could be threatened (Thomas et al. 1993; Hamer et al. 1994).

The main predators of spotted owls are thought to be great horned owls (*Bubo virginianus)* and northern goshawks (*Accipiter gentilis)* (Forsman et al. 1984; Miller 1989; USDI 1992b). Spotted owls are known to nest in goshawk territories and to defend their nests against goshawk attacks (USDI 1992b p.21). Great horned owls appear to occupy more fragmented habitats than do spotted owls (Fredrickson et al. 1990; Johnson 1993) and thus probably prey more frequently on spotted owls when the latter's habitat becomes more fragmented or when juvenile spotted owls are dispersing through younger, more open forests (Forsman et al. 1984). The Recovery Team reported that 40 percent of 91 adult or subadult owls and 25 percent of 60 juvenile owls that were radio marked and then died between 1975 and 1991 were killed by other birds (USDI 1992b p. 46).

HABITAT CHARACTERISTICS AND SELECTION

Spotted owls use a variety of forest types and stand structures for nesting, roosting, and foraging throughout their range. Forest types include Douglas fir, western hemlock, mixed conifer, mixed evergreen, redwood, mixed Douglas fir and hardwood, evergreen hardwood, ponderosa pine, and western red cedar.

Spotted owls use existing structures for nests. Nesting habitat is generally found in mature and old-growth stands and contains a high degree of structural complexity. (See discussion below.) In older forests, spotted owls select cavities or broken-top trees more frequently than platforms (mistletoe brooms, abandoned raptor and gray squirrel nests, and debris accumulations) (Forsman et al. 1984; LaHaye 1988). In younger forests, they tend to use platforms more frequently (LaHaye 1988; Buchanan 1991).

Roosting habitat has characteristics similar to nesting habitat, i.e., high canopy closure, a multi-layered canopy, and large diameter trees. In the summer, spotted owls roost in shady spots and near streams. The multi-layered canopy helps owls regulate body temperature by providing various microclimates vertically throughout the canopy (Forsman 1980; Barrows 1981; Solis 1983; Forsman et al. 1984).

Foraging appears to occur in more varied habitat conditions than does nesting and roosting (Thomas et al. 1990). Within these variations however, foraging habitat is still characterized by high canopy closure and complex structure (USDI 1992b p. 24).

Current understanding of characteristics of suitable spotted owl habitat is derived from several types of studies. Bart and Earnst (1992) divide these studies into the following categories:

(1) structural characteristics of utilized habitat,
(2) amount and distribution of suitable habitat within home ranges,
(3) habitat selection for roosting and foraging,
(4) abundance of spotted owls in different habitats,
(5) demographic rates of spotted owls in different habitats, and
(6) studies of different resources needed by spotted owls.

Descriptions of habitat characteristics are best used in combination with correlational studies that determine habitat preference and the survivability of owls in different habitat types, and with functional studies that determine the specific resources of value to spotted owls in their preferred habitats. Any of these types of information in isolation gives an incomplete picture of habitat suitability (Bart and Earnst *in* USDI 1992b, Appendix B, p. 26). Thomas et al. (1990) provide a comprehensive review of spotted owl habitat studies; Bart and Earnst (1992) review new information made available since that 1990 study. The following summary discussion is derived primarily from Bart and Earnst (1992) and Thomas et al. (1990). More recent literature is also discussed.

Structural Characteristics

Spotted owls use sites with a high average canopy cover (greater than 70 percent) and which contain large live trees, down logs and snags (Thomas et al. 1990; Buchanan 1991; Hanson et al. 1993; North 1993). In studies that quantified structural characteristics, the average number of trees that have a specific diameter at breast height (dbh) was consistent, while the number of trees decreased as dbh class increased. Fewer large trees occurred in the eastern Washington Cascades province, eastern California Cascades province and in the western part of the California Cascades province than in other parts of the spotted owl range (Bart and Earnst 1992 p. 38).

Studies summarized in USDI 1992b that compared structural characteristics of utilized sites with those of old-growth forests found average snag density was similar for both. Average values for tree density, snag density, and canopy closure were similar in nesting, roosting, and foraging habitats. Spotted owls use stands dominated by conifers, with hardwood understories present in California, but largely absent in Washington and Oregon. Bart and Earnst (1992) caution that average values should be taken as that and not as a description of each site. Variations in canopy cover, numbers of large trees and snags, and composition of the understory occur in habitat actually used by spotted owls.

Amount of Habitat in Home Ranges

The large size of spotted owl pair home ranges and the amount of late seral stage forest the owls require account for the controversial character of spotted owl conservation. Thomas et al. (1990) summarized the amounts of old-growth and mature forest in spotted owl pair home ranges. (Because there can be extreme outlyers, calculating the median acreage has been found to be more reliable than considering average sizes.) Median acreages of mature and old-growth forest in the Olympic Peninsula and western Cascade province spotted owl home ranges are 4,579 and 3,281 respectively. Hanson et al. (1993) reported the median amount of late successional habitat in spotted owl pair home ranges as 3,827 acres on the Olympic Peninsula and 3,586 acres in the western Washington Cascades. In the eastern Washington Cascades, the median amount of suitable habitat in home ranges was 3,248 acres (Hanson et al. 1993). The median amount of mature and old-growth forest in home ranges varies from 615 acres in the Klamath province to 4,579 acres in the Olympic Peninsula province. Median amounts of old growth in home ranges were less than 1,000 acres in only two studies. Variation also occurred within provinces (Thomas et al. 1990 p. 195; Hanson et al. 1993).

Bart and Earnst (1992 p. 40) point out that the large variation in the amounts of late successional forest within home ranges poses problems for determining what habitat and how much to maintain around individual nest sites to allow for successful replacement of spotted owl pairs. Given that the large cluster reserve concept (Thomas et al. 1990; USDI 1992a and b; FEMAT 1993) is the approach that will be applied on federal lands (USDA and USDI 1994b), how much habitat to conserve around site centers is an issue for land owners and managers attempting to avoid take on nonfederal land by protecting individual nest sites. Some of the uncertainty could be resolved through additional studies that combine estimates of home-range size and amount of old growth within them with analyses of stand structure, viability assessments, and analyses of the functional components of preferred habitat within the home range (Bart and Earnst 1992 p. 41).

Habitat Selection

Gutierrez (in USDI 1992b p. 22-23) discusses habitat use versus selection and preference. Habitat use is determined by observation of an animal in a certain habitat type without defining the context of the observation. Habitat selection is the choice of a habitat or habitats directly available to the animal. Habitat preference is the choice of habitat or habitats that the animal would make if all habitat types were available to it. Several studies have shown that spotted owls select mature and old-growth habitat with a concomitant selection against young stands (Forsman 1980; Carey et al. 1990, 1992; Blakesley et al. 1992).

Several recent studies confirm earlier hypotheses that spotted owls select older stands that have a high degree of structural complexity for their nesting habitat. Most nests located on public land have been found in mature and old-growth forests (Forsman et al. 1984; LaHaye 1988). The proportion of late seral stage forests surrounding nests has been found to be significantly greater than in surrounding random sites in the area (Meyer et al. 1990; Ripple et al. 1991). Lehmkuhl and Raphael (1993) found that spotted owl pair locations had significantly more habitat composed of primarily late successional forest than did random sites. LaHaye (1988) and Buchanan (1991) found that nests were located in stands whose structure was more complex than that of the surrounding areas. Buchanan et al. (1993) also found that nest trees in the eastern Washington Cascades were significantly older than trees at randomly selected sites. These studies suggest that spotted owls select nesting habitat with certain characteristics.

An exception to the generally old age of nesting habitat occurs in eastern Washington where spotted owl nest sites are found in stands that are younger than nest stands in other parts of the spotted owl's range, including western Washington. Buchanan et al. (1995) found that the median age of forest stands in more than half of the 85 nest sites located for their study was 130 years. Median age of actual nest trees in their study area was 137 years (Buchanan et al. 1993). They concluded that the difference in age of the stands and trees between western and eastern Washington was due to regional differences in patterns of disturbance, climate, and tree growth (Buchanan et al. 1993 p. 5).

Spotted owl nest sites have been found in younger managed stands on private land. These sites tend to be in areas where there was some previous uneven-aged management or in areas with rapid tree growth that facilitates habitat development in a relatively short period. Nest sites on managed land retain some structural characteristics of old growth (Thomas et al. 1990). Gutierrez (in USDI 1992b p. 23) pointed out that (1) the health of spotted owl populations found on private ownerships cannot be ascertained because no critical demographic studies have been completed on them, and (2) the presence of breeding owls alone in managed stands does not establish that such habitat is capable of supporting a self-sustaining population.

Thomas et al. (1990) reviewed the literature about selection of habitat for roosting and foraging. Old-growth stands were consistently preferred for both activities in Washington and Oregon west of the crest of the Cascade range. Young stands, pole stands and other stands were consistently avoided. Selection of mature stands was varied. Most studies defined old growth as stands older than 200 years and mature stands as 80-200 years old and containing few canopy layers.

Bart and Earnst (1992) have summarized more recent data. They concluded that the criteria for habitat selection are less clear in California and in the Oregon portion of the Klamath province than in other areas. While Thomas et al. (1990) found that young forests (less than 80 years) were avoided by 55 percent of spotted owls and selected by only 3 percent, Blakesley et al. (1992) and Zabel et al. (1991) found no tendency for owls to avoid stands in the 11- to 21-inch dbh size class (roughly equivalent to the "young" category in Thomas et al. 1990). Blakesley et al. (1992) noted, however, that the small-size class stands in their study areas were produced by natural processes and contained diverse composition and complex structure. Thus selection rates may not apply to even-age managed stands of a similar size class (USDI 1992b, Appendix B, p. 42).

Abundance of Spotted Owls in Different Habitats

Thomas et al. (1990) found that spotted owl density increased with the amount of old growth in a landscape or study plot. Density was very low in landscapes dominated by stands that were 80 years old or less and that lacked old-growth characteristics. Thomas et al. (1990) also recognized studies that indicated the potential for suitable habitat to develop faster in coastal California redwood and mixed Douglas fir forests than in other portions of the spotted owl's range and that more research is necessary in this area. Bart and Forsman (1992) found on both a landscape scale (5,000 - 171,000 acres) and a home range scale (1,000-acre plots) that spotted owl density was significantly higher for areas with greater than 60 percent older forest than for areas with less than 20 percent older forest.

Demographic Rates in Different Habitats

Results of studies analyzing the relation between demographic rates and the amount of old growth in spotted owl nesting territories indicate that the proportion of territories with pairs and reproductive success declined as the amount of old growth declined (Thomas et al. 1990). Bart and Earnst

(1992 p. 47-49) analyzed data from Meyer's and Johnson's unpublished data and found that persistence of spotted owl pairs in territories increased with the amount of forest more than 120 years old. Persistence was defined as the "probability that an owl present in a circle at the start of a year would be found at that site the next year, given that the site was revisited the following year." The authors took persistence as a surrogate measure for adult survival. These results further corroborate the above-mentioned findings of Thomas et al. (1990) on spotted owl density. In contrast, however, Irwin and Fleming (1994) found no correlation between occupancy rates or reproductive success and the amount of late successional habitat within 2.1 miles of spotted owl nests in the eastern Washington Cascades.

In summary, descriptions of habitat used for nesting, roosting, and foraging have shown that these activities take place in older forest; correlational studies have shown that spotted owls prefer older stands for roosting and foraging. Some, though not all, studies have shown that reproductive success is higher for pairs that have more old growth in their home ranges; spotted owl density and adult persistence has also been demonstrated as correlated with increasing amounts of old growth (Bart and Earnst 1992 p. 26).

Dispersal Habitat

In order to disperse successfully, juvenile spotted owls need both sufficient cover to avoid predators and opportunities for foraging. Dispersal habitat as a category distinct from nesting, roosting, and foraging habitat is necessary, given the extent to which older forest habitat has been reduced and fragmented throughout the spotted owl's range. Evidence suggests that juveniles prefer mature and old-growth forests for roosting (Miller 1989) and that risk of predation during dispersal is high in open and fragmented landscapes (Forsman et al. 1984; Johnson 1993). In the current landscape, large areas exist between patches of suitable nesting, roosting, and foraging habitat that juvenile spotted owls need to cross to establish new territories. For the demographic and genetic stability of small sub-populations, juveniles must be able to move between clusters of territories; to do this, they also need to cross large areas of younger forests between large late successional habitat reserves (USDA and USDI 1994b).

The concept of dispersal habitat was first proposed in the Interagency Scientific Committee's report called A Conservation Strategy for the Northern Spotted Owl (Thomas et al. 1990). The idea of establishing specific stand conditions over a large area to facilitate movement of juvenile and non-territorial adults between areas of suitable nesting, roosting, and foraging habitat is based on radio-telemetry data that suggests juvenile owls disperse in random directions (Miller 1989). Thus linear, directional corridors are unlikely to be useful. The Interagency Scientific Committee's report recommended that forested federal lands between designated Habitat Conservation Areas be managed such that 50 percent of every quarter township have forest stands in which trees have an average dbh of 11 inches and at least a 40 percent canopy closure. (This is commonly referred to as the 50-11-40 rule.) The committee proposed this set of specific guidelines as a management hypothesis with the clear understanding that further research was necessary to establish its effectiveness (Thomas et al. 1990, Appendix R). No definitive research on spotted owl dispersal habitat has been published since this recommendation.

POPULATION VIABILITY AND DYNAMICS

Questions of how many spotted owl pairs and how much habitat are sufficient to prevent the species from going extinct are at the center of policy debates and conservation planning involving the northern spotted owl. Addressing these questions involves studies of population dynamics — how birth and death rates contribute to changes in size of the population over time. An understanding of population dynamics can then be used to analyze how large a population needs to be, and how its habitat needs to be distributed across landscapes, to persist over time. This is known as population viability analysis.

A viable population is one that is of sufficient size and distribution to be able to persist for a long period of time in the face of demographic variations, random events that influence the genetic structure of the population, and fluctuations in environmental conditions, including catastrophic events (Meffe and Carroll 1994). The northern spotted owl population currently exists in small sub-population units that are separated in some portions of its range by large areas of unsuitable habitat. The rate at which dispersing juveniles move among these small sub-populations to add to local breeding populations influences the overall likelihood that the whole population will persist. This is called metapopulation dynamics. Metapopulation dynamics are often influenced by the distribution of high quality habitat over the landscape. Areas of lower-quality habitat may function as sinks — areas that need regular immigration of individuals from other sub-populations to survive. Areas of higher quality nesting, roosting, and foraging habitat can often serve as source populations that are self-maintaining and that provide emigrants to sink areas (Harrison 1991; Meffe and Carroll 1994). Viability analyses for spotted owls attempt to take these dynamics into account.

Population modeling also requires data on demographic trends. Studies of recapture or re-observance of banded owls are used to estimate survival rates of juveniles, subadults, and adults (Burnham et al. 1987; Lebreton et al. 1992). These estimates combined with data on the number of females produced by breeding pairs (fecundity) can be analyzed to assess population trends (Anderson and Burnham 1992; Burnham et al. 1994). (For a discussion of the results of recent demographic analyses, see section below on status of and threats to the spotted owl.) Estimates of demographic trends can be used to get a picture of the current situation, but they cannot be used to project population trends into the future (Burnham et al. 1994; USDA and USDI 1994b, Appendix J3). Mathematical and spatial simulation models enhance population viability analyses (USDA and USDI 1994b, Appendix J3, p. 7).

Viability analyses for the spotted owl have used mathematical demographic-based models that do not take spatial arrangement of habitat and territories into account (Lande 1987, 1988), as well as map-based, spatially explicit simulation models (Doak 1989; Lamberson et al. 1992; McKelvey et al. 1993; Holthausen et al. 1994; Lamberson et al. 1994; Raphael et al. 1994).

Modeling efforts have led to several important insights about the factors influencing viability of spotted owl populations[2]. Lande (1987, 1988) used a non-spatial model of dispersal and territory occupancy to estimate the minimum amount of habitat needed to sustain a population of northern spotted owls in a large region. He concluded that if the total landscape (all ownerships) contained less than 21 percent suitable habitat, the population would eventually become extinct. Results from later models that incorporated spatial factors also concluded that sharp thresholds exist in the amount of nesting, roosting, and foraging habitat needed to support a viable spotted owl population (Doak 1989; Lamberson et al. 1992; Carroll and Lamberson 1993).

[2]For a discussion of the differences among these models, see Lamberson et al. (1994) and Appendix J3 in USDA and USDI 1994a.

The analysis by Lamberson et al. (1992) also indicated that another threshold response may occur if population density became too low. When territories become too sparse, the ability of spotted owls to find mates theoretically becomes an insurmountable barrier to maintaining replacement levels of reproduction.

McKelvey et al. (1993) and Lamberson et al. (1994) concluded that in addition to the overall amount of suitable nesting, roosting, and foraging habitat, spatial arrangement of habitat is a very important factor in influencing the persistence of spotted owl populations. These modeling efforts demonstrated that arranging suitable habitat to support large clusters of owls (20-25 pairs) rather than a dispersed arrangement of single territories increased population stability and reduced the potential impacts of random demographic events.

The model described by McKelvey et al. (1993) allows the effects of different management scenarios to be simulated over time. Raphael et al. (1994) used this model to compare the relative differences in effects on spotted owl populations of three alternatives described in the federal Supplemental Environmental Impact Statement (SEIS) on Management of Habitat for Late-Successional and Old Growth Forest Related Species within the Range of the Northern Spotted Owl. They demonstrated that population sizes and occupancy rates that resulted from their model runs were sensitive to assumptions made about juvenile, subadult, and adult survival rates used to set parameters for the model. One set of assumptions or "rule sets" resulted in declining populations for all scenarios modeled (No Cut, SEIS Alternative 1, SEIS Alterative 7, and SEIS Alternative 9, the preferred alternative); use of the other two rule sets resulted in populations that declined and then stabilized. The differences in actual alternatives were swamped by the use of different assumed survival rates for spotted owls (USDA and USDI 1994a, Appendix J3). The fact that results varied depending on assumed demographic rates indicates the need for solid demographic data to use as input in these models in order to achieve more realistic outcomes.

While spotted owl biologists have increased the ability of models to incorporate more realistic assumptions (Lamberson et al. 1994), the results of such models should not be viewed as real predictions of spotted owl population behavior. Holthausen et al. (1994) caution that results of their modeling experiment on the Olympic Peninsula should be viewed as "repeatable projections of sets of assumptions" (p. 45). In USDA and USDI (1994a), the authors view models as "one tool in evaluating wildlife populations and habitat, and do not replace sound professional judgement in decision making" (USDA and USDI 1994a, Appendix J3).

STATUS AND THREATS

The northern spotted owl currently inhabits areas within most of its historic range. However, its distribution has changed markedly from hypothesized historical distributions due to removal or alteration of nesting, roosting, and foraging habitat. Booth (1991) has estimated that more than 80 percent of the old growth that existed prior to European settlement of the Pacific Northwest had been logged by the early 1980s. While not all old growth is suitable habitat, this represents a substantial loss of potential suitable nesting, roosting, and foraging habitat. The Interagency Team responsible for writing the Environmental Impact Statement for the President's Forest Plan estimates that there are 7.4 million acres of suitable habitat left on federal lands throughout the spotted owl's entire range (USDA and USDI 1994a p. 214).

Spotted owl populations are sparse and small in British Columbia, the Oregon Coast Range, the western Washington lowlands province, and other low elevation areas. Local populations have been extirpated from the Puget Trough and Willamette Valley due to habitat loss from urbanization, logging, and agricultural development. Most of the remaining habitat occurs at mid to high elevations (between 2,500 and 5,000 feet) and on federal land.

There are approximately 4.1 million acres of potentially suitable spotted owl habitat on all ownerships in Washington. Approximately 490,000 acres of this is on DNR-managed lands (DNR GIS 1995).

The federal Northern Spotted Owl Recovery Team reported that there are approximately 3,602 known spotted owl pairs in Washington, Oregon, and northern California as of 1992 (USDI 1992 p. 39). Population estimates have been updated for the Olympic Peninsula (Holthausen et al. 1994) (see later discussion on spotted owls on the Olympic Peninsula), but similar efforts have not been undertaken in the rest of the spotted owl's range. The true population size is unknown. There are currently 354 spotted owl site centers that are either on or have a median home range radius (Hanson et al. 1993) that includes DNR-managed lands (WDFW Non-game Database May 1995a).

The Recovery Team identified 10 threats to existing populations of spotted owls. The severity of each threat varies by physiographic province. The most significant factor contributing to the overall decline of the species is loss of nesting, roosting, and foraging habitat to clear-cutting and other even-aged harvest methods (Thomas et al. 1990). Habitat loss also ranks as the most severe future threat to the spotted owl (USDI 1992a p. 41). The following description of threats has been condensed from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992a p. 41-48) and from the Report of the Scientific Analysis Team (Thomas et al. 1993).

Limited Habitat

Limited habitat poses a threat to spotted owls because productivity levels and occupancy decrease in areas with low proportions of suitable nesting, roosting, and foraging habitat (Bart and Forsman 1992). Areas with less than 20 percent habitat cover do not provide spotted owls with suitable habitat. The Recovery Team considered limited habitat to be a severe threat in provinces that had about or less than 20 percent suitable habitat by area. The northern portion of western Washington Cascades province and the entire western Washington lowlands province fell into this category. A moderate threat exists in provinces with 20 to 60 percent suitable habitat coverage. The rest of the Washington provinces fell into this category.

Population Decline

Rates of population decline are measured by analyzing birth and death rates (see USDI 1992b p. 44 and Appendix C; Thomas et al. 1993) or by using population density studies that examine actual changes in territorial owls per unit area over time (USDA 1992b p. 15). Anderson and Burnham (1992) summarized the results from a demographic analysis from five sites distributed throughout the spotted owl's range. The results indicated that female territorial spotted owls were declining at rates of between 6 and 16 percent per year at individual study sites. The average was 10 percent per year (Anderson and Burnham 1992). A demographic meta-analysis of the complete data set showed that, in addition to populations decreasing at individual study sites, female survival rates were declining at an increasing rate (Anderson and Burnham 1992).

The federal Scientific Analysis Team (Thomas et al. 1993) reported that the Anderson and Burnham (1992) study may have overestimated rates of population decline by assuming that undetected emigrants were dead when they may actually have been alive. The Scientific Analysis Team used a population density method to estimate rates of population decline from 12 study sites. They concluded the overall rate of decline to be 3.2 percent (Thomas et al. 1993 p. 180). Density studies are thought to result in underestimates of rates of population decline. The Scientific Analysis Team (Thomas et al. 1993) concluded that the real annual rates of population decline were somewhere between the results reported in both studies (p. 192).

At the prompting of a group of 14 scientists concerned with the viability of the northern spotted owl, the Clinton Administration directed Anderson, Burnham, and White (Burnham et al. 1994) to conduct an intensive analysis of all existing demographic data, which included new data since Anderson and Burnham's 1992 report. More than 50 specialists undertook the analysis during a 12-day workshop in December 1993 at Fort Collins, Colorado. They analyzed capture-recapture data from 1985-1993 for 11 large study areas. They used estimates of average age-specific survival probabilities and fecundity rates to calculate rates of population change. They estimated the population to be declining at a rate of 4.5 percent per year and found that the rate of population loss is accelerating. They also found that annual survival probabilities for adult females have declined significantly in the six study areas for which they had more than six years of banding data as well as in the other five areas for which they had shorter term records. They concluded that the population of resident territorial female owls is declining at both a biologically and statistically significant rate. This analysis was corrected for undetected emigrants, thus lessening potential underestimations of survival rates.

The discussion of the meaning of the results of this analysis is under way in the scientific community. Bart (1995) argues that Burnham et al. (1994) still underestimate juvenile and adult survival rates by not considering that spotted owls could move to portions of study areas that are inaccessible to researchers and thus go undetected. Holthausen et al. (1994) incorporate unpublished updated data for juvenile emigration from Forsman et al. in their estimates of annual vital rates on the Olympic Peninsula, which results in an estimated annual juvenile survival rate of 0.612 and estimated annual rate of population change of 1.058. Without this readjustment, the estimated rate of annual population change is 0.955. Holthausen et al. (1994) cite Forsman's caution that this adjusted juvenile emigration rate is based on data from only 35 owls and from only two years of study. Estimation of vital rates thus remains inexact and uncertain.

The Recovery Team ranked population decline as a moderate threat in the western Washington Cascades (north and south) and on the Olympic Peninsula. They considered population decline to be a severe threat in the western Washington lowlands and an unknown threat in the eastern Cascades (USDI 1992b p. 42).

Small Populations

Small populations of plants and animals are vulnerable to extinction through random fluctuations in environmental conditions (environmental stochasticity) and in age and sex structure of populations (demographic stochasticity) (USDI 1992b). Small populations can also suffer loss of genetic diversity, which reduces general fitness of the population (USDI 1992b).

The Recovery Team (1992b) considered small populations to be a severe threat in the northern portion of the western Washington Cascades, the Olympic Peninsula, and the western Washington lowlands and a moderate threat in the southern portion of the western and eastern Washington Cascades.

Distributions of Habitats and Populations

Local spotted owl populations and habitat can be unevenly distributed across the landscape. Clusters of spotted owl pairs can become isolated when surrounded by unsuitable habitat. These local populations then are vulnerable to the same fluctuations described above for small populations. Where clusters of spotted owls or patches of suitable habitat are separated by more than 12 miles of poor habitat, persistence of the clusters becomes increasingly unlikely (USDI 1992b p. 45).

Sparse population and lack of habitat distribution is considered a severe threat in the eastern Washington Cascades, western Washington Cascades (northern portion), and western Washington lowlands provinces; they are a a moderate threat in the southern portion of the western Washington Cascades and on the Olympic Peninsula (USDI 1992b p. 42).

Province Isolation

If provinces are separated by physical barriers or lack of suitable habitat, genetic interchange between sub-populations may be blocked. Isolated populations are also vulnerable to genetic, environmental, and demographic fluctuations. Immigration of a few individual spotted owls per generation is necessary for a local population to maintain genetic diversity. A higher rate of immigration may be necessary to counteract demographic imbalance (USDA 1992b).

The Recovery Team identified province isolation as a severe threat in the western Washington Cascades (north), Olympic Peninsula, and the western Washington lowlands provinces, and as a moderate threat in the eastern Cascades and the western Washington Cascades (south) (USDI 1992b). Subsequent analysis by Holthausen et al. (1994) suggests that province isolation may not be as severe a threat to the spotted owl population on the Olympic Peninsula as was previously thought.

Predation

The great horned owl, northern goshawk, red-tailed hawk, and common raven are documented predators of the northern spotted owl. Great horned owls are the most common predator (Miller 1989). This species occurs more frequently in highly fragmented landscapes than does the spotted owl (Anthony and Cummins 1989; Hamer et al. 1989; Johnson 1993). Thus predation by great horned owls is more of a problem in fragmented landscapes than in areas with relatively intact forest cover. Barred owls are starting to share the same range with spotted owls and tend to be dominant in spotted owl/barred owl interactions (Hamer 1988). While barred owls are not a direct predator, they have displaced spotted owls in some areas and are decreasing the amount of habitat available to spotted owls (USDA 1988; Hamer et al. 1989).

The Recovery Team did not feel there was enough information to assess the severity of the predation threat in either the eastern or western Washington Cascades (north and south). They considered predation to be a severe threat in the western Washington lowlands and a moderate threat on the Olympic Peninsula.

Vulnerability to Natural Disturbances

In an unfragmented landscape with abundant suitable habitat, loss of habitat from natural disturbance is generally not a threat to population viability. Given the highly fragmented pattern and reduced amount of the remaining suitable habitat, loss of habitat from fire, windthrow, or insect and disease infestation can pose a significant threat to spotted owls in certain areas. The Recovery Team determined that natural disturbance is a severe threat in the eastern Washington Cascades, a moderate threat in the Olympic Peninsula, and a low threat in the western Washington Cascades (USDI 1992b).

Spotted Owls on the Olympic Peninsula

LIFE HISTORY

Aspects of spotted owl life history that have been well-studied on the Olympic Peninsula and are important to the HCP proposal include reproduction, dispersal of juveniles, and survivorship of both adults and juveniles.

Reproduction

Average annual fecundity rates (numbers of female fledglings produced per female) of adult owls from 11 geographically distinct areas varied from 0.231 to 0.565; the median value was 0.323 (Burnham et al. 1994). Annual fecundity in the Olympic Peninsula study area was 0.380, or 0.76 young per pair per year. There is considerable annual variation in reproductive effort within and among sub-populations of spotted owls, and among individual owl pairs within years. For example, Forsman et al. (1984) observed nesting in 16-89 percent (mean = 62 percent) of pairs during a five-year study in Oregon. Annual variation in fecundity in seven geographically distinct areas with at least five years of study ranged from 0.3-13.4 percent (coefficient of variation, median = 5.6 percent, see Thomas et al. 1993, Table 4-3). Annual variation in fecundity of the Olympic Peninsula sub-population was third highest, c.v. = 10.2 percent. Reproductive rates of spotted owls on the Olympic Peninsula thus seem to be consistent with those observed elsewhere in the species' range, but annual variability in reproduction is relatively high.

Dispersal of Juveniles

Spotted owls leave their natal territories after their first summer. This dispersal appears to be innate (Howard 1960), and may function to maintain the species' distribution in available habitat and maintain genetic diversity among sub-populations (Howard 1960; Greenwood and Harvey 1982). Early studies of dispersing juvenile spotted owls used backpack-mounted radio-transmitters (Forsman et al. 1984; Gutierrez et al. 1985; Miller 1989) or relied on re-observations of owls banded as fledglings (Forsman 1992a) to track their movements and survival. These studies provided information on the directions and distances of movement, habitat associations, and survival. However, there is evidence that the relatively large, backpack-mounted radio-tags influenced survival (Paton et al. 1991) and reproduction (Paton et al. 1991; Foster et al. 1992) of adult owls (with the inference that they may have influenced behavior and survival of juveniles as well), and that emigration of banded owls from study areas causes underestimates of survival (Forsman 1992a). A discussion of juvenile survival is presented in the subsequent section on survivorship.

Dispersing juvenile owls in three study areas from the 1991 (Miller et al. 1992) and 1992 cohorts (Forsman 1992b) were radio-tagged with much smaller transmitters mounted on their tail feathers (a new system with presumably less effect on their behavior). These studies are beginning to provide important, additional information on habitat relationships, dispersal distances, rates of emigration, and survival probabilities. Data from these studies consist of relocations, estimated by triangulation, that were obtained at approximately weekly intervals mostly during the day-time, with less frequent, direct observations. They are probably suitable for descriptions of the general areas traversed and used by dispersing juveniles and descriptions of roost-sites but not for evaluating habitat use for foraging. Analyses are in progress, but it appears that the general trend is for dispersing juveniles to attempt to settle, at least temporarily, in areas that provide good habitat for nesting, foraging, and roosting by adult owls. Further analyses of these data may provide better insights as to cover types that provide habitat for dispersing spotted owls.

Preliminary estimates of first-year dispersal distances (15.12±0.98 miles) of 111 juveniles from the Olympic Peninsula and the east slope of the Cascades Range are similar to those reported by earlier radio-telemetry studies (Gutierrez et al. 1985; Miller 1989). Dispersal distances for 31 juveniles on the Olympic Peninsula ranged from 5.39 to 36.20 miles, and averaged 15.05±1.58 miles. In the four known cases of dispersal to and/or from DNR land in the Olympic Experimental State Forest, owls banded as fledglings were recaptured 9, 14, 18, and 30 miles from their natal sites as adult or subadult members of pairs.

Survivorship

Survival rates are estimated based on annual re-observation of banded spotted owls. Simulation modeling suggests that the survival rate of adult females is the aspect of spotted owl life history that most strongly influences rates of population change (Noon and Biles 1990). Estimates of adult female survival probabilities average 0.844±0.005 across the spotted owl's range, and 0.862±0.017 for the Olympic Peninsula sub-population (Burnham et al. 1994). While their meta-analysis of survival rates across the range of the spotted owl indicated that survival rates were declining, they found that these rates did not change during the study on the Olympic Peninsula. Survival rates for males may be higher; Forsman (1992b) estimated annual survival probabilities for Olympic Peninsula males at 0.893±0.026 for the period 1987-1992.

Estimates of both range-wide and Olympic Peninsula survival probabilities for juvenile birds are much lower (0.258±0.036 and 0.245±0.064 respectively; Burnham et al. 1994). However, those estimates are based solely on re-observations of birds banded as fledglings and are negatively biased because some juveniles emigrate from the study area or to non-monitored sites within the study area and are thus unavailable for re-observation (Burnham et al. 1994; Holthausen et al. 1994; Bart 1995a).

Burnham et al. (1994) used the average emigration rate (0.316±0.053) of 76 juvenile spotted owls that were monitored with radio-telemetry and survived one year to adjust their overall estimate of juvenile survival (averaged over all 11 study areas) to 0.377±0.060. But their analysis did not account for emigration of juveniles to non-monitored sites within the study area (Bart 1995a). Bart (1995b, Table 5) simulated juvenile dispersal to estimate a 21 percent rate of dispersal to non-monitored sites across those study areas and further adjust the juvenile survival estimate of Burnham et al. (1994) to 0.48 (Bart 1995a). Furthermore, Burnham et al. (1994) argued that they did not have area-specific estimates of emigration rates and thus could not derive area-specific, adjusted juvenile survival rates. But the emigration rate they used was derived by averaging over two study areas in which the estimates differ markedly (13/57 = 0.228 Roseburg, Oregon; 11/19 = 0.579 Olympic Peninsula; Burnham et al. 1994). These areas are profoundly different in the degree to which spotted owls are able to disperse from them to areas inaccessible to normal re-observation techniques. Roseburg is entirely commercial forest lands, accessible by road throughout, and surrounded mostly by other study areas. In contrast, almost half of the spotted owl habitat on the Olympic Peninsula study area is in Olympic National Park, which is nearly roadless and extremely difficult to survey for owls. No other study areas border the Olympic Peninsula. Thus, while Holthausen et al. (1994) correctly note that the area-specific emigration and adjusted juvenile survival estimates should be viewed with caution because few data (they studied 35 owls over two years, one of which had an exceptionally mild winter that may have favored juvenile survival) were used to derive them, there are some data and sound logic with which to develop an estimate of emigration (both within and outside of the study area) specific to the Olympic Peninsula. Holthausen et al. (1994) used data additional to that reported by Burnham et al. (1994) to estimate the emigration rate for the Olympics at 0.600±0.083. This results in an adjusted juvenile survival rate of 0.612±0.204, over two times the unadjusted estimate of Burnham et al. (1994). While neither this estimate of juvenile survival in the Olympics, nor Bart's (1995a) metapopulation estimate are conclusive, they suggest that survival rates may be substantially higher than the metapopulation estimate reported by Burnham et al. (1994).

POPULATION ECOLOGY

Trends in the population of spotted owls are extremely important to management decisions relevant to conservation of spotted owl habitat. Thus, analyses and interpretations of ongoing studies of spotted owl populations are closely scrutinized and are subject to considerable controversy. The review and discussion under the subheading Population Decline of these analyses, interpretations, and disagreements provides a good, general overview. A more detailed summary and discussion of findings from the Olympic Peninsula follows.

Population Estimates

The most up-to-date and rigorous estimate of the number of spotted owl pairs on the Olympic Peninsula was provided by Holthausen et al. (1994). They used three sources of data for their estimate: extrapolations from the Washington Department of Fish and Wildlife non-game database for DNR-managed, private, and tribal lands, a nearly complete inventory of territorial owls; extrapolations from nearly complete inventories of territorial owls conducted by the U.S. Forest Service PNW Research Station since 1987 in the Olympic National Forest (Forsman 1992a); and estimates of density for the Olympic National Park based on extrapolating from the density of territories located in randomly selected sample areas (Seaman et al. 1992). The density estimates for the park are the results of preliminary analyses, and await another year of fieldwork and further statistical analysis to refine the point estimate and develop confidence intervals for the estimate. Holthausen et al. (1994) used two sets of assumptions to develop two estimates for the numbers of spotted owl pairs on the Olympic Peninsula: a lower estimate derived by adding the known pairs (and, at least for DNR-managed lands, sites at which pairs had been observed in the past) on DNR-managed and Olympic National Forest lands to the estimated numbers in the Olympic National Park; and a higher estimate derived by adding the known pairs and other sites where spotted owls had been located but pairs not documented on national forest and DNR-managed lands to the estimated numbers in the park. They estimated 282 or 321 pairs of spotted owls on the Olympic Peninsula. These numbers are substantially higher than previously estimated; for example, Thomas et al. (1990) estimated a population of 177 pairs: 40 in the Olympic National Park (Table C2), 131 in the Olympic National Forest (W-38 in Table Q6), and six on state and private lands (W-37, 38 in Table Q6).

Population Trends

Burnham et al. (1994) used the estimates of survival and productivity reviewed above to estimate the rate of change in the population of resident female owls on the Olympic Peninsula. Changes in the population of resident female owls ultimately equate to those of the entire population because the resident females produce the juveniles that maintain the population. They estimated the annual rate of population change (±) for the Olympic Peninsula, using unadjusted estimates of juvenile survival, as 0.9472±0.0255 or an annual loss of 3-8 percent of the resident females (significantly less than ± = 1, a stable population). Their adjusted estimate of juvenile survival results in an estimate of ± = 0.9894, or an annual loss of 1 percent of the resident females (significance needs to be calculated). Holthausen et al. (1994) estimated ± = 1.058±0.065, or an annual change ranging from a 1 percent loss to a 12 percent increase (not significantly different from ± = 1), using their Olympic Peninsula-specific adjustment of juvenile survival rates. They advise that this estimate be interpreted with caution for the reasons noted in the discussions of juvenile survival.

THREATS TO POPULATION PERSISTENCE

This section reviews and discusses recent thoughts on significant threats to the viability of spotted owls on the Olympic Peninsula. Two original discussions are reviewed and compared, that of the interdisciplinary Northern Spotted Owl Recovery Team appointed by the Secretary of the Interior in February 1991 (USDI 1992a) and that of the Reanalysis Team (Holthausen et al. 1994), a team of U.S. Forest Service and National Biological Survey scientists. This review is important because the HCP proposal for the Olympic Experimental State Forest attempts to address the threats identified and discussed in those original reports.

Threats to Owls on the Olympic Peninsula

The Recovery Team (USDI 1992a) identified low population levels, poor population distribution, habitat loss, population isolation, and natural disturbances as major threats to owls on the Olympic Peninsula. Their estimate of population size was 200±25 pairs. They characterized the current distribution of spotted owls as a “doughnut”, with owls largely restricted to the mid-elevation forests on mainly federal lands. Over half of the area of the northwestern Olympic Peninsula, 712,000 acres (Table III.1), is in younger forest cover or other open conditions; the great majority of this cover-type is the result of harvests of older forests within the past 40 years. The Recovery Team expected habitat loss to continue at high rates under management regimes then in use. Isolation of the Olympic Peninsula population from other reproductive owls can place the population at risk of extinction or inbreeding if catastrophic or stochastic events caused it to decline severely. Catastrophic fire and/or wind were predicted under a worst-case scenario to reduce the habitat capability up to 30 percent over 100 years (USDI 1992a).

Holthausen et al. (1994) used simulation analyses and other techniques to evaluate the risks to owls on the Olympic Peninsula, and they presented different interpretations of those risks than did the Recovery Team (USDI

Table III.1: Estimates of forest cover types on lands of different ownerships in the Olympic Experimental State Forest area, July 1991

Land cover estimated by supervised classification of Landsat Thematic Mapper scenes taken July 1991 (WDFW 1994c). Land ownership estimated from DNR's digital public lands map (DNR GIS 1995).

Landowner	Cover type	Total area (acres)	Percent of area[1]	Percent of cover type[2]
Olympic National Park	late seral[3]	216,137	16.5	59.1
	mid-seral[4]	16,298	1.2	18.7
	other[5]	143,857	11.0	16.8
Olympic National Forest	late seral	66,325	5.0	18.1
	mid-seral	15,434	1.2	17.7
	other	93,294	7.1	10.9
DNR-managed lands	late seral	52,150	4.0	14.3
in the OESF	mid-seral	20,990	1.6	24.1
	other	197,974	15.1	23.1
Other[6]	late seral	30,983	2.4	8.4
	mid-seral	34,293	2.6	39.4
	other	421,558	32.1	49.2
Total		**1,309,293**	**100**	

[1] The area within the cover type within the ownership class, divided by the total area described.

[2] The area within the cover type within the ownership class, divided by the total area within the cover type.

[3] Late-seral forests include old growth and large sawtimber.

[4] Mid-seral forests include small sawtimber.

[5] Other land cover includes pole, sapling, open canopy/mixed conifer, open areas (clearcuts, high-elevation barrens, towns, etc), water, cloud/shadow cover.

[6] Other lands include all private ownerships, tribal lands, DNR-managed lands outside the OESF.

1992a). They estimated a population size of 282 or 321 pairs, substantially greater than the estimate of the Recovery Team. Their evaluations of risk to the population posed by the spatial and ecological distribution of habitat generally concurred with those of the Recovery Team. Their simulations showed that maintaining all current habitat on all nonfederal lands on the peninsula increased the predicted numbers of pairs occupying sites on both federal and nonfederal lands by about 20 percent over simulations based on no nonfederal habitat, and they concluded that it was unlikely that owls would occupy coastal lowland forests in the Olympic Experimental State Forest area without habitat on nonfederal land.

The current plans for management of the Olympic National Forest have established large reserves in which owl habitat will be maintained and/or restored (USDA and USDI 1994b). In light of these management plans for federal lands, Holthausen et al. (1994) concluded that "...it is likely, but not assured, that a stable population would be maintained on portions of the Olympic National Forest and the core area of the national park in the absence of any nonfederal contribution of habitat." They also analyzed the potential impacts of establishing a significant (370,500 acres of high-quality habitat) connecting corridor between the southern Cascades and the Olympic Peninsula. They concluded that habitat conditions on the Olympic Peninsula were the most important factor determining the stability of the sub-population; in other words, isolation of the sub-population is not as serious a threat as the Recovery Team (USDI 1992a) thought.

Holthausen et al. (1994) evaluated the effects of a worst-case fire by simulating a complete loss of habitat in portions of the eastern and northern Olympic Peninsula that are at high risk of large-scale fires (33 percent of federal land on the peninsula, Holthausen et al. 1994, Figure 5). Their analyses suggested that the total area managed for habitat on federal lands is large enough that an otherwise stable population of spotted owls would be robust to a disturbance of this scale. They discussed but did not analyze the effects of a large-scale windstorm on the western peninsula in combination with the simulated fire loss. They concluded that such a scenario would cause significantly greater impacts to the peninsula owl population, but that the combination was extremely unlikely.

DNR's Survey Data

DNR's spotted owl surveys identify the distribution and presence of northern spotted owls on the landscape and reduce the possibility of violating the Endangered Species Act. Surveys also provide information on the patterns of spotted owl use on both local and statewide scales.

HISTORY

From 1985 through 1987, DNR personnel participated with the Washington Department of Wildlife and Olympic National Park staffs in surveying selected portions of Olympic National Park and DNR's Hoh-Clearwater Block on the Olympic Peninsula. In 1988 and 1989, DNR again conducted surveys on the Hoh-Clearwater Block. The results of these surveys were compiled into a report titled 1988-1989 Hoh-Clearwater Spotted Owl Inventory Project (Anthony and Cummins 1989).

In 1990, inventory surveys were continued in the Hoh-Clearwater Block and were also conducted in the Columbia River Gorge area of southwest Washington.

In 1991, DNR developed an agency protocol for surveying for spotted owls based on draft survey guidelines from the U.S. Fish and Wildlife Service. In the same year, DNR began surveying areas surrounding planned management activities in all DNR regions within the range of the spotted owl.

In 1992, the U.S. Fish and Wildlife Service endorsed the Protocol for Surveying Proposed Management Activities that May Impact Northern Spotted Owls (hereafter referred to as the USFWS Protocol). From 1992 through 1995, DNR conducted surveys according to the USFWS Protocol.

METHODS

The USFWS Protocol includes the Northern Spotted Owl Survey Protocol, which DNR follows strictly with the following EXCEPTIONS:

(1) Prior to the 1994 survey season, DNR surveyed all suitable spotted owl habitat located within a 2.2-mile radius around management activities west of Interstate Highway 5, including the Olympic Peninsula and southwest Washington; elsewhere in the state, DNR surveyed all suitable habitat within a 1.8-mile radius. In 1994, the U.S. Fish and Wildlife Service increased the 2.2-mile radius to 2.7 miles; however, the 1.8-mile radius stayed the same. The 1.8-mile and 2.7-mile radii are based on radio telemetry data showing that spotted owls have larger territories in some parts of the state than in others. In addition, DNR surveys an extra 0.1 mile (1.9 and 2.8 respectively) to allow for management activities that move slightly during the planning stages.

(2) The USFWS Protocol for Spot Calling requires projecting taped calls through a megaphone from predetermined locations (or stations) for 10 minutes per station. DNR has extended this time to 12 minutes per station so as to detect spotted owls that may be slow to respond.

(3) Some surveys may contain spotted owl habitat that cannot be accessed because of difficult terrain or inability to cross private ownership. When these situations arise, DNR and the Washington Department of Fish and Wildlife review each restriction to determine if surveys in the rest of the area will still provide reliable information about spotted owls on the landscape. Because access issues are not addressed in the USFWS Protocol, these restrictions necessitate a protocol departure. In most situations, additional survey efforts compensate for inaccessible habitat by adding extra stations along the edges of the restricted lands, extending calling to 20 minutes instead of 12, and, depending on the amount and shape of the inaccessible habitat, conducting as many as three extra visits within a 0.5- or 1.0-mile wide buffer around the area. These activities can be considered "reasonably consistent" with the USFWS Protocol Standards.

DATA REVIEW

Prior to 1993, the Washington Department of Wildlife reviewed DNR spotted owl surveys on a case-by-case basis as requested by DNR. In 1993, when DNR's spotted owl survey program was expanded significantly, the Washington Department of Fish and Wildlife indicated that DNR should conduct its own data review. DNR established a data review section in its Forest Resources Division, which reviews and evaluates spotted owl surveys using the Washington Department of Fish and Wildlife's Guidelines for Reviewing Spotted Owl Surveys (WDFW 1994a) to determine if individual surveys are reasonably consistent with the USFWS Protocol.

RESULTS

DNR's survey effort has gradually increased, from 53,000 acres of habitat surveyed in 1988 and 1989 to 329,000 acres surveyed in 1993 and 1994.

The Washington Department of Fish and Wildlife tracks all spotted owl detections and uses this information to locate site centers. As of the end of the 1995 survey season, there was a total of 344 site centers on or affecting DNR-managed lands (using the owl circle radii as defined in the USFWS Protocol). (See Table III.2.) Most of these site centers were classified as status 1 (providing habitat for a pair). However, three site centers have been changed to historic status (formerly occupied) according to Washington Department of Fish and Wildlife criteria because surveys for three consecutive years have failed to detect spotted owls at these sites.

Table III.2: Northern spotted owl site centers on or affecting DNR-managed lands as of the end of the 1995 survey season

(Source: WDFW Non-game database October 1995 for site centers; DNR GIS April 1995 for land base)

Status 1 - Pair status	217
Status 2 - Two owls, status unknown	11
Status 3 - Resident single owl	50
Status 4 - Status unknown	63
Status 5 - Historic status (formerly occupied)	3
Total site centers	**344**

B. Marbled Murrelet

B. Marbled Murrelet

Species Ecology/Literature Review

INTRODUCTION

In October 1992, the U.S. Fish and Wildlife Service listed the marbled murrelet, a Pacific seabird, as threatened, due primarily to loss of nesting habitat and secondarily to loss of the bird in gill nets. The state of Washington has also listed the marbled murrelet as threatened.

TAXONOMY

The marbled murrelet belongs to the family Alcidae, which consists of 22 species divided into 12 genera worldwide (DeSanto and Nelson 1995). Other familiar members of this marine family of diving birds include murres, puffins, guillemots, auks, and auklets. There are two subspecies of marbled murrelet, the North American race, *Brachyramphus marmoratus marmoratus,* and the Asian race, *Brachyramphus marmoratus perdix*, commonly known as the long-billed murrelet. Recent evidence indicates that the long-billed murrelet may be a distinct species (Friesen et al. 1994). A related North American murrelet is the Kittlitz's murrelet (*Brachyramphus brevirostris),* whose habitat is strongly associated with glacial ice (Ralph et al. 1995a).

PHYSICAL CHARACTERISTICS

The marbled murrelet is a medium-size seabird (approximately 9.5 inches in length) with a heavy compact body, short tail and neck, and short stubby wings. Males and females have identical plumage, though their plumages vary seasonally (Marshal 1989). Adult marbled murrelets have an alternate plumage in summer and a basic plumage in winter (Carter and Stein 1995). The alternate plumage coincides with the breeding season when the birds are blackish-brown on the upper part of their body with rust coloring at the tips of the back feathers. The sides of their heads, the sides and front of their necks, and their underparts have white feathers with broad dark-brown margins (Kozlova 1957). This pattern gives the murrelet its "marbled" look, which most likely protects breeding birds from detection by predators in forested environments (Binford et al. 1975; Nelson and Hamer 1995a). Adults in the winter have a brownish-gray upper body, a white lower body, and a white band below the neck. Fall juveniles have a brownish mottling on their chest, breast, and sides and are otherwise similar to winter adults. By winter, juveniles are indistinguishable from adults (Marshal 1989; Carter and Stein 1995).

Distinguishing characteristics of murrelets on the water include an upward pointing tail and bill (Marshal 1989; Nelson 1992). The murrelet's body shape facilitates underwater swimming, but its short wings require that it fly faster than 50 miles per hour to avoid stalling.

GEOGRAPHIC DISTRIBUTION

Marbled murrelets occur in North America along 6,500 miles of coastline between the Bering Sea, Alaska, and central California. The geographic center of their distribution is in the northern portion of southeast Alaska, near the Alexander Archipelago (Ralph et al. 1995a; see Map III.2). Populations are fairly large and continuous between the coastline just west of Kodiak Island and the southern edge of British Columbia, with the largest concentrations occurring between the southern part of southeast

Alaska and Prince William Sound (Ralph et al. 1995a). Distribution becomes more disjunct at the southern end of the marbled murrelet's range. In Washington, Oregon, and California, there are distinct gaps between breeding populations. These gaps are thought to be a result of logging activity that has removed nesting habitat, i.e., old-growth and late successional forest (Carter and Erickson 1992; Leschner and Cummins 1992; Nelson et al. 1992; Ralph et al. 1995a). See section below on population status and demography for numbers of murrelets in each portion of their range.

Distribution of the murrelet population at sea during breeding seasons appears to be determined by the distribution and accessibility of adjacent old-growth and late successional forest (Ralph et al. 1995a). The correlation between old-growth and offshore murrelet populations has been circumstantially established between California and southwest Washington. During the breeding season, the largest concentrations of marbled murrelets have been observed at sea adjacent to areas where nesting habitat was available (Sowls et al. 1980; Nelson et al. 1992). The fact that marine productivity is high along this entire coast during the breeding season suggests that foraging habitat is not a limiting factor (Ralph et al. 1995a). The relation between occurrence of murrelets at sea and onshore late successional and old-growth habitat has been more difficult to observe in northern Washington, British Columbia, and Alaska because the coastline is more complex, more old growth remains, and extensive survey efforts have not been made (Ralph et al. 1995a).

Marbled murrelets nest along the coast and in late successional and old-growth forests. The maximum distance inland murrelets have been found is approximately 66 miles in Oregon. In Washington, the detection farthest inland has been at 52.25 miles (Hamer 1995). Most detections of murrelets have been within 40 miles of marine waters (Hamer 1995; Miller and Ralph 1995). However, their inland nesting distribution is not fully known because survey effort is inconsistent in areas greater than 40 miles from saltwater (Hamer 1995; Miller and Ralph 1995; Ralph et al. 1995a).

BEHAVIOR

The following section briefly reviews recently published literature on marbled murrelet behavior and nesting ecology. For a more detailed treatment of foraging behavior and food habits, see Strachen et al. (1995), Burkett (1995), and Hunt (1995). For a more detailed treatment of nesting ecology and behavior, see Nelson and Hamer (1995a).

Foraging

The marbled murrelet feeds in near-shore ocean waters and in inland saltwater bays, sounds, and inland passageways. It also occurs occasionally on large freshwater lakes, though its foraging habits there have not been documented (Marshal 1989). Murrelets feed on marine invertebrates and small fish traveling in schools. Euphasids and mysids (invertebrates) are dominant prey items in the winter and spring, and small fish such as sand lance, herring, anchovy, and sea perch are more important during the breeding season (Burkett 1995). Interannual changes in the marine environment can result in major changes in prey consumption (Burkett 1995).

Marbled murrelets dive to catch prey (Ashmole 1971). They are most often observed to forage singly or in pairs in a band between approximately 328 and 2,200 yards offshore (Strachen et al. 1995). Murrelets have been observed farther than 2,200 yards offshore, but in much lower numbers (Sealy 1975; Ainely et al. 1995; Piatt and Naslund 1995; Ralph and Miller

1995). Strachen et al. (1995) suggest that murrelets dive simultaneously when foraging in pairs for efficiency. Larger foraging flocks occur in the northern part of the murrelet's range than in the southern portion (Carter 1984; Carter and Sealy 1990). Murrelets forage at all times of day but most actively during the morning and late afternoon. They forage at night as well, possibly when there is enough ambient light to allow them to locate prey (Strachen et al. 1995) and to take advantage of fish that feed near the surface at night (Carter and Sealy 1987, 1990). Nelson and Hamer (1995a) hypothesize that adults may forage at night in order to make dawn feeding flights to nestlings.

Marbled murrelets forage in pairs or small single-species flocks in exposed ocean waters but in mixed-species flocks in protected waters. Glaucous-winged gulls (*Larus glaucescens)*, Bonaparte's gulls (*Larus philadelphia)*, pigeon guillemots (C*epus columba)*, common mergansers (*Mergus merganser)*, and pelagic cormorants (*Phalacrocorax pelagicus)* join foraging murrelets after murrelets drive jumping schools of sand lance and herring to the surface (Mahon 1992; Hunt 1995). Mixed-species foraging generally occurs in the northern part of the murrelet's range (Stachen et al. 1995). The reason for mixed-species versus monospecific foraging is unknown (Hunt 1995).

Nesting

Murrelets are the only member of the Alcidae family that nests in trees (Nelson 1992; Nelson and Hamer 1995a). Murrelets do not build nests but use large limbs covered with a thick layer of moss or duff, or use mistletoe brooms or other deformities that create a sufficiently wide and flat space. They nest almost exclusively in inland mature and old-growth coniferous forests. In Alaska, beyond the extent of coastal coniferous forests, they nest on the ground where trees are absent. There is also some ground nesting at or near the tree line (Piatt and Ford 1993).

Courtship occurs at sea. It is believed that pairs visit the nest stand to copulate, form and maintain pair bonds, and select nest sites before laying an egg (Nelson and Hamer 1995a).

The marbled murrelet nesting season varies in length and by starting and ending dates in different parts of its range. Hamer and Nelson (1995a) constructed nesting chronologies based on 86 breeding records from California (n = 25), Oregon (n =1 3), Washington (n = 13), British Columbia (n = 23), and Alaska (n = 12). In Washington, the breeding period is estimated to be 124 days long, with incubation occurring between April 26 and July 30 and nestling (the period after the chick has hatched and before it leaves the nest) occurring between May 26 and August 27. They estimated a 118-day breeding period in British Columbia in which incubation started on May 2 and ended July 4. The nestling period began June 1 and ended by August 30. The breeding season in Alaska was estimated to be only 106 days long. Incubation occurred between May 14 and July 30 and nestling occurred between June 13 and August 27. Hamer and Nelson found the nesting season decreased as they went north in the murrelet's range.

Murrelets have been observed to lay one egg per nesting attempt. Incubation lasts 27-28 days (Sealy 1974, 1975; Simons 1980; Hirsch et al. 1981; Carter 1984). Both the female and the male share incubation responsibilities, with one brooding the egg while the other forages. Incubation shifts can last up to 24 hours. Murrelets will leave the egg unattended for three to four hours (Nelson and Hamer 1995a p. 59). This may be a strategy to maximize forage time and accumulate energy reserves, as similar behavior for these purposes has been observed in other seabirds (Nelson and Hamer 1995a).

Murrelet pairs exchange incubation shifts from 82 minutes before to one minute after dawn in Alaska, Oregon, and California (n = 12 nests), but later on rainy or overcast days (Nelson and Hamer 1995a). No incubation exchanges have been observed in Washington or British Columbia.

Murrelet chicks are born with downy feathers. Juvenile plumage begins to develop under the down before they are 26 days old. The chick removes any remaining down 12-48 hours prior to leaving the nest. Chicks fledge at 30-40 days. Their first flight is believed to be directly to the ocean (Sealy 1975; Quinlan and Hughes 1990; Hamer and Cummins 1991).

Murrelet chicks appear to be inactive for most of the time they are on the nest until two days prior to fledging. Researchers have observed chicks (n = 8 nests) sleeping or remaining motionless 80-94 percent of the time while on the nest (Hamer and Cummins 1991; Naslund 1993; Nelson and Hamer 1995a). Chick activity increases markedly on the two evenings prior to fledging (Hamer and Cummins 1991; Singer et al. in press), when they pace continually and rapidly on the nest platform, flap their wings frequently and vigorously, peer over the edge of the nest platform, move their heads rapidly, and preen constantly (Nelson and Hamer 1995a).

Flight Behavior

Murrelets have distinctive flight behaviors near nest trees and in nest stands. These subcanopy behaviors are associated with nesting and include single or paired birds flying into, through, and out of the canopy and landing in trees (Nelson and Hamer 1995a). Nelson and Hamer (1995a p. 64) report that "landings and departures from trees have been observed at nests, on other branches in nest trees, in trees adjacent to nest trees, and other trees in the nest stand throughout breeding season." Observation of murrelets landing in trees where a nest has not yet been located is a good indication that nesting activity is occurring somewhere in the stand (Ralph et al. 1994). Murrelet researchers have also seen single birds or flocks of murrelets circling above the forest canopy of nesting stands (Gaston 1992; Nelson and Hamer 1995a) and consider this behavior to indicate that the stand is occupied by murrelets (Ralph et al. 1993, 1994). Occupied behaviors suggest, but do not definitively confirm breeding (Paton 1995).

Murrelets follow linear openings such as creeks, roads, or other natural or human-made corridors to directly approach and depart from nest stands (Eisenhawer and Reimchen 1990; Singer et al. 1991, in press; Nelson and Peck in press). Murrelets use similar flight paths to approach and depart from nest trees (Nelson and Hamer 1995a). There appears to be a positive correlation between the direction of approach and departure from nest trees and openings in the canopy around the nest tree, as well as in gaps in horizontal cover around the nest limb (Nelson and Hamer 1995a p. 64).

NESTING SUCCESS AND PREDATION

Seabird nesting success is influenced by a variety of factors such as food availability, habitat quality, physiological condition of breeding females, predation, and climatic conditions (Nettleship and Birkhead 1985; Croxall 1987; Vermeer et al. 1993). However, the relatively low number of known marbled murrelet nests limits current knowledge of the manner in which different factors influence nesting success, and thorough studies have not been conducted (Nelson and Hamer 1995b). Nelson and Hamer (1995b) compiled and analyzed existing information on nest success from records of 65 marbled murrelet nest trees found in North America between 1974 and 1993. Adequate information to determine nest success was available for 32 of the 65 nest tree sites. Of these 32 sites, 72 percent failed (23 of 32). Predation was the cause of egg or chick mortality at 43 percent of the 23 nesting attempts that failed. Predation was the cause of failure for 57 percent, or eight of 14 nests, that failed in Washington, Oregon, and California. These rates of predation are higher than those observed for other alcid species, with the possible exception of those in areas with high numbers of predators or introduced predators (Nelson and Hamer 1995b p. 93). Nelson and Hamer (1995b) also reported that the source of mortality was unknown for 22 percent of the 23 nest sites that failed. Abandonment, the chick falling out of the nest, and the chick dying from other than predation accounted collectively for 34 percent of the 23 nests that failed (Nelson and Hamer 1995b p. 92).

The authors recognized that the high rates of predation reported in their study may have resulted from a biased sample because most of the records came from nests that were in fragmented areas and near forest edges (Nelson and Hamer 1995b p. 94). Nests that were successful were located significantly farther from forest edges than those that failed (Nelson and Hamer 1995b, p. 96). Nests located by researchers may also be more easily located by predators, although information is insufficient to evaluate that source of bias (Nelson and Hamer 1995b p. 94). Other factors believed to affect predation rates are stand size, canopy closure, percent cover over the nest cup, and distance of the nest from the tree trunk (Nelson and Hamer 1995b).

Observed predators of marbled murrelet chicks and eggs are common ravens (*Corvus corax)* and Stellar's jays (*Cyanocitta stelleri)* (Singer et al. 1991; Naslund et al. in press). Other suspected or potential predators are great horned owls (*Bubo virginianus*), other species of forest owls, accipiters such as the northern goshawk, American crows (*Corvus brachyrynchos)*, raccoons (*Procyon lotor),* martens (*Martes americana)*, fishers (*Martes pennati)*, and several species of rodents (Nelson and Hamer 1995b p. 93).

Both the relation between nest predation and distance to an edge and the high rate of nest failure due to predation raise concern for the effects of forest fragmentation on increased predator access to murrelet nest trees and consequently, concern for the effects of forest practices on increased predation of murrelets. Because marbled murrelets produce only one egg per clutch, high rates of nest predation can have a significant negative effect on the murrelet population. This concern is discussed more thoroughly in the section on status and threats.

NESTING HABITAT

Several detailed studies of marbled murrelet nesting habitat have been conducted since 1990. These studies have examined nest stand characteristics (Nelson and Hamer 1992; Hamer and Nelson 1995b), nest tree characteristics (Hamer and Nelson 1995b), inland habitat associations, i.e., landscape, stand, and tree characteristics statistically associated with marbled murrelet occupancy and documented nesting (Hamer and Cummins 1990; Hamer et al. 1994b; Burger 1995a; Grenier and Nelson 1995; Hamer 1995; Kuletz et al. 1995; Miller and Ralph 1995), and larger scale forest landscape patterns associated with murrelet occupancy (Raphael et al. 1995). The results of these studies establish a strong association of marbled murrelet occupancy and known nest sites with old-growth forests or uneven-aged forests with old-growth characteristics. This section summarizes the results of these studies with a focus on data from Washington. Studies are under way to establish habitat associations in younger forest stands. (See the later section in this chapter on DNR's Survey Studies for more discussion of these studies.)

Nest Stand Characteristics

Hamer and Nelson (1995b) compiled published and unpublished information from 61 nest stands and nest trees in North America exclusive of ground nests in Alaska. They defined a nest stand as a contiguous group of trees (including the nest tree) with gaps no larger than 330 feet. They calculated mean, range, and standard deviation for each nest stand characteristic by state or province and also pooled sample statistics for California, Oregon, Washington, and British Columbia. They treated Alaska separately because stand and tree conditions there are different from those further south in the murrelet's range. Results are shown in Table III.3.

Table III.3: Characteristics of nest stands used by the marbled murrelet

The mean, standard deviation, and range, for characteristics of forest stands in North America containing marbled murrelet nest trees (n = 61). Sample sizes for each variable are shown in parentheses. The Pacific Northwest data include nests located in California, Oregon, Washington, and British Columbia. For some characteristics, either no data were available for that state or province, or the sample size was too small to calculate the mean and range.

(Source: Hamer and Nelson 1995b)

Characteristics	California n = 10	Oregon n = 20	Washington n = 6	British Columbia n = 9	Pacific Northwest n = 45	Alaska n = 14
Aspect (degrees)	210±122	147±63	180±121	——	166±92	267±66
	45-352	48-253	39-331	——	35-39	270-360
	(7)	(19)	(5)		(33)	(14)
Elevation (feet)	938±410	1243±499	1142±577	1053±1017	1089±676	315±164
	148-151	200-2119	49-2001	46-3599	46-3599	98-853
	(10)	(10)	(6)	(9)	(35)	(14)
Slope (percent)	18±14	41±27	21±13	3±4	23±23	69±16
	0-41	10-87	0-39	0-11	0-87	47-100
	(7)	(10)	(6)	(7)	(30)	(10)
Slope position[1]	1±0	2.1±0.9	1.3±0.5	1.3±0.7	1.5±0.8	——
	1-1	1-3	1-2	1-3	1-3	——
	(7)	(10)	(6)	(7)	(30)	
Stand size (acres)	871±1070	198±121	877±993	——	510±869	77±64
	248-2725	7-369	12-2452	——	7-2724	10-156
	(4)	(9)	(5)		(16)	(10)

[1] Slope position codes: 1 = lower 1/3, 2 = middle 1/3, and 3 = upper 1/3.

Table III.3: Characteristics of nest stands used by the marbled murrelet *(continued)*

Characteristics	California n = 10	Oregon n = 20	Washington n = 6	British Columbia n = 9	Pacific Northwest n = 45	Alaska n = 14
Stand composition[2]	100±0	100±0	90±9	64±29	91±19	64±14
(percent in low-	100-100	100-100	78-100	20-100	20-100	39-91
elevation trees)	(10)	(10)	(5)	(6)	(31)	(8)
Total tree density	95±72	48±29	55±30	120±55	73±53	232±92
(number/acre)	37-203	19-114	34-65	60-214	19-214	119-395
	(5)	(10)	(5)	(5)	(25)	(8)
Canopy height	289±0	194±26	177±16	——	210±53	75±13
(feet)	289-2899	157-246	144-194	——	125-289	52-98
	(5)	(9)	(5)		(20)	(14)
Canopy layers	——	2.2±0.4	3.4±0.5	——	2.5±0.7	——
(number)	——	2-3	3-4	——	2-4	——
		(10)	(4)		(20)	
Canopy closure	39±6	43±27	69±18	——	49±23	62±15
(percent)	25-48	12-99	36-88	——	12-99	40-85
	(7)	(8)	(5)		(21)	(12)
Distance to coast	8±5	16±6	10±18	7±2	10±7	0.3±0.2
(miles)	3-17	1-25	3-21	2-11	1-5	0.06-0.7
	(10)	(10)	(6)	(9)	(35)	(14)
Distance to stream	354±220	919±1024	230±226	328±541	522±735	358±354
(feet)	998-705	26-328	46-656	16-1640	16-3281	7-1066
	(7)	(10)	(5)	(7)	(29)	(9)
Distance to	——	219±230	213±108	——	302±430	——
nearest opening	——	49-984	59-394	——	49-2298	——
(feet)		(20)	(5)		(30)	
Stand age (years)	——	209±48	879±606	——	522±570	——
	——	180-350	450-1736	——	180-1824	——
		(10)	(3)		(16)	

[2] Measure of the percent of western hemlock, Douglas fir, western redcedar, Sitka spruce, and coast redwood in a stand.

Hamer and Nelson (1995b) described both landscape and forest stand characteristics associated with nest trees and stands. Landscape variables included distance to marine waters, elevation, slope, and aspect. The 45 nest stands in the Pacific Northwest were located a mean distance of 10.4 miles from marine waters. The maximum distance was 24.8 miles on the south fork of the Coos River in Oregon (Nelson et al. 1992). In Washington, the mean distance from marine water for six nests was 9.9 miles, and the nest stand farthest inland was 21.2 miles.

The mean elevation of the 35 nest stands (measured from nest tree) in the Pacific Northwest was 1,089 feet. The highest elevation was 3,599 feet in British Columbia. In Washington, the mean nest tree elevation was 1,142 feet and the highest was 2,001 feet. Nests in the Pacific Northwest occurred on slopes averaging 23 percent grade. In Washington, the mean slope was 21 percent, with a range from 0 percent to 39 percent. Eighty percent of nests in the Pacific Northwest were located on the lower two-thirds of slopes. Aspects of the nest varied. (See Table III.3.)

Forest stand characteristics described by Hamer and Nelson (1995b) included age, tree and snag size in stand, tree species composition, canopy height, number of canopy layers and percent canopy cover, stand size, and distance to openings. Ages of stands were determined by using either an increment borer, or stand information data bases from landowners, or by counting rings on nearby stumps. For the Pacific Northwest, mean age of 16 nest stands was 522 years, ranging from 180 years (Oregon) to 1,824 years (mainland coast of British Columbia). In Washington, the mean nest stand age for six nests was 879 years, and the range was 450 years to 1,736 years old. All 61 nest sites reported to date have been in mature or old-growth forests (Hamer and Nelson 1995b p. 72).

Data for tree size (diameter at breast height) in nest stands were available only for Washington and Oregon (Hamer and Nelson 1995b p. 72), where mean tree size was 19 inches dbh (Nelson and Hamer 1992). Tree density in nest stands in the Pacific Northwest was 73 per acre. For five nests in Washington, tree density in nest stands averaged 55 per acre and ranged from 34 to 65 trees per acre.

Nest stands in the Pacific Northwest were largely composed of tree species that occur at low elevations, including Douglas fir, western redcedar, Sitka spruce, western hemlock, and coast redwood (California). Nest stands in Washington had a mean composition of 90 percent low-elevation species.

Forest canopies in nest stands in the Pacific Northwest (no data reported for British Columbia) were characterized by multiple layers — between two and four (n = 20), heights averaging 210 feet (n = 20), and an average canopy closure (n = 21) of 49 percent. In Washington nest stands, there were three to four canopy layers, a mean canopy height of 177 feet, and a mean canopy closure of 69 percent.

Nest stands in the Pacific Northwest (n = 16) averaged 510 acres. The smallest nest stand was 7 acres (Oregon) and the largest was 2,725 acres (California). In Washington, mean nest stand size was 877 acres. The smallest nest stand size was 12 acres and the largest was 2,452 acres.

Nest Tree Attributes

Hamer and Nelson (1995b) described several attributes of nest trees. (See Table III.4.) Nest tree species in the Pacific Northwest (n = 47) were Douglas fir (57 percent), Sitka spruce (15 percent), western hemlock (13 percent), coast redwood (11 percent) and western redcedar (2 percent). One nest was located in an Alaska yellow cedar tree in British Columbia (2 percent). Of six Washington nests, three nests (50 percent) were located in Douglas fir trees, two (33 percent) in western hemlocks, and one nest (17 percent) was located in a western redcedar. Nest trees in the Pacific Northwest had a mean diameter of 83 inches dbh. The smallest nest tree was 34.7 inches dbh, and the largest (in California) was 210 inches dbh (17.5 feet). In Washington, the mean diameter for nest trees was 59.9 inches dbh, with the smallest nest tree measuring 34.7 inches dbh and the largest measuring 86.7 inches dbh.

Data on branch width indicate that murrelets prefer large platforms for nesting. In the Pacific Northwest, mean tree branch diameter measured at the nest was 12.6 inches. The largest branch diameter at the nest was 31.9 inches and the smallest was 3.9 inches. In Washington (n = 4), mean branch diameter was 11.4 inches. The range was 4.3 to 18 inches.

Nest branch height in the Pacific Northwest averaged 147.6 feet above the ground, with a range of 59 feet to 239.5 feet above the ground. The mean nest branch height in Washington was 121.4 feet and the range was 75.4 feet to 173.9 feet.

Murrelets used moss and litter (small twigs, conifer needles, bark pieces) as substrate in their nest platforms. Moss comprised the majority of substrate in 67 percent of nests and litter formed the substrate in 33 percent of nests in the Pacific Northwest. When moss was the substrate, mean depth of moss in or directly adjacent to the nest cup was 1.8 inches. For litter substrate, mean depth was 2 inches.

Nest platforms were formed by large primary branches (32 percent), the fork of two primary branches (23 percent), the juncture between a branch and the bole of the tree (18 percent), dwarf mistletoe brooms (9 percent), large secondary limbs (7 percent), limb damage (2 percent), and an old stick nest (2 percent). Many of the limb nests had natural depressions in which murrelets created a nest cup (Nelson and Hamer 1995b p. 79).

Nests tended to have high canopy closure over them. Mean percent cover over nests in the Pacific Northwest was 85 percent. In Washington, the mean was 90 percent. Most nest trees were within 300 feet of a stream. Many nests were also within 300 feet of clear cuts or roads, but there may be bias in this observation due to ease of access to nest trees by observers (Hamer and Nelson 1995b p. 80).

From the data on 47 marbled murrelet nests and nest stands described to date outside of Alaska, some generalizations can be made about murrelet nesting habitat. Marbled murrelets nest in mature and old-growth trees and stands. No nests have been reported in stands younger than 180 years old, with most nest stands being significantly older. All 61 nest trees located to date have been in mature or old-growth stands. All murrelet nests have been found in low-elevation stands. Nelson and Hamer (1995b p. 80) speculate that low-elevation conifers — Douglas fir, western hemlock, western redcedar, Sitka spruce, and coast redwood — probably have a higher abundance of potential nest platforms than higher elevation stands that are dominated by Pacific silver fir and mountain hemlock.

Table III.4: Characteristics of nest trees used by the marbled murrelet

The mean, standard deviation, and range for platform and tree characteristics of marbled murrelet nest trees (n = 61) located in North America. Sample sizes for each variable are shown in parentheses. The Pacific Northwest data include nests located in California, Oregon, Washington, and British Columbia. For some characteristics, either no data were available for that state or province or the sample size was too small to calculate the mean and range. Calculations were rounded to the nearest inch for measurements except nest substrate depth.

(Source: Hamer and Nelson 1995b)

Characteristics	California n = 10	Oregon n = 22	Washington n = 6	British Columbia n = 9	Pacific Northwest n = 47	Alaska n = 14[1]
Tree species:						
Sitka spruce		1		6	7	5[1]
Douglas fir	4	20	3		27	
western hemlock	1	1	2	2	6	
western redcedar			1		1	
Alaska yellow cedar				1	1	
coast redwood	5				5	
mountain hemlock						7[1]
Tree diameter (inches)	110±54 55-210 (10)	76±19 50-109 (22)	60±18 35-87 (5)	84±30 35-146 (9)	83±36 35-210 (46)	25±7 12-41 (14)
Tree height (feet)	240±26 200-282 (10)	220±36 118-282 (22)	187±23 148-213 (5)	190±49 98-262 (9)	217±43 98-282 (46)	75±13 52-98 (14)
Tree diameter at nest height (inches)	42±19 28-78 (5)	32±9 14-48 (15)	28±8 16-38 (5)	43±24 20-82 (5)	35±15 14-82 (30)	— — — —

[1]This is the data from Hamer and Nelson (1995b). The discrepancy between the 12 trees listed and total of 14 was not explained.

Table III.4: Characteristics of nest trees used by the marbled murrelet *(continued)*

Characteristics	California n = 10	Oregon n = 22	Washington n = 6	British Columbia n = 9	Pacific Northwest n = 47	Alaska n = 14
Branch height (feet)	154±36 108-223 (10)	167±39 59-240 (21)	121±36 75-174 (5)	108±26 59-144 (9)	148±43 59-240 (45)	43±7 33-56 (14)
Branch diameter at trunk (inches)	14±5 8-24 (8)	12±4 6-22 (19)	14±5 6-19 (5)	13±4 7-17 (9)	13±4 4-24 (41)	6±2 4-11 (12)
Branch diameter at nest (inches)	13±5 6-24 (10)	13±7 4-32 (20)	11±5 4-18 (4)	11±4 6-15 (7)	13±6 4-32 (41)	7±2 5-11 (11)
Branch crown position (percent)	64±13 50-91 (10)	74±12 50-92 (21)	63±15 41-81 (5)	58±11 40-74 (9)	68±14 40-92 (45)	59±12 44-79 (14)
Branch orientation (degrees)	203±103 45-360 (10)	173±87 20-360 (20)	233±109 110-342 (4)	187±90 18-341 (9)	189±96 18-360 (43)	—— ——
Distance trunk to nest (inches)	19±24 0-72 (10)	48±63 0.4-300 (21)	10±10 0-22 (4)	53±48 0-134 (9)	35±52 0-300 (44)	24±26 0-88 (13)
Nest platform length (inches)	9±4 3-16 (10)	16±7 5-28 (21)	11±6 4-22 (5)	8±5 5-20 (6)	13±7 3-28 (42)	—— ——
Nest platform width (inches)	6±3 2-9 (10)	11±5 3-20 (21)	9±4 4-15 (5)	5±1 4-7 (6)	9±5 3-20 (42)	—— ——
Nest platform moss depth (inches)	1±1 0.3-3 (5)	2±1 0.2-5 (17)	1±0.3 0.8-1.3 (2)	2±0.5 1-3 (9)	2±1 0.2-5 (33)	2±5 0.8-2 (12)
Nest platform duff and litter depth (inches)	3±3 1-8 (4)	1±0.2 1-1 (2)	1±.3 0.8-1 (3)	—— ——	2±2 0.8-8 (9)	—— ——
Cover above nest (percent)	90±28 5-100 (10)	79±14 40-100 (18)	90±10 70-100 (5)	100±0 100-100 (2)	85±20 5-100 (35)	89±0.5 81-95 (8)

Most nest stands were within 19 miles of marine waters and all of them were within 25 miles. These near distances most likely do not represent the inland distribution of nesting activity for two reasons. First, occupied behavior, which is indicative of nesting, has been observed in many stands located farther than 25 miles from the coast. In Washington, 36 percent of occupied stands are more than 29 miles from marine water, with the farthest occupied stand located 52.2 miles inland. In Oregon, one instance of occupied behavior was observed more than 66 miles inland, though most detections of murrelets have been within 25 miles of the coast (Hamer and Nelson 1995b). Second, survey effort has not been high in areas further than 40 miles from marine waters (Hamer 1995). There are no data on which to assess how much of the population nests farther from, as opposed to closer to, marine waters (Hamer and Nelson 1995b p. 80).

Murrelets appear to nest in stands that have somewhat open canopies. This probably is related to ease of access to the nest tree, which would be important for a bird that approaches the nest at high speeds. The nest itself is well covered, which is probably a predator-avoidance strategy, given the murrelet's apparently high rates of predation (see previous text and Hamer and Nelson 1995b; Nelson and Hamer 1995b). Nests also tended to be close to streams or other openings that facilitate access to the nest tree. Murrelets have been observed using stream and road corridors to travel through forest stands (Nelson and Hamer 1995b).

Nests themselves were located on large branches, in deformities in branch structure or in mistletoe brooms. This suggests that the presence of structure in the stand and the processes that create those structures are important features of murrelet nest habitat (Hamer and Nelson 1995b; Grenier and Nelson 1995). Large, old trees without the structural attributes of nest platforms would probably not constitute nesting habitat. A study by Nelson et al. (in press) in which 15 nest trees were compared to randomly located trees within the same nest stand showed that nest trees had significantly more platforms than the other trees. In addition, murrelets selected trees that had four or more platforms and avoided trees that had three or fewer platforms. Naslund et al. (in press) also showed that nest trees in Alaska had more platforms than random trees surrounding the nest trees. Nest trees also had higher percentages of epiphyte cover, which likely contributes hiding cover for nests.

The data suggest strong associations between murrelet nesting habitat and old, structurally complex, low-elevation forests. Further evidence in Burger (1995a), Grenier and Nelson (1995), and Miller and Ralph (1995) corroborate these observations. In addition, occupancy of stands and abundance of murrelets appear to be correlated with the amount of old-growth habitat available (Hamer and Cummins 1990; Hamer 1995; Miller and Ralph 1995; Raphael et al. 1995; Kuletz et al. in press). Generalizations of nest stand, nest tree, and nest attributes should be viewed cautiously in light of the small sample size from which they were drawn. Furthermore, nest tree and nest stand characteristics describe what birds are using, but do not indicate habitat quality. Habitat quality will need to be assessed by correlating habitat attributes with reproductive success (Hamer 1995; Nelson and Hamer 1995b; Ralph et al. 1995a). In addition, more extensive surveys of non-old-growth habitat will help determine if, and the extent to which, murrelets use younger and smaller trees.

Inland Habitat Associations in Washington

As of 1993, murrelet occupancy had been verified in 1,107 stands in California, Oregon, and Washington (Washington Forest Practices Board 1995). In Washington, occupied behavior has been verified in 229 stands (WFPB 1995). Occupied behavior is indicative of nesting activity in a stand (Ralph et al. 1994; Paton 1995). Thus, the number of documented occupied stands provides a larger sample from which to draw conclusions about murrelet nesting habitat than is available from the six known nest tree stands in Washington. Hamer (1995) used logistic regression analysis to compare characteristics of 62 occupied stands with characteristics of 87 unoccupied stands. Starting with 38 forest stand variables, he found that the probability of occupancy of an old-growth stand increased with an increase in the total number of potential nest platforms, percent moss coverage on limbs of trees greater than 32 inches diameter at breast height, percent slope, stem density of dominant trees (dominant trees are greater than or equal to 32 inches dbh), and the mean dbh of western hemlock. At the same time, he found that the probability of occupancy of a stand decreased with an increase in the percent coverage of lichens on the branches of dominant trees, stand elevation, and canopy closure. (See WFPB 1995 and Hamer 1995 for a complete description of the model and variables used.)

Hamer (1995) also analyzed detection rates and number of surveyed stands that were verified as occupied against elevation and distance inland. He found that mean detection rate and number of stands verified as occupied declined sharply above 3,500 feet and at distances greater than 39 miles from marine waters. More than 98 percent of all murrelet detections were from forest stands below 3,500 feet, and 98.5 percent of all detections were from areas less than 40 miles inland.

Statistical models such as described by Hamer (1995) can be useful for predicting what forest types are potentially occupied murrelet nesting habitat, for determining what forest management activities would degrade potentially occupied or suitable habitat, and for designing silvicultural prescriptions that could accelerate the development of habitat from currently unsuitable stands. As discussed above, descriptions of nesting habitat associations need to be augmented by a more thorough understanding of how these associations relate to reproductive success of murrelets. Statistical models based on occupancy versus non-occupancy are only an interim step until habitat quality can be defined in terms of reproductive success.

ESTIMATES OF MURRELET ABUNDANCE, POPULATION DEMOGRAPHY, AND TRENDS

Population Estimates

Marbled murrelet population is currently estimated by surveys done at sea, from both planes and boats. Total population based on the most current information is 300,000 individuals. Approximately 85 percent of this estimated population is concentrated along the Gulf of Alaska and Prince William Sound. The total Alaska population is estimated to be 220,900 birds (Piatt and Naslund 1995: Klosiewski and Laing 1994). At the edge of the murrelet's range, in the Aleutian Islands, the population is less than 5,000 (Piatt and Naslund 1995). The British Columbia population is estimated to be between 45,000 and 50,000 birds (Rodway et al. 1992). The Washington population is estimated at approximately 5,500 birds (Speich and Wahl 1995; Varoujean and Williams 1995). Two estimates have been derived for Oregon: Varoujean and Williams (1995) used aerial surveys to derive an estimate of 6,600 individuals, and Strong et al. (1995) arrived at an estimate of between 15,000 and 20,000 using boat surveys. For California, Ralph and Miller (1995) estimated 6,450 individuals.

The use of at-sea surveys for murrelets is a recent technique whose accuracy is currently being assessed (Ralph et al. 1995a). Well-established methods for determining population sizes of other alcid species are ineffectual for marbled murrelets because they have secretive nesting habits and consequently are virtually inaccessible for banding. Census survey results have varied between years, locations, and methods. Ralph et al. (1995a) identified aspects of surveys that can affect accuracy and suggested ways to reduce sources of error.

Population Trends

Keeping in mind these limitations for population estimates, researchers still think there is enough evidence to suggest that the murrelet population is declining. Circumstantial evidence of population decline includes observations that murrelets are abundant offshore of areas where extensive old-growth stands still exist (the Gulf of Alaska), while distribution is disjunct in areas where most of the old growth has been harvested (Washington, Oregon, and California), with murrelets found offshore along remaining stands of older forest (Ralph et al. 1995a). More quantitative assessments are available from Alaska and British Columbia for trends over the past 20 years. In Alaska, Piatt and Naslund (1995) concluded from comparing small-boat survey counts from 1972-1973 and 1989-1991 and Christmas bird counts that populations have decreased on the order of 50 percent in the past 20 years. In British Columbia, Burger (1995b) also concluded that populations have decreased by 50 percent in Clayquot Sound, based on density estimates made from surveys between 1979 and 1993. However, Burger (1995b) found that survey results in Barclay Sound indicated populations there decreased in 1992 and 1993, but doubled or tripled the following year, in 1994. He speculates that the low numbers in 1992 and 1993 may have been due to El Niño factors.

Data for quantitative assessment of long-term population trends is lacking in many parts of Washington, Oregon, and California. Speich et al. (1992) and Speich and Wahl (1995) report that qualitative accounts of murrelet abundance in the Puget Sound from early this century suggest that numbers are lower now than they were then. These authors indicate that further analysis of recent census data is needed to assess the role that spatial and temporal variation in census results plays in the low numbers that have been observed in recent years. Speich and Wahl (1995) also report that no early qualitative assessments of murrelet populations on the outer Pacific coast of Washington are available, but census data collected over the last 23 years from nearshore waters off Grays Harbor, Washington, indicate that murrelet abundance has decreased there since 1989, with especially low numbers observed in 1993. Their 1993 observations were confirmed by aerial surveys done along the Washington outer coast by Varoujean and Williams (1995). Speich and Wahl (1995 p. 323) suggest that overall changes in marine carrying capacity may be contributing to observed population declines in the past two years because other oceanic bird species with various foraging strategies have been observed the past two years to have the lowest recorded abundances since 1971.

Historic anecdotal accounts of murrelet occurrence in Oregon reported that murrelets were "common" or "abundant" near the Columbia River and offshore of Tillamook County in the northern half of the state and near the mouth of the Yaquina River in central Oregon (Taylor 1921; Strong et al. 1995). Onshore sightings of murrelets in these areas have been infrequent in recent years, suggesting a population decline in the northern half of Oregon (Nelson et al. 1992; Strong et al. 1993; Strong et al. 1995). Historical accounts of murrelet abundance in California also suggest that the population has declined (Carter and Morrison 1992). The presence of two small disjunct populations in California, one off the coast of central California and the other off the coast of northern California, coincides with the existence of remnant old-growth stands onshore and suggests that populations may be declining as the availability of nesting habitat is declining (Ralph et al. 1995a p. 12). Incidental killing in gill nets and by oil spills and other marine pollution is also thought to reduce murrelet populations (see below).

Demography

Long-term data on the vital rates of marbled murrelet sub-populations are unavailable. This information is crucial for determining rates of population change and what segments of the population (i.e., juveniles or adults) contribute most to population stability and for predicting what rates of decline the population can sustain and for how long before extinction thresholds are crossed. (See discussion of population viability analysis in the spotted owl ecology literature review in the preceding section of this chapter.) Understanding these aspects of murrelet population ecology is necessary to design adequate long-term conservation plans. Preliminary research on nesting success (Nelson and Hamer 1995b) indicates that marbled murrelets may have one of the lowest juvenile survival rates of alcid species (DeSanto and Nelson 1995). Observations of ratios of juveniles to adults at sea indicate that the adult reproductive rate is low (Ralph and Long 1995; Varoujean and Williams 1995; but see below). Low rates of juvenile survival and annual reproduction in any species mean that high rates of adult survival are necessary for a stable population. If high rates of juvenile mortality are the result of human management activity and not a part of natural demographic processes in the population (see above and Hamer and Nelson 1995a), a change in management practices that reduce juvenile mortality rates could significantly improve long-term prospects for the species.

Preliminary demographic modeling indicates that the marbled murrelet population is declining at between 4 and 6 percent per year (Beissinger 1995). This assessment is based on juvenile to adult ratios observed at sea and from inferences of possible adult survival rates made from other alcid species. Ralph et al. (1995a) caution that there are several potential sources of error in counting juveniles at sea and that the years in which these data were taken were characterized by unusually warm sea temperatures. Counts of juveniles at sea assume that observers can accurately distinguish adults from juveniles. In addition, nesting chronology data (Hamer and Nelson 1995a) indicate that in some areas, murrelet chicks may not fledge until September. By this point in the season, adults have molted and are not distinguishable from juveniles; the result is a potential low estimate of the number of juveniles. Warm ocean conditions can reduce prey availability and result in adults forgoing breeding or in chicks starving (Ainley and Boekelheide 1990), which may have adversely affected reproductive rates and thus given a non-representative picture of long-term demographic trends.

Knowledge of population dynamics in general and of demographic data from other alcid species allows for identification of some factors that affect demography of marbled murrelets. These factors include age at first breeding, the proportion of the adult population that breeds, the number of young that survive to breeding age, adult mortality rates, and subadult mortality rates (Ralph et al. 1995a p. 13). Conditions that affect the proportion of the adult population that breeds include limitations of the amount of suitable nesting habitat that is not already occupied by other murrelets and prey availability offshore of suitable nesting habitat (Ralph et al. 1995a). Loss of nesting habitat is occurring and is very likely limiting the proportion of adults that can breed. Evidence (discussed earlier) of large local concentrations of murrelet populations offshore of extensive old-growth forest, smaller populations where old growth is limited, and no murrelet activity at sea where old growth is absent supports this hypothesis.

Food availability will be affected by oceanic conditions and the degree to which prey species of murrelets are over-fished by humans. El Niño events have decreased the availability of food for seabirds (Ainley and Boekleheide 1990). Long-term changes in marine productivity have had major effects on seabirds in the Bering Sea (Ralph et al. 1995a). Fisheries exist for some prey species of the murrelet — primarily Pacific herring, rockfish, and northern anchovy. These fish populations are currently depressed due to overfishing (Ainley et al. 1994). However, Ralph et al. (1995a) do not think that food availability is currently a limiting factor affecting murrelet populations, though El Niño events could have short-term effects on the number of adults breeding.

Predation appears to have a large influence on reproductive success. Thirty-one percent of all nests discovered thus far have failed due to predation, and 43 percent of all nests that have failed for any reason have failed due to documented predation (Nelson and Hamer 1995b). Nelson and Hamer (1995b) also found that successful nests were located significantly further from stand edge than those that failed. (See earlier discussion on predation.) This suggests that forest fragmentation could have an adverse effect on reproductive success of marbled murrelets.

Adult mortality is affected by predation in transit between foraging areas and nests. It may also be affected by predation at sea, but no predator takings of murrelets at sea have been recorded (Ralph et al. 1995a p. 16). Adult and subadult mortality rates are increased by deaths due to human activities such as gill-netting (Carter et al. 1995; Fry 1995), pollution, and oil spills (Carter and Kuletz 1995).

Currently, demographic analyses cannot distinguish the relative effects of habitat loss from other factors affecting population trends (Ralph et al. 1995a). It is generally known, however, that populations that do not produce enough young to replace adults eventually become extinct. Thus, the extent to which murrelet nesting habitat has been lost will certainly have a negative effect on the size of the murrelet population. In addition, because murrelets only produce one egg per clutch, they will not recover quickly from higher adult mortality. Increased adult mortality at sea from human activities will also have a large negative effect on the overall population.

Collecting demographic data for murrelets is difficult because of their inaccessibility. Traditional banding and re-observation techniques of both adults and juveniles are not practical, given the difficulties in locating murrelet nests. Alternative methodologies such as refinement of at-sea observation techniques and completely new techniques suitable to murrelet biology will need to be developed to assess accurately demographic trends and determine the relative contribution of different influences on population viability (Ralph et al. 1995a).

HABITAT STATUS IN WASHINGTON

Estimates of the amount of potential marbled murrelet nesting habitat in Washington have been made using satellite data developed by the Washington Department of Fish and Wildlife and modified by DNR (see Raphael et al. 1995; WFPB 1995 based on data developed by Eby and Snyder 1990 and updated by Collins 1993). These estimates were based on broad definitions of old-growth and large-saw forests. The amount of potential nesting habitat by ownership based on these estimates is shown in Table III.5.

Table III.5: Old-growth, large-saw, and small-saw forests below 3,500 feet and less than 66 miles from marine waters, by ownership

(Source: DNR GIS, November 1994)

Ownership	Old growth (acres)	Large saw (acres)	Small saw (acres)
Federal	798,231	710,347	352,853
State	62,950	64,656	173,131
Local	1,162	3,227	2,659
Tribal	3,607	1,302	5,614
Private	67,154	100,656	335,232
Total	**933,104**	**880,188**	**869,489**

Status of Habitat on DNR-managed Lands

From data in Hamer et al. (1994b), DNR derived another estimate of potentially suitable nesting habitat for the lands it manages, assuming that (1) marbled murrelets would use a stand that contains at least eight trees per acre that are equal to or greater than 32 inches dbh; (2) at least 40 percent of such trees are Douglas fir, western hemlock, western redcedar, or Sitka spruce; and (3) the stand contains at least two nesting platforms per acre. This definition was derived from minimum conditions of occupied murrelet stands in Washington. Using forest growth models incorporating site index and assumptions of how managed stands versus unmanaged stands grow, DNR estimated the age at which a stand would develop eight trees greater than or equal to 32 inches dbh. Data from Hamer et al. (1994b) indicate that in unmanaged low-elevation stands, three trees per acre that are greater than or equal to 30 inches dbh would produce at least two platforms per acre. The platform per acre criterion is thus captured by the tree size and density criteria.

DNR's computerized geographic information system data base was queried to assess how many acres of DNR-managed land met this minimum definition of murrelet habitat within 66 miles of marine waters. The estimate was between 55,773 and 63,614 acres, depending on whether growth was assumed to be for a managed stand or a natural stand. This represents 3.4 percent to 3.8 percent of all DNR-managed forest lands in the area covered by the HCP. However, combining old-growth and large-saw estimates from the Washington Department of Fish and Wildlife results in an estimate of 126,606 acres of potential murrelet habitat on DNR-managed land.

The two-year murrelet habitat relationship study currently under way on DNR-managed lands will result in the most accurate picture yet of how much actual potential nesting habitat exists. This study is explained in more detail later in this chapter.

Habitat trends

The amount of available murrelet nesting habitat has been decreasing. Murrelets have been found thus far to nest almost exclusively in low-elevation old-growth and mature forests within 40 miles of marine waters, although they have been observed as far as 66 miles inland. About 10 percent of pre-settlement old growth remains in western Washington (Norse 1990; Booth 1991). Logging, urbanization, and agricultural development have all contributed to the loss of this habitat.

Management under the President's Forest Plan is expected to result in retention of 97 percent of the remaining 980,000 acres of potential murrelet habitat on federal lands in Washington (USDA and USDI 1994a; Perry 1995). Although there are currently no federal restrictions on logging of murrelet nesting habitat on nonfederal lands, landowners are still liable for take of murrelets under the Endangered Species Act. To avoid risk of taking, DNR began a voluntary deferral of timber harvesting in potential murrelet habitat in 1992. The Forest Practices Board is developing a rule for murrelet habitat on state and private lands under the State Forest Practices Act.

THREATS

Habitat Loss and Fragmentation

In its listing decision, the U.S. Fish and Wildlife Service identified habitat loss as the major factor causing the decline of marbled murrelet populations (Federal Register v. 57, p. 45328-37). Threats associated with loss of nesting habitat are (1) a decrease in the proportion of the population that is able to reproduce through reduced availability of nest sites; (2) decrease in reproductive rate of population due to inability of displaced adult breeders to locate new nest sites after their previous sites have been destroyed; (3) packing, i.e., an increased density of birds nesting in the habitat that is available; and (4) fragmentation of existing habitat, which increases the accessibility of nest sites to predators and isolates portions of the population, leading to increased vulnerability to genetic and environmental changes (Divoky and Horton 1995; Ralph et al. 1995a; WFPB 1995).

A decrease in the proportion of the population breeding threatens the species because it could lead to rates of population decline from which the species could not recover. In other words, an extinction threshold could be reached. Current knowledge of murrelet demography is not sufficient to determine where this threshold lies (Beissinger 1995; Ralph et al. 1995a).

The ability of adult breeders to disperse to new nesting stands is not well understood. Drawing from a comparative study of other alcids and knowledge of murrelet nesting habits, Divoky and Horton (1995) suggest that murrelet adults may not be well adapted to disperse to new nest stands once their natal stand has been destroyed. If this is true, it may be difficult for displaced adults to be able to breed, thus reducing the reproductive output of local populations.

Packing is problematic for at least two reasons. First, when all high-quality nest sites are occupied, murrelets may be forced to nest in lower quality habitat or at the edge of suitable stands. Either of these cases could result in a lower likelihood of nesting success. For instance, if a nest is established on a smaller limb or platform than would otherwise be chosen, there could be a higher risk of a chick falling out of the nest. Dead chicks that have fallen out of nests have been documented (Nelson and Hamer 1995b). Nesting on the edge of a stand increases likelihood of nest failure due to predation (Nelson and Hamer 1995b). Second, a high density of nest sites in a stand provide more opportunities for predators to form search images of murrelets as they approach or depart from the nest stand (Ralph et al. 1995).

Forest fragmentation in general increases the number of smaller forest patches (Harris 1984; Forman and Godron 1986). Forests in the Pacific Northwest have experienced a high degree of fragmentation due to clearcut harvest practices in this century (Harris 1984; FEMAT 1993; Thomas et al. 1993). The relation between increased bird nest predation and forest fragmentation has been established in several studies. Bryant (1994) demonstrated that artificial ground and shrub nests located within 328 feet of a forest clearcut edge suffered higher rates of predation than did nests located between 328 feet and 1,804 feet from an edge. Paton (1994) summarized data that demonstrated that songbirds had reduced nesting success when their nests were located near a forest edge. Populations of corvids (jays, ravens, and crows) have been observed to increase in forest edges in British Columbia (Bryant, personal communication, cited in Burger 1995a p. 158) and in the west in general (Marzluff 1994). Densities of great horned owls are also higher in fragmented forests as compared to areas with more contiguous stands (Johnson 1993). Corvids are known predators of marbled murrelets, and great horned owls are suspected predators of murrelets (Nelson and Hamer 1995b).

In addition to the above evidence, Nelson and Hamer (1995b) found that successful murrelet nests were farther from an edge than nests that failed due to predation. Stand size was greater and amount of canopy closure near the nest was higher for successful than for unsuccessful nests; however, the difference was not significant between nests that failed due to predation and nests that failed due to other reasons. Finding these characteristics of successful nests led Nelson and Hamer (1995b) to conclude that changes in configuration of habitat, such as amount of edge, may significantly affect nesting success.

Forest fragmentation also poses the risk of isolation of small sub-populations of murrelets. Small sub-populations that do not interact to a high degree with other sub-populations are susceptible to extirpation through a variety of mechanisms: inbreeding depression, which reduces the fitness of the population (Frankle and Soule 1981; Saunders et al. 1991); random demographic fluctuations, i.e., an unfavorable ratio of males to females or breeding adults to non-breeding adults or subadults; and random environmental catastrophes. (See discussion of spotted owl demography in Section A of this chapter.)

Evidence discussed in this review suggests that the amount of nesting habitat is a limiting factor for murrelet populations at this time (See also Ralph et al. 1995a.). In addition, marbled murrelet nests are extremely vulnerable to loss through predation (Nelson and Hamer 1995a, b). Loss of a chick through predation in turn appears to be influenced by the distance of the nest from forest edge (Nelson and Hamer 1995b). Thus, the overall amount, size, and contiguity of suitable nesting stands are important factors in murrelet conservation.

The U.S. Fish and Wildlife Service has designated critical habitat for the marbled murrelet (Federal Register v. 61, no. 102, p. 26255-26320). Most of this habitat designation includes lands that are to be managed as Late successional Reserves under the President's Northwest Forest Plan (USDA and USDI 1994 a and b). Some nonfederal land has been included, the vast majority of which is DNR-managed land. Most of this land occurs in southwest Washington and on the Olympic Peninsula. The U.S. Fish and Wildlife Service conducted an assessment of the effects of the HCP strategies on designated critical habitat on DNR-managed lands, the results can be found in the Biological Opinion.

Mortality at Sea

High rates of adult survivorship are necessary to maintain population stability in species with low reproductive output. Marbled murrelets are particularly sensitive to adult mortality because they only produce one egg per nesting attempt (Beissinger 1995; Ralph et al. 1995a). Thus, human-caused mortality of adult murrelets above natural levels can have significant negative impacts to the murrelet population. Large oil spills, chronic oil pollution, organochlorine pollution, and entanglement in gill nets are significant sources of mortality for marbled murrelets at sea.

Oil spills destroy the ability of feathers to regulate a bird's body temperature; oil also affects most of a bird's physiological systems (Burger and Fry 1993). The 1989 *Exxon Valdez* oil spill directly killed approximately 5,000 marbled murrelets and 3,000 unidentified murrelets, which included marbled murrelets, Kittlitz's murrelets, and ancient murrelets in Prince William Sound, Alaska (Carter and Kuletz 1995); this was the largest recorded single mortality event for marbled murrelets in North America (Carter and Kuletz 1995). Indirect effects on murrelets from the spill included sub-lethal levels of oil that reduced prey populations, disturbance from increased human activity in Prince William Sound during clean-up and monitoring after the spill, and reduced reproductive output of the local population in the vicinity of the spill (Irons 1992; Oakley and Kuletz 1994; Oakley et al. 1994; Kuletz in press; Piatt and Anderson in press; Carter and Kuletz 1995).

Oil spills also pose a significant threat to murrelets in Washington, Oregon, and California, where there is a high volume of commercial shipping, and barge and oil tanker traffic along the Pacific coast (Fry 1995). Several medium to large oil spills have occurred along the Pacific coast within the range of the murrelet since the late 1800s. Collection of systematic records of seabird carcass recovery did not begin until recently. Seven major spills have occurred in Washington since 1971. Oiled murrelet carcasses were recovered at the 1985 *Arco Anchorage* spill near Port Angeles and the 1988 *Nestucca* spill off Grays Harbor. Approximately 45 murrelet carcasses were recovered at the site of the 1991 *Tenyo Maru* spill off Willapa Bay, and estimates suggested that a total of 200-400 murrelets actually died. This represents a large portion of the local breeding population (Carter and Kuletz 1995) and is the largest recorded loss of murrelets to an oil spill on the U.S. Pacific coast south of Alaska (WFPB 1995). Thus, small murrelet populations could potentially be eliminated in a single oil spill event.

Chronic oil pollution, including small spills, bilge seeps, dumping, and undetected slow leaks from coastal tanks, pumps, and pipelines, can also pose a threat to the murrelet population. This type of oil pollution is poorly documented, making an assessment of the level of threat difficult. However, retrieval of dead oiled murrelets on beaches in times that did not coincide with medium to large oil spills indicates that chronic oil pollution does kill (Carter and Kuletz 1995). Murrelet populations in the Puget Sound and the Columbia River/Grays Harbor areas of Washington are highly susceptible to oil pollution from tanker traffic. Because the Puget Sound area is highly industrialized, the likelihood of murrelet exposure to chronic oil pollution from small spills is also increased.

Fry (1995) identified organochlorine compounds as a prevalent non-oil pollution threat within the range of the murrelet. Specifically, polychlorinated dibenzo-dioxins (PCDD) and polychlorinated dibenzo-furans (PCDF), which are contained in pulp-mill discharges, cause significant injury to fish, birds, and estuarine environments (Elliot et al. 1989; Whitehead 1989; Colodey and Wells 1992; Fry 1995). PCDDs and PCDFs bioaccumulate in marine sediments, fish, and fish-eating birds and impair bird production (Elliot et al. 1989; Bellward et al. 1990). There has been no record of bioaccumulated residues or breeding impairment in marbled murrelets to date, although murrelets that feed in areas of historic or current discharge from bleached paper mills could be at risk from eating fish with bioaccumulated organochlorine compounds (Fry 1995). Active chlorine bleach mills in Washington are located in Port Angeles, Bellingham, Everett, and Grays Harbor.

Mortality to murrelets from gill net fisheries is well documented in Alaska and British Columbia, but not in Washington (Carter et al. 1995). Results of several seabird observer programs initiated in 1993 are still preliminary. The U.S. Fish and Wildlife Service estimated a total take of 10 murrelets from all-citizen fisheries programs and tribal fisheries for 1993, which they did not judge to put the species in jeopardy (Carter et al. 1995 p. 281). However, Carter et al. (1995) estimate that there is significant mortality from gill and purse seine nets in the northern Puget Sound and San Juan Islands because of the high concentration of fishing activities and coincidence of a large portion of the murrelet breeding population there. They estimate that take is on the order of tens to hundreds of birds and recommend continuation and augmentation of observer programs in order to assess more accurately the impact of gill nets to murrelets in Washington.

DNR's Forest Habitat Relationship Studies

DNR is conducting a marbled murrelet forest habitat relationships study in each of the HCP planning units within the murrelet's Washington range. The objective of the habitat relationships studies is to determine the influences of distance from marine waters and habitat type on murrelet occupancy of DNR-managed forest lands. Results will be used to formulate a threshold definition of murrelet habitat for DNR-managed forest lands and to develop a long-term murrelet conservation strategy.

DESIGN

Two years of murrelet surveys will be conducted in each of the five westside HCP planning units and the Olympic Experimental State forest. Each planning unit will contain 54 survey areas on DNR-managed lands. These survey areas will be stratified by two factors: (1) distance from marine waters and (2) habitat type (Table III.6). Habitat descriptions of the survey areas will characterize forest conditions, nesting opportunities, and topography.

In each planning unit, 18 survey areas will be selected in each of three distance bands (near, mid, and far). Band width will be based on the distribution of DNR-managed lands from marine waters, each band containing a third of the DNR-managed lands within the planning unit. Thus, actual band width will differ within and among planning units.

Within each distance band, six survey areas will be located in each of three habitat classes: old-forest habitat with an average density of at least two suitable nesting platforms per acre, young-forest habitat with an average density of at least two suitable nesting platforms per acre and young-forest habitat with at least one suitable nesting platform. For the purposes of these studies, old forest will be defined as old-growth forests or mature forests where most of the co-dominant trees are more than 120 years old. Young forest will be defined as sub-mature forests where most of the co-dominant trees are less than 120 years old. A suitable nesting platform is a horizontal limb, tree structure, or deformity at least 7 inches in diameter and a minimum of 50 feet above the ground.

Table III.6: Allocation of survey areas in each planning unit, by habitat type and distance from marine waters

Habitat type	Distance of area from marine waters		
	Near band	**Mid band**	**Far band**
Old forest, ≥2 platforms/acre	6	6	6
Young forest, ≥2 platforms/acre	6	6	6
Young forest, at least 1 platform	6	6	6

In each planning unit, survey areas will be selected to ensure consistency within each habitat class. Consistency will be sought in terms of landscape context, forest type, elevation, stand origin, stand size, and distribution of platforms in the survey area. To ensure that each survey area represents an independent sampling unit, survey areas will be at least one-half mile apart.

Each survey area will be surveyed from two, three, or four stationary survey stations. Theoretically, one survey station can cover up to 30 acres of habitat, allowing for a maximum survey area size of 120 acres. However, because in many places actual station coverage will be less than 30 acres, we will select survey areas between 40 and 80 acres in size will be selected. This assumes an actual station coverage of about 15 acres per station, half the theoretical maximum. Stands less than 20 acres will not be considered as survey areas.

Each planning unit will be surveyed for two consecutive years. In year 1, each survey area will be visited on at least four mornings. Survey areas where murrelet presence is detected will receive two additional survey visits, for a total of six visits. In year 2, each survey area will again be

Table III.7: Prescribed number of visits for each survey area for both years of the DNR marbled murrelet forest habitat relationships studies

Year-1 status	Year-2 status	Number of year-1 visits	Number of year-2 visits	Number of total visits
No detections	No detections	4	4	8
	Presence	4	10	14
	Occupancy	4	6-10*	10-14*
Presence	No detections	6	10	16
	Presence	6	10	16
	Occupancy	6	6-10*	12-16*
Occupancy	No detections	6	6	12
	Presence	6	6	12
	Occupancy	6	6	12

*The number of year-2 survey visits and total visits depends on when occupancy is determined in year 2.

Definitions

detection: The sighting or hearing of one or more murrelets acting in a similar manner.

presence: A stand of potential habitat where one or more murrelets have been seen or heard.

occupancy: A stand of potential habitat where (1) an active nest or recent nest site has been discovered as evidenced by a fecal ring or eggshell fragments, (2) a chick or eggshell fragments have been discovered on the forest floor, or (3) murrelets have been observed exhibiting subcanopy behaviors. See discussion titled Flight Behavior earlier in this section for examples of subcanopy behaviors.

visited on at least four mornings. Survey areas where murrelet presence was detected in year 1 or is detected in year 2 but occupancy has not been confirmed will be surveyed until (a) occupancy is confirmed and six year-2 survey visits have been completed or (b) ten year-2 survey visits have been completed, whichever comes first. Survey areas where murrelet occupancy was determined in year 1 will receive six year-2 survey visits (Table III.7).

Observations will be made and data recorded according to procedures described in Methods for Surveying Marbled Murrelets in Forests: A Protocol for Land Management and Research (Ralph et al. 1994) and its 1995 supplement (Ralph et al. 1995b) and any subsequent updates or modifications as required by the U.S. Fish and Wildlife Service. Data will also be mapped for input into an ARC/INFO coverage on DNR's geographic information system.

The habitat of each survey area will be accurately described with respect to forest conditions, nesting opportunities, and topography. This information will be used to determine the influences of these factors on murrelet occupancy of DNR-managed forest lands. Habitat descriptions will:

(1) be made using objective, scientifically accepted methods that can be repeated with the same results,

(2) be made in a manner that allows comparison with results of other studies of murrelet habitat relationships,

(3) describe forest conditions within the entire survey area, and

(4) be limited to those variables that might reasonably influence murrelet occupancy of DNR-managed forest lands.

STUDIES IN PROGRESS

In 1994, marbled murrelet forest habitat relationships studies were initiated in the South Coast and most of the Olympic Experimental State Forest HCP planning units. This work was carried out by the Washington Department of Fish and Wildlife through an interagency agreement with DNR.

In 1995, year 2 of murrelet surveys in the South Coast and most of the Olympic Experimental State Forest planning units were again conducted by the Washington Department of Fish and Wildlife, which completed the habitat relationships studies for these planning units. Also in 1995, habitat relationships studies were initiated in the Columbia and Straits (including the rest of the Olympic Experimental State Forest) planning units; this work is being carried out by DNR. Year 1 of marbled murrelet surveys and habitat descriptions of survey areas will be completed in the Straits and Columbia Planning Units.

C. Other Federally Listed Species Within the Range of the Northern Spotted Owl

Nine wildlife species within the range of the northern spotted owl are listed by the federal government as threatened or endangered: the northern spotted owl, marbled murrelet, Oregon silverspot butterfly, Aleutian Canada goose, bald eagle, peregrine falcon, gray wolf, grizzly bear, and Columbian white-tailed deer. Discussions of species ecology for the spotted owl and marbled murrelet are found in Sections A and B of this chapter, respectively. Habitat needs of the other seven species are reviewed below, followed by Table III.8, which lists for each of the nine species its federal and state status and in which HCP planning unit each could potentially occur.

Oregon Silverspot Butterfly

The Oregon silverspot butterfly (*Speyeria zerene hippolyta*) is the only federally listed species of arthropod that is found in Washington (WDW 1993a). This butterfly is currently listed by the federal government as threatened and by the state as endangered. However, no critical habitat in Washington has been designated under the Endangered Species Act (WDW 1993b).

The Oregon silverspot is found only in habitats that support its larval host plant, western blue violet (*Viola adunca*). Such habitats include coastal salt-spray meadows and open fields. In Washington, potential habitat for the Oregon silverspot is limited to the coastal grasslands on the Long Beach peninsula near Loomis Lake (WDW 1993b; WDW 1991). Adult butterflies are thought to rest and feed in adjacent open spruce/shoreline pine forest glades, where they are protected from wind and can feed on nectar available from a number of plant species. (WDW 1993b; WDW 1991). The presence of heavy grass thatch and woody plant invasion threatens the silverspot butterfly habitat. DNR manages accreted lands on the Long Beach peninsula that could contain Oregon silverspot habitat.

Aleutian Canada Goose

The Aleutian Canada goose (*Branta canadensis leucopareia*), a subspecies of the Canada goose, was downlisted by the federal government from endangered to threatened in 1990 (Federal Register v. 55, no. 239, p. 51112). The subspecies is listed as endangered by the state. The subspecies is distinguished from the other locally ubiquitous species by a broad white ring at the base of the neck. A major cause of the early decline of the Aleutian Canada goose was predation by foxes and other small mammals in the subspecies' nesting areas which are located on Buldir and Chagulak islands in the Aleutian Archipelago and on Kaliktagik in the Semidi Islands in Alaska. In the early 1800s, foxes were introduced onto the Aleutian islands and neighboring islands as a fur supply and some rodents were inadvertently introduced with the landing of ships. The winter range was not defined until the early 1970s. Wintering areas extend from Alaska to California and into parts of Japan. From less than 800 individuals in 1975, their numbers have increased to 12,000-14,000 individuals in 1994. The most recent counts indicate about 20,000 individuals. Currently the San Joaquin Valley, northern California coast, and Sacramento Valley form the subspecies' main wintering area, but they also winter in western Oregon and southwestern Washington. They regularly stop in the Willamette Valley of Oregon in September or October. Their winter range is expanding as the population increases. The species may occur in the area covered by the HCP but only as a migrant or winter resident. Habitat used during migration or winter residency includes lakes, ponds, wetlands, grasslands, and agricultural fields. Control of foxes, use of seasonal Canada goose hunting closures to reduce incidental take, and conversion to nontoxic shot have all contributed to the recovery of the subspecies.

Bald Eagle

The bald eagle *(Haliaeetus leucocephalus)* is listed by both the federal government and the state as threatened (WDW 1993a). Throughout Washington, the bald eagle typically occurs along the coasts, major rivers, lakes, and reservoirs (USDI 1986). Potential habitats are riparian areas along rivers, streams, lakes, sloughs, and reservoirs; coastal estuaries and beaches; freshwater beaches; and mature and old-growth forest stands within 1 mile of water (Brown 1985).

Washington supports the largest population of nesting bald eagles in the seven-state area covered by the Pacific States Bald Eagle Recovery Plan (USDI 1986). Most nesting in Washington occurs on the San Juan Islands and along the Olympic Peninsula coast; however, nesting territories are also found along Hood Canal, on the Kitsap Peninsula, in Island, Pierce, and Thurston counties, along the Columbia River in southwestern Washington, in the Cascade Range, and in eastern Washington (USDI 1986). Bald eagles typically nest near water, usually on prominent features overlooking aquatic foraging areas (Stalmaster 1987; Anthony and Isaacs 1988). In western Washington, distance between nest sites and water averages 282 feet (Grubb 1976); within the seven-state recovery area, nest sites are generally within 1 mile of water (USDI 1986). The average territory radius ranges from 1.55 miles in western Washington to 4.41 miles along the lower Columbia River, where reproduction rates are low (Grubb 1980; Garrett et al. 1988). The three main factors affecting distribution of nests and territories are:

(1) proximity to water and food,

(2) suitable nesting, perching, and roosting trees, and

(3) the number of breeding eagles (Stalmaster 1987).

Nest sites in western Washington are found most commonly in Douglas fir and Sitka spruce trees. Nest trees average 116 feet tall and 50 inches dbh and typically exceed the U.S. Forest Service's minimum diameter-at-breast-height specifications for old-growth inventory (Anthony et al. 1982).

Washington also supports the largest population of wintering bald eagles in the seven-state recovery area. Primary wintering areas include the Olympic Peninsula, the San Juan Islands (particularly Cypress Island), Puget Sound and its tributaries, Hood Canal, and the Cowlitz and Columbia rivers. The Skagit River supports one of the largest concentrations of wintering bald eagles in the contiguous United States, with as many as 553 individuals counted during peak periods. At least six bald eagle winter communal roost sites occur along the North Fork of the Nooksack River, all at least partially on DNR-managed land. Food availability is the major factor that attracts bald eagles to wintering locations (Stalmaster 1987). Many areas that have abundant populations of overwintering waterfowl or salmon runs also support large concentrations of wintering eagles (Biosystems Analysis, Inc. 1984; Keister et al. 1987).

Bald eagles use perches during nesting, hunting, feeding, territorial maintenance, and behavioral displays (Stalmaster 1987). Eagles select perches that provide a good view of the surrounding territory; typically, the tallest perch tree available is preferred (Stalmaster 1987). Along the Nooksack River, dead trees are strongly preferred as daytime perches during the winter; tree species commonly used are black cottonwood, big leaf maple, or Sitka spruce (Stalmaster and Newman 1979). Because of its relatively low height, red alder is used less often (Stalmaster 1976).

Wintering bald eagles often roost communally in single trees or large forest stands. Most of these areas are near a rich winter food source (typically anadromous fish and water fowl) and in forest stands that are of uneven ages and have some old-growth characteristics (Anthony et al. 1982). Many roost sites are in ravines and draws that protect eagles in bad weather (Hansen 1978; Keister 1981). Roost sites are generally positioned in the tallest, most dominant trees that provide unobstructed views of the surrounding landscape (Anthony et al. 1982). In western Washington, communal roost sites have been documented in black cottonwood, Douglas fir, western redcedar, western hemlock, and other tree species (Hansen et al. 1980; Anthony et al. 1982).

Anthony and Isaacs (1988) recommend that habitat alterations not occur within 1,312 feet of bald eagle nests and that disturbance activities within 2,625 feet of nests be restricted between January 1 and August 15. The Pacific States Bald Eagle Recovery Plan (USDI 1986) recommends temporary buffers of 1,312 feet around screened roosts and 2,625 feet around visible roosts. Timber harvests can occur, but only between November 1 and April 1. Along foraging areas, a 164- to 326-foot wide strip of tall perch trees should be maintained. Stalmaster (1987) recommends that a buffer zone of 820 to 984 feet be maintained where little screening cover is present. Under WAC 232-12-292, the Washington Department of Fish and Wildlife works with landowners to design site-specific management plans that provide flexible land use instead of setting standard buffer distances.

Peregrine Falcon

The peregrine falcon (*Falco peregrinus*) is listed by both the federal government and the state as endangered (WDW 1993a). In Washington, three subspecies occur: *F. p. anatum, F. p. peali,* and *F. p. tundrius* (Allen 1991), but only *F. p. anatum* is believed to nest here (Peregrine Falcon Recovery Team 1982; Johnsgard 1990). Fifteen nesting pairs of peregrine falcons were recorded along the outer coast, in the San Juan Islands, and along the Columbia River Gorge in 1990 (Allen 1991). Washington primarily provides important migratory and wintering habitat for peregrines, including estuaries such as Skagit River flats, Grays Harbor, and Willapa Bay, where falcons prey on large concentrations of waterfowl and shorebirds. *F. p. peali* and *F. p. tundrius* are present as winter migrants.

Most peregrine nests are on cliffs or high escarpments that dominate the nearby landscape, although office buildings, bridges, and river cutbanks have also been used for nesting (PFRT 1982; Craig 1986). Most preferred nesting cliffs are at least 150 feet high and can be found from sea level to 11,000 feet (PFRT 1982). Foraging habitat includes marshes, lakes, river bottoms, croplands, and meadows where peregrines prey primarily on songbirds, waterfowl, and shorebirds (Porter and White 1973). During the breeding season, peregrine falcons will travel as far as 17 miles from the aerie to hunt, although a hunting range of 10 miles is considered typical (Porter and White 1973; PFRT 1982).

Human disturbance during the nesting season can greatly inhibit peregrine falcon nesting success. Guidelines for protection of falcon nest sites include prohibition of land-use activities that alter or eliminate characteristics of hunting and prey habitat within 10 miles of aeries and of nesting habitat within 1 mile of a nest cliff. Disturbances and human activities should also be restricted from February 1 through August 1 within 0.5 mile of a nest cliff (PFRT 1984).

Gray Wolf

The gray wolf *(Canis lupus)* is listed by both the federal government and the state as endangered in Washington (WDW 1993a). This species ranges over large areas (Laufer and Jenkins 1989) and potentially occurs throughout the same range as that of the grizzly bear (see below), as well as the Washington Cascade mountains south to the Columbia River.

The gray wolf uses virtually any type of forest and natural opening as long as the level of human activity is low and there is an ungulate prey base (Laufer and Jenkins 1989). Because the wolf is currently becoming re-established throughout many parts of Washington and little data have been collected on its habitat use, all naturally vegetated lands should be considered potentially suitable habitat for this species. Vegetation types used include quaking aspen, mixed conifer, ponderosa pine, white or grand fir, alpine meadows, shrublands, riparian zones, marshes, bogs, and swamps (Thomas 1979). Wolf dens are normally located under logs or in rock outcrops.

The species is wide-ranging. On Vancouver Island, in temperate conifer forests similar to those in the area covered by HCP, two home ranges for wolf packs were 40 and 47 square miles (Scott 1979).

Grizzly Bear

The grizzly bear *(Ursus arctos)* is listed by the federal government as threatened in Washington (USDI 1993) and by the state as endangered (WDW 1993a). This species potentially occurs throughout the Cascade Range, from Canada south to near Yakima, and across the northern third of the state from the Okanogan Highlands to the Idaho border (Almack et al. 1993). The federally designated North Cascades Grizzly Bear Ecosystem extends through this region at elevations from about 492 to 10,778 feet. In the east- and west-side planning units of the HCP, DNR manages 122,300 acres in the North Cascades Grizzly Bear Recovery Area. The grizzly bear ranges over large areas and typically uses many vegetation types to fulfill its life requisites. Of special importance to bears are wet meadows, swamps, bogs, streams, and conifer, subalpine, and lodgepole pine forests, as well as alpine meadows and parklands (Brown 1985). However, these habitats alone would not be sufficient for supporting this species. Areas with little human disturbance may be preferred as habitat; many studies have shown the potential negative effect of human disturbance on grizzly bears (McLellan and Shackleton 1988; Kawsorn and Manley 1989; Mace and Manley 1993).

All naturally vegetated land types are considered suitable grizzly bear habitat. Den sites of grizzly bears can be found in nearly any type of forest, but are typically in coniferous forests. Bears normally select den sites on steep slopes near the tree line (Almack 1986). Bears forage in many vegetation types in order to obtain sufficient plant and animal foods. Their diet includes 124 species of plants, winter-killed ungulates, small mammals, and anadromous fish (Almack et al. 1993). Some DNR-managed parcels of land within the federally designated North Cascades Grizzly Bear Recovery Area could potentially provide lower elevation spring habitat for grizzly bears.

Grizzly bears are wide-ranging. Knight et al. (1988 as discussed in USDI 1993) estimated a density of one bear per 16 square miles in the U.S. portion of the Selkirk Ecosystem (northeast Washington and northwest Idaho). Assuming a circular home range, a territorial bear would range over a distance of 4.5 miles, the home-range diameter. Ten miles is thought to be the minimum "long distance movement" for grizzlies in the Selkirk Mountains. (Almack 1986).

Columbian White-tailed Deer

The Columbian white-tailed deer (*Odocoileus virginianus leucurus*) is listed by both the federal government and the state as endangered in Washington. The deer's current range is limited to areas less than about 10 feet above sea level (USDI 1983). Approximately 700 to 1,000 Columbian white-tailed deer occur along the Columbia River (USDI 1983). They are found only in bottomlands and on several islands in an 18-mile reach of the Columbia River near Cathlamet, Washington, and in an area near Roseburg, Oregon (USDI 1983). In Washington, these deer occur in the Julia Butler Hansen Columbian White-tailed Deer National Wildlife Refuge, and on Puget, Brown, Jackson, Ryan, Little, and Hunting Islands, which are owned privately or managed by DNR. Several DNR parcels of land in the refuge and on Puget Island are leased to the U.S. Fish and Wildlife Service and private landowners. Some of the deer's range is within the Columbia Planning Unit of this HCP.

Potential habitat for the Columbian white-tailed deer includes Columbia River bottomland riparian forests (alder, cottonwood, and spruce), grassland, pastures, and farmland not occupied by black-tailed deer (WDW 1991). Columbian white-tailed deer are primarily grazers, feeding in active and abandoned farm fields and pastures within 750 feet of forest cover and forest parks (WDW 1991). The deer's historical habitats include tidal spruce swamps, park forest, open-canopy forest, sparse rush, and wetlands (USDI 1983). Spruce, alder, cottonwood, and willow are common tree and shrub species used by deer for foraging, resting, and thermal cover (USDI 1983).

Although the population of Columbian white-tailed deer is apparently doing well (i.e., down- or de-listing this population has been considered), range expansion has not occurred, primarily because black-tailed deer have taken over other suitable habitat along the Columbia River, precluding white-tailed deer from using these areas.

Table III.8: Federally listed wildlife, their state status, and their potential occurrence in HCP planning units

SE = state endangered, ST = state threatened (WDW 1993a); OESF = Olympic Experimental State Forest.

		Planning Unit								
Species	State Status	Klickitat	Columbia	South Coast	South Puget	Yakima	Chelan	North Puget	Straits	OESF
Federally listed as threatened:										
Northern spotted owl	SE	X	X	X	X	X	X	X	X	X
Marbled murrelet*	ST	X	X	X	X	X	X	X	X	X
Oregon silverspot butterfly	SE			X						X
Bald eagle	ST	X	X	X	X	X	X	X	X	X
Grizzly bear	SE				X	X	X	X		
Aleutian Canada goose	SE		X	X	X			X		X
Federally listed as endangered:										
Peregrine falcon	SE	X	X	X	X	X	X	X	X	X
Gray wolf	SE	X	X		X	X	X	X		
Columbian white-tailed deer	SE		X							

*Potential habitat for the marbled murrelet exists in the east-side planning units. However, at this time, the marbled murrelet is not known to inhabit the east-side planning units.

D. Salmonids and the Riparian Ecosystem

Introduction

Salmon are one of the most important natural resources for the economy of the state of Washington. The resource is exploited by three main fishing groups: nontreaty commercial, treaty (Indian) commercial, and recreational fishers. From 1981 to 1990, the total marine and freshwater salmon catch for Washington averaged 7.2 million fish per year (Palmisano et al. 1993). According to historical records, the peak harvests between 1961 and 1979 were 57 percent lower than those between 1864 and 1922 (The Wilderness Society 1993). This large reduction in the productivity of the Pacific Northwest salmon fishery has been attributed to many factors, including large-scale water projects (dams), poor fisheries management (overfishing and hatchery practices), urbanization, agriculture, and detrimental forest practices (Palmisano et al. 1993; Nehlsen et al. 1991). As a consequence, some stocks east of the area covered by the HCP have been listed by the federal government as threatened, and several stocks in the area covered by the HCP are candidates for federal listing.

Bull trout (*Salvelinus confluentus*) and seven species of anadromous salmonids inhabit the rivers and streams of western Washington: sockeye salmon (*Oncorhynchus nerka*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), and sea-run cutthroat trout (*O. clarki*). Anadromous fish spend part of their life at sea and return to freshwater to reproduce. During the portion of their life cycle spent in rivers and streams, these fish are vulnerable to forest practices that affect the integrity of riparian ecosystems (Hicks et al. 1991).

The life cycles of anadromous salmonids and bull trout are reviewed separately below, followed by a discussion of general salmonid habitat needs and the riparian ecosystem. The section ends with a review of current status and distribution of these species.

Anadromous Salmonid Life Cycle

Sockeye, pink, chum, chinook, and coho salmon and steelhead and sea-run cutthroat trout each have unique geographical distributions, life cycles, and habitat requirements. But from the perspective of forest land management, the similarities among the anadromous species of the family Salmonidae far outweigh the differences. There are few significant differences in the ways that forest practices impact each species. Therefore, in the following discussion, distinctions among the life cycles of these species are not emphasized. For additional information, the natural history and habitat requirements of salmonids are thoroughly reviewed by Groot and Margolis (1991) and Meehan (1991). The effects of forest management on salmonid freshwater habitat are reviewed by Salo and Cundy (1987), Meehan (1991), and Naiman (1992).

The salmonid life cycle consists of seven principal stages: egg, alevin, fry, parr, smolt, subadult, and adult. Eggs are laid in a nest, or redd, constructed by an adult female in a gravel streambed. After the eggs are laid and fertilized, the female covers them with gravel. Alevins hatch from the eggs after about three months of incubation (Meehan and Bjornn 1991). This larval stage is characterized by the presence of a yolk sac. Alevins can reside in the gravel for several months and emerge upon becoming fry, the next stage in their development (Meehan and Bjornn 1991). Because fry are small and weak, they are highly susceptible to predation. They are unable to swim against strong currents and therefore tend to stay along the stream margins in channel pools and eddies. Pink and chum juveniles remain in freshwater for a short period (0 to 30 days). Other species, in particular coho, steelhead, and cutthroat, remain in freshwater for 1 to 4 years (Palmisano et al. 1993). As fry become larger and stronger, they develop dark vertical bars on their sides called parr marks, and hence are known as parr. Parr venture away from the stream margins into swifter currents where larger prey are more prevalent. The juveniles of coho, steelhead, and cutthroat spend the summer months competing for food and space (Chapman 1966). Juveniles of some species (particularly coho) overwinter in tributaries, sloughs, and side channels (Emmett et al. 1991). Depending on the species, these juvenile freshwater stages end a few days to four years after leaving the redd and are marked by migration toward the sea (Meehan and Bjornn 1991).

Parr become smolts as they migrate to estuaries, where they remain until they complete the physiological changes needed to survive in the marine environment. Subadults spend one to four years in the ocean (Meehan and Bjornn 1991). During this time, individuals undertake long migrations, some traveling more than 1,000 miles. The path and distance are affected by ocean currents and abundance of prey. Some salmonid species migrate as far as the western portions of the Gulf of Alaska (Emmett et al. 1991). The vast majority of subadults return to the stream of their origin, but some natural straying into non-natal streams does occur (Waples 1991). The timing of this upstream migration varies among species and stocks.

Just prior to entering freshwater, individuals begin a dramatic metamorphosis to the adult or spawning stage. Most species develop a noticeable difference between sexes (sexual dimorphism). Spawning typically occurs in shallow riffle areas of a stream. Both sexes may mate with several partners before dying. In some species, females may guard the redd. Trout species can survive after spawning, migrate back to the ocean, and return to spawn one or two more years (Emmett et al. 1991). Chemical nutrients released through the decay of adult carcasses may be critical to the health of riparian ecosystems and probably sustain the productivity of the next generation of juvenile salmon (Willson and Halupka 1995). Some differences among life cycles of western Washington anadromous salmonids are summarized in Table III.9.

Bull Trout Life Cycle

The bull trout is a candidate for federal listing. The genus *Salvelinus*, also known as charr, belongs to the family Salmonidae. One other member of this genus is native to Washington, the Dolly Varden (*S. malma*). Until 1978, when it was recognized by Cavender (1978) as a separate species, bull trout was considered to be Dolly Varden. The separate classification was officially recognized in 1980 (Mongillo 1993). However, the geographic range of the two species overlaps in Washington and British Columbia (Goetz 1989), and the two species use the same freshwater habitat (Mongillo 1993; Brown 1994), have similar life histories, are known to hybridize (Mongillo 1993; Goetz 1989), and are difficult to distinguish. Information on geographical distribution and population status developed by the Washington Department of Fish and Wildlife is recorded as bull trout/Dolly Varden (Mongillo 1993; WDFW 1994b).

Bull trout populations exhibit anadromous, adfluvial, fluvial, and resident behaviors. Anadromous forms mature at sea, adfluvial in lakes, and fluvial in the main stem of rivers. The life cycle and freshwater habitat of bull trout are similar to that of salmon (genus *Oncorhynchus*). (See the preceding discussion of salmon life cycle and the following discussion of habitat needs.)

Table III.9: Life cycles of western Washington anadromous salmonids in freshwater, by species and run

(Source: Palmisano et al. 1993)

Species (Run)	**Age at return (years)**	**Time of return**	**Spawning season**	**Area of juvenile development**	**Time in freshwater**	**Place of origin**
Chinook salmon (Spring)	2 - 6	Mar - May	Early fall	streams, rivers, estuaries	90 days to 1 yr	hatchery & wild
Chinook salmon (Summer)	2 - 5	Jun - Jul	Late Sep - Nov	streams, rivers, estuaries	90 - 180 days	hatchery & wild
Chinook salmon (Fall)	2 - 5	Aug - Sep	Fall	streams, rivers, estuaries	90 - 180 days	hatchery & wild
Sockeye	3 - 5	Mar - Jul	Sep - Jan	lakes	1 - 2 years	wild in lakes
Coho salmon	2 - 3	Aug - Nov	Oct - Dec	streams, rivers, lakes	1 year	hatchery & wild
Chum salmon	3 - 5	Sep - Mar	Sep - Mar	estuaries	0 - 30 days	hatchery & wild
Pink salmon	2	Aug - Sep	Sep - Oct	estuaries	0 - 7 days	wild
Steelhead trout[1] (Winter)	4 - 6	Nov - Apr	Jan - Jun	streams, rivers	2 - 3 years	hatchery & wild
Steelhead trout[2] (Summer)	3 - 5	May - Oct	Jan - Jun	streams, rivers	2 years	hatchery & wild
Cutthroat trout[1] (Sea-run)	2 - 6	Jul - Dec	Dec - Jun	streams, rivers	1 - 4 years	hatchery & wild

[1]Less than 5 percent of returning fish are repeat spawners.

[2]Less than 1 percent of returning fish are repeat spawners.

Adults spawn in September and October (Brown 1994). Typically, redds are built by a single pair. Eggs incubate until about March (Brown 1994), when fry emerge from the gravel and become free-swimming (Goetz 1989). Juveniles are territorial. They are found immediately above, on, or within the stream bed (Pratt 1992), often in pockets of slow water formed by cobbles and woody debris. Individuals less than about 4.3 inches long feed on aquatic insects, and their diet includes more fish as they become larger. Anadromous, adfluvial, and fluvial juveniles migrate downstream at age two or three (Brown 1994). Adfluvial bull trout mature for two to three years before they are ready to spawn (Brown 1994).

Adult bull trout move upstream beginning in April, and the majority reach tributary streams in August. The strength of homing to natal streams may vary with each population (Goetz 1989). Once there, they seek cover in deep pools, large woody debris, and undercut banks until it is time to spawn. Males may spawn more than once in a single season (Goetz 1989), and both males and females, can spawn in either successive or alternate years (Brown 1994). After spawning, adults return to the sea, lake, or mainstem river, depending on their life history.

Bull trout are a cold-water species; they are often found near cold perennial springs. The development of eggs and alevins requires very cold water, optimally between 35.6° and 39.2° F (Goetz 1989). In Washington, the most intense spawning occurs in water that is 41° to 42.8° F (Brown 1994). Adults prefer deep pools of cold water and are seldom found in streams warmer than 64.4° F (Brown 1994).

Eggs, alevins, and fry require clear water. The embryonic stages remain in the redd for about 223 days (Goetz 1989), and this prolonged period makes them highly susceptible to the deposition of fine sediments, which can reduce the flow of oxygenated water through the redd or can entomb emerging fry (Pratt 1992). Fry are bottom dwellers and prefer small pockets of slow water formed by cobbles and large woody debris. When sediment fills these pockets, they become less suitable as rearing habitat. Juvenile densities decline as this occurs (Pratt 1992).

Habitat complexity provided by woody debris affects stream carrying capacity and survival rates. Population densities increase or decrease with the amount of woody debris (Rieman and McIntyre 1993) that provides protection from predators and enhances overwinter survival (Rieman and McIntyre 1993).

Bull trout are adversely affected by human activities in the same ways that salmon are. Removing riparian vegetation can lead to higher water temperatures, increased sediment loads, and decreased amounts of instream large woody debris (Ratliff and Howell 1992; Murphy and Meehan 1991). The requirements of the eggs and alevins make them highly susceptible to habitat degradation. Juvenile rearing habitat may be an ecological bottleneck that affects the viability of populations (Brown 1994). Of the 46 bull trout/Dolly Varden populations identified within the five west-side planning units and the Olympic Experimental State Forest, 56 percent are impacted by forest management (Mongillo 1993).

Bull trout populations have also been harmed by dams, overfishing, and agriculture as well as by exotic species. Dams block or delay migration, affecting 21 percent of the 77 bull trout/Dolly Varden populations in Washington (Mongillo 1993). Overharvesting by sports fishermen (Mongillo 1993) affects 27 percent of the populations. Agriculture, including grazing, affects 25 percent of the populations. Through competition and hybridization, brook trout (*S. fontalis*), a closely related species introduced to Washington from the eastern United States, poses a threat to 31 percent of the populations (Mongillo 1993).

Salmonid Habitat Needs and the Riparian Ecosystem

Because the life cycles and freshwater habitat needs are similar for the various western Washington anadromous salmon species and bull trout, the following discussion applies to all of them. All freshwater life stages of salmonids require moderate stream flows; cool, well-oxygenated, unpolluted water; low suspended-sediment load; adequate food supply; and structural diversity provided by submerged large woody debris (Cederholm 1994). Well-functioning riparian ecosystems are necessary to satisfy these habitat needs.

The riparian ecosystem is where aquatic and terrestrial ecosystems interact. From water's edge to upland, there exists a continuum of physical and biological characteristics. Nevertheless, the riparian ecosystem can be effectively modeled as three unique zones: an aquatic zone, a riparian zone, and a zone of direct influence (Naiman et al. 1992; see Figure III.1). The aquatic zone is the location of aquatic ecosystems. Adjacent to the aquatic zone is the riparian zone, a narrow band of moist soils and distinctive vegetation. Beyond the riparian zone lie upland areas, and the spatial extent of upland influences on aquatic ecosystems delineates the direct influence zone. The health of the aquatic ecosystems is affected by terrestrial products and processes, most notably shade, soil erosion, litter (e.g., fallen leaves, twigs, and conifer needles), and large woody debris (e.g., tree trunks) (Cederholm 1994). Salmonids inhabit the aquatic zone, but, in effect, their habitat encompasses the entire riparian ecosystem.

THE AQUATIC ZONE

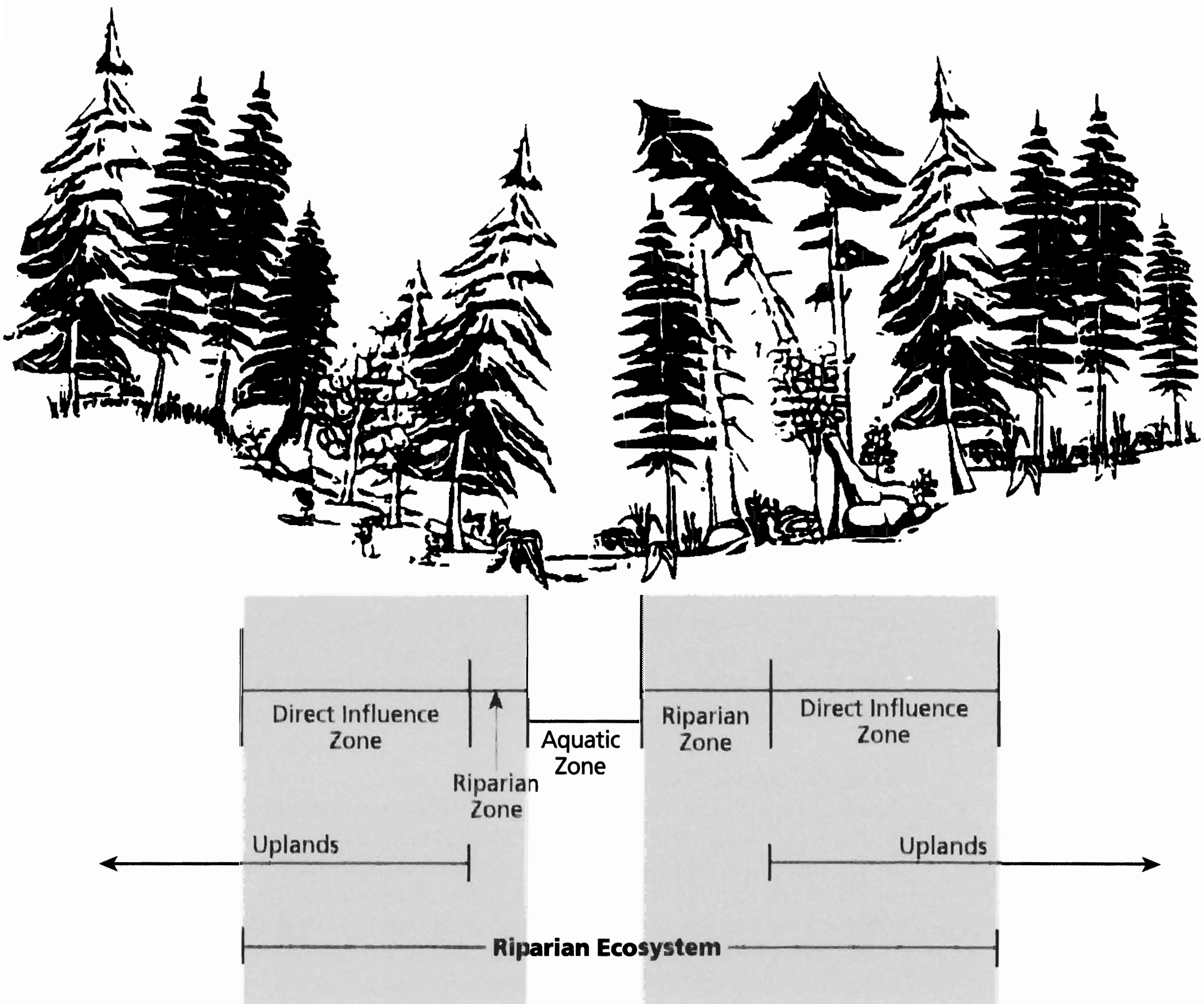
Each salmonid life stage has slightly different critical habitat requirements, and a lack of suitable habitat for a single life stage could affect the viability of an entire stock. Eggs incubating in a redd require a high concentration of dissolved oxygen, which is a function of several environmental variables: water temperature, biological oxygen demand, stream flow, and sediment load (Bjornn and Reiser 1991). High water temperatures decrease the solubility of oxygen in water. High biological oxygen demand, caused by microbial decomposition of organic materials, also decreases the amount of oxygen available to the developing egg. Inadequate streamflow reduces the circulation of fresh oxygenated water through the gravel to the redd as well as the removal of the egg's metabolic wastes (Bjornn and Reiser 1991). Fine sediments settle into the spaces between gravel, which also impedes the flow of water to the eggs (Everest et al. 1987). Excessive streamflow (floods) can destroy redds.

Alevins reside in the redd and have similar needs for clean, cool, well-oxygenated water. Sediment load can affect alevins in an additional way. If the spaces between gravel are blocked by fine sediments, then emerging in dividuals may be entombed within the redd (Everest et al. 1987).

The survival of fry and parr is determined by water quality (temperature, dissolved oxygen, and suspended sediment), food, cover, and space (Bjornn and Reiser 1991). Water temperature affects the rate of growth and development — all cold-water fish cease growth at temperatures above 68.5° F (Reiser and Bjornn 1979). Salmonids are cold-water fish, and their preferred temperature range is between 50° and 57° F (Bjornn and Reiser 1991).

Figure III.1: The riparian ecosystem

Although the riparian ecosystem is a continuum from water's edge to upland, the lines approximate the natural zonation of a riparian forest landscape, i.e., the extent of the riparian ecosystem and the zones within the ecosystem. (Adapted from: Sedell et al. 1989)



The upper lethal temperature limit lies between 73.4° and 78.4° F (Reiser and Bjornn 1979), and the lower lethal temperature limit is near 32° F (Bjornn and Reiser 1991).

Large amounts of small organic material, high temperatures, and low flows can reduce dissolved oxygen to harmful levels (Bjornn and Reiser 1991). High loads of suspended sediment may abrade and clog fish gills (Reiser and Bjornn 1979). Too much fine sediment may indirectly affect juveniles by destroying their food supply (Reiser and Bjornn 1979).

Stream productivity and riparian vegetation are two factors that affect the density of insects, the principal prey of juveniles. The amount of small organic material, or detritus, present in a stream is an important variable affecting stream productivity (Bjornn and Reiser 1991). High stream productivity leads to high densities of herbivorous aquatic insects. Terrestrial insects enter streams by falling or being blown off vegetation; this input has been found to be an important component of the prey base (Reiser and Bjornn 1979).

Depending on the species, juveniles exhibit varying degrees of territorial behavior (Emmett et al. 1991). Territoriality limits the amount of space shared among individuals of the same species, and therefore, as species become more territorial, stream carrying capacity becomes more a function of space. In addition to habitat complexity, space is a function of streamflow and water depth (Bjornn and Reiser 1991). Off-channel areas function as essential over-wintering habitat for juveniles. Side-channels and wetlands are used by juveniles to escape high flows in the main channel.

Juveniles are highly susceptible to predation by other fish and terrestrial animals. Riparian vegetation, undercut banks, submerged boulders and logs, turbulent water, and aquatic vegetation create places where fish can avoid predators (Bjornn and Reiser 1991). Cover also creates shaded areas that provide the preferred microclimatic conditions of many juvenile salmonids (Reiser and Bjornn 1979).

The survival of smolts is affected by many factors. Smolts require stream flows adequate to direct their migration (Bjornn and Reiser 1991). Relatively high temperatures may interfere with the parr-to-smolt transition (Bjornn and Reiser 1991). Smolts use pools to rest and cover to reduce the threat of predation.

Stream flow, barriers, and water quality are the main factors that can affect the upstream migration of returning adults. If the environment along the migration route is too stressful, then adults may not survive the migration or possess sufficient energy for spawning. Adults may halt migration if water is too warm, too turbid, or poorly oxygenated (Bjornn and Reiser 1991). Barriers (dams, culverts, log jams) and inadequate stream flows may impede or completely block the movement of adults upstream. Adults use pools for resting and the security of cover. Because adults feed infrequently or not at all during their spawning migration, the prey base is less important during this stage of the life cycle.

Suitable spawning habitat requires the proper substrate and adequate cover, stream flow, and water quality. The different species of salmonid typically spawn in different parts of the stream network. Cutthroat trout and coho generally use small tributaries, while steelhead trout, pink, and chinook salmon use larger tributaries and the upper reaches of mainstream stems. Sockeye use stream areas linked to lakes. Bull trout use cold water tributaries. The size of preferred spawning gravel and the depth and velocity of water at spawning sites is related to adult size. Lengths of adult salmonid species range from about 8 inches for cutthroat to 58 inches for chinook (Emmett et al. 1991). This results in preferred spawning conditions ranging from sand and pebbles (for cutthroat) to cobble (for chinook), as well as the occurrence of redds in nearly all fishbearing streams containing suitable habitat. Most species spawn in gravel between 0.5 inches and 4 inches in diameter. The area utilized for spawning also varies across species. A single pair of chinook requires about 24 square yards; a trout pair needs about 2 square yards.

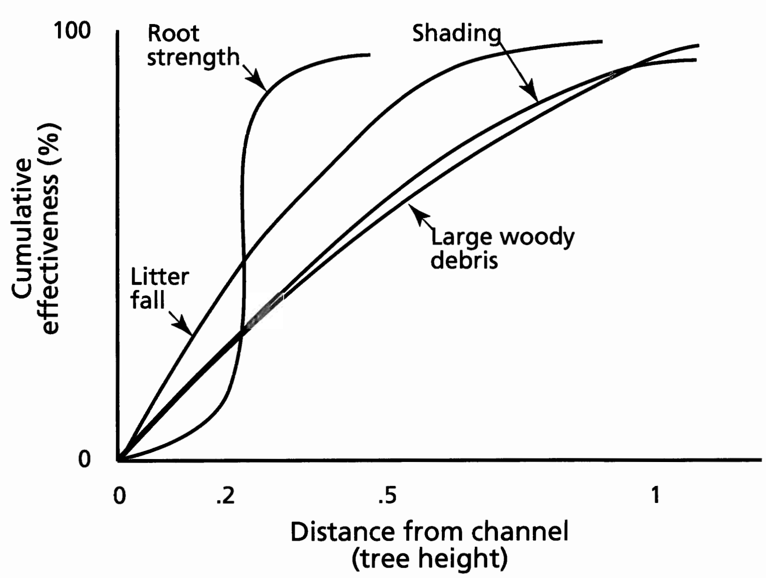
Salmonids benefit in each stage of their life cycles from high structural complexity. High structural complexity corresponds to high diversity in the size, location, and variety of physical, hydrological, and biological elements. A variety of gravels, pools of various depths, riffles, eddies, side channels, undercut banks, boulders, aquatic vegetation, amount of cover, and large woody debris are among the elements that contribute to structural complexity. The most important of these is large woody debris (Cederholm 1994). For streams coursing through intact riparian ecosystems, large woody debris continually influences the physical and biological processes affecting salmonid habitat. The importance of large woody debris to riparian ecosystems is discussed below.

THE DIRECT INFLUENCE ZONE

The degree to which aquatic ecosytems and terrestrial ecosystems interact decreases as the distance from surface water increases (FEMAT 1993; Cederholm 1994) (Figure III.2). The finite width of the riparian ecosystem is a result of this inverse relation. The terrestrial ecosystem principally affects water temperature, stream bank stability, sediment load, and detrital nutrient load of the aquatic ecosystem, and it is the source of large woody

Figure III.2: Relation between effectiveness of terrestrial elements of salmonid habitat and distance from stream channel

Root strength influences stream bank stability. Litter fall contributes organic nutrients to the aquatic food chain. Large woody debris performs many physical and biological functions essential to habitat quality. (See text.) (Modified from FEMAT 1993)



debris (Cederholm 1994; FEMAT 1993). Suitable salmonid habitat exists within ranges of variability for each of these key habitat elements and is best described by the natural regime under unmanaged conditions. From the perspective of forest management, the demonstrable effects of the direct influence zone on these key elements of salmonid habitat provide a guide for the development of riparian conservation strategies.

Water Temperature

Water temperature is principally a function of vegetative cover. Over-stream riparian vegetation moderates energy flow into and out of aquatic ecosystems (Chamberlin et al. 1991). Removing riparian vegetation and the shade it provides increases summer water temperatures. Lower winter water temperatures may also occur because removing riparian vegetation (Chamberlin et al. 1991) allows heat to escape. Steinblums et al. (1984) found that local topography (slope) and forest stand density (basal area) were the most statistically significant variables determining the amount of stream shading (angular canopy density). In general, riparian buffer widths are not a good predictor of shade protection (Steinblums et al. 1984; Beschta et al. 1987). Nevertheless, Beschta et al. (1987) claim that buffer widths of 100 feet or more will provide the same level of shading as that of an intact old-growth forest stand, whereas Steinblums et al. (1984) showed that in some cases buffer widths of 125 feet or more may be necessary to achieve this level of shading.

The degree to which water temperature is affected by riparian vegetation is a function of stream size (Chamberlin et al. 1991). For example, the temperature of shallow water bodies responds more quickly to changes in air temperature, and the temperature of small streams is more sensitive to changes in riparian vegetation because the forest canopy covers a higher proportion of the stream's surface (Chamberlin et al. 1991).

Stream Bank Stability

Riparian vegetation stabilizes stream banks. Therefore, removing vegetation leads to increased mass wasting (such as landslides) and sediment loading (amount of suspended and deposited sediments). The strength and density of the root network play a critical role in stream bank stability. Root strength declines appreciably at distances greater than one-half a tree crown diameter (FEMAT 1993). Therefore, the most important trees for bank stability lie within one-half a tree crown diameter from the stream bank. Likewise, the size and density of trees growing along a stream should be key variables determining bank stability, but no studies have investigated the relationship between relative density and stream bank stability.

Sediment Load

Sediment load can be increased by natural mass-wasting processes, timber harvesting, and roads (Cederholm 1994; Chamberlin et al. 1991). Riparian buffers can intercept sediments flowing from upland human-caused disturbances. Studies (Lynch et al. 1985; Moring 1982) have found that buffer strips of approximately 100 feet are effective in intercepting sediments from clearcuts. Broderson (1973) suggested that on slopes less than 50 percent (27 degrees), a riparian buffer at least 50 feet wide is needed to control the overland flow of sediments. On steep slopes greater than 50 percent, he suggested that buffers as wide as 200 feet would be effective in protecting water quality. Further discussion of sediments appears in the subsection titled Upland Influences on Salmonid Habitat.

Nutrient Load

The amount of instream small organic material, or detritus, affects stream productivity (Bjornn and Reiser 1991). Higher stream productivity leads to higher densities of herbivorous aquatic invertebrates. In forested small- and medium-order streams, riparian vegetation is the primary source of detritus (Gregory et al. 1987; Richardson 1992). Removal of vegetation along headwaters will lessen this input and may significantly affect stream productivity throughout a watershed. For a watershed in eastern Quebec, estimates showed that approximately 23 percent of the annual particulate organic load collected at the bottom of the watershed was contributed by first-order streams (comparable to Types 4 and 5 streams as defined in WAC 222-16-030) (Conners and Naiman 1984). This finding suggests that upper headwater areas without fish contribute detrital input to downstream segments that support fish. However, the importance of this upstream contribution to detrital input is not known.

Stand age and canopy cover significantly influence detrital input to a stream system. Old-growth forests contribute approximately five times as much detritus to streams as clearcut forests (Bilby and Bisson 1992). Richardson (1992) found that old-growth forests contributed approximately twice as much detritus as either 30- or 60-year-old forests. However, even though streamside timber harvest reduces detrital input, the resulting reduction in forest canopy in the riparian zone leads to increased light levels and algae production in the aquatic zone, which in turn produces detritus in the stream (Bilby and Bisson 1992).

Richardson (1992) estimated that 70 to 94 percent of all leaves that enter a stream segment are transported downstream. Some detritus added to streams originates from beyond the immediate streamside area. The maximum source distance of instream detritus is not known, but it has been estimated that 14 to 25 percent of the total litter input is blown in (Richardson 1992).

Erman et al. (1977) found that the composition of invertebrate communities in streams with riparian buffers wider than 100 feet was indistinguishable from those of unlogged streams. From this result, FEMAT (1993) inferred that riparian buffers at least 100 feet wide delivered sufficient small organic material to maintain a diverse aquatic community (Figure III.2).

Large Woody Debris

Large woody debris is the most important link between terrestrial and aquatic ecosystems, acting on stream flows to create essential elements of salmonid habitat — pools, riffles, side channels, and undercut banks (Swanston 1991; Maser et al. 1988). Large woody debris causes lateral migration of the stream channel, creating backwaters along stream margins and increasing variations in depth (Maser et al. 1988). Large woody debris also serves as cover from predators and competitors (Bjornn and Reiser 1991), and this cover may create preferable microclimatic conditions as well. Large woody debris moderates the energy of stream flows, thereby decreasing streambed scour and bank erosion. Dams formed by logs perform at least three functions:

(1) They store fine sediments in Types 4 and 5 streams that would adversely affect downstream spawning areas and invertebrate populations.

(2) They retard the flow of nutrients down the channel, thus increasing stream productivity.

(3) They retain gravel of various sizes essential to spawning (Bisson et al. 1987).

Gravel and nutrients retained by large woody debris are the substrate for the growth of some aquatic vegetation.

During floods, large woody debris in the riparian zone is important for the maintenance and development of riparian soils. Large woody debris performs at least three functions during floods:

(1) it moderates the energy of stream flows,

(2) it stabilizes soils, and

(3) it traps suspended sediments and organic nutrients.

The saturated soils of some riparian zones may impede the regeneration of conifer species. Large woody debris enhance conifer regeneration by acting as nurse trees.

Through stream bank erosion, windthrow, tree mortality, and beaver activity (Bisson et al. 1987), the riparian zone supplies nearly all large woody debris. The probability that a falling tree will enter a stream is a function of distance from the channel and tree height (Van Sickle and Gregory 1990). For a riparian forest stand of uniform height, mathematical models demonstrate that large woody debris input to streams is theoretically maximized when the riparian buffer width is equal to the height of the forest stand (Van Sickle and Gregory 1990). The same models show that the function relating input of large woody debris to buffer width is nonlinear. Ninety percent of the theoretical maximum is reached when a buffer width equals approximately 40 percent of the forest stand height (Van Sickle and Gregory 1990).

In old-growth forests of southeastern Alaska, Murphy and Koski (1989) found that the sources of 90 percent of instream large woody debris were within approximately 50 feet (slope distance) of the stream bank. The approximate average height of trees along the streams in this study area was 130 feet. In effect, Murphy and Koski (1989) showed that riparian buffer widths equal to 40 percent of an average tree height will recruit almost all potential large woody debris. Measurements from sites in western Washington and Oregon indicate that in old-growth conifer forests (average tree height 189 feet, range 164 to 262 feet) riparian buffers 120 feet wide (slope distance) would be 90 percent effective in delivering large woody debris to aquatic ecosystems, and that in mature conifer forests (average tree height 157 feet, range 131 to 213 feet) the same level of effectiveness would be provided by buffer widths of 90 feet (McDade et al. 1990). In terms of tree height, McDade et al. (1990) show that 90 percent of the potential large woody debris lies within a zone whose width is about 60 percent of the height of the average tree in the riparian ecosystem.

To date, studies making forest management recommendations for the recruitment of large woody debris have not considered the lateral migration of the stream channel (Murphy and Koski 1989; Robison and Beschta 1990; McDade et al. 1990; WFPB 1994). Stream channels are dynamic, and static riparian buffers, which today provide adequate large woody debris, may fail to do so after decades of stream migration. For long-term protection of larger streams (Types 1, 2, and 3) in low-gradient unconfined channels, riparian buffers may need to exceed the recommended minimums.

Instream stability and longevity of large woody debris are assumed to be important for its ecosystem function (Bisson et al. 1987). Stability is a function of size, with debris length relative to stream width having the greatest effect (Bisson et al. 1987). Instream longevity of large woody debris is a function of both size and species: larger pieces are more resistant to breakage, and conifers are more resistant to fragmentation and decomposition than red alder (Bisson et al. 1987), a hardwood often associated with riparian areas. Short harvest rotations in managed forests along streams produce trees that are too small to function properly as instream large woody debris.

UPLAND INFLUENCES ON SALMONID HABITAT

Hydrology and geomorphology link upland areas with the riparian ecosystem. Upland areas contribute water and sediment to the riparian ecosystem, and forest practices alter the physical processes that control delivery rates.

Water Quantity

Water quantity, or stream flow, can be modeled as annual precipitation minus annual evapotranspiration (Swanston 1991). The model is a useful approximation of real hydrological processes and has an important implication: there is a strong causal link between forest cover and stream flow. Within a watershed, the fraction of land that is forested is one of the most important variables affecting annual runoff (Chamberlin et al. 1991; Hicks et al. 1991). Forest harvest reduces the amount of both intercepted precipitation and evapotranspiration. In some cases, this produces an increase in annual water yield and stream flow during seasons of low flow, which is thought to have a short-term beneficial effect for some aquatic resources (Cederholm 1994). In other cases, a reduction in fog interception and drip may decrease water yield and summer low flows (Harr 1982).

Excessive peak flows can produce dramatic changes in stream channel form and function. Forest management that significantly increases the magnitude or frequency of peak-flow events can result in long-term damage to riparian ecosystems and the loss of salmonid habitat. Peak-flow events can destabilize and transport large woody debris, fill pools with sediments, and destroy salmon redds. Structurally complex channels containing large woody debris and composed pools, riffles, and side channels can be transformed to simple uniform channels with limited habitat value to salmonids.

After timber harvest, annual water yield in a watershed changes. When annual water yield returns to pre-harvest levels, the forest stand is said to be "hydrologically mature" with respect to those processes (principally interception and evapotranspiration) that affect annual water yield. In other words, when a given hydrologic variable (e.g., annual water yield, low and peak flow levels) for a young forest stand is similar to that of a mature forest stand, then the young stand is said to be hydrologically mature with respect to those processes that affect that variable.

Forest practices that affect winter snow accumulation and melt can have significant long-term detrimental impacts on aquatic resources. Basin-wide cumulative effects of reducing mature forest cover may lead to peak flows that damage stream beds when the windy and warmer conditions associated with large rainstorms cause the quick melting of shallow snowpacks that have accumulated during the winter. These are known as rain-on-snow events. The initiation of many landslides is linked to rain-on-snow events. For example, Harr (1981) reported that 85 percent of all landslides in small watersheds in western Oregon were associated with rain-on-snow events. In western Washington, rain-on-snow events are most common and most severe between 1,200 feet and 4,000 feet in elevation — the rain-on-snow zone (WFPB 1994). Forest canopy density is the principal feature determining the hydrologic maturity of a forest stand with respect to rain-on-snow discharge (Harr 1981; Coffin and Harr 1992). Young conifer forests reach hydrological maturity with respect to rain-on-snow peak flows between ages 25 and 35. The state Forest Practices Board (WFPB 1994) defines maximum rain-on-snow hydrological maturity as a forest stand with greater than 70 percent crown closure and less than 75 percent of the crown in hardwoods or shrubs.

Wetlands are a primary part of the permanent soil and ground water hydrology of forests in many watersheds. Their influence on stream flow has been repeatedly demonstrated (Winter 1988; Waddington et al. 1993). Wetlands also moderate storm flow and store the water for future discharge (Richardson 1994). Specifically, wetlands augment low flows by releasing stored water to streams or ground water. Modification of wetlands through channelization or timber harvest can increase storm discharge, produce more frequent channel eroding flows downstream, and reduce water storage and discharge during summer low-flow periods.

Water quality is also influenced by wetland function. Because wetlands slow water flow, they allow sediments to precipitate or adhere to vegetation. Oberts (1981) found that watersheds with less than 10 percent wetlands had suspended-solid loading rates per unit area that were as much as 100 times greater than those of watersheds with more than 10 percent wetlands.

Sediments

Sediments are delivered naturally from uplands to riparian ecosystems primarily through landslides. These large-scale random events add large quantities of material to the stream network rapidly. In undisturbed watersheds, the concentration of sediments increases substantially during storms, and much of this increase is the direct result of soil mass-wasting (landslides) (Swanston 1991). Mass-wasting occurs when gravitational force overcomes the strength of soil materials. Slope stability is strongly affected by the steepness and form of the slope, thickness of the soil layer, and amount of moisture in the soil. Typically, landslides occur where local changes in the water table increase soil saturation, which in turn decreases the friction between soil particles to the point that they slide down the slope under the force of gravity. Three groups of general mass-wasting processes affect riparian ecosystems: slumps and earth flows, debris avalanches, and debris torrents. Slumps are deep-seated failures that generally develop as a result of long-term water accumulation. Earth flows typically begin with a slump and are slow moving — from 1 inch to 90 feet per year (Swanston 1991). Debris avalanches are shallow rapid landslides and constitute some of the most common soil mass movements (Swanston 1991). Debris torrents are large quantities of soil, rock, and large woody debris suspended in a slurry that rapidly flows down steep stream channels. Debris torrents are typically a consequence of the flood outburst when dams created by debris avalanches fail.

The presence of clearcut units in a watershed increases the likelihood of mass-wasting events (Swanson and Dyrness 1975; Swanson et al. 1987). Timber harvest affects the landsliding process in four ways. First, transpiration is decreased with tree removal. Decreased transpiration increases soil moisture and tends to raise water-table levels, thus increasing the risk of slope failure. Second, the forest canopy can intercept significant quantities of precipitation, and its removal leads to increases in soil moisture. Third, timber harvest may disturb the soil in such a way as to create macropores in the soil; these macropores act as conduits that facilitate soil saturation. Fourth, tree harvest results in stump roots that decay, which decreases soil strength and can increase the frequency of landsliding until new root systems are established. This period of decreased stability lasts for approximately 5 to 20 years after harvest (Sidle et al. 1985).

Roads in upland areas have significant detrimental impacts on salmonid habitat. In few locations can roads be built that have no negative effects on streams (Furniss et al. 1991). Landslides resulting from road construction are considered a significant source of sediment input into streams (Wu and Swanston 1980; Chesney 1982; Everest et al. 1987; Sidle 1985). In the Pacific Northwest, roads appear to contribute more to landslides than clearcutting, although this association varies substantially with location (Sidle et al. 1985) and seems to be highly dependent on watershed hydrology and geomorphology (Duncan and Ward 1985). Cederholm et al. (1981) reported a significant positive correlation between fine sediment in spawning gravels and the percentage of basin area covered by roads.

Status and Distribution

In western North America, anadromous salmonids range from mid-California to the Arctic Ocean (Meehan and Bjornn 1991). Their historic distribution included southern California and Mexico (Wilderness Society 1993). Freshwater salmonid habitat extends eastward into Idaho, i.e., the Snake River and its tributaries. All species from the Pacific Northwest migrate out into the Pacific Ocean, some traveling as far north as the Bering Sea. Anadromous salmonids occupy all of Washington except the area north of the Snake River drainage and east of the Columbia River in central Washington and the area east of the Okanogan Highlands in northeastern Washington (WDF 1993).

Bull trout are found in the Rocky Mountains, Cascade Range, and Olympic Mountains of the northwestern United States and southwestern Canada (Meehan and Bjornn 1991). Populations exist in Washington, Oregon, Idaho, western Montana, northern California, northern Nevada, British Columbia, and Alberta.

STOCKS AND EVOLUTIONARILY SIGNIFICANT UNITS

Fisheries management of salmon is normally done according to runs, which are aggregations of stocks. A stock is a discrete breeding population. The Washington State Salmon and Steelhead Stock Inventory (WDF et al. 1993) has defined stock to be:

> The fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season (p. 10).

The spatial or temporal reproductive isolation required by this definition is reflected in the names given to stocks, e.g., "Nisqually River winter steelhead" or "Snohomish River fall chinook". Stocks may possess distinct biological characteristics (e.g., physical appearance, habitat preferences, genetics, or population demography), but not necessarily. As noted by Meehan and Bjornn (1991), "stock" can be considered synonymous with "subspecies."

The Endangered Species Act defines species as "any distinct population-segment of any species of vertebrate fish or wildlife which interbreeds when mature" (16 U.S.C. 1532(15)). For purposes of the Endangered Species Act, salmon stocks are grouped into populations known as Evolutionarily Significant Units (ESU). If conditions warrant federal listing of a salmon, it is the stated intention of National Marine Fisheries Service to list ESUs, rather than an entire salmon species or individual stocks (Federal Register v. 56, p. 58612-8). (Bull trout have not been separated into ESUs.)

An ESU is a population that (1) is substantially reproductively isolated from other population units of the same species and (2) represents an important component in the evolutionary legacy of the species (Waples 1991). The first criterion is essentially the same as the Washington State Salmon and Steelhead Stock Inventory (WDF et al. 1993) definition of a stock. The second criterion requires that sub-populations in separate ESUs possess significant genetic or other biological differences. As a result, many stocks are lumped into a single ESU. For example, agencies in Washington, Oregon, and California have identified more than 200 distinct stocks of coho salmon. These stocks have been grouped into six ESUs. Washington contains at least 90 stocks of coho (WDF et al. 1993), and these are distributed among three ESUs.

SALMONID STATUS IN THE PACIFIC NORTHWEST

Nehlsen et al. (1991) assessed extinction risks for 214 native naturally spawning salmonid stocks occurring in Idaho, Washington, Oregon, and northern California. They defined three risk categories: high risk of extinction, moderate risk of extinction, and special concern. Stocks with a high or moderate risk of extinction have likely attained the threshold for listing under the Endangered Species Act. Stocks with a moderate risk have a larger number of spawning adults each year than do stocks with a high risk. Stocks of special concern have not attained the threshold for listing, but do face some risk of extinction or possess some unique characteristic that requires attention. Nehlsen et al. (1991) estimated that 101 stocks in the Pacific Northwest had a high risk of extinction, 58 had a moderate risk, and 54 were of special concern.

Under the Endangered Species Act, the National Marine Fisheries Service regulates salmon, and it has declared several different salmonid populations as threatened or endangered. The agency listed Sacramento River winter chinook as threatened in 1990 (Nehlsen et al. 1991) and Snake River sockeye as endangered in 1991 (Federal Register v. 56, no. 224, p. 58619-24). Spring/summer and fall runs of Snake River chinook were listed as threatened in 1992 (Federal Register v. 47, no. 78, p. 14653-5). In March 1995, the steelhead populations in the Klamath Mountain of northern California were proposed for listing as threatened (Federal Register v. 60, no. 51, p. 14253-61).

The National Marine Fisheries Service initiated status reviews for west coast steelhead trout in May 1993 and coho salmon in October 1993 (Federal Register v. 58, no. 206, p. 57770-1; v. 59, no. 102, p. 27527-8). The status review for steelhead is expected to be completed in 1996. The status review for coho, completed in July 1995, proposed that the species be federally listed in Oregon and California, but not in Washington (Federal Register v. 60, no. 142, p. 38011-30).

The federal government initiated coastwide status reviews for the other five anadromous salmonids in September 1994 (Federal Register v. 59, no. 175, p. 46808-10). The first of these reviews, for pink salmon, was to be completed in 1995. Completion of the status reviews for chum, sockeye, and chinook salmon, and sea-run cutthroat will probably occur in 1996. The federal listing of salmonid species could be followed by federal regulations pertaining to forest practices on nonfederal lands.

The bull trout is regulated by the U.S. Fish and Wildlife Service and was made a category 2 candidate for federal listing in 1985 (Federal Registery, v. 50, no. 181, p. 37958-67). In response to petitions, the U.S. Fish and Wildlife Service began a rangewide status review in May 1993. This review, completed in June 1994, concluded that the status of the bull trout warranted its listing as a threatened species, but listing was precluded by other higher priority actions. At that time, the species was assigned a listing priority number of 9 (on a scale of 1 to 12, with 1 being the highest priority) and made a category 1 candidate. In April 1995, the species was moved up to a listing priority number of 3. Dolly Varden is not a federal candidate.

SALMONID STATUS IN WASHINGTON

The Washington State Salmon and Steelhead Stock Inventory (WDF et al. 1993) identified 435 distinct salmonid stocks in Washington. Information for 322 stocks was adequate to assess their status, and of these, 38 percent were classified as depressed, 4 percent as critical, and 58 percent as healthy (WDF et al. 1993). A depressed stock is one "whose production is below expected levels based on available habitat" (WDF et al. 1993 p. 30), and a critical stock is one for which "permanent damage to the stock is likely or has already occurred" (WDF et al. 1993 p. 30).

Nehlsen et al. (1991) compiled a list of Pacific Northwest salmon stocks threatened with extinction. For stocks in Washington, their list describes 47 as having a high risk of extinction, 18 as having moderate risk, and 27 as being of special concern. A partial list of extinct stocks (Nehlsen et al. 1991) includes 42 stocks from Washington.

Using a different definition, Williams et al. (1989) listed the bull trout as a species of special concern. In Washington, 77 separate bull trout/Dolly Varden populations have been identified (Mongillo 1993). Information was adequate to determine the status of only 34 populations. Of these, nine were considered to have a high risk, six a moderate risk, and 13 a low risk of extirpation.

SALMONID STATUS IN THE AREA COVERED BY THE HCP

The riparian conservation strategies proposed under this HCP will be applied to only the HCP planning units west of the Cascade crest. Therefore, the discussion of stock status in the area covered by the HCP is confined to those planning units. There are 387 distinct salmonid stocks in these HCP planning units (WDF et al. 1993). The status of these stocks is summarized in Table III.10. For those 277 stocks for which a status could be determined, 32 percent were depressed, 4 percent were critical, and 64 percent were healthy (WDF et al. 1993). Nehlsen et al. (1991) rated 40 stocks as having a high risk of extinction and 12 as having a moderate risk. Bull trout and Dolly Varden were not included in either the Washington State Salmon and Steelhead Stock Inventory or Nehlsen et al.

DISTRIBUTION ON DNR-MANAGED LANDS IN THE FIVE WEST-SIDE AND THE OLYMPIC EXPERIMENTAL STATE FOREST PLANNING UNITS

To determine the distribution of species of anadromous salmonids on DNR-managed lands covered by the HCP, DNR staff performed an analysis using the agency's computerized geographic information system with input from

Table III.10: Status of salmonid stocks in the five west-side planning units and the Olympic Experimental State Forest

Species[1]	Status (Source: WDF et al. 1993)				Extinction risk (Source: Nehlsen et al. 1991)		
	Healthy	Depressed	Critical	Unknown	High	Moderate	Special Concern
Coho	37	33	1	18	7	0	1
Chinook	46	17	4	14	15	0	1
Chum	48	3	2	18	4	3	0
Sockeye	1	4	1	1	1	1	0
Pink	9	2	2	2	2	1	0
Steelhead	36	30	1	57	9	7	10
Sea-run cutthroat[2]	—	—	—	—	2	1	8
Total stocks	**177**	**89**	**11**	**110**	**40**	**12**	**21**

[1]Bull trout and Dolly Varden were not included in the WDF et al. (1993) or Nehlsen et al. (1991) studies

[2]Species not included in WDF et al. (1993)

the Washington Department of Fish and Wildlife's Washington Rivers Information System, which identifies all streams that salmonids are known or expected to inhabit. Digital data are to the 1:100,000 scale, and the presence of fish species is recorded by river reach.

Using this database, all Watershed Administrative Units (WAUs) that are known or thought to contain salmonids were tabulated. Over 80 percent of DNR-managed lands west of the Cascade crest in the area covered by the HCP are in WAUs that contain coho, chinook, and steelhead (Table III.11). Smaller percentages of DNR-managed lands are in WAUs that contain the other four anadromous salmonids and bull trout/Dolly Varden. All DNR-managed lands in the Olympic Experimental State Forest are in WAUs that contain coho and steelhead (Table III.11). With the exception of the South Puget Planning Unit, all west-side planning units have at least 80 percent of their DNR-managed lands within WAUs that contain a salmonid species.

WAUs range in size from 10,000 to 50,000 acres. Given the relatively small area of WAUs compared to HCP planning units, DNR staff assumed that all fishbearing streams (Types 1, 2, and 3) in a WAU identified as containing a salmonid species are actually inhabited by that species. Using this extrapolation, the assessment shows that more than 1,000 miles of fishbearing streams on DNR-managed forest land in the five west-side and Olympic Experimental State Forest planning units potentially contain coho, steelhead, chinook, chum, and sea-run cutthroat (Table III.12). On the basis of stream miles, the density and distribution of salmonids vary widely among planning units. For example, the DNR analysis shows that the Olympic Experimental State Forest has more than 400 stream miles occupied by anadromous salmonids, whereas the North Puget Planning Unit has about 250 miles. All the fishbearing stream miles on DNR-managed land in the Olympic Experimental Forest and South Coast planning units contain at least one species of anadromous salmonid. At least 90 percent of fishbearing streams on DNR-managed land in the Straits, North Puget, and Columbia planning units contain a species of anadromous salmonid.

To estimate the potential impacts of forest practices activities on DNR-managed land, DNR staff assumed that (1) all managed land within a WAU affects salmonid habitat, and (2) impacts by individual landowners are proportional to the amount of land they manage within a WAU. For some WAUs, these assumptions may be weak. For example, DNR may manage 10 percent of a WAU, but that 10 percent affects 90 percent of the salmonid spawning habitat in that WAU. Nevertheless, this analysis provides a useful estimate of DNR's potential impacts on salmonid populations. DNR staff calculated the total area of WAUs identified as containing salmonid species as well as the total area of DNR-managed land within these WAUs. The ratio of these two numbers is the proportion of DNR-managed land that could affect salmonids. This proportion suggests the magnitude of the potential impact that DNR forest management may have on these species. For example, in the Olympic Experimental State Forest, on average, about 26 percent of all land that could impact salmonids is managed by DNR (Table III.13). For the five west-side planning units, on average, about 11 percent of all land that could affect salmonids is managed by DNR.

Differences in impacts by individual planning units among species reflect their geographical distribution (Table III.13). For example, pink salmon generally spawn in the lower reaches of coastal rivers (Emmett et al. 1991), and therefore, planning units with DNR-managed lands near the coast have a greater impact on this species. In the OESF, 33 percent of all land that could impact pink is managed by DNR, but in the South Puget Planning Unit, only 2 percent is managed by DNR.

Table III.11: Percent of DNR-managed forest land west of the Cascade crest in Watershed Administrative Units that contain salmonids

The five west-side planning units consist of South Coast, Straits, North Puget, South Puget, and Columbia. OESF is the Olympic Experimental State Forest. Each HCP planning unit contains several WAUs. (For more information on this, see the section in Chapter I titled Organization of the Planning Area.)

(Source: DNR GIS April 1995)

Planning Unit	Coho	Chinook	Chum	Sockeye	Pink	Steelhead	Sea-run Cutthroat	Bull Trout/ Dolly Varden	Total DNR-managed acres
South Coast	100	97	91	3	1	97	96	5	238,700
Straits	98	93	93	18	67	90	98	26	111,700
North Puget	82	80	77	48	62	81	37	74	396,400
South Puget	73	73	63	9	18	71	52	23	145,500
Columbia	81	67	39	25	0	78	81	23	289,300
Total for five west-side planning units	86	80	70	26	29	83	67	37	1,181,600
OESF	100	94	52	74	13	100	98	33	267,000
Total five west-side and OESF planning units	**88**	**83**	**67**	**35**	**26**	**86**	**73**	**36**	**1,448,600**

Table III.12: Estimated miles of fishbearing streams on DNR-managed lands west of the Cascade crest

Only Types 1, 2, and 3 waters are considered. OESF is the Olympic Experimental State Forest.

(Source: DNR GIS April 1995)

Planning Unit	Coho	Chinook	Chum	Sockeye	Pink	Steelhead	Sea-run Cutthroat	Bull Trout/ Dolly Varden	Total stream miles
OESF	418	388	232	326	63	418	410	121	418
South Coast	240	236	222	33	2	240	230	15	240
Straits	94	70	91	22	71	91	94	24	95
North Puget	258	239	245	138	198	258	84	233	284
South Puget	89	89	84	3	15	88	73	17	117
Columbia	236	208	144	76	0	227	230	91	263
Total	**1,335**	**1,230**	**1,018**	**598**	**349**	**1,322**	**1,121**	**501**	**1,416**

Table III.13: Percent of total land area west of the Cascade crest that impacts salmonids and is managed by DNR

DNR-managed lands in the Columbia Planning Unit have no pink salmon. The five west-side planning units consist of the Straits, North Puget, South Puget, South Coast, and Columbia. OESF is the Olympic Experimental State Forest.

(Source: DNR GIS April 1995)

Planning Unit	Coho	Chinook	Chum	Sockeye	Pink	Steelhead	Sea-run Cutthroat	Bull Trout/ Dolly Varden
South Coast	13	15	15	4	5	13	13	3
Straits	15	15	15	11	13	15	15	8
North Puget	13	14	15	14	13	13	15	14
South Puget	5	5	5	1	2	5	6	3
Columbia	14	13	13	16	—	14	13	15
Total for five west-side planning units	12	12	12	10	10	12	13	10
OESF	25	25	23	28	33	25	24	22

E. Other Species of Concern in the Area Covered by the HCP

For the purposes of this HCP, species of concern are defined as those wildlife species that are (a) listed by the federal government as threatened or endangered, (b) listed by the state as threatened, endangered, or sensitive, or (c) proposed as candidates for listing by the federal or (d) state government. Previous sections of this chapter discuss habitat needs of the federally listed species and of anadromous salmonids and bull trout. This section provides information on habitat needs of other federal candidate species and state-listed and state candidate species that have no federal status. The species are organized in the following taxonomic groups: mollusks, arthropods, fish, amphibians, reptiles, birds, and mammals. The section starts with Table III.14, which lists for each species its federal and state status and in which HCP planning unit each could potentially occur.

At the time of writing the draft HCP and the draft EIS, the U.S. Fish and Wildlife Service used a system of classifying species that were candidates for listing as threatened or endangered into separate categories. Category 1 species were those for which the Service had sufficient information to issue a proposal for listing. Category 2 species were those for which existing information indicated that listing was possibly appropriate but sufficient data did not exist on the biological status of the species or threats to that species to warrant the issuance of a proposed rule. Both category 1 and category 2 species were considered as species of concern in the draft HCP and Draft EIS. On February 28, 1996, the U.S. Fish and Wildlife Service published an updated list of candidate species using a revised categorization system (Federal Register v. 61, no. 40, p. 7596). Former category 1 species are now referred to simply as candidates for listing. Former category 2 species are no longer considered candidates for listing, though most of them have been retained on a list of federal species of concern (Federal Register v. 61, no. 40, p. 7596). There are now two species in the HCP Planning Area that are candidate species - the spotted frog and bull trout. This section reflects the change in federal candidate status of unlisted species of concern as of the date of HCP approval and issuance of the Incidental Take Permit. Descriptions of former category 2 taxa are retained and still considered species of concern for the purposes of this HCP. Additionally, there are six species that were formerly listed as federal category 2 that are considered sensitive but have no official state or federal status.

Table III.14: Other species of concern by federal and state status and their potential occurrences in the HCP planning units

Federal candidate - Substantial data support listing the species as endangered or threatened; listing proposals are either under way or delayed.

Federal species of concern - Data point to listing species but not conclusively; additional data are being collected.

Other sensitive species - formerly listed as federal category 2.

Under state status, S = state; E = endangered; T = threatened; C = candidate; M = monitor; G = game; Sen = sensitive.
OESF = Olympic Experimental State Forest.

		Planning Unit								
Species	**State status**	**Klickitat**	**Columbia**	**South Coast**	**South Puget**	**Yakima**	**Chelan**	**North Puget**	**Straits**	**OESF**
Federal candidate										
spotted frog	SC	X	X		X	X	X	X		
Federal species of concern										
Newcomb's littorine snail	SM			X						
California floater	—	X	X			X	X			
great Columbia River spire snail	SC	X	X							
Beller's ground beetle	SC				X			X		
Hatch's click beetle	SC				X			X		
Fender's soliperlan stonefly	—		X		X					
river lamprey	—		X	X	X			X	X	X
Pacific lamprey	—	X	X	X	X			X	X	X
Larch Mountain salamander	SSen	X	X							
tailed frog	SM	X	X	X	X	X	X	X	X	X
Cascades frog	—	X	X		X	X		X	X	X
northwestern pond turtle	SE	X	X		X			X		
northern goshawk	SC	X	X	X	X	X	X	X	X	X
olive-sided flycatcher	—	X	X	X	X	X	X	X	X	X
long-eared myotis	SM	X	X	X	X	X	X	X	X	X

Table III.14: Other species of concern by federal and state status and their potential occurrences in the HCP planning units *(continued)*

Species	State status	Klickitat	Columbia	South Coast	South Puget	Yakima	Chelan	North Puget	Straits	OESF
		Planning Unit								
Federal species of concern *(continued)*										
fringed myotis	SM	X	X			X				
long-legged myotis	SM	X	X	X	X	X	X	X	X	X
small-footed myotis	SM	X	X			X				
Townsend's big-eared bat	SC	X	X	X	X	X	X	X	X	X
Pacific fisher	SC		X	X	X	X	X	X	X	X
California wolverine	SM		X		X	X	X	X		
lynx	ST						X			
California bighorn sheep	SG					X	X			
State-listed, no federal status										
sandhill crane	SE	X	X							
western gray squirrel	ST	X			X	X	X			
State candidate, no federal status										
Olympic mudminnow	SC		X	X	X				X	
long-horned leaf beetle	SC							X		
Dunn's salamander	SC			X						
Van Dyke's salamander	SC		X	X	X				X	X
California mountain kingsnake	SC	X	X							
common loon	SC			X	X		X	X	X	X
golden eagle	SC	X	X	X	X	X	X	X	X	X
Vaux's swift	SC	X	X	X	X	X	X	X	X	X
Lewis' woodpecker	SC	X	X	X	X	X	X	X	X	

Table III.14: Other species of concern by federal and state status and their potential occurrences in the HCP planning units *(continued)*

		Planning Unit								
Species	**State status**	**Klickitat**	**Columbia**	**South Coast**	**South Puget**	**Yakima**	**Chelan**	**North Puget**	**Straits**	**OESF**
State candidate, no federal status *(continued)*										
pileated woodpecker	SC	X	X	X	X	X	X	X	X	X
purple martin	SC	X	X	X	X			X	X	
western bluebird	SC	X	X	X	X	X	X	X	X	
Other sensitive species										
Lynn's clubtail	—	X				X				
green sturgeon	—		X	X						
northern red-legged frog	—		X	X	X			X	X	X
Harlequin duck	SG	X	X	X	X	X	X	X	X	X
black tern	SM	X				X	X			
little willow flycatcher	—	X	X	X	X	X	X	X	X	X
Yuma myotis	—	X	X	X	X	X	X	X	X	X

Federal Candidate Species, Federal Species of Concern, State-listed Species, State Candidate Species, and Other Sensitive Species

MOLLUSKS

At least 120 species of mollusks occur in Washington. However, many species have yet to be described, and the distribution and habitat requirements of those that have been described are still not well understood (Frest 1993; Frest and Johannes 1993; Neitzel and Frest 1993). None of the 120 species are currently listed by either the federal or state government. Three are federal species of concern (Federal Register v. 61, no. 40, p. 7569) and numerous others are species of special concern.

This section is a summary of information obtained primarily from three mollusk experts: T. Burke (Washington Department of Wildlife), T. Frest (Deixis Consultants, Seattle), and A. Stock (Washington Natural Heritage Program). It addresses only the three federal species of concern that may occur in the area covered by the HCP. These are Newcomb's littorine snail (*Algamorda newcombiana,* a.k.a. *Littorina subrotunda*), an estuarine snail; the California floater (*Anodonta californiensis*), a freshwater clam; and the great Columbia River spire snail (*Fluminicola columbianus*), a freshwater snail (WDW 1993a).

Newcomb's Littorine Snail

Newcomb's littorine snail is also a state monitor species (WDW 1993a). This is an estuarine species that is known to occur near the high-tide mark in *Salicornia* salt marshes near Grays Harbor in the South Coast Planning Unit.

California Floater

The California floater is a freshwater clam that inhabits fairly large streams, lakes, and slow rivers including the Columbia, Wenatchee, and Okanogan rivers. Its original geographic distribution included Cowlitz, Clark, Skamania, and Klickitat counties.

Great Columbia River Spire Snail

The great Columbia River spire snail (a.k.a. Columbia pebblesnail), also a candidate for state listing (WDFW 1993a), is a freshwater species restricted to rivers and large streams with ample oxygen. Historically, the species inhabited the lower Columbia River and its major tributaries (Neitzel and Frest 1993). It now occurs in the Methow and Okanogan rivers in the Columbia, Klickitat, and possibly Chelan planning units, as well as in other rivers in eastern Washington, Oregon, and Idaho. The Methow River is the smallest stream the Great Columbia River spire snail is known to inhabit.

ARTHROPODS

From 85 to 90 percent of the total biota found in forests of the Pacific Northwest is composed of species of arthropods (Lattin 1993). This diverse group occupies a variety of habitats including, forests, streams, lakes, wetlands, lichen and moss habitats in arboreal and terrestrial situations, tree canopies, and riparian communities. In forests, arthropods play an important role in preparing litter, soil, and decaying logs for processing by fungi and bacteria (Shaw et al. 1991). Because many arthropods found in soil, litter, and decayed wood in old-growth conifer forests are wingless or flightless, habitat fragmentation is a severe obstacle to maintaining biological diversity (Lattin 1990; Olson 1992). In addition, McIver et al. (1990) reported that arachnid communities are altered significantly when forests are clearcut.

Although several arthropod species are reported to be vulnerable to extinction due to their rarity or threatened state, few have been formally listed, primarily because of inadequate information or oversight. Lattin and Moldenke (1992) list a number of arthropods that could serve as indicator species for ecosystem health. Pyle (1989) presents a list of more than 200 Washington butterfly (Lepidoptera) species, their distribution, habitats, and potential threats.

Six species of arthropods that are known to occur or may occur in the HCP planning units are considered species of concern. One is federally listed (see Section C of this chapter titled Other Federally Listed Species), three are federal species of concern, one is a sensitive species, and one is a candidate only for state listing.

Beller's Ground Beetle

The Beller's ground beetle (*Agonum belleri*) is a federal species of concern and candidate for state listing (WDW 1993a). It occurs exclusively in eutrophic sphagnum bogs of Washington, Oregon, and southwestern British Columbia (Johnson 1986; WDW 1991) that are associated with lakes below 3,280 feet in elevation, where it likely scavenges plant and animal material (Dawson 1965; WDW 1991). In Washington, Beller's ground beetle is known to occur only in two DNR Natural Area Preserves — Snoqualmie Bog, located along the North Fork of the Snoqualmie River, and in Kings Lake Bog in King County.

Long-horned Leaf Beetle

The long-horned leaf beetle (*Donacia idola*) is a candidate only for state listing (WDW 1993a). It occurs specifically in lowland sphagnum bogs of Washington and southwestern British Columbia (WDW 1991). In Washington, this species has been documented historically only in Snohomish County and is currently known only at Chase Lake, near Edmonds. Long-horned leaf beetle larvae forage on submerged plants, while adults forage on the exposed portions of aquatic plants (White 1983).

Hatch's Click Beetle

Hatch's click beetle (*Eanus hatchi*) is a federal species of concern and a candidate for state listing (WDW 1993a). Like Beller's ground beetle, Hatch's click beetle inhabits eutrophic sphagnum bogs in or near lakes at less than 3,280 feetin elevation (WDW 1991). Adult beetles feed on honey, dew, pollen, nectar, and small soft insects (WDW 1991). This species occurred historically in Snohomish and King counties, but is now known to occur at only three bog sites located in central King County, including Kings Lake Bog Natural Area Preserve.

Fender's Soliperlan Stonefly

Fender's soliperlan stonefly (*Soliperla fenderi*) is a federal species of concern. One specimen was collected from St. Andrews Creek in Mount Rainier National Park. On the basis of the biology of other stonefly species the habitat requirements of Fender's soliperlan are met in and adjacent to water, preferably which is clean and well-oxygenated.

Lynn's Clubtail

Lynn's clubtail (*Gomphus lynnae*) is a sensitive species. This species of dragonfly is known to prefer large rivers, but it has also been recorded at mountain lakes. Lynn's clubtail breeds in silty water and tends to occur along low-elevation streams or rivers with a fair amount of siltation. All habitat requirements are assumed to occur within and adjacent to aquatic habitats (i.e., Types 1 through 5 waters).

FISH

Four species of fish considered species of concern (Federal Register v. 61, no. 40, p. 7596), not including anadromous salmonids and bull trout, are known to occur in the HCP planning units; two are federal species of concern, one is a candidate for state listing, and one is a sensitive species. Anadromous salmonids and bull trout are discussed in Section D of this chapter titled Salmonids and the Riparian Ecosystem.

River Lamprey

The river lamprey (*Lampetra ayresi*) is a federal species of concern . The main threats to its continued existence are thought to be dams on mainstream rivers and habitat degradation. A parasite of herring and salmon (Beamish and Youson 1987), the river lamphrey's range is along the Pacific coast from northern California to south-eastern Alaska (Wydoski and Whitney 1979). In Washington, the species probably occurs in most large coastal rivers (Wydoski and Whitney 1979). There are no records of its being caught for food (Scott and Crossman 1973).

Little is known about the river lamprey. It is anadromous. Adults enter fresh water from mid-September to late winter, and spawning occurs from April to June (Beamish 1980). Both sexes work to dig a single shallow nest in the gravel of stream riffles. Adults die after spawning. Eggs need clean cold water and clean gravel to survive. Ammocoetes (larvae) are filter feeders that consume plankton and remain in the fine sediments of streams for three to five years until they metamorphose into adults. They migrate to the sea from May to July (Beamish 1980). Adults remain at sea until mid-September (Beamish and Youson 1987).

Pacific Lamprey

The Pacific lamprey (*Lampetra tridentata*) is a federal species of concern. The main threats to its continued existence are thought to be dams on mainstream rivers and habitat degradation. Its range is along the Pacific coast from southern California to the Gulf of Alaska (Wydoski and Whitney 1979). The species is a parasite of salmon, and its freshwater range once matched that of its host. In Washington, the species occurs in most large coastal river systems, and it has been known to ascend the Snake River into Idaho (Wydoski and Whitney 1979). Historically, Native Americans harvested Pacific lampreys for food. Today, the species is commercially harvested to be used as bait.

The Pacific lamprey is anadromous. Adults enter fresh water in late spring and early summer. Spawning occurs from April to July of the following year (Beamish 1980). Both sexes work to dig a single shallow nest in the gravel of stream riffles. Adults die after spawning. Eggs need clean cold water and clean gravel to survive. Ammocoetes (larvae) are filter feeders that consume plankton and remain in the fine sediments of streams for approximately five years until they metamorphose into adults (Beamish and Levings 1991). They migrate to the ocean from March to July (Wydoski and Whitney 1979). Adults remain at sea for one year (Beamish and Levings 1991).

Olympic Mudminnow

The Olympic mudminnow (*Novumbra hubbsi*), a candidate for state listing in Washington, is jeopardized by its limited distribution and population isolation in drainages along the west coast of Washington, the Chehalis River, and the lower Deschutes River (Meldrim 1968; Harris 1974; Wydoski and Whitney 1979).

This mudminnow tolerates a wide range of water-quality conditions but is found most often in turbid water. However, it does not occur in newly silted areas containing only inorganic sediment. Although the mudminnow prefers cooler waters, it is found in water temperatures ranging from 32° to 70°F (Wydoski and Whitney 1979). Elevation restrictions are not reported in the literature, but on the basis of its preferred habitat, this species is not expected to occur in high-gradient streams at higher elevations.

Spawning and rearing habitats for the Olympic mudminnow are limited to ponds and marshy streams in coastal lowlands (WDW 1991) with the following characteristics: (1) at least several inches deep, (2) slow-flowing or still water, (3) choked with aquatic vegetation, and (4) soft mud bottom containing organic matter (Hagen et al. 1972; Harris 1974; Wydoski and Whitney 1979). The female lays eggs in the vegetation within a male's territory; the eggs are adhesive and stick to the vegetation. After the eggs hatch, the fry remain in the vegetation for seven days before dispersing from the hatching site (Wydoski and Whitney 1979).

GREEN STURGEON

The green sturgeon (*Acipenser medirostris*) is a sensitive species. The main threat to its continued existence is thought to be dams on mainstream rivers. Also, because the species lives up to 60 years (Emmett et al. 1991) and is a bottom feeder, it may bioaccumulate pollutants (Emmett et al. 1991). Its range is along the Pacific coast from Ensenada, Mexico, to southeast Alaska, and extends to parts of Asia (Emmett et al. 1991). In Washington, the species is known to occur in Willapa Bay and Grays Harbor (Wyd-oski and Whitney 1979: Emmett et al. 1991) and has been reported 140 miles upstream in the Columbia river. The commercial and sport green sturgeon fisheries in Washington are negligible (Wydoski and Whitney 1979).

The green sturgeon is anadromous. Little is known about its life cycle, but it is commonly assumed to be similar to that of the white sturgeon (*Acipenser transmontanus*) (Emmet et al. 1991; Wydoski and Whitney 1979; Scott and Crossman 1973). Eggs, larvae, and young juveniles of white sturgeon live in rivers. As juveniles mature, they move into deeper and more saline habitat (Emmett et al. 1991). White sturgeon mature late in life (Emmett et al. 1991); males are sexually mature at nine years of age and females at 13 to 16 years (Wydoski and Whitney 1979). Females carry from 60,000 to 140,000 eggs, but they do not breed every year (Emmett et al. 1991.) Adults move into fresh water in the fall and winter to spawn. The green sturgeon, like other sturgeons, probably uses large cobble as a spawning substrate (Emmett et al. 1991) they breed in the lower reaches of rivers in depths greater than 10 feet (Emmett et al. 1991).

AMPHIBIANS

Seven species of amphibians that occur in the area covered by the HCP are considered species of concern. One is a candidate for federal listing (Federal Register v. 59, no. 219, p. 58982-9028), three are federal species of concern, and one is a sensitive species. One of these is already listed by the state. Two additional species are candidates for listing by the state (WDFW 1995b).

Dunn's Salamander

Dunn's salamander (*Plethodon dunni*) is a candidate for state listing (WDFW 1995b) found in southwestern Washington, western Oregon, and the extreme northwestern corner of California. In Washington, the species is found only in the Willapa Hills (Leonard et al. 1993).

Dunn's salamanders are considered to be a highly aquatic species of woodland salamander (Leonard et al. 1993). They are commonly associated with seeps or streams located in heavily shaded areas (WDW 1991). The species inhabits the splash zone of creeks, typically under rocks and occasionally under woody debris (Leonard et al. 1993). It has also been found in talus where there is high humidity (Leonard et al. 1993). The principal management recommendation of WDW (1991) is the maintenance of riparian corridors along all stream types, but especially Types 4 and 5 streams. Additional recommendations exist for wet talus where the species is known to occur.

Larch Mountain Salamander

The Larch Mountain salamander (*Plethodon larselli*) is a federal species of concern; it is already listed by the state as sensitive (WDW 1993a). It was first described as a subspecies of the Van Dyke's salamander (*Plethodon vandykei*) (Burns 1954).

The Larch Mountain salamander's range (Herrington and Larsen 1985) is along about 40 miles of the Columbia River Gorge in Washington and Oregon. Most habitat for the Larch Mountain salamander is protected in the Columbia Gorge National Scenic Area (Leonard et al. 1993). Aubry et al. (1988) recently extended the range into two areas of the central Cascades of Washington. Larch Mountain salamanders have been found at a minimum of 35 sites in Washington (WDW 1993c). The Washington Department of Fish and Wildlife identifies the main Washington distribution as extending from the Washougal River to near the Klickitat River, with isolated populations occurring as far north as Lewis and King Counties (WDW 1991, 1993c). A disjunct population occurs inside a lava tube cave in the Mount St. Helens National Volcanic Monument. Larch Mountain salamander sites also occur at Archer Falls and along the Washougal River in the HCP's Columbia Planning Unit; however, surveys of potential habitat are needed to confirm actual presence.

The Larch Mountain salamander occurs at elevations between 165 and 4,100 feet (WDW 1993c) and appears to have fairly restricted habitat requirements, including stabilized talus ranging in length between 0.4 and 2.3 inches with soil deposits in the interstices. Larch Mountain salamanders are more common in areas where dense overstories of coniferous or deciduous trees help maintain higher moisture levels (WDW 1993c). Herrington and Larsen (1985) make a solid case for a direct, dependent relationship between this salamander and Pacific Northwest old-growth forests. In their study, one site (along Mabee Mines Road in Skamania County, Washington) consisted of two talus slopes separated by a creek. One talus slope had been clearcut 10 years before their study began, and no Larch Mountain salamanders were found in the cut-over area; however, the other talus slope, directly across the creek from the cut slope, was covered with mature forest and contained Larch Mountain salamanders.

No data exist regarding the population dynamics of the Larch Mountain salamander. Individuals of this species behave like most other Pacific Northwest plethodontid salamanders; they are active at or near the surface whenever temperature and moisture regimes permit, which could be any day of the year in the Columbia River Gorge (Herrington and Larson 1985; Herrington 1987). Courtship behavior has not been observed, but mating occurs primarily in the fall and occasionally in the spring (Herrington and Larsen 1987). No clutches of eggs have been found for this species.

Any land-use practice that impacts moisture regimes in suitable stabilized talus slopes probably will eliminate populations of the Larch Mountain salamander. Herrington and Larson (1985) point out that the Columbia River Gorge is an area with numerous potential uses by humans, many of which could be detrimental to populations of these salamanders. Logging, harvesting talus for road building, and housing developments could all adversely affect the status of this species. The Washington Department of Fish and Wildlife (as WDW1991) recommends that a buffer of up to 150 feet of uncut forest be maintained around any occupied talus slope to protect populations of this salamander.

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 mobility of the various species. They determined that the Larch Mountain salamander is a species at high risk (score of 9, where 1 is low and 10 is high). Thomas et al. (1990) considered populations of this species to be at a medium to high viability risk.

Van Dyke's Salamander

Van Dyke's Salamander (*Plethodon vandykei*) is a candidate for state listing (WDFW 1995b) and is endemic to western Washington (Leonard et al. 1993). Approximately half of its known geographical distribution is on the Olympic Peninsula. It is considered at risk due to its limited distribution and the isolation of its disjunct populations.

Van Dyke's salamanders are considered to be the most aquatic species of woodland salamanders (Leonard et al. 1993). They are commonly associated with seeps or streams located in mature and old-growth coniferous forests (WDW 1991) and are typically located in the splash zone of creeks under rocks, logs, and woody debris (Leonard et al. 1993). The species has also been found in wet talus and forest litter (WDW 1991). The principal management recommendation of the Washington Department of Fish and Wildlife (as WDW 1991) is the maintenance of riparian corridors along all stream types, but especially along Types 4 and 5 streams. Additional recommendations exist for wet talus where the species is known to occur.

Tailed Frog

The tailed frog (*Ascaphus truei*) is a federal species of concern. Its range lies between the Cascades and the Pacific coast from southwestern British Columbia to northwestern California, with a disjunct area in southeast Washington, northeast Oregon, and central Idaho (Leonard et al. 1993). Tailed frogs are found throughout most of the HCP planning units. They are known to occur from elevations near sea level to 5,250 feet (Leonard et al. 1993). The principal threat to their continued existence is the degradation of riparian areas through intensive timber harvesting.

Tailed frogs are the only genus of anurans in North America adapted for life in cold fast-flowing mountain streams (Nussbaum et al. 1983). The "tail" of the species appears on males and is an erectile copulatory organ that enables internal fertilization of eggs (Welsh 1990). Internal fertilization is rare among amphibians and is probably an adaptation for successful breeding in fast-flowing streams. Tadpoles have a unique oral disc that enables them to adhere to rocks in swift currents (Nussbaum et al. 1983). The species prefers cold water and tolerates a narrow range of temperatures. Summer temperatures of a stream in the Oregon Cascades inhabited by tailed frogs ranged from 51.8° to 53.6° F (Nussbaum et al. 1983). The upper limit for egg development is 65.3° F (Brown 1975).

The species shows a preference for older forests. Welsh (1990) found that at elevations less than 3,280 feet, tailed frog density is correlated with forest age, and Carey (1989) found that tailed frogs are closely associated with old-growth forests. Tailed frogs sometimes disappear from streams within logged areas (Nussbuam et al. 1983); high water temperatures and increased siltation are the probable causes.

Lehmkuhl and Ruggiero (1991) included the tailed frog in a list of species associated with late successional Douglas fir forests in the Pacific Northwest. The risk of local extinction from habitat loss or fragmentation for each species was modeled, based on the frequency of occurrence, abundance, body size, and mobility of the species. Populations of the tailed frog were considered to be at moderately high risk.

Northern Red-legged Frog

The northern red-legged frog (*Rana aurora aurora*) is a sensitive species. Northern red-legged frogs inhabit moist and riparian forests, typically below 2,790 feet in elevation in the Pacific Northwest (Nussbaum et al. 1983; Stebbins 1985). This species is generally found near permanent water, including small ponds, quiet pools along streams, reservoirs, springs, lakes, and marshes (Gordon 1939; Stebbins 1954, 1985; Nussbaum et al. 1983). Although Stebbins (1954) describes northern red-legged frogs as being "highly aquatic", individuals have been found in forests at considerable distances from water (Gordon 1939; Stebbins 1954; Nussbaum et al. 1983). Nussbaum et al. (1983) reported finding individuals up to 984 feet from standing water and frequently along roads during rainy nights. Although not restricted to old-growth habitat, the northern red-legged frog is 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. Bury et al. (1991) found that northern red-legged frogs were most abundant at lower elevations with flatter slopes in Oregon and Washington. Breeding areas for this species vary greatly and include small temporary ponds, relatively large lakes, potholes, overflows of lakes and rivers, or slow reaches of rivers (Storm 1960; Licht 1969, 1971; Calef 1973; Brown 1975; Nussbaum et al. 1983).

Although no long-term studies of northern red-legged frogs have been conducted, observations from several biologists suggest that populations of this species are dwindling. For example, Nussbaum et al. (1983) stated that the northern red-legged frog is less common than it once was in the Willamette Valley of Oregon. The species has also declined greatly in California, presumably due to habitat exploitation by humans and introduced bullfrogs (Jennings and Hayes 1985; Hayes and Jennings 1986). Depletion of old-growth forests that provide habitat for northern red-legged frogs is likely to have detrimental effects on their populations.

Lemkuhl and Ruggiero (1991) included the northern red-legged frog in a list of species associated with late successional Douglas fir forests in the Pacific Northwest. The risk of local extinction from habitat loss or fragmentation for each species was modeled, based on the frequency of occurrence, abundance, body size, and mobility of the species. Populations of the northern red-legged frog were considered to be at moderately high risk.

Cascades Frog

The Cascades frog (*Rana cascadae*) is a federal species of concern. It is found in the Olympic Mountains and in the Cascade Range of Oregon, Washington, and northern California, typically above 2,625 feet and in small bodies of water rather than in large lakes (Sype 1975; O'Hara 1981; Nussbaum et al. 1983). Frequently used habitats include small, unvegetated potholes and marsh-like areas that are overflows of larger lakes. (See O'Hara 1981.) On occasion, Cascades frogs are found in forests away from water (Nussbaum et al. 1983).

Adults use the same sites for breeding from year to year (O'Hara 1981). Breeding sites in the central Cascades of Oregon are shallow, gently sloping margins of the lake shore or overflow areas, generally over soft substrates and protected from severe wave action (O'Hara 1981). The Cascades frog tends to lay eggs in microhabitats that produce maximal embryonic growth (Sype 1975; O'Hara 1981; Wollmuth et al. 1987). Tadpoles do not move much farther than several yards from where they hatched (O'Hara 1981); various features of the habitat (e.g., substrate type, cold water) bar their dispersal (O'Hara 1981). In the larger ponds where they are found, Cascades frog tadpoles prefer fairly warm, shallow water close to the shoreline with abundant vegetation (O'Hara 1981).

Relatively little is known about the population dynamics of adult Cascades frogs. (See Briggs and Storm 1970; Briggs 1978; Nussbaum et al. 1983; Olson 1988, and references therein.) Declines in populations of this species seem to have begun in the mid-1970s (Blaustein and Wake 1990; Wake 1991). One estimate is that 80 percent of the 30 populations that have been monitored since the mid-1970s have disappeared at least temporarily (Blaustein and Wake 1990). These declines, however, may reflect natural population fluctuations.

Lemkuhl and Ruggiero (1991) included the Cascades frog in a list of species associated with late successional Douglas fir forests in the Pacific Northwest. The risk of local extinction from habitat loss or fragmentation for each species was modeled based on the frequency of occurrence, abundance, body size, and mobility of the species. Populations of the Cascades frog were considered to be at moderately high risk.

Spotted Frog

The spotted frog (*Rana pretiosa*) is currently a candidate for both federal and state listing (WDW 1993a; Federal Register v. 61, no. 40, p. 7596). Historically, spotted frogs ranged north to extreme southeastern Alaska, south to central Nevada and central Utah, and east to western Montana and northwestern Wyoming. However, spotted frogs have become extremely rare in the western portion of their range (Nussbaum et al. 1983; Stebbins 1985; McCallister and Leonard 1990, 1991). Although occurring historically throughout the western Cascades and Puget Sound trough, spotted frogs are now very rare west of the Cascade mountains in Washington. One spotted frog population was documented in Trout Lake on DNR-managed land in the HCP's Columbia Planning Unit. The last published observation west of the Cascades in Oregon was in 1971 (Nussbaum et al. 1983; McCallister and Leonard 1990, 1991). The status of the spotted frog in eastern Oregon and Washington is unknown (McCallister and Leonard 1990, 1991). Causes for the decline of this species are unknown, although

Nussbaum et al. (1983) and Stebbins (1985) suggest that introduced bullfrogs (*R. catesbeiana*) may have contributed to their decline. Kirk (1988) noted DDT poisoning killed adult spotted frogs in Oregon. Because the frogs are dependent on shoreline and marsh vegetation, alteration caused by grazing and timber harvest can have serious negative effects on the species.

Spotted frogs are highly aquatic, using marshy ponds, streams, and lakes as high as 9,842 feet in parts of their range (Stebbins 1954, 1985; Nussbaum et al. 1983). They are found in numerous habitat types, including those dominated by Douglas fir and ponderosa pine as well as semi-arid to arid sites dominated by sagebrush (Stebbins 1954, 1985). In Oregon, spotted frogs may be sympatric with northern spotted owls in parts of their range. Stebbins (1985) suggests that this species is more common in fairly cool waters; however, in Wyoming, stagnant pools are used for mating (Turner 1958), and most ovulation sites are found in the shallow and warm portions of a 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). In Washington, the state Department of Fish and Wildlife (1991) reports that courtship and breeding occurs in the warm, shallow margins of ponds or rivers and 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, spotted frogs are active from February through October and hibernate in muddy pond or river bottoms in winter (WDW 1991). The maximum movement recorded from a breeding site is 4,225 feet.

The diet of the spotted frog varies with age and size of the frog and includes algae, vascular plants, numerous insect species, arachnids, and mollusks (Morris and Tanner 1969; Miller 1978; Whitaker et al. 1983; Licht 1986). Whitaker et al. (1983) suggested that management practices in Oregon may have altered the food items available for spotted frogs. Frogs from variously managed sites ate different foods than frogs at non-managed sites. For example, more grasshoppers were consumed at sites where soil was compacted, presumably by grazing livestock.

REPTILES

Two species of reptiles that occur in the area covered by the HCP are considered species of concern. One is a federal species of concern (Federal Register v. 61, no. 40, p.7596) and is already listed by the state; the other is a candidate only for state listing.

Northwestern Pond Turtle

The northwestern pond turtle (*Clemmys marmorata marmorata)* is currently a federal species of concern and is listed by the state as endangered (WDW 1993a). This species occurs at elevations from sea level to 6,000 feet from extreme southwestern British Columbia to the Sacramento Valley in California, principally west of the Sierra-Cascade crest (Bury 1970; Stebbins 1985). However, all sightings of the turtle north of the Willamette Basin in Oregon occurred below 2,400 feet (WDW 1993d). Recorded sightings in Washington seem to be clustered around the southeastern edge of Puget Sound and along a small portion of the Columbia River (Nussbaum et al. 1983; WDW 1993d). The distance between these populations is the largest known disjunction in the range of the northwestern pond turtle (WDW 1993d). Populations are confirmed only in Klickitat and Skamania counties, and individuals have been seen in Pierce and King counties (WDW 1993d). Historical records also exist for Clark and Thurston counties. Sixty-nine turtles were recorded at 15 sites in Washington in 1992 (Nordby 1992).

Northwestern pond turtles inhabit marshes, sloughs, moderately deep ponds, and slow reaches of creeks and rivers. They need basking sites, such as partially submerged logs, vegetation mats, rocks, and mud banks (Nussbaum et al. 1983). Evenden (1948) reported two records of northwestern pond turtles in rapid-flowing, clear, cold, rock and gravel streams in the Cascade foothills. The pond turtle has also been sighted in brackish coastal waters (Ernst and Barbour 1972). Northwestern pond turtles hibernate in the bottom mud of streams or ponds, or on land as far as 1,640 feet from water (Ernst and Barbour 1972). Northwestern pond turtles feed on aquatic vegetation, invertebrates, small fish, frogs, and carrion (WDW 1993d); however, they apparently prefer live or dead animal tissue to plant material.

Bury (1972) conducted a four-summer study of northwestern pond turtles in a 2.17-mile stretch of Hayfork Creek in Trinity County, California. The study site included woods (oak, ponderosa pine, and scattered Douglas fir), chaparral, and open grassy areas at 2,000 feet above sea level. Estimates of the northwestern pond turtle's home-range size were: for adult males, 2.41 acres; for adult females, 0.61 acre; and for juveniles, 0.90 acre.

Throughout their range, northwestern pond turtles nest from late April through August, but in Oregon, the peak breeding period is thought to be June to mid-July. Eggs are deposited in an earthen nest in soft soil on upland sites (Stebbins 1954; Nussbaum et al. 1983) and generally excavated in the morning. The nest is most often located near the margin of a pond or stream, but pond turtle nests have been found hundreds of yards from water.

Because Washington populations of northwestern pond turtles are extremely low, the continued presence of this species must be confirmed where they have been documented previously. Records in Washington are few and scattered, indicating the possibility of rarity or an ongoing decline. The literature is devoid of information on the possible association of northwestern pond turtles with truly forested areas. In view of the need for lengthy periods of direct sunshine for the successful hatching of buried eggs, the use of ponds or streams in older forests appears unlikely. The possibility of their use of cut-over areas, given proper aquatic habitats, has not been investigated.

Bullfrogs and non-native fish species present a risk to populations of northwestern pond turtles through predation and resource competition. Other risks include predation by carnivorous mammals, degradation of shoreline vegetation, and alteration of upland habitat within a quarter-mile of watercourses (WDW 1993d).

California Mountain Kingsnake

The California mountain kingsnake (*Lampropeltis zonata*) is currently a candidate for state listing (WDFW 1995b). Specimens have been collected in Skamania and western Klickitat counties from sites near the Columbia River Gorge (Nussbaum et al. 1983). California mountain kingsnakes occur in oak and pine forests and on chaparral up to 9,000 feet in elevation (Nussbaum et al. 1983). Their breeding, foraging, and resting habitat is primarily in early to mid-seral stage forests (Brown 1985). They have been found under and inside rotting logs and under rocks (Nussbaum et al. 1983). This species consumes lizards, snakes, mice, and nestling birds (Nussbaum et al. 1983).

BIRDS

In addition to the northern spotted owl and marbled murrelet, 16 bird species that occur in the area covered by the HCP are considered species of concern. Three of these species are federally listed and are discussed in Section C of this chapter titled Other Federally Listed Species. Two bird species are federal species of concern (Federal Register v. 61, no. 40, p. 7596), three are sensitive species, and seven are candidates for listing by the state. One more is already listed by the state.

Common Loon

The common loon (*Gavia immer*) is a candidate for state listing (WDFW 1995b). The species is known to breed at only a few locations in western Washington (WDW 1991), and it winters along the Pacific coast. Declines in common loon populations have been attributed the loss of nesting habitat (Erhlich et al. 1988).

Common loons breed on large wooded lakes with dense populations of fish (WDW 1991). Nests are built on the ground within 5 feet of the water's edge (WDW 1991). Nest sites can be reused in successive years. The breeding season occurs between April 1 and September (WDW 1991).

The species is very susceptible to human disturbance during nesting. A study of lake shore development in Canada found that the breeding success of common loons declined as the number of cottages increased within 500 feet of the nest.

Harlequin Duck

The harlequin duck (*Histrionicus histrionicus*) is a sensitive species and is also a state game animal (WDFW 1995b). Harlequin nesting success is highly sensitive to human disturbance. Its range covers the Pacific coast from northern California to Alaska and extends inland to the northern Rocky Mountains. In the east, its range includes areas of Labrador, Greenland, and the Atlantic coast north of Virginia. In Washington, it breeds throughout the Olympic, Cascade, and Selkirk mountains (WDW 1991).

Potential habitat for the harlequin duck is rivers, streams, creeks, and adjacent conifer forests (closed sap-pole, large sawtimber, and old growth per Brown 1985). Typical population densities are one pair per 2 to 4 river miles (Brown 1985). In Washington, breeding habitat for this species has been documented along the Soleduck, Hamma Hamma, North Fork of the Nooksack, Stillaguamish, Suiattle, Elwha, Methow, Nisqually, and Stehekin rivers as well as Morse Creek. Nests are typically located on rocky shores adjacent to rapids in turbulent mountain streams. Nests are built on the ground, under bushes, or between rocks (Bellrose 1976). This species feeds on mollusks, crustaceans, insects, fish, and echinoderms (Bellrose 1976). Wintering areas are saltwater habitats within 164 feet of the coast and most of the Puget Sound (Wahl and Paulson 1991; WDW 1991).

To create loafing sites, riparian corridors should be managed for stream recruitment of large woody debris. The Washington Department of Fish and Wildlife recommends that trails or roads should be at least 165 feet from streams and should not be visible from the stream (WDW 1991).

Northern Goshawk

The northern goshawk (*Accipiter gentilis*) is a state (WDW 1993a) candidate for listing as a threatened species and a federal species of concern. Habitat loss resulting from intensive timber harvest is believed to be the principal reason for its decline. Goshawks are circumpolar in the boreal, temperate, and highland subtropical northern hemisphere. They have been observed using a variety of forest types, but Austin (1994) demonstrated through statistical analysis that goshawks prefer closed-canopy mature and old-growth forests. In the Pacific Northwest, goshawks are associated with late successional coniferous forests and are most abundant in old growth (Thomas et al. 1993). The species occurs throughout Washington, primarily in both wet and dry conifer forest habitats (Wahl and Paulson 1991).

Breeding goshawks use large tracts of mature and old-growth forest where they can maneuver in and below the canopy to forage, and where trees are large enough to provide a foundation for nest construction (Bartlet 1977; Hennessy 1978; Reynolds and Wight 1982; Crocker-Bedford 1990a,b; Marshall 1992; Reynolds et al. 1992). In northwestern California, nest sites were found in trees with an average of 23 inches dbh (Hall 1984). On the Olympic Peninsula, nest trees averaged 28.2 inches dbh per breeding territory (n = 7) and ranged from 8.1 to 57.5 inches dbh. There are apparently some similarities in the nesting habitat of northern goshawks and northern spotted owls. Spotted owl nests and goshawk nests have been located less than 100 yards from each other (Marshall 1992). In mixed conifer forests on the east slope of the Cascades, 47 of 85 spotted owl nests were on stick nests built by goshawks (Buchanan 1992 as discussed in Marshall 1992).

Goshawks prey on a variety of small- to medium-size animals such as the American robin, Steller's jay, grouse, vole, Douglas squirrel, mountain beaver, and snowshoe hare. These prey species live in a variety of forest types and seral stages and along forest edges.

Where nest sites are readily available, the primary determinant of home range size is prey density (Reynolds et al. 1992). Using radiotelemetry, Titus et al. (1994) found that, in the temperate coniferous forests of southeast Alaska, the total area traversed by adults (n = 27) ranged from 1,899 to 348,863 acres; a mean home range area was not calculated due to the extreme variability in data. Applying minimum convex polygons methods to radio-telemetry data, Austin (1994) calculated a mean home range of 7,657 acres for adults (n = 10) in the southern Cascades.

There are no reported studies of dispersing juvenile goshawks, but theoretically, habitat traversed by dispersing juveniles must provide foraging and roosting opportunities in amounts adequate to promote their survival. It is likely that snags, downed logs, and a developed understory will enhance the density of goshawk prey (Reynolds et al. 1992). Roosting opportunities should provide cover from predators (horned owls) and adverse weather.

Goshawks may be highly sensitive to human disturbance. Timber harvesting within a 0.25-mile radius (the nearest 125 acres) of goshawk nest sites in Idaho resulted in a 75 to 80 percent reduction in occupancy of their nesting territories (Patla 1990).

The most intensive research on goshawks in North America has been conducted in the southwestern United States. On the basis of this research, Reynolds et al. (1992) made a set of specific management recommendations. (1) Three suitable nest areas and three replacement nest areas, each a minimum of 30 acres, should be maintained per home range. In the southwest, home ranges are about 6,000 acres. Nest areas should be 100 percent mature and old-growth forest, and no adverse activities should occur at any time within nest areas. (2) A post-fledgling family area (PFA) of 420 acres should be maintained around the nest areas. PFAs should contain 40 percent mature and old-growth forest. Management activities should be prohibited from March through September within the PFA. (3) A 5,400-acre foraging area should be maintained around the PFA, in which forest conditions are very similar to those of the PFA. Larger openings are preferred in the foraging area to provide habitat for certain species of goshawk prey. Reynolds et al. (1992) state that because the habitat needs of the goshawk are not adequately understood, they used the largest areas reported in the literature for establishing the size of nest sites and home ranges. It is uncertain how these recommendations would be extrapolated to the forests of western Washington.

Golden Eagle

The golden eagle (*Aquila chrysaetos*) is a candidate only for state listing (WDFW 1995b). Golden eagles declined over portions of their range because they were considered a threat to livestock and therefore killed. The destruction of rangeland is the principal threat to the species in Washington. Prior to 1982, nesting of the golden eagle west of the Cascade mountains in Washington state was considered rare (Bare et al. 1982). The species is more commonly associated with open rangeland. Clearcut logging creates forest conditions highly favorable to golden eagles (Bare et al. 1982), and therefore, recent forest practices appear to have expanded the amount of suitable golden eagle habitat.

Golden eagles use the same territory annually but may change nests from year to year (WDW 1991). The nests are in large trees or on cliffs. Nesting occurs between February 15 and July 15 (WDW 1991). In western Washington, nest sites are primarily in very large trees in mature or old-growth forests near clearcuts (WDW 1991). Golden eagles hunt mammals (snowshoe hares, squirrels, mountain beaver) in large open areas. The species can survive in intensively managed forests where timber harvests create a variety of seral stages within drainage basins.

Human disturbance is thought to be a factor in the failure of golden eagle nests (WDW 1991). A buffer distance of 1,500 to 1,600 feet during the nesting season is a general guideline to minimize the adverse impacts of human disturbance (WDW 1991).

Sandhill Crane

The sandhill crane (*Grus canadensis*) is a state endangered species (WDFW 1995b) that has no federal status. Sandhill cranes migrate throughout the state, and breeding has been documented in both eastern and western Washington. Sandhill cranes are extremely wary and therefore use only large tracts of open habitat with good visibility (WDW 1991). Habitat for this species includes grain fields, wet meadows, nonforested wetlands, and shallow ponds (Types 2 and 3 waters) (Brown 1985; WDW 1991). Nesting habitat is extensive shallow marshes with dense emergent plant cover (Littlefield and Ryder 1968). Wet meadows and grasslands are used for foraging and resting habitat (Brown 1985; WDW 1991). The sandhill crane may potentially occur in the HCP's Columbia Planning Unit.

Black Tern

The black tern (*Chlidonias niger*), a sensitive species, is a common summer resident in eastern Washington and a migrant in western Washington (Wahl and Paulson 1991). It appears to migrate primarily along the coast (Haley 1984), but probably uses the Columbia River as a route from breeding areas in eastern Washington and British Columbia.

Habitat for this bird is considered to be inland lakes, ponds, reservoirs, freshwater marshes, and wet meadows. The black tern typically nests in inland areas on pond and lake shorelines, marshes, swamps, bogs, and wet meadows (Brown 1985; National Geographic Society 1987). In Iowa, black terns nest only in marshes larger than 12.5 acres (Brown and Dinsmore 1986). Nests are loosely constructed of reeds and built on muskrat houses, fallen canes, or almost any other marsh substrate. Most black tern nests are built only a few inches above water in the same nesting habitats as Forster's terns, which typically use higher, drier locations. Nest success for this species is often low because of predation or weather (Haley 1984). During the nesting season, black terns feed on insects and small fish (Haley 1984).

Vaux's Swift

Vaux's swift (*Chaetura vauxi*) is a candidate only for state listing (WDFW 1995). It resides in the Pacific Northwest during the breeding season, and it winters from central Mexico to northern South America (Erhlich et al. 1988).

Vaux's swift nests in late successional coniferous forests (Bull and Collins 1993). There are indications that it depends on old-growth forests for survival (Carey 1989). The species requires large hollow snags or live trees for nesting and night roosting. Hundreds of Vaux's swifts may use a single large hollow tree for night roosting. There is typically one nest per tree. In 20 trees containing Vaux's swift nests, Bull and Cooper (1991) found only one tree that had two nests. In northeastern Oregon, the mean diameter of trees used for nesting was 26.6 inches dbh ($n = 21$); diameters ranged from 18 to 38 inches (Bull and Cooper 1991). Vaux's swifts are sometimes commensal with pileated woodpeckers, gaining access to hollow trees through holes excavated by pileated woodpeckers (Bull and Cooper 1991).

Vaux's swift preys on flying insects and spiders. They exploit all seral stages while foraging (Brown 1985) but show a strong preference for spaces over water (Bull and Beckwith 1993).

Lewis' Woodpecker

Lewis' woodpecker (*Melanerpes lewis*) is a candidate only for state listing (WDFW 1995b). The species breeds throughout most of Washington (WDW 1991) but is very rare in coniferous forests west of the Cascade crest. It winters in southern Oregon, northern California, and the southwestern United States (NGS 1987; WDW 1991). Declines in Lewis' woodpecker populations have been attributed to the loss of riparian habitat and competition for cavities and snags (WDW 1991).

Lewis' woodpecker is associated with open ponderosa pine forests and cottonwood riparian areas (WDW 1991; Erhlich et al. 1988). It also uses selectively logged or burned coniferous forest and oak woodlands (WDW 1991). The species excavates nest cavities but also occupies natural cavities or cavities excavated by other woodpeckers. Lewis' woodpecker catches insects in flight and prefers riparian deciduous forest and early-seral coniferous forest as foraging habitat (Brown 1985).

Pileated Woodpecker

The pileated woodpecker (*Dryocopus pileatus*) is a candidate only for state listing (WDFW 1995b). The pileated woodpecker occurs throughout Washington in mature and old-growth forests with large snags and fallen trees. The best habitat appears to be conifer stands with two or more canopy layers, with the uppermost being 80 to 100 feet high (WDW 1991). Pileated woodpeckers excavate nest cavities in snags or live trees with dead wood.

On the Olympic Peninsula, the mean diameter of trees used for nesting was 37.6 inches dbh (n = 13) and ranged from 25 to 45 inches dbh (Aubry and Raley 1992). Thirty-six nest trees in northeastern Oregon averaged 31 inches dbh (Bull et al. 1992). Roost tree characteristics are similar to those of nest trees (WDW 1991).

In managed forests of western Oregon, pileated woodpeckers had an average home range of 1,180 acres (n = 11) (Mellen et al. 1992). Forty-seven percent of these home ranges were covered by vegetation classes older than 70 years. Within their home range, these woodpeckers show a preference for foraging in forests 40 years or older and in riparian areas (Mellen et al. 1992), where they search for insects on large snags, logs, and stumps.

Olive-sided Flycatcher

The olive-sided flycatcher (*Contopus borealis*) is a federal species of concern. There may be evidence of a decline in the number of olive-sided flycatchers in the western United States, although data is weak and the causes of this decline are uncertain (Hejl 1994; DeSante and George 1994). The likely cause is destruction of forest habitat in both the olive-sided flycatcher's summer breeding range and wintering range. Its breeding range includes nearly all the boreal forests of North America and extends into the montane forests of the southern Sierra Nevada and Rocky Mountains (NGS 1992). The species winters in South America, from Columbia and Venezuela to southeastern Peru (Erhlich et al. 1988).

The preferred habitat of the olive-sided flycatcher is mature coniferous forest, in particular open coniferous forest with tall standing dead trees (Bent 1963). The species is often found along forest edges, where it perches on tall, exposed snags. On the western Olympic Peninsula, the bird is usually detected where late successional forest is bordered by a clearcut (Sharpe 1994). Nests are typically constructed on a horizontal branch between 15 and 50 feet above the ground (USDA 1991) in a variety of tree species — cedars, firs, spruces, or alders (Bent 1963). Bees and wasps are the main components of the flycatcher's diet (Bent 1963).

There are no established management recommendations for the olive-sided flycatcher. The creation of forest edges through clearcutting probably benefits the species, but extensive clearcutting with short harvest rotations would eliminate the mature forests and tall snags which this species requires.

Little Willow Flycatcher

The little willow flycatcher (*Empidonax traillii brewsteri*) is a sensitive species. Data indicate a decline in the number of little willow flycatchers in the Pacific Northwest (Paulson 1992), although there is uncertainty about the causes. Destruction of habitat in the bird's summer breeding range and wintering range is a likely cause, as is cowbird brood parasitism. The breeding range of the flycatcher species includes most of the United States except Florida, Louisiana, and southern portions of Texas, Arizona, and California. The range extends northward into southern British Columbia (NGS 1992). The subspecies *E. t. brewsteri* inhabits the portion of this range west of the Cascade and Sierra Nevada mountains. The bird's winter range extends from southern Mexico to Panama (Erhlich et al. 1988).

The preferred habitat of the little willow flycatcher is stands of alder or willow, thickets of salmonberry or blackberry, and low dense shrubby vegetation. In drier climates, the species occurs mainly in riparian areas. In wetter climates, such as the western Olympic Peninsula, the bird has been observed using shrubby habitats in regenerating clearcuts and in sapling stands between 10 and 20 years old. Nests are typically constructed in horizontal forks or upright crotches of shrubs or small trees between 3 and 25 feet above the ground (USDA 1991). A variety of woody plant species is used for nesting — alder, willow, or buttonbush (USDA 1991). Bees, wasps, and flies are the main components of this flycatcher's diet (Bent 1963).

There are no established management recommendations for the little willow flycatcher. Where it is strongly associated with riparian habitat, such as on the eastern Olympic Peninsula, the preservation of riparian areas would be critical for the species. On the western peninsula, even-aged forest management should provide the type of nesting habitat that the bird requires. If brood parasitism is a threat to the species, then increasing forest patch (i.e., stand) size may be recommended. Brittingham and Temple (1983) found that the density of cowbirds in the forest interior and the rate of brood parasitism decreased with distance from the forest edge. In drier climates, wider riparian buffers may reduce brood parasitism.

Purple Martin

The purple martin (*Progne subis*) is a candidate only for state listing (WDFW 1995b). The species breeds in western Washington (WDW 1991) and winters in northern South America east of the Andes Mountains (Erhlich et al. 1988). Declines in purple martin populations have been attributed to a reduction in the number of snags across its breeding range (Erhlich et al. 1988).

Purple martins require cavities for nesting. Historically, the species probably utilized cavities excavated by woodpeckers, but only a few such nests are known today (WDW 1991). Now, nesting is more common in bird boxes (WDW 1991). Its preferred breeding habitat is open areas near water (Erhlich et al. 1988).

The species is an aerial forager of insects and uses all seral stages of riparian and wetland forest as foraging habitat (Brown 1985).

Western Bluebird

The western bluebird (*Sialia mexicana*) is a candidate only for state listing (WDFW 1995b). The species breeds throughout Washington and resides year-round in western portions of the state (NGS 1987), but it is rare in coniferous forests west of the Cascade crest. Declines in western bluebird populations have been attributed to competition for nest cavities with starlings and house sparrows (Erhlich et al. 1988).

Western bluebirds require cavities for nesting and often nest in cavities excavated by woodpeckers (WDW 1991). Nests are found in open woodlands, burned areas with snags, and other open areas with scattered trees (WDW 1991; Erhlich et al 1988). In coastal Oregon, western bluebirds were found in most clearcuts where snags were present, and bluebird density was positively correlated with snag density (Schreiber and deCalesta 1992). The mean diameter of snags used for nesting was 28 inches dbh and ranged from 10 to 54 inches dbh; the snags were about 30 feet tall (Schreiber and deCalesta 1992).

The species forages on small invertebrates and berries. Prey are often captured by hawking from a low perch.

MAMMALS

Fourteen species of mammals that may occur in the area covered by the HCP are considered species of concern. Three are federally listed (discussed in Section C of this chapter titled Other Federally Listed Species), one is listed only by the state, nine are federal species of concern (Federal Register v. 61, no. 40, p. 7596; WDFW 1995a), and one is a sensitive species.

Myotis Bats

The long-eared myotis (*Myotis evotis*), fringed myotis (*M. thysanodes*), long-legged myotis (*M. volans*), and small-footed myotis (*M. ciliolabrum*), are species of concern. The Yuma myotis (*M. yumanensis*) is a sensitive species. Little is known about the ecology of these species. Thomas et al. (1993) listed 208 Pacific Northwest forest species for which information is seriously limited. Only 10 species were vertebrates, and nine of those were bats. The long-eared, fringed, long-legged, and Yuma myotis bats were among those listed.

Harvesting of old-growth forests has probably led to population declines in forest dwelling bats. In Washington, myotis species were detected 2.7 to 5.7 times more often in old-growth forests than in young and mature forests (Christy and West 1993). Feeding rates of myotis bats were found to be 10 times greater over water than in the forest interior (Christy and West 1993), implying that the species depend on old-growth forests for roost sites rather than for prey base.

Recommendations for conservation (Christy and West 1993) are preserving roost sites and foraging areas, but the dearth of knowledge about these species hinders effective conservation.

LONG-EARED MYOTIS

The long-eared myotis ranges across western North America from Baja California to central British Columbia, Alberta, and Saskatchewan (Nagorsen and Brigham 1993). It is found in a variety of habitats such as mature and immature conifer, alder/salmonberry, and arid grasslands (Maser et al. 1981; Nagorsen and Brigham 1993) at elevations from sea level to 6,725 feet (Nagorsen and Brigham 1993). The long-eared myotis uses buildings and slabs of loose bark attached to trees as day roosts (Maser et al. 1981). There are also records of the species roosting in caves and rock fissures (Nagorsen and Brigham 1993). Maternity colonies of 12 to 30 individuals have been found in buildings and hollow trees (Maser et al. 1981). The main prey of the species is moths and other flying insects.

FRINGED MYOTIS

The fringed myotis is typically found in deserts, arid grasslands, and forests (Nagorsen and Brigham 1993), but it has also been found in coniferous forests of coastal Oregon and in the western Cascades (Maser et al. 1981; Thomas and West 1991). The species prefers to forage in areas of grass-forbs and shrubs (Brown 1985). Roosting sites include buildings, mines, caves, and rock crevices (Nagorsen and Brigham 1993). Maternity colonies have been discovered in caves and buildings (Nagorsen and Brigham 1993).

LONG-LEGGED MYOTIS

The long-legged myotis ranges across western North America from Mexico to southeastern Alaska and western Canada (Nagorsen and Brigham 1993). It is found in a variety of habitats such as mature and immature conifer, alder/salmonberry, and arid range lands (Maser et al. 1981; Nagorsen and Brigham 1993) at elevations from sea level to 3,400 feet (Nagorsen and Brigham 1993). The long-legged myotis uses buildings and bark attached to trees as day roosts and for maternity colonies (Nagorsen and Brigham 1993), which typically contain several hundred individuals (Maser et al. 1981). Seventy-five percent of the bat's diet consists of moths (Nagorsen and Brigham 1993).

SMALL-FOOTED MYOTIS

The small-footed myotis is typically found near cliffs and rock outcrops in arid valleys and badlands (Nagorsen and Brigham 1993), but it has also been found in the western Cascades (Thomas and West 1991). The species forages over rocky bluffs and seldom over water. Sites for roosting and maternity colonies include cliffs, boulders, and talus slopes (Nagorsen and Brigham 1993).

YUMA MYOTIS

The Yuma myotis ranges across western North America from Mexico to southern British Columbia (Nagorsen and Brigham 1993). It is found in a variety of habitats such as coastal forests, Douglas fir forests, and arid grasslands (Nagorsen and Brigham 1993) at elevations from sea level to 2,400 ft (Nagorsen and Brigham 1993). It is closely associated with water (Maser et al. 1981), spending 61 percent of foraging time over aquatic areas (Brigham et al. 1992). The Yuma myotis uses buildings and rock crevices as day roosts (Nagorsen and Brigham 1993). Maternity colonies of 1,500 to 2,000 individuals (Nagorsen and Brigham 1993) and as many as 5,000 individuals have been discovered (Maser et al. 1981) in buildings, mines, or caves. Its main prey is aquatic insects such as mayflies and caddisflies.

Townsend's Big-eared Bat

The Townsend's big-eared bat (*Plecotus townsendii townsendii*) is a federal species of concern and a candidate for state listing in Washington (WDW 1993a). In the winter of 1989-1990, 534 hibernating Townsend's big-eared bats were documented in Washington, in Yakima, Skamania, Klickitat, and Whatcom counties, as well as in several other counties on the east side of the Cascades (Perkins 1990).

Townsend's big-eared bats have been documented from sea level to 10,365 feet (Pearson et al. 1952). This species can occur in nearly any forest type as long as suitable roost, nursery, and hibernaculum sites are present (Perkins and Levesque 1987; ODFW 1992). Big-eared bats use caves, buildings, mines, and the undersides of bridges with appropriate temperature and humidity for nurseries and for hibernation (ODFW 1992). Caves located within clearcuts may not be suitable because the lack of vegetation can affect the microclimate (WDW 1991). The nursery colonies, which support as many as 100 adult females, are used year after year from spring through August. Big-eared bats also use hollows in snags and tall stumps on occasion. Townsend's big eared bat forages on insects, mainly moths, in almost any habitat. This species is relatively non-migratory, with recorded annual movements generally less than 18.6 miles (Humphrey and Kunz 1976; Wackenhut 1990). Townsend's big-eared bats typically begin arriving at their hibernacula from late September to late October (Maser et al. 1981).

The Washington Department of Fish and Wildlife Nongame Program and M. Perkins, a regional bat expert at J. M. Perkins-Consultants, Portland, Oregon, each maintain databases of known bat sites in Washington. M. Perkins has provided location and big-eared bat population data for critical sites, including a minimum of 34 sites in the Columbia Planning Unit, 17 in the Klickitat, one in the Yakima, and two in the Chelan Planning Unit.

Western Gray Squirrel

The western gray squirrel (*Sciurus griseus*) is the only state-listed species of mammal with no federal status that may occur in the area covered by the HCP. It is listed by the state as a threatened species (WDW 1993a). The distribution of this squirrel in Washington is closely tied to that of Oregon white oak (WDW 1993e). Three habitats in three regions support western gray squirrels:

- white oak/Douglas fir on the edges of prairies in Pierce and Thurston counties,
- oak/ponderosa pine mixed forests along the Columbia River, and
- grand fir/Douglas fir forests in Chelan and Okanogan counties (WDW 1993e).

Mid- to late successional forests with intertwined canopies are required to allow arboreal movement of these squirrels. Nesting occurs in trees that are 8.3 to 22.8 inches dbh (WDW 1993e). The western gray squirrel may potentially occur in the Chelan, Columbia, Klickitat, and South Puget planning units of the HCP.

Pacific Fisher

The Pacific fisher (*Martes pennanti pacifica*) is a federal species of concern and a state (WDW 1993a) candidate for listing as a threatened species. As a protected species under the Wildlife Code of Washington (WAC 232-12-011), it cannot legally be trapped. Fishers occur throughout the boreal forests of North America. This species is thought to occur throughout the western Washington Cascades near the crest, in the Olympic Mountains in the Lilliwaup and Hoh-Clearwater areas, and in eastern Washington in portions of the Okanogan Highlands (Aubry and Houston 1992; WDW 1991).

Pacific fishers prefer riparian areas in mature and old-growth coniferous forests (Powell and Zielinski 1994). The species avoids nonforested areas and forest stands with low canopy closure (Powell and Zielinski 1994). Fishers are associated with low- to mid-elevation forests. West of the Cascade crest, all trapping records of this species are from locations below 5,900 feet in elevation, and 87 percent of the records are from below 3,300 feet (Aubry and Houston 1992). It is thought that fishers avoid high e levations because they are poorly adapted to deep snowpacks (USDI and USDA 1994a).

The structural complexity of older forests results in dense prey populations for Pacific fishers and provides den and rest sites (Powell and Zielinski 1994). Fishers prey on a variety of small to medium-size mammals and birds and also feed on carrion. They require habitat with large hollow snags or logs, which they use as maternity dens. Estimates of home range size vary from 4,695 to 19,521 acres for males, which have home ranges nearly three times larger than those of females (Powell and Zielinski 1994). Evidence suggests that between 148,260 and 494,200 acres of suitable contiguous habitat may be adequate for a minimum viable population of fishers (Powell and Zielinski 1994).

The Forest Ecosystem Management Assessment Team (FEMAT, as discussed in USDA and USDI 1994a) expressed concern about the geographical distribution of fishers because of:

- the lower amount of federal reserves at lower elevations,
- the low rates of recolonization by fishers after local extirpation, and
- their natural scarcity.

However, according to the rating in FEMAT (1993), of the President's Forest Plan would provide habitat of sufficient quality, distribution, and abundance to allow the Pacific fisher population to stabilize on federal land.

California Wolverine

The California wolverine (*Gulo gulo luteus*) is a federal species of concern. It is a protected species under the Wildlife Code of Washington (WAC 232-12-011), and therefore cannot legally be trapped. This sub-species of the wolverine may occur throughout the area covered by the HCP, although its distribution on the Olympic Peninsula and south coast areas appears to be very limited and may be restricted to a portion of Mason County (Butts 1992).

A large wide-ranging species, wolverines use a variety of habitats but are generally found in remote montane forest areas (Butts 1992). The habitat is probably best defined in terms of adequate year-round food supplies in large remote wilderness areas, rather than in terms of plant associations (Banci 1994). Den sites are generally in areas with an abundance of fallen logs and deep snow; however, more specific habitat associations have yet to be determined (Hatler 1989). Wolverines forage by scavenging ungulates or preying on small mammals.

Hatler (1989) indicated that the only way to manage habitat for wolverines is to use an ecosystem approach. Wolverines may use managed lands as long as the land is adjacent to a refugium such as a U.S. Forest Service Wilderness Area (Banci 1994). A primary component of suitable habitat for this species is a low level of human activity.

Lynx

The lynx (*Felis lynx canadensis*) is a federal species of concern and is listed by the state as a threatened species in Washington (WDW 1993a). Washington's lynx population is estimated to be between 96 and 191 individuals, with the population responding largely to snowshoe hare prey abundance (WDW 1991, 1993f). The lynx in Washington is found at elevations above 3,280 (Brittell et al. 1989); it ranges from Canada into northeast and north-central Washington, east of the Cascade crest and through the Okanogan Highlands into northern Idaho (McCord and Cardoza 1990; WDW 1991, 1993f). Although recent sightings have been reported throughout Washington and in Oregon, few have been confirmed, and it is uncertain if these represent breeding individuals.

Lynx are extremely wide-ranging, with home ranges between 12.4 and 186.3 square miles, depending on sex, age, season, and prey availability (Brittell et al. 1989; WDW 1991, 1993f). They are almost totally dependent upon snowshoe hares for food, although they will feed on squirrels, small mammals, and birds when hares are scarce.

The lynx occurs in remote areas, using extensive tracts of dense forests that are interspersed with rock outcrops, bogs, and thickets (McCord and Cardoza 1990). Lynx use a mosaic of forest types from early successional to mature conifer and deciduous forests, as long as snowshoe hares are present. Koehler (1990) found that lodgepole pine, Engelmann spruce, subalpine fir, Douglas fir, western larch, open meadow, and ponderosa pine were all used in the Okanogan Highlands. Lynx foraging habitat in early successional forests typically provides good snowshoe hare habitat (Koehler 1990). Lodgepole pine stands over 20 years old provide significantly more foraging habitat than older stands or other vegetation types (Koehler 1990).

Den sites of the lynx tend to be located in mature (over 150 years old) forest stands that have abundant down woody debris and are:

- at least 5 acres in size,
- undisturbed by humans,
- within 3.4 miles of foraging areas, and
- adjacent to natural travel corridors such as ridges and riparian areas (Brittell et al. 1989; Koehler 1990; WDW 1991, 1993f).

In Washington, travel cover is defined as contiguous areas close to or encompassing foraging cover that contains coniferous or deciduous vegetation less than 6 feet high (Brittell et al. 1989). Artificially created openings should not be larger than 40 acres (WDW 1991). The habitat associations discussed here were based on observations in only one area of Washington and may not apply to other areas with different vegetation or prey resources.

California Bighorn Sheep

The California bighorn sheep (*Ovis canadensis californiana*) is a federal species of concern. This species has been reintroduced into the state over the last several decades. Based on available information, it is questionable whether the range of bighorn sheep extends into any of the HCP planning units. No sheep have been recorded on the west-side of the Cascade crest, and their elevational range varies locally. California bighorn sheep are known to occur along the Columbia River about midway between Wenatchee and Chelan, along the Yakima River between Ellensburg and Yakima, and near Chinook and White Pass. This species is restricted to semi-open, precipitous terrain with rocky slopes, ridges, and cliffs or rugged canyons. Bighorn sheep normally avoid thick forests (Lawson and Johnson 1982), although they occasionally use scattered ponderosa pine/Douglas fir stands.

F. Listed and Candidate Plants

Non-vascular Plants and Fungi

As of the writing of this draft HCP, no non-vascular plants or fungi in the area covered by the HCP are listed by the federal government as threatened or endangered.

Vascular Plant Taxa of Concern

Several vascular plant taxa that occur in the area covered by the HCP are of concern at a federal level, whereas others are of concern at the state level. In general, these species have very limited ranges or narrow habitat requirements and are restricted to very small areas. Therefore, these plant taxa can likely be effectively conserved while meeting other land management objectives. DNR's Natural Heritage Program maintains a comprehensive database for these species, including both site-specific and species-specific information, that will be useful in managing for these species. For the purposes of this HCP, species of concern at the federal level consist of those listed under the federal Endangered Species Act, those proposed for listing, and those that are candidates for listing.

FEDERALLY LISTED AND PROPOSED VASCULAR PLANT SPECIES

Table III.15 lists those plant species in the area covered by the HCP that have been listed by the federal government or proposed for listing. Brief statements about each species are provided below; additional information can be obtained from either the Endangered Species office of the U.S. Fish and Wildlife Service in Olympia or from DNR's Natural Heritage Program.

Table III.15: Federally listed and proposed vascular plant taxa in the area covered by the HCP

NHP = Natural Heritage Program; POEX = possibly extinct or extirpated; WW = western Washington; EW = eastern Washington within the range of the northern spotted owl.

Scientific name	Federal status	NHP status	HCP planning areas	Geographic area and/or habitat
Arenaria paludicola	Endangered	POEX	WW	"swamps near Tacoma"
*Castilleja levisecta***	Proposed	Threatened	EW, WW	Puget trough grasslands
Howellia aquatilis	Threatened	Endangered	WW	Pierce County southward; shallow ponds in lowland forested areas
*Lomatium bradshawii***	Endangered	*	WW	Clark County; moist to wet meadows
Sidalcea nelsoniana	Threatened	Endangered	WW	Lewis and Cowlitz counties; moist meadows

* At the time of the most recent revision to Endangered, Threatened and Sensitive Vascular Plants of Washington (DNR 1994), this species was not known to occur in Washington.

** These species are unlikely to be affected by proposed HCP management plans. See Section G of Chapter IV on plants.

Arenaria paludicola

Swamp sandwort was historically known from "swamps near Tacoma" but has not been seen or collected in Washington since the late 1800s. Reports from several other western Washington locations have been determined to be misidentifications. However, additional inventory in Washington is needed, primarily in wetlands within the Puget lowlands. The only known site in the world is a brackish wetland in California.

Castilleja levisecta

Golden paintbrush occurs from Thurston County northward to Vancouver Island. Historically it was also known from the Willamette Valley in Oregon and Clark County, Washington. The species is restricted to grasslands and areas dominated by a mixture of grasses and shrubs. There are only ten known sites in the world, eight of which are in Washington. All sites are small and subject to a variety of threats, the most serious of which is invasion by Douglas fir, Scot's broom, blackberries, and roses.

Howellia aquatilis

Water howellia is an aquatic annual generally found in vernal ponds or portions of ponds in which there is a significant seasonal draw-down of the water level. All ponds where this plant is known to grow are rimmed by deciduous trees; most have conifers as well. The species is currently known to occur in Washington, Idaho, and Montana. In Washington, it has been found in Clark, Pierce, and Spokane counties. Historically, it was also known from Thurston and Mason counties, as well as Oregon and California.

Lomatium bradshawii

Bradshaw's lomatium was thought to be endemic to the Willamette Valley in Oregon until 1994, when it was discovered in Clark County, Washington. The one site in Washington is a seasonally flooded wetland dominated by grasses, sedges, and rushes.

Sidalcea nelsoniana

Nelson's checkermallow was also thought to be restricted to Oregon until relatively recently. There are now known sites in moist to wet meadows in Cowlitz and Lewis counties, Washington.

FEDERAL CANDIDATE AND SPECIES OF CONCERN

There are numerous vascular plant taxa known to occur, or suspected of presently occurring, in the area covered by the HCP that are candidates for federal listing under the Endangered Species Act or are species of concern to the U.S. Fish and Wildlife Service. These are listed in Tables III.16 and III.17. Additional information about these species can be obtained from DNR's Natural Heritage Program.

Table III.16: Federal candidate vascular plant taxa in the area covered by the HCP

NHP = Natural Heritage Program; POEX = possibly extinct or extirpated; E = endangered; T = threatened; S = sensitive; OESF = Olympic Experimental State Forest; WW = western Washington; EW = eastern Washington within the range of the northern spotted owl.

Scientific name	NHP status	HCP planning areas	Geographic area and/or habitat
Sidalcea oregana var. *calva**	E	EW	Wenatchee Mountains; meadow and forest

Table III.17: Federal species of concern vascular plant taxa in the area covered by the HCP

NHP = Natural Heritage Program; POEX = possibly extinct or extirpated; E = endangered; T = threatened; S = sensitive; OESF = Olympic Experimental State Forest; WW = western Washington; EW = eastern Washington within the range of the northern spotted owl.

Scientific name	NHP status	HCP planning areas	Geographic area and/or habitat
Abronia umbellata ssp. *acutalata*	POEX	WW, OESF	Clallam and Kitsap counties; scattered coastal
Artemisia campestris ssp. *borealis* var. *wormskioldii*	E	EW	Klickitat and Grant counties; along the Columbia River
Aster curtus	S	WW	lowland prairies
Astragalus australis var. *olympicus*	T	WW	NE Olympic Mts. talus/scree
Astragalus pulsiferae var. *suksdorfii*	E	EW	Klickitat County; open forest
Botrychium ascendens	S	WW, EW	mid- to upper elevations ridges and meadows
Calochortus longebarbatus var. *longebarbatus*	S	EW	Klickitat County meadow and open forest
Castilleja cryptantha	S	WW	Mt. Rainier moist meadows
Cimicifuga elata	T	WW	low-elevation forest
Corydalis aquae-gelidae	T	WW	Skamania and Clark counties; seeps, creeks above 2,500 ft

Table III.17: Federal species of concern vascular plant taxa in the area covered by the HCP *(continued)*

NHP = Natural Heritage Program; POEX = possibly extinct or extirpated; E = endangered; T = threatened; S = sensitive; OESF = Olympic Experimental State Forest; WW = western Washington; EW = eastern Washington within the range of the northern spotted owl.

Scientific name	NHP status	HCP planning areas	Geographic area and/or habitat
Cypripedium fasciculatum	T	EW	forest
Delphinium leucophaeum	E	WW	SE Washington; lowland prairies
Delphinium viridescens	E	EW	Wenatchee Mountains; meadows and moist areas
Dodecatheon austrofrigidum	T	WW, OESF	southern Olympic Mountains
Erigeron howellii	T	WW	Columbia River Gorge; nonforested areas
Erigeron oreganus	T	WW	Columbia River Gorge; exposed basalt
Filipendula occidentalis	T	WW	SW Washington riparian
Hackelia venusta	E	EW	Wenatchee National Forest; talus/scree
Lathyrus torreyi	----**	WW	Clark, Pierce counties mixed conifer forest
Lomatium suksdorfii	S	EW	Klickitat County; open slopes
Lomatium tuberosum	T	EW	Kittitas, Yakima, Benton and Grant counties; talus slopes
Lupinus sulphureus var. *kincaidii**	E	WW	SW Washington; lowland prairies
*Meconella oregana**	T	WW, EW	Puget Trough and Klickitat County; grassland and savannah
*Mimulus jungermannioides**	POEX	EW	Klickitat County; seeps in Columba River basalt
*Penstemon barrettiae**	T	EW, WW	Klickitat County; exposed basalt
Petrophyton cinerascens	T	EW	Chelan and Douglas counties; endemic along Columbia River

Table III.17: Federal species of concern vascular plant taxa in the area covered by the HCP *(continued)*

NHP = Natural Heritage Program; POEX = possibly extinct or extirpated; E = endangered; T = threatened; S = sensitive; OESF = Olympic Experimental State Forest; WW = western Washington; EW = eastern Washington within the range of the northern spotted owl.

Scientific name	NHP status	HCP planning areas	Geographic area and/or habitat
*Silene seelyi**	T	EW	Wenatchee Mountains; exposed rock
Sisyrinchium sarmentosum	T	WW	Skamania and Klickitat counties; meadows
*Sullivantia oregana**	T	WW	Columbia River Gorge; exposed rock
Tauschia hooveri	T	EW	Kittitas and Yakima counties; nonforested areas
*Trifolium thompsonii**	T	EW	Chelan and Douglas counties; grassland and forest edge

*These species are unlikely to to be affected by proposed HCP management plans. See section G of Chapter IV on plants.

**The NHP status of Lathyrus torreyi was undetermined as of August 1996. It was thought to be possibly extirpated until a population was discovered on McCord Air Force Base in 1994.

IV. The Habitat Conservation Plan

IV. The Habitat Conservation Plan

A. Minimization and Mitigation for the Northern Spotted Owl in the Five West-side and All East-side Planning Units

Conservation Objective

DNR's conservation objective for the northern spotted owl is to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal. Demographic support refers to the contribution of individual territorial spotted owls or clusters of spotted owl sites to the stability and viability of the entire population (Hanson et al. 1993 p. 11). Maintenance of species distribution refers to supporting the continued presence of the spotted owl population in as much of its historic range as possible (Thomas et al. 1990 p. 23; USDI 1992 p. 56). Dispersal is the movement of juvenile, subadult, and adult animals (in this case, spotted owls) from one sub-population to another. For juvenile spotted owls, dispersal is the process of leaving the natal territory to establish a new territory (Thomas et al. 1990 p. 303).

This conservation objective applies to the five west-side planning units and all three east-side planning units. The Olympic Experimental State Forest has different conservation objectives because of its unique mission of learning how to integrate forest production activities and conservation across the landscape. (See Section E in this chapter on the Olympic Experimental State Forest for a discussion of its conservation objectives and strategy for the northern spotted owl. See the section in Chapter I titled Organization of the Planning Area for a discussion of why the Olympic Experimental State Forest is unique.)

Due to differences in the habitat ecology of the spotted owl in western Washington and eastern Washington, the conservation strategies for each side of the Cascades are described separately. The intent of the spotted owl conservation strategy for for the five west-side planning units is twofold. First, the strategy is intended to provide nesting, roosting, and foraging (NRF) habitat and dispersal habitat in strategic areas in order to achieve the conservation objective of providing habitat for demographic support, maintenance of species distribution, and dispersal. Second, in areas designed to provide NRF habitat, the strategy is intended to create a landscape in which active forest management plays a role in the development and maintenance of the structural characteristics that constitute such habitat. To accomplish this, the strategy is composed of a research phase, a transition phase, and an integrated management phase.

The research phase is designed to develop a more precise description of functional spotted owl nesting habitat at the stand level, to develop silvicultural techniques to create such habitat, and to acquire a better understanding of what constitutes a sufficient distribution of nesting structure at the landscape level. Because such information is currently not available, patches of old forest with a high degree of structural complexity (i.e., forest types known to support nesting spotted owls) will be retained in an unmanaged state during the research phase. These nesting patches, which total approximately 20,000 acres, will exist within the larger spotted owl habitat landscape that will be managed to provide high quality roosting and foraging functions. (See below for a detailed description of the strategy.) Based on current understanding of spotted owl habitat, forest that provides structure for roosting and foraging functions is somewhat less structurally complex than forest that provides the actual nesting component of NRF habitat. The strategy will operate on the hypothesis that active forest management techniques can be applied to develop and maintain roosting and foraging habitat from the outset of the HCP. This hypothesis also applies to the creation and maintenance of dispersal habitat. These assertions will be tested as part of the monitoring component of the HCP. (See the section titled Monitoring in Chapter V for more discussion of this.)

The transition phase is envisioned as the middle phase of the HCP in which results of the research described above are applied within spotted owl habitat areas. During this period, the goal is to begin moving away from a landscape in which old-forest nesting habitat patches are unmanaged to a landscape in which management can be used to create and maintain nesting structure in a distribution that research shows is appropriate. This will be a period of transition because active monitoring will be needed to ensure successful application of research results and to modify silvicultural techniques for local conditions. The end of the transition phase will be marked by DNR's confidence in its ability to provide adequate nesting habitat without maintaining unmanaged nesting habitat patches.

The integrated management phase is the final period of the HCP in which knowledge gained through research, application of this knowledge to larger areas, and monitoring have moved forest management to a point where commercial timber harvest and maintenance of functional spotted owl nesting habitat coexist throughout spotted owl management areas.

The intent of the spotted owl conservation strategy for DNR-managed lands east of the Cascade crest is the same as for the west side. However, on the east slope of the Cascades, spotted owls appear to be able to nest in landscapes in which active management occurs. For eastern Washington, the strategy will start with the assertion that DNR can manage spotted owl NRF habitat. Again, this hypothesis will be tested as part of the monitoring component of the HCP.

Regional and site-specific conservation objectives — i.e., where does the need exist to provide demographic support, contribute to maintenance of species distribution, and provide dispersal linkages; and where do the opportunities exist for DNR-managed lands to contribute habitat to the provision of these functions — have been identified on the basis of data from each planning unit. The specifics of each spotted owl conservation strategy (west-side and east-side) are described separately. The components of the strategy are outlined first, followed by habitat definitions and the basis for those definitions. The section concludes with a discussion of the rationale used to develop the conservation objective and the strategies, a look at current and projected habitat, and a summary of potential benefits and impacts of the strategies to the species.

Conservation Strategy for the Five West-side Planning Units

The west-side and east-side conservation strategies for the northern spotted owl consist of four main components: identification of DNR-managed lands most important to spotted owl conservation; determination of habitat goals for areas established to provide NRF habitat; guidelines for management activities allowed in NRF habitat areas; and guidelines for provision of dispersal habitat. The specifics for the east-side strategy are detailed later; below, each component for the west-side strategy is described in detail. This strategy provides mitigation for the entire approximately 1,180,000 acres of DNR-managed lands covered by the HCP in the five west-side planning units.

IDENTIFICATION OF DNR-MANAGED LANDS MOST IMPORTANT TO SPOTTED OWL CONSERVATION

In order to determine the potential role in spotted owl conservation that could be played by DNR-managed lands within each planning unit, questions were considered, such as presence of habitat, forest type, distribution and pattern of DNR-managed lands with respect to other DNR-managed parcels and other landowners, proximity of DNR-managed lands to federal reserves and existing spotted owl clusters, biological status of the spotted owl population and existing threats in each planning unit, and the regional role of each planning unit for supporting spotted owl conservation in the state. Management recommendations from previous spotted owl conservation planning efforts (USDI 1992; Hanson et al. 1993; FEMAT 1993) were also taken into consideration. Based on the answers to these questions, an assessment of the role of DNR-managed lands for spotted owl conservation was made. DNR-managed lands fell into one of the following categories:

- important for demographic support;
- important to maintain species distribution;
- important for dispersal;
- not important for spotted owl conservation; or
- management for spotted owl habitat on DNR-managed lands alone would not make a significant contribution to owl conservation.

DNR-managed lands that emerged as important for demographic support were those that are intermingled with federal lands designated in the President's Forest Plan (see the section of Chapter II titled Federal Plans and Rules for a discussion of the President's Forest Plan) as Congressional Reserves, Late successional Reserves, Managed Late successional Reserves, or Adaptive Management Areas, as well as those that fall within 2 miles of these reserve designations. Two miles represents the radius of a circle that most closely approximates the median spotted owl home range size in the western Cascades (Hanson et al. 1993). In addition, some DNR-managed lands farther than 2 miles from federal reserves in the Columbia Planning Unit were determined to be important for both maintaining species distribution and demographic support. DNR-managed lands that fell between large federal reserves were determined to be important for dispersal.

Lands identified to provide demographic support and to contribute to maintaining species distribution shall be managed as NRF habitat.

For the purposes of this HCP, NRF refers to habitat that is primarily high quality roosting/foraging habitat with sufficient amounts of nesting structure interspersed so that the entire area can be successfully utilized by reproducing spotted owls. See description of rationale for habitat definitions later in this section. Lands identified to facilitate dispersal shall be managed as dispersal habitat. Stand conditions for each of these habitat types are defined below. DNR-managed lands selected for NRF habitat management and dispersal habitat management are shown for each of the five west-side planning units in Maps IV.1-IV.5.

Approximately 1.6 million acres of DNR-managed lands are covered by the HCP. The five west-side planning units contain approximately 1,180,000 acres of DNR-managed lands. NRF management areas encompass approximately 202,000 acres of DNR-managed lands. NRF areas in the five west-side planning units encompass approximately 163,000 acres. Dispersal management areas encompass approximately 200,000 acres of DNR-managed lands, 116,000 acres of which occur in the five west-side planning units. The provisions of the strategy (described next) will result in the maintenance of at least 50 percent of the forested lands within NRF and dispersal areas in the appropriate habitat type at any one time. Thus, the target conditions will be to maintain at least 101,000 acres of nesting, roosting, and foraging habitat and 100,000 acres of dispersal habitat at any one time in total for both the west- and east-side planning units.

DNR-managed lands that were determined not to have the potential to make a significant contribution to spotted owl conservation are those that are farther than 2 miles from federal reserves and in areas where there are currently no large clusters of spotted owls and little or no habitat, or that are not in key linkage areas where dispersal habitat or support of nonfederal spotted owl sites was needed. In some areas where federal reserves are absent, DNR did not designate specific NRF management areas. In one planning unit where federal reserves are present, DNR did not designate NRF management areas because it was determined that even DNR-managed lands adjacent to the reserves would most likely not make a significant contribution to demographic support of the spotted owl population. (See explanation in the discussion of rationale later in this section.)

DETERMINATION OF NRF HABITAT GOALS ON A LANDSCAPE SCALE FOR LANDS IDENTIFIED FOR A NRF HABITAT ROLE

In areas designated to provide NRF habitat, DNR shall provide a target condition of at least 50 percent of its managed lands measured within each Watershed Administrative Unit (Watershed Administrative Unit has been defined by DNR in cooperation with other agencies, tribes and the public and averages between 10,000 and 50,000 acres in size) as NRF habitat.

Criteria for determining the target amount of habitat for DNR NRF areas in each WAU are discussed below.

The amount of habitat on the combination of DNR NRF areas and federal reserves existing at the time timber harvest is planned for a WAU that contains designated NRF areas will be determined using the best information available. As the HCP is implemented, the amount of habitat on DNR-managed lands shall be field verified through a landscape assessment process. After initial field verification, habitat levels in WAUs containing DNR NRF management areas should be assessed every 10 years. DNR will not be required to field-verify habitat in federal reserves, but will rely on updated federal habitat inventories for lands within federal reserve status. Depending on the habitat conditions that exist at the time a WAU is entered for timber management, on of four possible scenarios would apply:

(a) If the amount of existing NRF habitat in a WAU is equal to or greater than 50 percent of the total area of federal reserves plus DNR-designated NRF areas, then DNR will maintain 50 percent of its designated NRF lands in the WAU as NRF habitat.

(b) If DNR-designated NRF areas by themselves contain less than 50 percent habitat, DNR will develop new habitat up to 50 percent of the area of those lands, regardless of the amount of current habitat on federal reserves plus DNR-designated NRF areas in the WAU.

(c) If the amount of current habitat in the WAU is less than 50 percent of the total area of federal reserves plus DNR-designated NRF areas, and DNR-designated NRF areas by themselves contain greater than 50 percent habitat, DNR will maintain an amount of habitat that is equal to the current amount. For example, if the WAU condition (federal reserves plus DNR-designated NRF areas) were 30 percent habitat, but 65 percent of DNR-managed lands in designated NRF areas were habitat, then DNR would maintain 65 percent of its managed lands in the designated NRF area as NRF habitat.

(d) If there are no federal reserves in a WAU in which DNR-designated NRF areas occur, DNR will maintain 50 percent of its lands designated as NRF management areas in NRF habitat.

In some places the boundary of a WAU divides a DNR-designated NRF area such that a smaller designated NRF area is created in a WAU with no other designated NRF areas (or disjunct from other NRF areas) and no federal reserves. For the purposes of calculating habitat targets and for management, such "orphaned" parcels can be grouped with DNR-designated NRF areas in the adjacent WAU that contains the larger area of designated parcels.

Under scenarios (a), (b), and (d), harvest of habitat can take place in WAUs where there is greater than 50 percent habitat on DNR-managed lands in designated NRF areas. Harvesting shall be designed to leave a specified level of nesting structure in the landscape. The amount, structural criteria, and configuration of nesting habitat are described below.

In places where DNR-managed lands are ecologically incapable of developing or maintaining 50 percent NRF habitat due to poor soils, high elevation, forest type, or other natural factors, the maximum coverage of habitat that those lands can support shall be maintained. For example, if DNR NRF areas within a WAU are only capable of growing 35 percent habitat due to poor soils, then DNR will maintain 35 percent habitat in that WAU throughout the term of the HCP.

MANAGEMENT OF FOREST STANDS WITHIN NRF HABITAT AREAS

During the research phase of the HCP, forest management activities within DNR-designated NRF areas will likely take place in four situations:

(1) in existing NRF habitat that counts toward the target amount for a WAU;

(2) in forest stands that are not yet habitat but are managed with the intent of developing habitat;

(3) in forest stands that are identified for harvest when the WAU has exceeded the target amount of NRF habitat; and

(4) in forest stands that do not count toward the target amount of NRF habitat.

The standards described here apply to the research phase only. New standards shall be developed for the transition and integrated management phases, the content of which will depend on the results of those efforts. New standards shall ensure adequate provision of nesting habitat. The following standards apply to the appropriate situation.

Management in DNR NRF habitat that counts towards the target amount of habitat in a WAU

Management can take place within this type of habitat as long as two conditions are met: adequate nesting habitat remains in the landscape, and forests that are managed for commercial wood production outside nesting habitat areas remain as sub-mature (Hanson et al. 1993; see habitat definitions below) or higher quality habitat after management activities have taken place. The specifics of each condition are as follows.

PROVISION OF NESTING HABITAT

(a) For the North Puget and Columbia planning units, nesting habitat (defined below) shall be provided in two 300-acre nesting patches per approximately 5,000 acres of DNR-designated NRF areas. In the South Puget Planning Unit, one 300-acre patch of nesting habitat shall be provided in the DNR-designated NRF area located directly north of the Mineral Block, and one 300-acre patch shall be located in section 16 of T 20 N, R 11 E; this designation accounts for low acreage of and wide separation between designated NRF areas in the South Puget Planning Unit. Based on a preliminary computer simulation of nest patch placement, there will be 68 nest patches encompassing a total of 20,400 acres[1].

(b) The 300 acres of nesting habitat shall occur within a larger contiguous 500-acre patch, the remaining 200 acres of which shall be composed of sub-mature or higher quality habitat (Hanson et al. 1993; see habitat definitions below). The entire 500-acre patch shall be contained entirely within a circle of 0.7-mile radius. Where 200 acres of sub-mature habitat are not available within the specified arrangement, the next highest quality habitat should be identified. If such a case occurs and there are no known active spotted owl nest sites in the vicinity (see iii below), silvicultural techniques may be applied to speed the development of sub-mature characteristics.

In cases where there are fewer than 1,000 acres of DNR-designated NRF in the WAU in which a nesting patch is located, DNR is obligated to provide only 50 percent total NRF habitat in the WAU. For example, a 640-acre section is the only DNR-designated NRF parcel in a WAU. A 300-acre patch of nesting habitat would constitute 47 percent of the 50 percent requirement in the WAU. DNR would not have to provide an additional 200 acres of sub-mature habitat. The priority in such cases is the establishment and protection of 300 acres of nesting habitat.

(c) If more than 200 acres of sub-mature habitat occurs in the area in which this habitat serves as a buffer, *and* the WAU is over its habitat target, the amount over 200 acres can be harvested. Habitat

[1]Given the spatial distribution of NRF areas, the number of nests patches will likely be slightly higher than results from a strict division of 163,000 acres by 5,000 acres (multiplied by 2) in order to achieve optimal distribution of nest patches.

of equal or better quality that is adjacent to a portion of the 300-acre nest patch or the remainder of the original 200-acre sub-mature buffer that will not be harvested must be immediately available to replace what is harvested - i.e., this provision cannot result in a degradation of habitat quality around the nest patch. If such harvest is planned during the breeding season, the harvest unit will be surveyed for spotted owl occupancy. Survey stations will be established such that an area 0.25 mile beyond the sale-unit boundary is covered by the surveys. Four visits will be conducted in a single year at least one week apart. If a detection is made within the harvest area or within 0.25 mile of it, seasonal restrictions will apply. If no detections are made, the sale unit will be available for harvest for four years.

(d) Nest habitat patches shall consist of the highest quality nesting habitat available in each 5,000-acre block and shall be identified using one of the following methods, listed in order of preference. Identification of nest habitat patches shall occur during the first year of HCP implementation. The U.S. Fish and Wildlife Service and National Marine Fisheries Service will review placement of nest patches at the 1-year review.

i. The location of known status 1 and 2 spotted owl site centers (sites where spotted owl pairs have been located) should be used as a starting point for delineating 300 acres of nesting habitat. When this option is used, habitat that meets the high-quality nesting habitat definition (see subsection titled Habitat Definitions) should be used as the first field screen. If habitat does not meet this definition, the Types A and B habitat definitions should be used next. All available Type A habitat should be included before Type B habitat is counted as part of a 300-acre nest patch.

ii. Where known spotted owl pair sites do not exist within a 5,000-acre block, habitat patches should be identified using the structural characteristics listed in the "high quality nesting habitat" definition described below. DNR forest inventory data can be used to identify these structural characteristics where the inventory data are available.

iii. Where inventory data are not available, existing field-typed habitat data that utilize DNR's Types A, B, and C typing system can be used. Forest stands that meet the Type A or B definitions can be counted toward the 300 acres of nesting habitat. All available Type A habitat should be included before Type B habitat is counted as part of a 300-acre nest patch.

iv. If data sources described above do not provide information to locate all the requisite nest habitat patches, DNR age-class data can be used as a starting point to locate potential habitat patches. The oldest forest stands in any particular 5,000-acre block are most likely to contain the structural characteristics of nesting habitat. Location and quality of habitat patches initially identified by this method shall be field-verified. Again, the high-quality nesting habitat definition should be used as the first field screen. If there is no habitat within a particular 5,000-acre block that meets this definition, then the Type A and Type B definitions shall be used next, with Type A habitat to be counted before Type B habitat is counted.

v. If there are no 300-acre nest patches that meet either the high-quality habitat definition or the Types A or B habitat definitions within a particular 5,000-acre block, the next highest quality 300-acre habitat patches should be identified. If the application of silvicultural techniques to such patches would speed the development of nesting structure where it is currently lacking, these activities are permitted, as long as they occur farther than 0.7 mile from any known spotted owl sites.

(e) The 300-acre nest patches shall be deferred from harvest until DNR can demonstrate the successful application of silvicultural techniques to create functional nesting habitat in managed stands. During the research phase of this HCP, DNR shall conduct the research necessary to determine what constitutes adequate nest structure at both the stand and landscape levels and conduct silvicultural experiments that attempt to create adequate nesting structure. Research may be conducted in cooperation with other landowners and managers. When DNR begins actively managing nestinghabitat stands, the target condition of the landscape shall be consistent with the results of the research described earlier. Development of new management standards for spotted owl nest habitat shall be done in consultation with the USFWS.

MANAGEMENT OF SUB-MATURE HABITAT THAT IS NOT DESIGNATED AS NESTING HABITAT

(a) If any harvest activity occurs in habitat that meets or exceeds the sub-mature definition, no more than 5 percent of the habitat on DNR-designated NRF lands in a WAU can undergo harvest activity in a two-year period. When any additional harvest is planned for habitat in the WAU, the stand or stands which constituted the first 5 percent in which harvest activities took place shall be assessed to ensure that sub-mature habitat characteristics remain. If these characteristics are present, an additional 5 percent of the habitat can be harvested.

(b) If characteristics of sub-mature habitat are not present after management activities have been conducted, no additional NRF habitat may be treated in that WAU until sub-mature quality is attained. In addition, subsequent silvicultural treatments should be modified so that forest stands are not reduced below sub-mature quality for more than two years.

(c) DNR will submit proposed exceptions to the U.S. Fish and Wildlife Service. If the U.S. Fish and Wildlife Service does not agree with the proposal, a multi-agency science team, including staff specialists from DNR, the U.S. Fish and Wildlife Service, and any third party scientist the U.S. Fish and Wildlife Service deems appropriate, shall be convened to resolve any outstanding issues.

Management in DNR NRF habitat in WAUs that contain less than 50 percent NRF habitat

Management can take place in this type of habitat as long as NRF habitat remains after management activities are complete. The standards described in paragraphs (a), (b), and (c) above apply to management within sub-mature habitat in WAUs that are below the target amount of habitat.

Management of stands that are not yet NRF habitat can take place only if management activities do not increase the amount of time that would be required for the target amount of NRF goal to be attained if all the stands in that WAU were left unmanaged.

Management in DNR NRF habitat in WAUs that contain more than the target amount of NRF habitat

Management can take place in this type of habitat if such management does not lower the total amount of NRF habitat below the target amount and does not reduce the amount and distribution of nesting habitat described earlier. Landscape-specific arrangements of habitat that meet the life-needs of the spotted owl will be determined during the landscape assessment process that is used to implement the HCP. Harvest of habitat that is in excess of the target amount for a WAU should be done in the context of a landscape assessment process. This process may consider the following factors:

- Larger patches of habitat constitute higher quality spotted owl habitat than smaller patches, thus limiting fragmentation of large, contiguous habitat patches is desirable.

- Habitat patches that are contiguous with large habitat patches on federal land have more habitat value than smaller or disjunct patches.

- Older forest may constitute higher quality habitat than younger forest that still meets the habitat definition.

- Planning harvest in excess habitat away from known spotted owl nest sites first and near the vicinity of known nest sites last would minimize impact to the spotted owl population.

In WAUs that are above the habitat target, DNR will avoid harvest of habitat within 0.7 mile of known nest sites during the breeding season. DNR will use any updated information on nest site locations provided by the U.S. Fish and Wildlife Service.

Management of DNR forest stands that do not count toward the target amount of NRF habitat in a WAU

Management can occur in these areas in WAUs that are at or above the target amount of NRF habitat as long as all activities adhere to all other provisions of the HCP and do not lower the total amount of NRF habitat below the target amount and do not reduce the amount and distribution of nesting habitat described earlier. If a spotted owl nest site is discovered during timber sale planning, seasonal harvest restrictions timed to avoid the breeding season shall be observed within a 0.7-mile radius of the nest site.

PROVISION OF DISPERSAL HABITAT

Dispersal habitat shall be maintained on 50 percent of DNR-managed lands selected for a dispersal habitat role. The stand characteristics of dispersal habitat are described in the habitat definition section below. The 50 percent goal shall be measured in DNR-designated dispersal areas on a WAU basis.

MANAGEMENT IN WAUs NOT DESIGNATED TO PROVIDE HABITAT FOR SPOTTED OWLS

When harvesting spotted owl habitat outside of designated NRF areas, DNR will consider recommendations of the the U.S. Fish and Wildlife Service for scheduling potential take of spotted owl site centers during the first decade. This will be done in order to retain sites that may have a valuable short-term contribution to the population. Otherwise, the provisions of the spotted owl strategy do not place any special conditions upon forest stands in WAUS that are not designated to provide habitat for the spotted owl. All other provisions of the HCP shall still apply, as shall Forest Practices regulations that do not pertain specifically to spotted owls as well as relevant policies of the Board of Natural Resources. If a spotted owl nest site is discovered during timber sale planning in a stand not designated to provide spotted owl habitat, seasonal harvest restrictions timed to avoid the breeding season shall be observed with a 70-acre core surrounding the nest site.

OTHER MANAGEMENT CONSIDERATIONS

Salvage Operations and Activities Related to Forest Health

DNR's HCP conservation strategies include commitments to develop and maintain wildlife habitat (in this case, NRF habitat and dispersal habitat for the northern spotted owl) over time in designated amounts and areas. In general, such conservation commitments made in the HCP will take priority over other DNR management considerations. However, these conservation commitments may, in some cases, be inconsistent with activities DNR must consider under state statutes pertaining to salvage (RCW 79.01.795) and forest health (RCW 76.06.040).

For example, salvage operations might be considered by the DNR for reasons such as windthrow, fire, disease, or insect infestation. Activities related to forest health might include risk reduction through underburning, thinning, or harvest to stop spread of disease or insect infestation.

When DNR determines that such potential exists, discussions shall be held with the U.S. Fish and Wildlife Service. If it is determined that such activities would adversely impact the HCP conservation strategies, DNR and the U.S. Fish and Wildlife Service shall identify additional mitigation that would allow the necessary activities to go forward.

In conducting salvage activities, DNR shall, to the extent practicable:

- minimize the harvest of live trees to those necessary to access and complete the salvage activity;
- maximize and clump the retention of large, safe, standing trees to provide future snags; and
- consider opportunities to retain concentration of snags and/or coarse woody debris which may benefit species such as black-backed and three-toed woodpeckers.

Support of Federal Reserves

DNR-managed lands selected to provide demographic support to spotted owl clusters on federal reserves may become less important as habitat on federal reserves develops. DNR may periodically review habitat conditions and any relevant demographic information to reassess the necessity of a contribution from DNR-managed lands. In some areas, it is possible that federal reserves alone will eventually be sufficient to support a self-sustaining spotted owl population. Where such conditions warrant, DNR may approach the U.S. Fish and Wildlife Service to amend the HCP accordingly. Proposals for such changes would be developed by DNR and submitted to the U.S. Fish and Wildlife Service and National Marine Fisheries Service. A multi-agency science team may be convened to resolve questions regarding the biological basis of the proposal.

HABITAT DEFINITIONS

This section defines the habitat types that are referred to in the NRF and dispersal management standards section above. This section is followed by a discussion of the origin and basis of these habitat definitions.

High-quality Nesting Habitat

The following definition is interim in nature due to limitations in the data from which it was derived and will be refined when DNR conducts the appropriate research. (See discussion below titled Basis for Habitat Definitions.) This definition is to be applied as an average condition over a 300-acre nesting habitat patch.

- At least 31 trees per acre are greater than or equal to 21 inches dbh with at least 15 trees, of those 31 trees, per acre greater than or equal to 31 inches dbh.
- At least three trees from the above group of 31 trees have broken tops
- At least 12 snags per acre larger than 21 inches dbh
- A minimum of 70 percent canopy closure[2]
- A minimum of 5 percent ground cover of large woody debris

The 15 trees per acre greater than or equal to 31 inches dbh should be from the largest size classes present. If there are not 15 trees per acre greater than or equal to 31 inches dbh, the next largest available trees per acre should be retained to maintain a total of 31 trees larger than 21 inches dbh per acre.

Type A Spotted Owl Habitat

- A multi-layered, multispecies canopy dominated by large (30 inches dbh or greater) overstory trees (typically 15-75 trees per acre)
- Greater than 70 percent[3] canopy closure
- A high incidence of large trees with various deformities such as large cavities, broken tops, and dwarf mistletoe infection
- More than two large snags per acre, 30 inches dbh or larger
- Large accumulations of fallen trees and other woody debris on the ground

Type B Spotted Owl Habitat

- Few canopy layers, multispecies canopy dominated by large (greater than 20 inches dbh) overstory trees (typically 75-100 trees per acre, but can be fewer if larger trees are present)
- Greater than 70 percent canopy closure
- Some large trees with various deformities
- Large (greater than 20 inches dbh) snags present
- Accumulations of fallen trees and other woody debris on the ground

[2]For all instances in which canopy closure is used in a habitat definition, relative density (RD) will be used as a measurement if and when DNR has established a correlation between RD and canopy closure in spotted owl habitat for its lands. Relative density is defined as the basal area of a stand divided by the square root of the quadratic mean dbh of the stand (Curtis 1982). Foresters prefer this measurement to canopy closure because of repeatability of results and because it uses standard inventory data.

[3]This is a modification from Hanson et al. (1994, Appendix 4), which stated "60-80 percent". See discussion of canopy closure in subsection titled Basis for Habitat Definitions.

The Type A and Type B habitat definitions have been used by DNR spotted owl surveying crews and Washington Department of Fish and Wildlife habitat biologists since March 1991. Both habitats support spotted owl nesting (Hanson et al. 1993 p. 114).

Sub-mature Habitat

The following definition should be applied as average stand conditions. Sub-mature habitat has the following characteristics:

- Forest community dominated by conifers, or in mixed conifer/hardwood forest, the community is composed of at least 30 percent conifers (measured as stems per acre dominant, co-dominant, and intermediate trees)
- At least 70 percent canopy closure
- Tree density of between 115 and 280 trees greater than 4 inches dbh per acre
- Dominant and co-dominant trees at least 85 feet tall
- At least three snags or cavity trees per acre that are at least 20 inches dbh

The Washington Forest Practices Board Spotted Owl Science Advisory Group (Hanson et al. 1993) determined that these characteristics constitute high-quality younger forest habitat for western Washington and reported that sub-mature forests provide roosting and foraging opportunities for spotted owls.

Based on thinking that has developed since the publication of Hanson et al. (1993), DNR has determined that a down woody debris component is also important for high-quality roosting and foraging habitat. Thus, a minimum of 5 percent ground cover of large down woody debris shall also be required for sub-mature habitat. This is an explicit addition to Hanson et el. (1993) definition of sub-mature habitat. (See subsection titled Basis for Habitat Definitions, below.)

Dispersal Habitat

Dispersal habitat has the following minimum characteristics:

- Canopy cover at of least 70 percent
- Quadratic mean diameter of 11 inches dbh for 100 largest trees per acre in a stand
- Top height of at least 85 feet (Top height is the average height of the 40 largest diameter trees per acre.)
- At least four trees per acre from the largest size class retained for future snag and cavity tree recruitment

Higher quality nesting habitat, Type A, Type B, and sub-mature habitat can be counted as dispersal habitat.

BASIS FOR HABITAT DEFINITIONS

Nesting Habitat

The definition of high-quality nesting habitat outlined above is derived from two studies that measured nest tree characteristics and vegetative structure around spotted owl nest sites in western Washington. One study included paired measurements from 15 nest sites and 15 random sites on the Olympic Peninsula (Hershey 1995), and the other included data from 11 nest sites in the western Cascades (Hamer 1995, unpublished data). This definition was developed as an attempt to replace the vague descriptive language used in the Type A and Type B habitat definitions. However, it should be viewed as an interim definition because of limitations in the data from which it was derived. These limitations stem from small sample size, less than full geographical representation of habitat types in western Washington, and the application of data derived from an unmanaged context to a managed context. This definition should be revised as more data becomes available on the vegetative characteristics of spotted nest stands and more information regarding the ability of spotted owls to nest successfully in a managed landscape. Proposals for such changes would be developed by DNR and submitted to the U.S. Fish and Wildlife Service and National Marine Fisheries Service. A multi-agency science team may be convened to resolve questions regarding the biological basis of the proposal.

TREE SIZE

Hershey (1995) found that mean nest tree size was 58 inches dbh; minimum nest tree size was 23 inches dbh and maximum size was 176 inches dbh. Hamer (1995, unpublished data) found that mean nest tree size was 74 inches dbh with a minimum of 47 inches dbh and a maximum of 115 inches dbh. (See Table IV.1.) Given that nest trees in these studies were so large, the definition for nesting habitat reflects the importance of retaining large trees in nest stands. The number and size class of large trees reflects the mean number of trees in a 21- to 31-inch dbh size class and a greater than 31-inch dbh size class found in nest stands in each study (Table IV.2). It should be noted that Hershey (1995) found no statistically significant difference in tree density in either the 21- to 31-inch-dbh and or the greater than 31-inch dbh size classes in nest plots versus random plots. (See footnotes in Table IV.2.)

SNAGS

The requirement of 12 snags per acre greater than 21 inches dbh is derived from taking the arithmetic mean of the sum of means from the 21 to 31-inch-dbh size class and the greater than 31-inch-dbh size class from each study. (See Table IV.2.) Snags are important both for nest trees and for prey. Seven of the 26 nest trees in both of these studies were snags. Carey (1995) found that the presence of large snags was the best predictor of abundance of northern flying squirrels, which is a principal prey species for spotted owls in western Washington. (See Section A of Chapter III on species ecology of the northern spotted owl.)

BROKEN-TOP TREES

The requirement for broken-top trees comes from the mean number of such trees observed in Hershey's study. Hamer did not measure density of broken-top trees. Trees with side or top cavities were used as nest trees in both study areas, however. (See Table IV.1.) These cavities are usually formed in trees with broken and secondary leaders and in trees from which large branches were broken.

CANOPY CLOSURE

A minimum of 70 percent canopy closure is consistent with a range of canopy closures defined by one standard deviation below the mean observed in both Hamer's (1989) and Hershey's (1995) studies. It is also consistent with recommendations of Hanson et al. (1993) on the basis of their review of the literature. DNR is in the process of collecting data to relate canopy closure to relative density in spotted owl habitat on its lands.

Table IV.1: Spotted owl nest tree characteristics in western Washington

dbh = diameter at breast height; s.e. = standard error; $\bar{x}$ = mean; n = number in sample

	Olympic Peninsula (Source: Hershey 1995)	**Western Washington Cascades** (Source: Hamer 1995, unpublished data)
Nest tree diameter (inches dbh)	$\bar{x}$ = 58 range = 23 to 176 s.e. = 9.7 n = 15	$\bar{x}$ = 74 range = 47 to 115 s.e. = 7.8 n = 10
Nest tree height (feet)	live trees $\bar{x}$ = 146 range = 99 to 186 n = 11 snags $\bar{x}$ = 57 range = 34 to 77 n = 4	live trees $\bar{x}$ = 194 range = 115 to 206 n = 7 snags $\bar{x}$ = 104 range 49 to 180 n = 3
Tree species	Douglas fir = 5 western redcedar = 5 western hemlock = 5	Douglas fir = 1 western redcedar = 8 western hemlock = 1
Nest structure	top cavities = 4 live tree = 1 snag = 3 side cavities = 10 live tree = 9 snag = 1 platform nests = 1	top cavities = 1 live tree = 0 snag = 1 side cavities = 9 live tree = 7 snag = 2 platform nests = 0

Table IV.2: Spotted owl nest stand characteristics in western Washington

dbh = diameter at breast height; s.e. = standard error; $\bar{x}$ = mean; n = number in sample; sd = standard deviation; p = probability that the difference is because of random characteristics within the population

	Olympic Peninsula (Source: Hershey 1995)[1]						Western Washington Cascades (Source: Hamer 1995, unpublished)[2]					
Tree density	Size class	$\bar{x}$	min	max	s.e.	sd	Size class	$\bar{x}$	min	max	s.e.	sd
by size class	4.0-11.0	90	12	297	22	85	4-11	80	32	131	11	38
(size in inches dbh,	11.1-21.0[3]	45	19	112	8	31	11-21	27	18	53	3.3	11
density in trees	21.1-31.0	16	5	31	1.7	7	21-31	16	10	24	1.5	5
per acre)	≥31	14	1.6	23	1.8	7	≥31	16	10	26	1.2	4
Tree density	Height class	$\bar{x}$	min	max	s.e.	sd						
by height class	25-49	40	7	110	8.3	32						
(height in feet,	50-75	34	10	120	8.5	33						
density in trees	76-100[4]	30	7	84	7.1	27						
per acre)	101-125[5]	25	8	78	5.3	20						
	126-150	17	8	44	2.3	9						
	≥150	11	0	23	2.0	8						
Snag density	Size class	$\bar{x}$	min	max	s.e.	sd	Size class	$\bar{x}$	min	max	s.e.	sd
by size class	4.0-11.0[6]	13	2.0	44	3.7	14	4-11	13	2	44	3.6	12
(snags in inches	11.1-21.0	4	0.8	8.5	0.6	2.3	11.21	10	2	18	1.3	4
dbh, density in	21.1-31.0	3.6	0.8	8.5	0.6	2.3	21-31	8	2	16	1.5	5
snags per acre)	≥31	3.3	0.0	9.7	0.8	3.0	≥31	8	4	12	0.8	3
Density of tree 21 in. dbh with broken tops and secondary leaders (trees per acre)		$\bar{x}$	min	max	s.e.							
		3.0	0	17	0.56							
Canopy closure		$\bar{x}$	min	max	s.e.	sd		$\bar{x}$	min	max	s.e.	sd
		78.8[7]	68.3	87.1	1.43	5.5		83	62	92	2.6	8.6

[1]Vegetation data around 15 nest sites were collected using five 0.1-ha plots, the first plot centered on the nest tree and the other four placed at four cardinal directions from nest tree. Snag data were collected using five 0.2-ha plots that surrounded the 0.1-ha plots. Vegetation was sampled around random sites as well. Random plots were chosen within a home range distance of nest sites and within forest stands in which dominant or co-dominant trees were at least 21 inches dbh. Data from random sites are not shown. Where there was a statistically significant difference between nest stands and random stands, data are shown in a footnote.

[2]Hamer's data are from the Mount Baker-Snoqualmie National Forest. Vegetation characteristics are based on 25-m-radius plots around 11 nest sites. Some of this data was originally published in USDI 1992. It was reanalyzed by Hamer for the purposes of this HCP in 1995.

[3]There was a significant difference between the mean density of trees around nest sites versus random sites in this size class. For random plots in the 11-21-inch-dbh size class the mean density was 29 trees per acre, p = 0.0467 (Hershey 1995). There were no significant differences between nest sites and random sites for any other size class.

[4]Mean density of trees in this height class at random sites is 16.3, p = 0.0236.

[5]Mean density of trees in this size class at random sites is 14.2, p = 0.0226.

[6]Mean density of snags at random sites in this size class is 7, p = 0.0402.

[7]Mean canopy closure for random sites is 74.4, s.e. = 1.27, p = 0.0033.

DOWN WOODY DEBRIS

Down wood is essential for small mammal communities (Maser and Trappe 1984; Harmon et al. 1986). Carey and Johnson (1995) found that the abundance of small mammal species was related to the amount of dead and down wood in both managed and naturally regenerated stands. From their empirical observations, they recommend that retention of 15 to 20 percent cover of coarse woody debris would allow most small mammal species to reach their potential abundances. Coverage of less than 10 percent probably would not allow these communities to reach their potential abundances (Carey and Johnson 1995 p. 347). Attaining an adequate level of large woody debris for small mammal communities is an important consideration for spotted owl nesting habitat. However, it is not clear whether providing for full potential abundance of small mammal communities is necessary given that the spotted owl's primary prey is the northern flying squirrel, which is an arboreal rodent. Down woody debris is also associated with species of fungi that are the primary food source for flying squirrels (Carey 1995). Again, the amount of woody debris cover needed to adequately provide this function is not known. A 5 to 10 percent range was chosen as the amount of down woody debris cover based on the reasoning that if 15 percent cover supported small mammal populations at their full potential abundance, the middle two-thirds of a range between 0 and 15 percent would likely provide for adequate spotted owl prey populations. This is clearly a management hypothesis and will be tested as part of the research that will be conducted to define more precisely spotted owl nest stand characteristics.

CONFIGURATION

The recommendation for arranging nesting habitat in a 300-acre nest patch within a larger 500-acre patch of suitable habitat is based on studies that demonstrate increasing probability of spotted owl occupancy with increasing amount of habitat close to site centers and studies that show concentrated use of habitat within 0.7 mile of site centers. In a study of 61 spotted owl sites on the east slope of the Cascades, Irwin and Martin (1992) found that spotted owl sites that were occupied either one or two years of a two-year survey had an average of 252 acres (s.d. = 20) of suitable habitat within a 0.5 mile circle in managed stands and 316 acres (s.d. = 20) in a 0.5 mile circle in unmanaged stands. There was a strong statistical relationship between the amount of habitat found at sites with 0, 1, or 2 years of occupancy at 0.5, 1.0, 1.5, and 2.0 miles from the site center with the strongest relationship occurring at 0.5 mile. Data on the amount of habitat found within 0.5 mile of occupied sites was used in a logistic regression analysis to predict occupancy. Their analysis predicted a 90 percent chance of pair site occupancy when there were 300 acres of suitable habitat within 0.5 mile of a site center. This study provided predictive abilities and did not establish minimum amounts of habitat needed by owls. As stated above, this study was conducted on the east side of the Cascade Crest where owl responses to habitat quality and quantity are different from forests on the west side of the Cascade Crest. DNR believes that patches of this size, in combination with surrounding sub-mature forest will provide the necessary habitat to support nesting owls in proximity to federal lands.

Irwin (1993) tracked the use of habitat within annual home ranges of 19 radio-tagged spotted owls and found that more than 60 percent of the area used annually was within a 700-acre area. (See also Hanson et al. 1993 p. 38-39.) In addition, Hanson et al. (1993) recommended that the area within 0.7 mile of a spotted owl activity center should be considered an area of exclusive use for that site because of data demonstrating concentrated use of habitat closer to site centers than farther away (Forsman et al. 1984), and because this area is used heavily by juvenile spotted owls during their first summer (Hanson et al. 1993 p. 33). Based on this information, it is reasonable to arrange habitat in contiguous 500-acre patches (300 acres of high-quality nesting habitat and 200 acres of at least sub-mature habitat) within a 0.7-mile-radius circle.

The distribution of one nesting habitat patch per 5,000 acres of DNR-designated NRF areas approximates a distribution of one nesting core per annual home range. Two nesting habitat patches per 5,000 acres of DNR-designated NRF area are provided to buffer against potential catastrophic loss and to increase the likelihood that suitable nesting patches will be found by dispersing juveniles.

Sub-mature Habitat

Sub-mature forest is a younger forest habitat category defined by Hanson et al. (1993). Sub-mature habitat includes mid-seral forest (non-late successional or old growth) that has the structural characteristics necessary to provide roosting and foraging functions. Foraging habitat is associated with healthy prey populations of small forest floor mammals and northern flying squirrels, though neither of these is as abundant as in older forests (Hanson et al. 1993 p. 53; Carey 1995; Carey and Johnson 1995). Roosting habitat is associated with the presence of potential perches at various vertical positions throughout the forest canopy. Sub-mature habitat corresponds with Type C habitat definition that has been used by DNR and the Washington Department of Fish and Wildlife for habitat typing in Washington. Sub-mature habitat is used infrequently for nesting by spotted owls (Hanson et al. 1993, Appendix 3, Appendix 5). Refer to Hanson et al. (1993 p. 55-59) for more information about the data they used to develop each component of the sub-mature habitat definition.

Hanson et al. (1993) proposed their spotted owl habitat definitions as working hypotheses and recommended that annual data reviews be conducted in order to revise these definitions as new pertinent information became available (Hanson et al. 1993 p. 50). Based on this recommendation, DNR is treating its use of the sub-mature habitat definition in this HCP as a working hypothesis and shall incorporate new information to revise the definition. The incorporation of a down woody debris component is an example of how DNR intends to build on the sub-mature habitat definition.

DNR added a down woody debris component to the original definition of sub-mature habitat because of the likelihood that there is an association between the presence of down woody material and abundant spotted owl prey populations as discusssed earlier. While a threshold of adequate versus inadequate amounts of down woody debris specifically for spotted owl habitat cannot be established based on existing data, the inclusion of a down wood component for sub-mature habitat is consistent with DNR's intent to provide high quality roosting and foraging habitat. Old-forest habitat is the habitat type selected by spotted owls over younger habitat types for both roosting and foraging and nesting functions (see Section A on spotted owl ecology in Chapter III) and is characterized by the presence of abundant down woody debris (Spies and Franklin 1991; Carey and Johnson 1995). Thus, during the research phase of this HCP, DNR will include a down woody debris component in both the nesting and the sub-mature habitat definitions until more data is available regarding the amount of down wood required to provide adequate foraging opportunities for spotted owls in a managed landscape.

Dispersal Habitat

Definitions of dispersal habitat based on an understanding of stand conditions and landscape patterns that relate to high rates of successful juvenile spotted owl dispersal are lacking. The model developed by Thomas et al. (1990) and adopted by the Northern Spotted Owl Recovery Team (USDI 1992) was based on range-wide conditions thought to support roosting adults. This approach, commonly referred to as the 50-11-40 rule, recommended managing areas outside of designated reserves such that 50 percent of forested lands in each quarter township would have an average canopy closure of 40 percent and trees would average 11 inches dbh. Habitat conservation plans prepared for the Murray Pacific Corporation in western Washington by Beak Consultants, Inc. of Kirkland, Washington (1993), and the Weyerhaeuser Corporation's Millicoma Tree Farm (1994) in coastal Oregon use more specific models to accomplish the same goal as the model proposed by Thomas et al. (1990). Both plans call for monitoring of the success of silvicultural prescriptions in attaining the desired stand conditions, but neither plan will monitor actual use of designated dispersal stands by dispersing juvenile spotted owls.

The Murray Pacific HCP differs from the 50-11-40 rule in that it proposes specific tree density and diameter criteria (130 trees per acre that are at least 10 inches dbh, with tree density not to exceed 300 trees per acre) to provide trees of adequate size for roosting and a canopy closure of 70 percent (versus 40 percent in the Thomas definition) that allows adequate space under the canopy for spotted owls to move in and provides adequate thermal cover. Beak (1993) considered 40 percent canopy closure inadequate for dispersal habitat for managed stands in western Washington because the tree limbs would be close to the ground and the understory vegetation would be dense. Both these conditions would likely inhibit successful foraging. The Murray Pacific HCP also provides a component of snags, live trees, and dead wood to provide foraging opportunities. This plan is designed for site conditions on the Murray Pacific Tree Farm in the western Washington Cascades.

The Weyerhaeuser Millicoma HCP also specifies tree density and size criteria, using 120 trees per acre that are at least 10 inches dbh and a maximum density of 300 trees per acre.

DNR recognizes the lack of data relating actual stand conditions and landscape patterns to successful spotted owl dispersal. For the purposes of this HCP, an interim definition will be adopted that will be replaced as better data become available. DNR is in the process of analyzing existing data for:

(1) use versus availability of habitat types by roosting adult spotted owls;

(2) habitat associations of northern flying squirrels; and

(3) habitat typing of stands used by successfully dispersed juvenile spotted owls in western Washington.

The results of this analysis will be used to derive a more precise definition of dispersal habitat. In the interim, DNR will adopt an approach similar to the model developed by Beak Consultants for Murray Pacific. The basis for each component of DNR's definition of dispersal habitat is as follows.

CANOPY COVER

For western Washington, a canopy cover of 70 percent is more likely to allow for sufficient maneuverability and thermal cover than a canopy closure of 40 percent (Beak Consultants 1993).

CANOPY HEIGHT

A top height of 85 feet should provide an adequate canopy lift, or area under the canopy that is free of obstruction from lower limbs, so as to not impede spotted owl flight, and thus enhance foraging activities.

GREEN TREE RETENTION

Green tree retention is intended for the eventual recruitment of snags and cavity trees. Snags or cavity trees are required for high densities of flying squirrels (Hanson et al. 1993; Carey 1995), a principal prey species of spotted owls in western Washington (Carey et al. 1992).

DOWN WOODY DEBRIS

The definition of dispersal habitat does not currently contain provisions for down woody debris. There are currently no data upon which to base a recommendation for down wood in dispersal habitat. However, given that one of the functions of dispersal habitat is to provide foraging opportunities, down woody debris would provide important habitat for spotted owl prey species. A down wood component shall be incorporated into the dispersal habitat requirements if and when research demonstrates its necessity or there is data upon which to base a reasonable management hypothesis.

Conservation Strategy for the Three East-side Planning Units

The conservation strategy for spotted owls on the east slopes of the Cascades is built on the same principles as the strategy for the five west-side planning units. Differences in the strategies arise from differences in forest ecology and spotted owl habitat ecology on the east and west sides of the Cascades. The outline of components is the same for both strategies, but the specifics in each component differ. (The rationale for both strategies follows the discussion of east-side habitat definitions and their basis.) The specifics for each component in the east-side strategy are described below. This strategy provides mitigation for the entire approximately 229,000 acres of DNR-managed lands covered by the HCP in the three east-side planning units.

IDENTIFICATION OF DNR-MANAGED LANDS MOST IMPORTANT TO SPOTTED OWL CONSERVATION

The process and criteria for determining what if any role DNR-managed lands could play in spotted owl conservation on the east side were similar to that used for lands on the west side. The only difference is that lands on the east-side within 1.8 miles of federal reserves were considered important for demographic support instead of within 2 miles as in western Washington. This difference reflects the difference in the radius of circles that approximate a median annual spotted owl home range on the eastern and western sides of the Washington Cascades (Hanson et al. 1993). Some lands selected to serve a demographic support function are located farther than 1.8 miles from a federal reserve. These lands are directly adjacent to the Yakama Indian Reservation and provide support for a cluster of spotted owls currently centered on a combination of DNR-managed lands, the Yakama Reservation, and federal reserve lands.

Approximately 229,000 acres of DNR-managed lands are covered by the HCP in the three east-side planning units. DNR NRF areas encompass approximately 39,000 acres in the three east-side planning units. Dispersal areas encompass approximately 85,000 acres of DNR-managed lands in eastern Washington. Lands selected for NRF and dispersal management are shown in Maps IV.6-IV.8.

DETERMINATION OF NRF HABITAT GOALS ON A LANDSCAPE SCALE FOR LANDS IDENTIFIED FOR A NRF HABITAT ROLE

The steps used to determine habitat goals for DNR designated NRF areas are the same as described earlier for the west-side strategy.

MANAGEMENT OF FOREST STANDS WITHIN NRF HABITAT AREAS

NRF habitat in eastern Washington is defined as sub-mature or higher quality forest. (See habitat definition below.) Forest management activities within DNR-designated NRF areas will take place in four different situations:

(1) in existing NRF habitat that counts toward the target amount for a WAU;

(2) in forest stands that are not yet habitat but are managed with the intent of developing habitat;

(3) in forest stands that are identified for harvest when the WAU has exceeded the target amount of NRF habitat; and

(4) in forest stands that do not count toward the target amount of NRF habitat.

Management in DNR NRF habitat that counts toward the target amount of habitat in a WAU

Management can take place within this type of habitat under the following conditions:

- The structural characteristics of sub-mature quality or higher are retained.

- No more than 5 percent of the NRF habitat within a WAU should be modified in a two-year period. Before the same WAU can be entered for any management activity that either degrades old-forest habitat to sub-mature habitat or results in the removal of commercial volumes of timber from sub-mature habitat, the original area that received such management treatment should be assessed to determine that the managed stands meet the definition of sub-mature habitat. After it has been determined that the managed stands meet the definition, an additional 5 percent old-forest or sub-mature habitat can be managed for commercial wood production.

- If the characteristics of sub-mature habitat are not present, no additional management within NRF habitat in the WAU can take place until the managed stands have again acquired sub-mature characteristics. Any future management activity should be modified so that forest stands are not reduced below sub-mature quality for more than two years.

Management in DNR NRF habitat in WAUs that contain less than 50 percent NRF habitat

Management can take place in this type of habitat as long as NRF habitat remains after management activities are complete. The standards described immediately above for management of sub-mature habitat apply in WAUs below the target condition as well. Management of stands that are not yet NRF habitat can take place only if management activities do not increase the amount of time that would be required for the target amount of NRF to be attained if all the stands in that WAU were left unmanaged.

Management in DNR NRF habitat in WAUs that contain more than the target amount of NRF habitat

Management can take place in this type of habitat if such management does not lower the total amount of NRF habitat below the target amount. As in western Washington, landscape-specific arrangements of habitat that meet the life needs of the spotted owl will be determined through a landscape assessment process that is used to implement the HCP. Harvest of excess habitat should be done in this context. This process may consider the following factors:

- Larger patches of habitat constitute higher quality spotted owl habitat than smaller patches; thus, limiting fragmentation of large, contiguous habitat patches is desirable.
- Habitat patches that are contiguous with large habitat patches on federal land have more habitat value than smaller or disjunct patches.
- Older forest may constitute higher quality habitat than younger forest that still meets the habitat definition.
- Planning harvest in excess habitat away from known spotted nest sites first and in the vicinity of known nest sites last would minimize impact to the spotted owl population.

In WAUs that are above the habitat target, DNR will avoid harvest of habitat within 0.7 mile of known nest sites during the breeding season. DNR will consider any updated information on nest site locations provided by the U.S. Fish and Wildlife Service.

Management of DNR forest stands that do not count towards the target amount of NRF habitat in a WAU

Management can occur in these areas in WAUs that are at or above the target amount of NRF habitat as long as all activities adhere to all other provisions of the HCP and do not lower the total amount of NRF habitat below the target amount.

PROVISION OF DISPERSAL HABITAT

Dispersal habitat shall be provided in designated areas according to the definition described below. Fifty percent of DNR-designated dispersal areas within a quarter township shall be maintained in dispersal habitat conditions. In some cases, the location of quarter township lines results in a configuration of DNR-designated dispersal areas that are too small to allow practical management activities to occur. Where such situations arise, DNR-designated dispersal areas can be grouped with adjacent DNR dispersal areas in adjacent quarter townships.

MANAGEMENT IN WAUs NOT DESIGNATED TO PROVIDE HABITAT FOR SPOTTED OWLS

When harvesting spotted owl habitat outside of designated NRF areas, DNR will consider recommendations of the the U.S. Fish and Wildlife Service for scheduling potential take of spotted owl site centers during the first decade. This will be done in order to retain sites that may have a valuable short-term contribution to the population. Otherwise, the provisions of the spotted owl strategy do not place any special conditions upon forest stands in WAUs that are not designated to provide habitat for the spotted owl. Mitigation for other listed species shall still apply, as shall Forest Practices regulations that do not pertain specifically to spotted owls as well as relevant policies of the Board of Natural Resources. If a spotted owl nest site is discovered during timber sale planning in a stand not designated to provide spotted owl habitat, seasonal harvest restrictions timed to avoid the breeding season shall be observed within a 70-acre core surrounding the nest site.

OTHER MANAGEMENT CONSIDERATIONS

Salvage Operations and Activities Related to Forest Health

DNR's HCP conservation strategies include commitments to develop and maintain wildlife habitat (in this case, NRF habitat and dispersal habitat for the northern spotted owl) over time in designated amounts and areas. In general, such conservation commitments made in the HCP will take priority over other DNR management considerations. However, these conservation commitments may, in some cases, be inconsistent with activities DNR must consider under state statutes pertaining to salvage (RCW 79.01.795) and forest health (RCW 76.06.040).

For example, salvage operations might be considered by DNR for reasons such as windthrow, fire, disease, or insect infestation. Activities related to forest health might include risk reduction through underburning, thinning, or harvest to stop spread of disease or insect infestation.

When DNR determines that such potential exists, discussions shall be held with the U.S. Fish and Wildlife Service. If it is determined that such activities would adversely impact the HCP conservation strategies, DNR and the the U.S. Fish and Wildlife Service shall identify additional mitigation that would allow the necessary activities to go forward.

In conducting salvage activities, DNR shall, to the extent practicable:

- minimize the harvest of live trees to those necessary to access and complete the salvage activity; and
- maximize and clump the retention of large, safe, standing trees to provide future snags.

HABITAT DEFINITIONS

This section defines the habitat types that are referred to in the NRF and dispersal management standards section above. This section is followed by a discussion of the origin and basis of these habitat definitions.

Nesting, Roosting, and Foraging Habitat

Nesting, roosting, and foraging functions are provided by sub-mature, mature, and old-growth forest types in eastern Washington (Hanson et al. 1993). Both Type A and sub-mature habitat provide nesting habitat. The Type A definition is included as a reference point for the range of habitat qualities that exist in eastern Washington. The management standards described above use the sub-mature definition as the minimum standard for spotted owl nesting habitat to be met within NRF management areas.

Type A Spotted Owl Habitat

Nesting, roosting, and foraging habitat in eastern Washington generally occurs in grand fir, Douglas fir, and ponderosa pine forest zones (Franklin and Dyrness 1973). Forest stands of Type A habitat are mature habitat that has naturally regenerated following windthrow or fire. These stands have the following characteristics:

- Multi-layered, multispecies canopy dominated by overstory trees that exceed 20 inches dbh (typically 35-100 trees per acre)
- At least 75 percent canopy closure
- Some dominant trees have mistletoe brooms, cavities, or broken tops
- Three snags per acre greater than or equal to 20 inches dbh
- Down woody debris that is greater than or equal to 20 inches dbh plus accumulations of other woody debris

Sub-mature habitat

This definition should be applied as average conditions over a stand. Sub-mature habitat has the following characteristics:

- Forest community composed of at least 40 percent Douglas fir or grand fir
- Canopy closure of at least 70 percent
- Tree density of between 110 and 260 trees per acre
- Either tree height or vertical diversity (one characteristic but not both needs to be present)
  - dominant and co-dominant trees at least 90 feet tall

  or

  - two or more canopy layers with numerous intermediate trees and low perches
- Either snags/cavity trees or mistletoe infection (one characteristic but not both needs to be present):
  - Three or more snags or cavity trees per acre that are equal to or greater than 20 inches dbh

  or

  - a moderate to high infection of mistletoe[4]
- Five percent ground cover of dead and down wood averaged over a stand

Dispersal Habitat

This is an interim definition of dispersal habitat. (See subsection below titled Basis for Habitat Definitions.)

- At least 50 percent canopy closure
- Overstory tree density of at least 40 trees per acre that are at least 11 inches dbh

[4]The Washington Forest Practices Board Spotted Owl Science Advisory Group recommended combining tree level indices of mistletoe infection (Baranyay and Safranyik 1970; Hawksworth 1977) with a stand level index (Roe and Amman 1970). In the tree level index, the tree canopy is visually divided into three vertical layers. Each layer is assigned a rating depending on the level of infection: 0 = no visible infection; 1 = less than half of the branches infected; 2 = more than half of the branches infected; and 3 = more than half of the branches infected and large brooms are present. The stand level index rating system is based on the number of trees in the stand that are infected: 1 = no trees infected; 2 = less than one-third of the trees infected; 3 = between one-third and two-thirds of the trees infected; 4 = more than two-thirds of the trees infected. The stand-level and tree-level ratings are then combined in a matrix to get an overall ranking. See Table IV.3 for the matrix. The Spotted Owl Science Advisory Group recommends that this system be field-verified and modified if necessary (Hanson et al. 1993 p.106-107).

Table IV.3: Recommended method for estimating habitat quality for spotted owls using tree- and stand-level indices of mistletoe infection

(Source: Reproduced from Hanson et al. 1993 p. 107)

	Stand-level infection index			
Tree-level infection index	**1 (no trees)**	**2 (< 1/3 of trees)**	**3 (1/3 - 2/3 of trees)**	**4 (> 2/3 of trees)**
0 (none)	None	None	Light	None
1 (<1/2 of branches)	None	Light	Moderate	Moderate
2 (>1/2 of branches)	None	Moderate	Heavy	Heavy
3 (>1/2 of branches, large brooms present)	None	Moderate	Heavy	Heavy

- Top height of at least 60 feet
- Retention of four green trees per acre from the largest size class present for recruitment of snags and cavity trees
- At least 50 percent of DNR-managed lands designated for a dispersal function on a quarter township basis will be maintained in the stand conditions described above

BASIS FOR HABITAT DEFINITIONS

Sub-mature Habitat

Sub-mature habitat in eastern Washington includes both even- and multi-aged stands. The characteristics of these stands result from a history of disturbance by fire, wind, insects, and disease and from selective forest management practices (Hanson et al. 1993 p. 63). Sub-mature forest has been documented to support successful nesting (Buchanan 1991; Buchanan et al. 1993, 1995; Hanson et al. 1993). See Hanson et al. (1993 p. 63-68) for an explanation of data supporting each habitat component.

Hanson et al. (1993) proposed their spotted owl habitat definitions as working hypotheses and recommended that annual data reviews be conducted in order to revise these definitions as new pertinent information became available (Hanson et al. 1993 p. 50). Based on this recommendation, DNR is treating its use of the sub-mature habitat definition in this HCP as a working hypothesis and shall incorporate new information to refine the definition.

Dispersal Habitat

As with west-side forests, an understanding of dispersal habitat based on use of stands by successfully dispersing juveniles is also lacking for forests on the east side of the Cascades. DNR's research strategy for developing more precise dispersal habitat definitions includes developing one or more region-specific definitions for the eastern Washington Cascades. The basis for devising the definitions is described in the components below.

CANOPY CLOSURE

Data from several radio-telemetry studies indicate that forest stands with a canopy closure of less than 50 percent are rarely used by spotted owls for roosting and foraging (Hanson et al. 1993 p. 65). DNR is in the process of collecting data to relate canopy closure to relative density for forests in eastern Washington.

OVERSTORY TREE DENSITY

Providing 40 trees per acre that are at least 11 inches dbh should contribute at least 50 percent canopy cover, ensure there are enough trees large enough to supply hiding cover, and include a large component of smaller trees in the stand.

STAND HEIGHT

Top height is a reliable and repeatable measure of stand height. Based on observations of stand conditions on DNR-managed lands in eastern Washington, conifers reach 60 feet in 40 to 70, years depending on site conditions. Trees in a stand at this stage of development have approximately 30 to 50 percent crown ratio. In other words, a 60-foot tree has between 30 and 42 feet of space between the ground and the first live branches. A stand with 30 to 42 feet of canopy lift should provide adequate flying space for juvenile spotted owls under the canopy.

GREEN TREE RETENTION

Retaining green trees is intended to provide for eventual recruitment of snags into dispersal stands. Snags are important for spotted owl prey species, particularly northern flying squirrels. Flying squirrels use cavities in snags as nests (Weigl and Osgood 1974). Research on snag requirements for northern flying squirrels has been conducted in western Washington but not in eastern Washington. However, snags are a documented component of spotted owl home ranges and are likely important habitat for prey species in eastern Washington (Hanson et al. 1993 p. 67).

UNIT AREA

DNR believes that a quarter township is an appropriate unit for calculating 50 percent dispersal habitat coverage in eastern Washington rather than using an entire WAU as in western Washington. The quarter township unit was recommended by Thomas et al. (1990) in their 50-11-40 rule and is smaller than a WAU. In western Washington, in addition to the stands managed directly for dispersal habitat, the conservation of riparian zones and forest stands designated for protection of marbled murrelets will provide a widespread network of older forest. This network will be absent on the east side. Thus, a smaller unit of habitat measurement is needed to reduce the potential gaps between dispersal stands.

Rationale for the Spotted Owl Conservation Objective and Strategies

DEMOGRAPHIC SUPPORT

In general, demographic support is accomplished by providing enough nesting, roosting, and foraging habitat to support one or more breeding pairs of spotted owls. Evidence from empirical studies and population modeling shows that larger clusters of breeding spotted owls — 15 to 25 pairs — have a higher likelihood of persisting in the face of random demographic, environmental, and genetic events than do smaller clusters or single pairs (Thomas et al. 1990; Lamberson et al. 1992, 1994; see also the spotted owl section in Chapter III). Thus providing habitat in or adjacent to areas currently occupied by large clusters or in areas capable of becoming occupied by large clusters of territorial spotted owls is more likely to contribute to maintaining the spotted owl population than providing habitat for dispersed single territories or small clusters.

Most of the remaining late successional and old-growth forest habitat in Washington is on federal land (USDA and USDI 1994a). Almost all of the remaining large clusters of territorial spotted owl sites are centered on federal land. However, many of the spotted owls whose sites are centered on federal land use nonfederal land to meet part of their habitat needs. There are 193 site centers on federal reserves designated under the President's Forest Plan that have DNR-managed land in some portion of their circle. Of these, 171 are territorial sites (WDFW 1995b). In order for existing sub-populations that are centered on federal land to persist, the sites near nonfederal lands need to be supported.

In addition, although the reserve system described in the President's Forest Plan was designed to accommodate large clusters of spotted owls, in many places, only small clusters exist now. Many of the federal reserves currently lack adequate amounts of suitable spotted owl habitat to support large clusters. In the eastern Washington Cascades, 16 of the 23 Late successional Reserves currently contain less than 40 percent suitable spotted owl habitat. The average amount of suitable habitat for these Late successional Reserves is 33 percent. In the western Washington Cascades, four of 22 Late successional Reserves have less than 40 percent habitat, while 10 have between 40 and 50 percent suitable habitat. The average habitat coverage for western Washington Cascades Late successional Reserves is 47 percent (USDA and USDI 1994a, Appendix G, p. 13-14).

For reasons outlined in the preceding paragraphs, DNR designed the main component of its spotted owl conservation strategies to provide NRF habitat on its managed lands that are intermingled with or within 1.8 miles of federal Congressional Reserves, Late successional Reserves, Managed Late successional Reserves, and Adaptive Management Areas in the eastern Washington Cascades or within 2 miles of these reserve designations in western Washington. DNR-managed lands in these areas will provide habitat that is important for spotted owls occupying site centers currently located on federal reserves but that use nonfederal habitat. The lands will also provide habitat to assist in supporting the development of larger clusters of spotted owl territories where smaller clusters exist now and sufficient habitat on federal lands is lacking, but the potential to support larger clusters clearly exists.

The 50 percent habitat level was chosen as a reasonable landscape coverage of nesting, roosting, and foraging habitat based on the median amount of suitable habitat found within median annual home ranges of spotted owl pairs in both eastern and western Washington (Hanson et al. 1993) and on studies of spotted owl abundance and amount of older forest habitat in the landscape. The median amount of late successional habitat found in the median annual pair home ranges in western Washington was 44 percent (n = 7) (Hanson et al 1993 p. 20-21). In these telemetry studies, late successional habitat was used in greater proportion than its abundance. In eastern Washington, the median amount of late successional habitat was 50 percent (n = 4) (Hanson et al. 1993 p. 21). In addition, Bart and Forsman (1992) found that levels of occupancy and reproductive success increased with an increasing amount of old growth in the landscape; spotted owl density and reproductive output were higher in areas with greater than 60 percent older forest than in areas with less than 20 percent forest. However, there was no significant difference in these variables in areas having between 50 percent and 60 percent older forest in the landscape (Bart 1995). Given that the spotted owl population is likely in a state of demographic decline (Burnham et al. 1994, see also the spotted owl section in Chapter III), maintaining habitat levels near the amount considered by the U.S. Fish and Wildlife Service to harm an individual — 40 percent of median home range-size circles — could likely lead to long-term negative consequences to the population. In other words, it could be argued that if the population is in a state of decline, maintaining the status quo would maintain the decline.

DNR chose not to provide specific spotted owl habitat conservation measures for demographic support to the population on the northeastern portion of the Olympic Peninsula (Straits Planning Unit). The reasons for this decision are two fold. First, the results of demographic modeling performed and analyzed by the federal Reanalysis Team (Holthausen et al. 1994) suggest that remaining habitat on nonfederal lands on the northeastern portion of the Olympic Peninsula is not crucial to maintaining the spotted owl population on the Olympic Peninsula as a whole. Holthausen et al. (1994) thought that nonfederal lands on the western side of the peninsula could make a potentially higher positive contribution to the population. The Olympic Experimental State Forest will contribute NRF habitat to support the Olympic Peninsula population in this area. (See a later section in this chapter on the Spotted Owl Strategy for the Olympic Experimental State Forest.) Second, DNR will likely provide older forest habitat in the Straits Planning Unit that is suitable for spotted owls as part of the riparian and marbled murrelet conservation strategies. Given the less important role for nonfederal lands for spotted owl conservation in the Straits Planning Unit, DNR feels that the indirect contributions from these other conservation strategies will provide benefits appropriate for that area.

DNR also chose not to provide specific spotted owl habitat conservation measures for the purposes of demographic support in its South Coast Planning Unit, which encompasses most of southwest Washington. The results of the federal Reanalysis Team's report (Holthausen et al. 1994) were again important in this decision. The federal Northern Spotted Owl Recovery Team (USDI 1992) identified nonfederal lands as important for supporting several clusters of spotted owls that would provide a demographic link between the Cascades and the Olympic Peninsula. In analyzing the Recovery Team's proposal, the Reanalysis Team found that the development of 370,000 acres of high-quality habitat in southwest Washington would not make a measurable difference in the stability of the Olympic Peninsula population, given that the population was already nearly stable. DNR manages approximately 239,000 acres of forest land in the South Coast planning unit, so even if the agency dedicated 100 percent of its acreage to NRF, the Reanalysis Team's report indicates that this contribution would not play an important role in the long-term persistence of spotted owls on the Olympic Peninsula as hypothesized by the Recovery Team.

MAINTENANCE OF SPECIES DISTRIBUTION

Maintaining the distribution of the spotted owl population throughout the range of ecological conditions and geographic locations in which the spotted owl has historically resided is important to conservation of the species because it reduces the risk of widespread extirpation (USDI 1992). The Northern Spotted Owl Recovery Team (USDI 1992) cited four ways in which a well-distributed population reduces the risk of extirpation. The first is that any substantial reduction in the range would lower the number of local populations contributing to the whole population (the metapopulation). The fewer local populations, the higher the chance that large portions of the metapopulation could become extinct, and thus the higher chances that the entire population could become extinct. Second, range reduction reduces the kinds of environments (i.e., forest types) that the spotted owl inhabits, thus subjecting the population to extirpation from random environmental events such as rapid change in climatic conditions or catastrophic loss of habitat from fires, insects, disease, or volcanic eruption. With a well-distributed population, it is unlikely that the entire population would be lost to a small number of such random environmental events. Third, the elevational and geographic fringes of a species' range are often where a species makes the most rapid adaptations to different environments. Thus losing the population at these fringes could inhibit the spotted owl's evolutionary capabilities. Fourth, the geographical and elevational fringes of the range may prove to be important in the face of climate change. The northern part of the range and higher elevation habitats would be important if climate change produced a warmer regional climate in the Pacific Northwest. If however, climate change produced local cooling pockets in the Pacific Northwest (Smith 1990), lower elevation habitats and the southern portion of the spotted owl's range would become important to the owl's survival as a species. Maintaining species distribution thus requires that clusters of breeding owls are maintained throughout the range of ecological conditions and geographic extent and that connectivity is maintained between sub-populations throughout the range.

DNR's strategy in western Washington contributes to the maintenance of species distribution in two ways. First, most habitat on federal lands is in the mid- to high-elevation zones of spotted owl use. DNR-managed lands occupy more mid- to low-elevation zones. By providing NRF habitat within 2 miles of federal reserves, DNR-managed lands will be providing habitat across a wider elevation gradient than would be present if habitat were maintained only on federal reserves. Second, DNR is providing large blocks of NRF habitat beyond the 2-mile band surrounding federal reserves in two areas that were identified by the Northern Spotted Owl Recovery Team (USDI 1992) as important for maintenance of species distribution. The Siouxon Creek area (in the Columbia Planning Unit) supports spotted owl cluster in under-represented low-elevation habitat. The Columbia River Gorge area south of the Gifford Pinchot National Forest (also in the Columbia Planning Unit) provides an important link between Washington and Oregon spotted owl populations.

The federal Reanalysis Team (Holthausen et al. 1994) recognized that maintaining and developing habitat in southwest Washington could have significant effects on maintaining species distribution, though they did not analyze this aspect. Given that southwest Washington constitutes a large geographical region within the historic range of the spotted owl, it is important for the reasons described above. However, without commitment on the part of surrounding private landowners to develop and maintain NRF habitat, it is not practical for DNR alone, given its trust responsibilities, to develop enough habitat to support large clusters of spotted owl sites.

Some positive benefit to the spotted owl may occur incidentally as a result of the riparian and marbled murrelet conservation strategies in this area.

DISPERSAL

The spotted owl population is comprised of semi-isolated sub-populations or local populations that are connected through dispersing juveniles and, possibly, non-territorial single owls. (See Section A of Chapter III on the spotted owl.) The maintenance of the whole population is dependent on successful movement of owls from sub-populations that are stable or increasing in size to sub-populations that are decreasing in size or to areas where a small sub-population may have been extirpated (USDI 1992). Interaction among clusters of spotted owls also ensures genetic integrity of the population. Dispersal is facilitated by managing forests that provide adequate food and cover for juveniles as they travel between their natal area and suitable, unoccupied habitat (Thomas et al. 1990). Because juvenile spotted owls disperse in random directions (Miller 1989), the conditions that allow for successful dispersal need to be present across large landscapes rather than restricted to selected corridors (Thomas et al. 1990). DNR's strategy includes providing dispersal habitat in areas that are crucial for movement of juveniles between spotted owl sub-populations.

DNR designated its managed forest lands for dispersal habitat in areas that were farther than 2 miles from federal reserves in western Washington or farther than 1.8 miles from federal reserves in eastern Washington, but where connectivity between federal reserves is important. In one place, dispersal habitat is designated to provide connectivity between the Yakama Indian Reservation and a federal reserve.

Current Habitat and Projected Habitat Growth in Nesting, Roosting, and Foraging and Dispersal Management Areas

Designated NRF areas under the HCP encompass approximately 202,000 acres of DNR-managed lands. Designated dispersal habitat areas encompass approximately 200,000 acres. A summary of acreages by planning unit is provided in Table IV.4. On the basis of estimates of current habitat and the criteria for deciding how much habitat to maintain in each WAU, the HCP will result in the retention of approximately 102,000 acres of spotted owl NRF habitat within NRF management areas and approximately 100,000 acres of dispersal habitat.

Although age class does not necessarily equate to habitat, age-class distribution has been used as a surrogate for projected habitat growth over the next 100 years in the five west-side planning units as shown in Figures IV.1-IV.5 Forest that are 70 years and older can contain structural elements of spotted owl habitat. Because so many of the forests on DNR-managed lands in the east-side planning units are in uneven-aged stands, it is not possible to use age-class distribution as a surrogate for habitat growth there.

These figures represent the outcome from one possible set of harvest scenarios modeled by DNR. The other HCP strategies were included in the modeling.

Table IV.4: Summaries of current spotted owl habitat conditions by planning unit

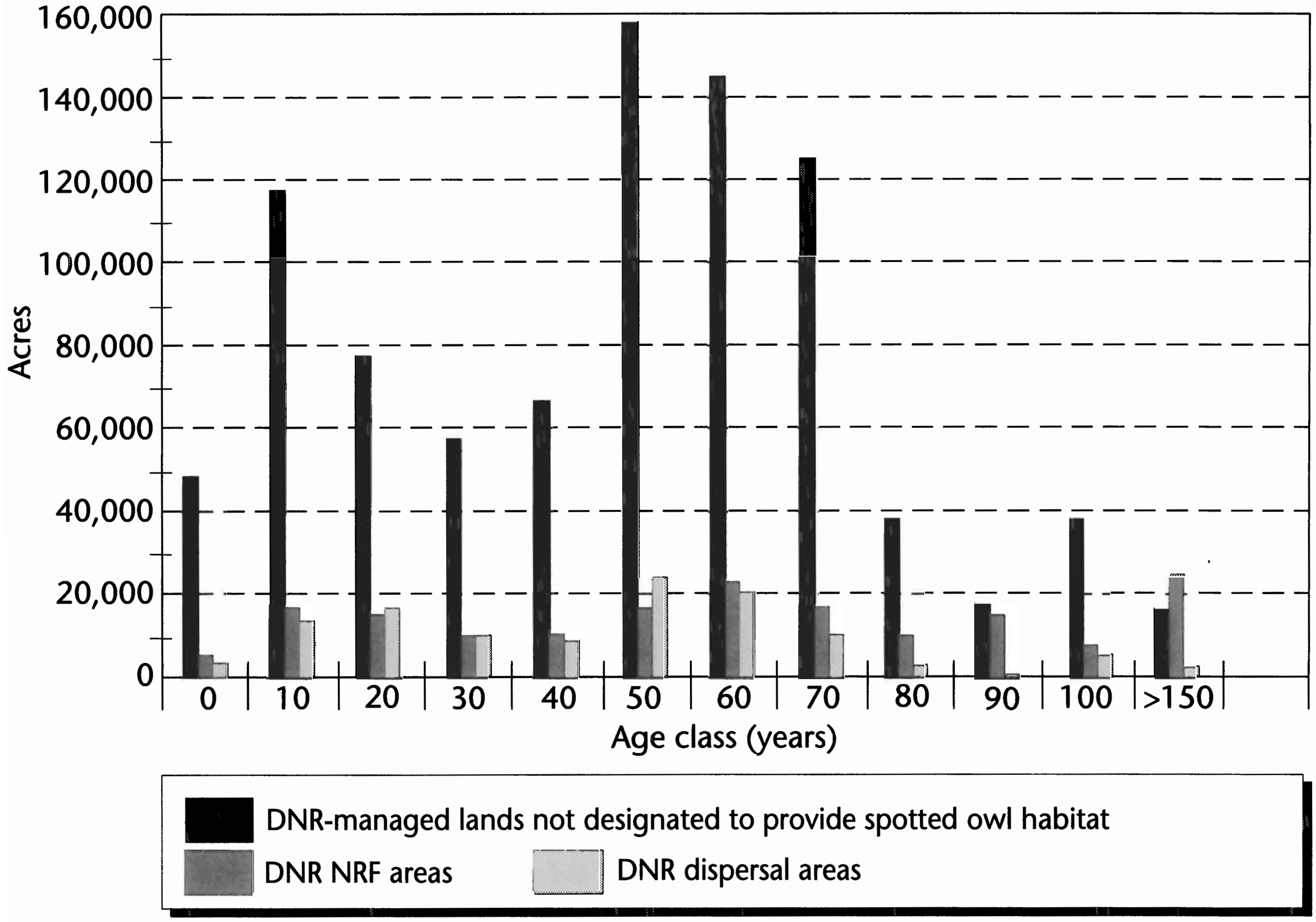
Planning unit	Acres of DNR-designated NRF areas[1]	Percent DNR-designated NRF areas currently in habitat (acres)	Acres of DNR-designated dispersal areas	Percent DNR-designated dispersal areas currently in potential dispersal habitat[2] (acres)
North Puget	107,599	48 (51,494)	22,234	51 (11,515)
South Puget	2,648	58 (1,535)	66,588	55 (56,534)
Columbia	52,996	60 (31,925)	27,029	82 (22,172)
Straits	0	0	0	0
South Coast	0	0	0	0
Chelan	5,647	54 (3,064)	0	0
Yakima	13,567	35 (4,714)	8,332	no data
Klickitat	19,939	58 (11,653)	76,726	no data
Totals	**202,397**	**51 (104,384)**	**200,909**	—

[1] Includes 14,765 acres of Natural Area Preserves (NAP) and Natural Resource Conservation Areas (NRCA). See Chapter I for an explanation of how these lands are treated in the HCP. The North Puget Planning Unit contains 13,108 acres of NAP and NRCA lands in NRF areas.

[2] Potential dispersal habitat was estimated assuming that forest stands that are 40 years old or older would have characteristics of dispersal habitat for western Washington. This estimate does not take into account the spatial arrangement specified in the management standards for dispersal habitat.

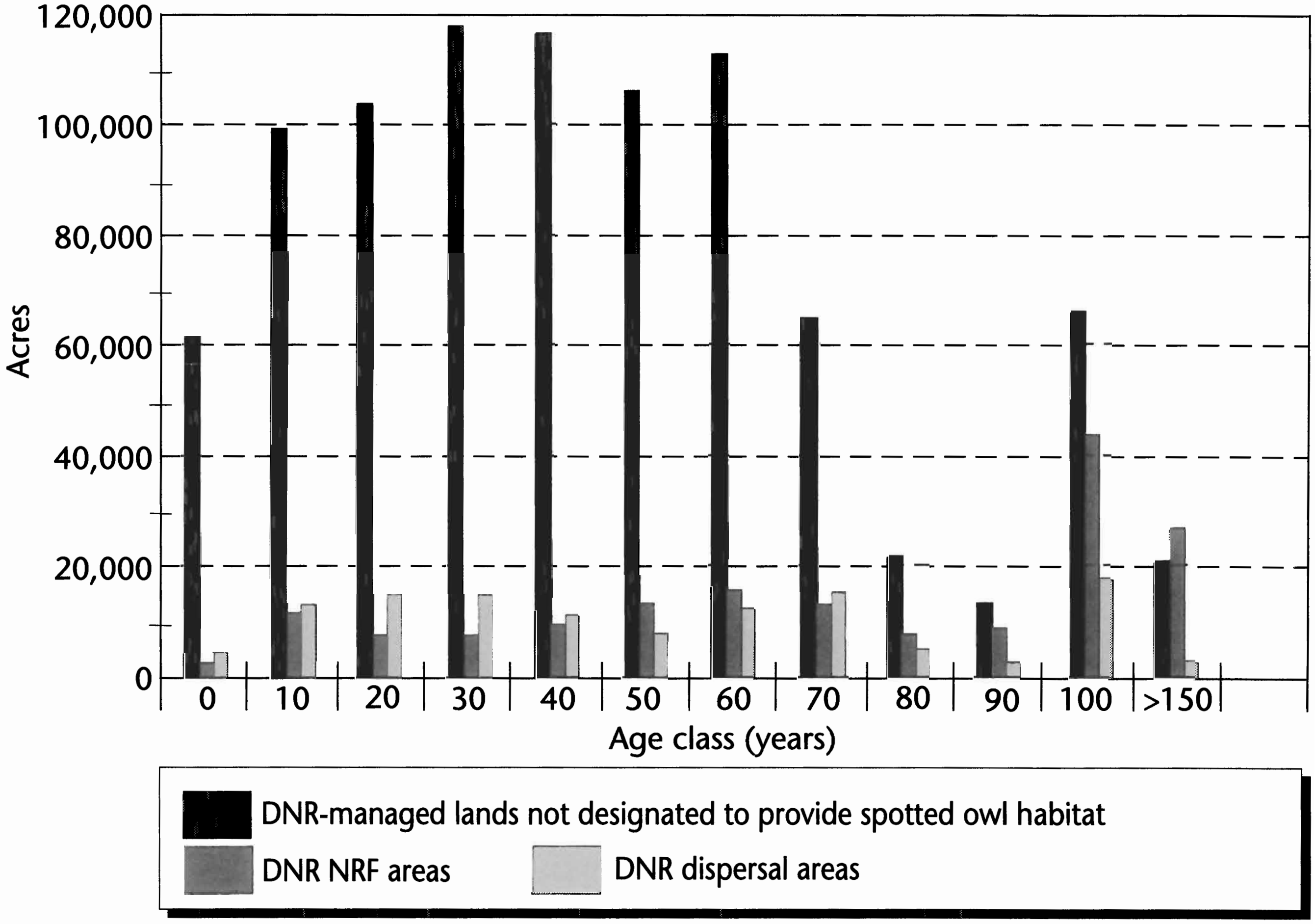
NRF = nesting, roosting, and foraging habitat

Figure IV.1: Age-class distribution in the five west-side planning units in 1996



NRF = nesting, roosting, and foraging

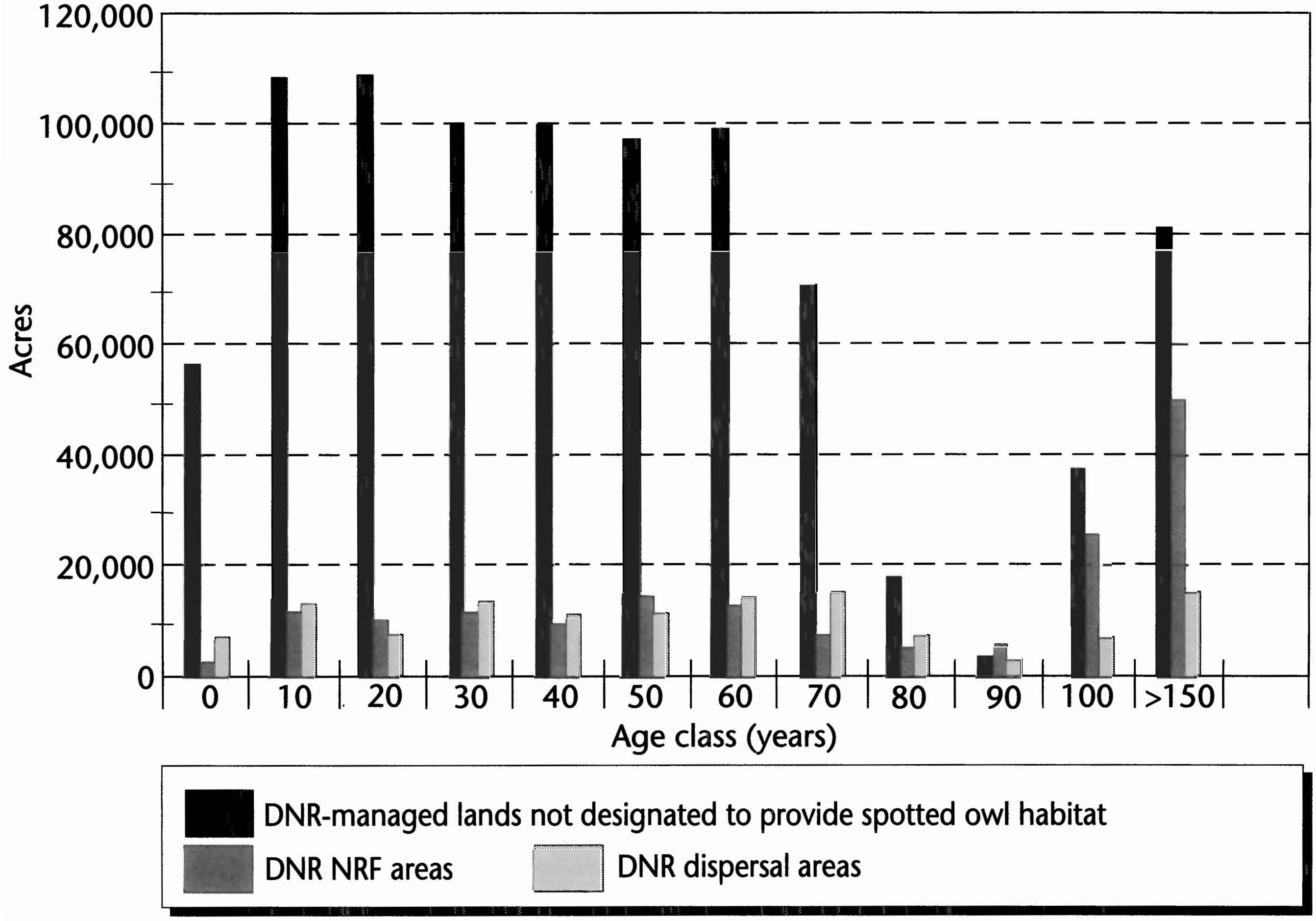
Figure IV.2: Projected age-class distribution in the five west-side planning units in 2046



Note: This represents the outcome from one possible set of harvest scenarios modeled by DNR. The other HCP conservation strategies were included in the modeling.

NRF = nesting, roosting, and foraging habitat

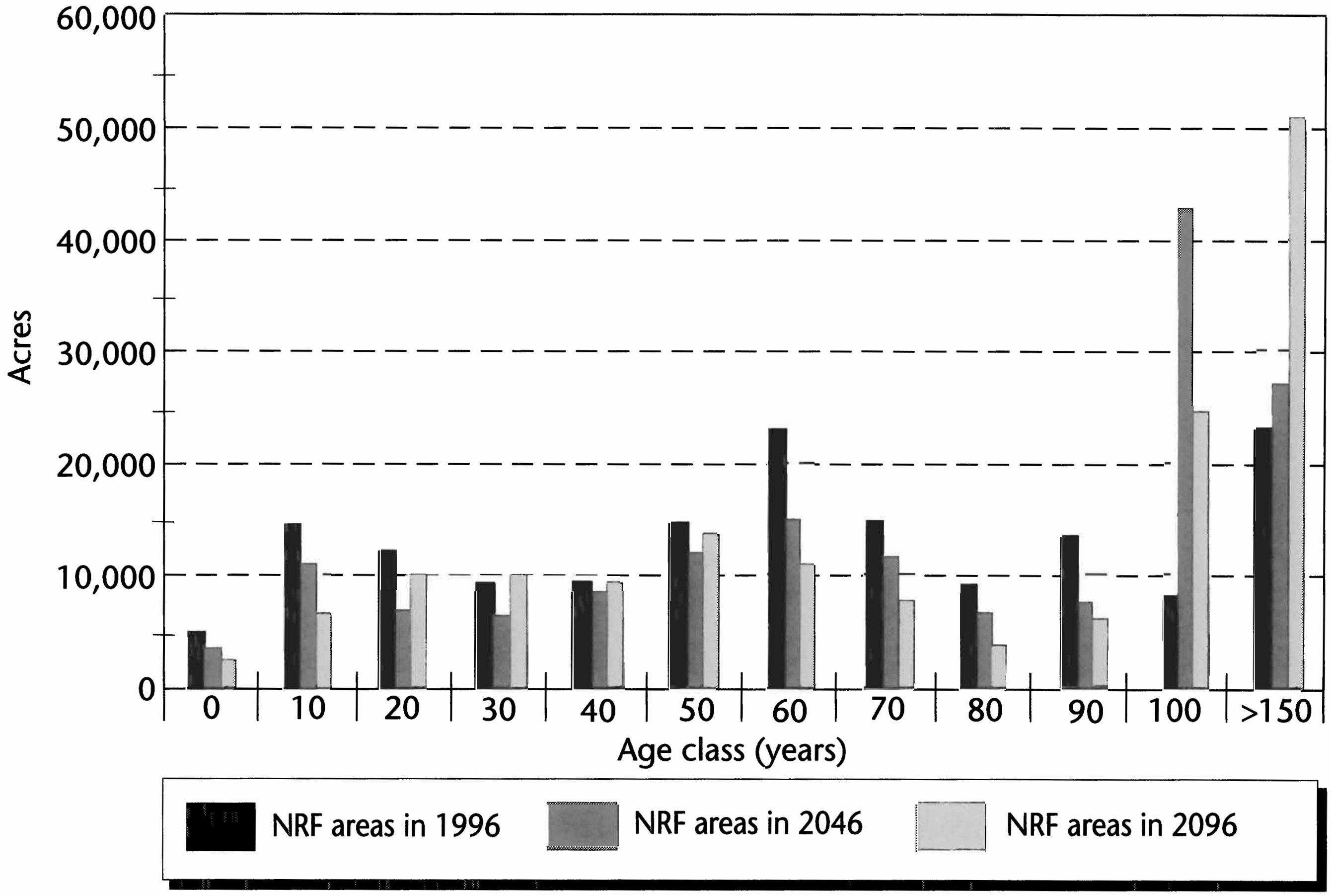
Figure IV.3: Projected age-class distribution in the five west-side planning units in 2096



Note: This represents the outcome from one possible set of harvest scenarios modeled by DNR. The other HCP conservation strategies were included in the modeling.

NRF = nesting, roosting, and foraging habitat

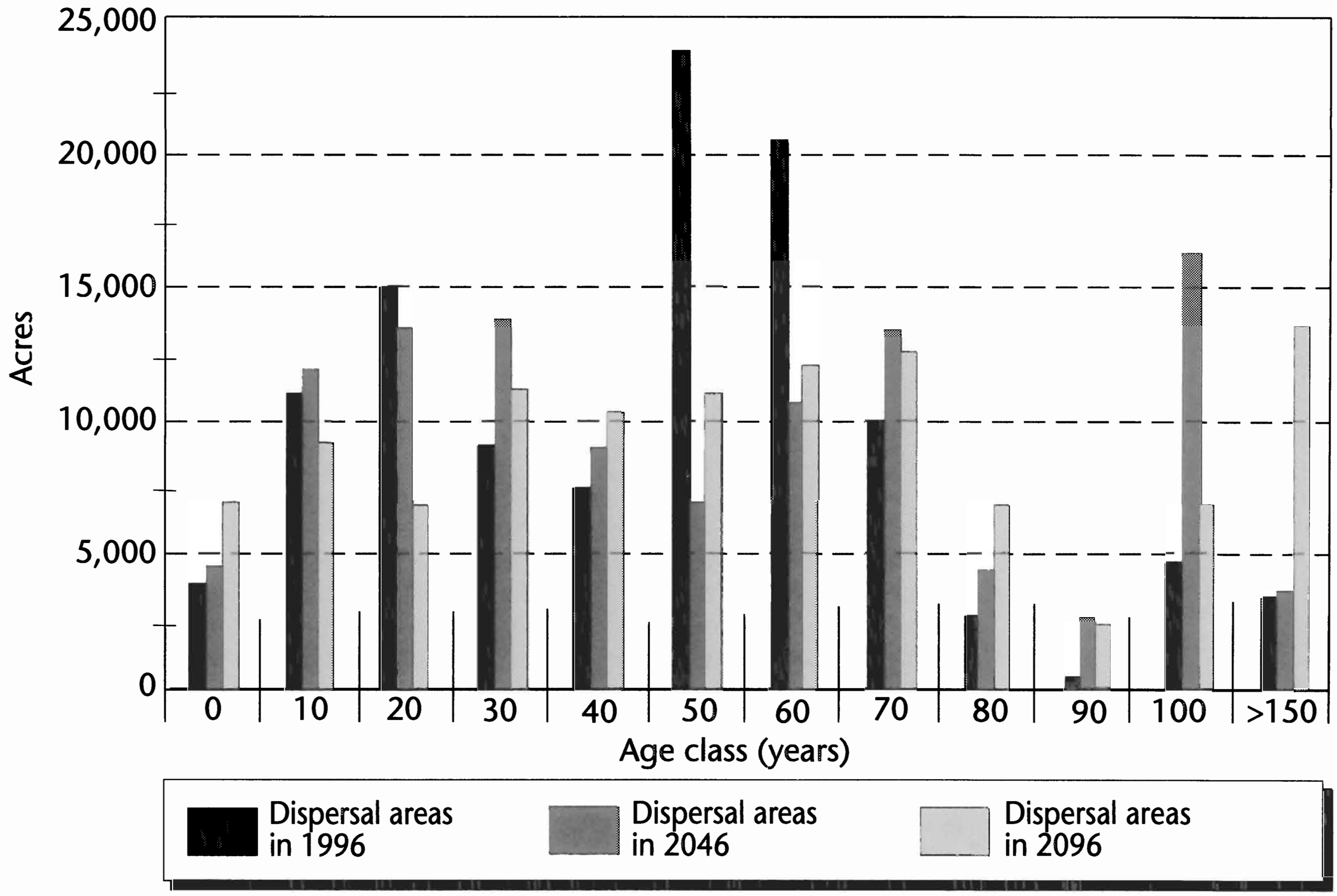
Figure IV.4: Projected age-class distribution in DNR NRF areas in the five west-side planning units from 1996 to 2096



Note: This represents the outcome from one possible set of harvest scenarios modeled by DNR. The other HCP conservation strategies were included in the modeling.

NRF = nesting, roosting, and foraging habitat

Figure IV.5: Projected age-class distribution in DNR dispersal areas in the five west-side planning units from 1996 to 2096



Note: This represents the outcome from one possible set of harvest scenarios modeled by DNR. The other HCP conservation strategies were included in the modeling.

Potential Benefits and Impacts to Spotted Owls

BENEFITS

The primary benefits of the HCP for spotted owls are:

(1) provision of NRF habitat in areas that make a significant contribution to the demographic support of the spotted owl population by supporting the federal reserve system established under the President's Forest Plan;

(2) provision of NRF habitat in areas that make a contribution to maintaining species distribution by maintaining habitat in a broader elevational and geographic range than would be provided by federal reserves alone; and

(3) provision of dispersal habitat in areas that are important for movement of dispersing juveniles between population clusters.

DNR currently manages its lands following the rescinded U.S. Fish Wildlife Service spotted owl take guidelines. Under this approach, DNR and other nonfederal landowners generally harvest suitable spotted owl habitat within regulatory spotted owl circles as long as the overall habitat level remains at or above 40 percent of the area of the circle. The result of this approach is that the amount of habitat available at individual spotted owl sites tends to move toward the 40 percent level with no incentive to develop new habitat in circles that are at or below the 40 percent level. Habitat that is lost due to attrition, natural disturbance or human-caused processes (e.g., loss of habitat functionality from increased fragmentation and edge effects) will not likely be replaced. Furthermore, harvest can occur in suitable, but unoccupied habitat, thus any opportunity for future occupancy by dispersing juvenile spotted owls is lost. Finally, there is no long-term planning at a landscape level that assesses where habitat is needed to support the population. The trend for nonfederal landscapes then is decreasing amounts of habitat and increasing fragmentation of remaining habitat.

This HCP moves away from the above circle-by-circle approach to a landscape-based plan that will provide at least 101,000 acres of NRF habitat in support of large and medium clusters of spotted owls that are located mainly on federal lands. The HCP provides habitat based on landscape condition that takes into account the amount of habitat both in DNR-designated NRF areas and adjacent or nearby federal reserves within any WAU in which DNR-designated NRF areas exist. At least 50 percent of the DNR-managed lands within a NRF area will provide habitat at a spatial scale that also allows spotted owls to use habitat on adjacent or nearby federal lands. In WAUs in which DNR NRF areas currently contain more than 50 percent habitat and federal reserves have less than 50 percent, DNR NRF lands will be maintained at current habitat levels to compensate for the inadequate habitat conditions on federal reserve lands.

In addition to providing demographic support within a median home-range radius of federal reserves, DNR NRF areas in the Siouxon and Columbia Gorge blocks in the Columbia Planning Unit provide large contiguous blocks of habitat that by themselves support medium-size clusters of spotted owl sites. The Siouxon block is important for providing low-elevation habitat in the western Cascades and for providing a potential link between the Oregon and Washington populations across the Columbia River (USDI 1992 p. 120). DNR-designated NRF lands in the Columbia Gorge area also provide an important link between Washington and Oregon spotted owl populations.

Both areas are thus important to maintaining species distribution by providing habitat at broader elevational ranges than on federal reserves alone and by providing habitat in areas where spotted owl clusters are needed to maintain population connectivity.

The third benefit to the spotted owl population from the DNR's HCP is the provision of 100,000 acres of dispersal habitat at any one time in areas where dispersal landscapes are needed for movement of juveniles among federal reserves. DNR management without an HCP makes no explicit provision for dispersal habitat. Landscape patterns that result from timber harvest can thus leave wide gaps between forest stands that provide adequate cover and structure to support dispersing spotted owls.

IMPACTS

There are currently 283 spotted owl site centers in the area covered by the HCP whose regulatory circles include some DNR-managed lands. This does not include the Olympic Experimental State Forest Planning Unit, which is discussed separately in a later section in this chapter. Of these spotted owl site centers, 226 are confirmed territorial pair or single sites[5]. Fifty-one of these territorial sites are located on DNR-managed lands. There are approximately 298,000 acres of DNR-managed lands within the 226 territorial spotted owl circles, 122,000 acres (40.1 percent) of which are estimated to be suitable habitat. Figure IV.6 shows the amounts of habitat on DNR-managed lands that contribute to spotted owl sites in the area covered by the HCP.

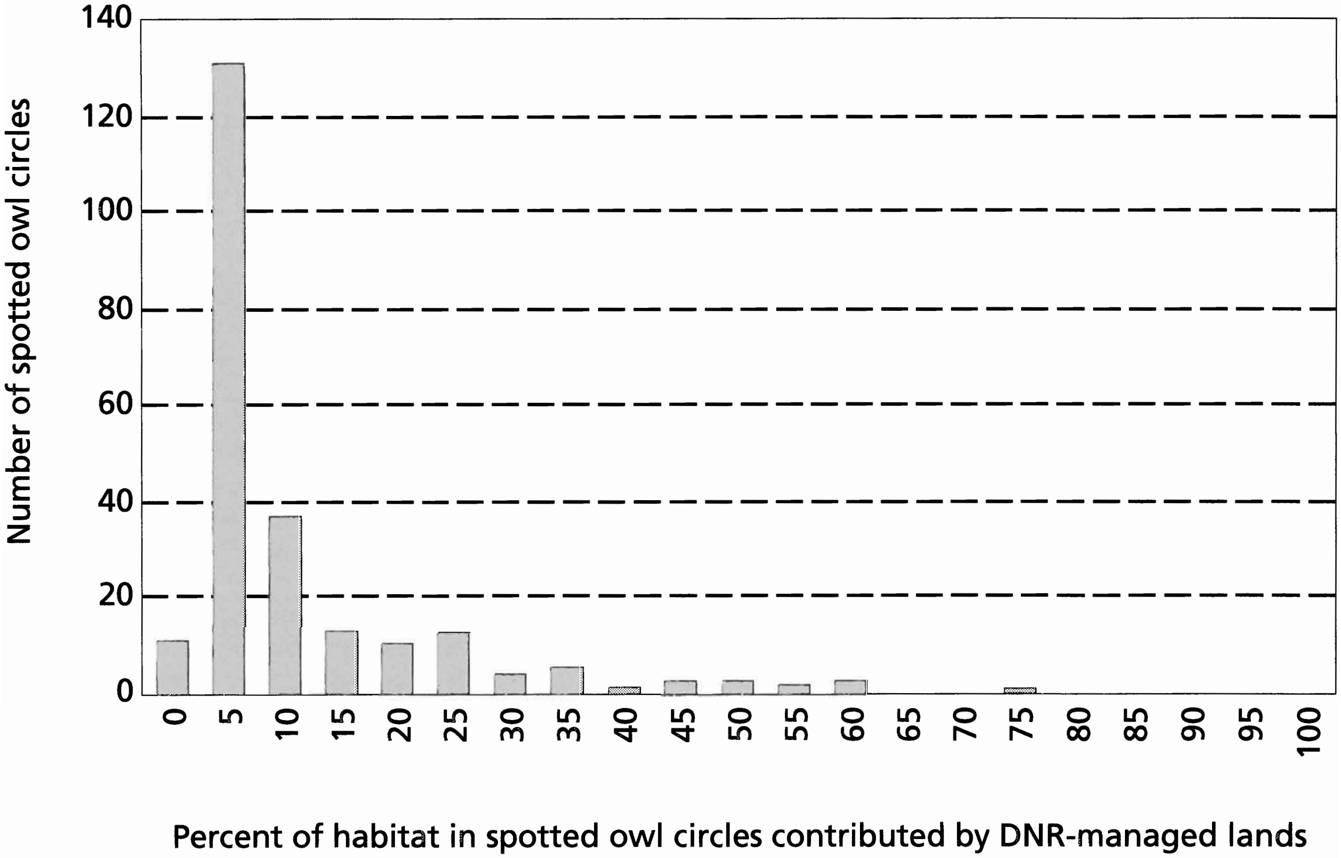
Under the provisions of the HCP, DNR will no longer manage forests specifically for spotted owl habitat in 112 of the 226 territorial spotted owl circles which include DNR-managed lands. These 112 site centers are outside DNR NRF areas. DNR-managed lands contribute habitat that amounts to 1 percent or less of the area of the regulatory spotted owl circle at 24 of these sites. Seventeen of the 112 circles have more than 40 percent of their area in habitat on federal reserves. (For a more specific discussion of impacts to these site centers, see the Draft Environmental Impact Statement that accompanies this HCP.)

Of the total 226 known territorial spotted owl circles that include DNR-managed lands, designated NRF areas will continue to contribute habitat to 114 of them. Currently, DNR-managed lands within NRF areas are contributing 66,400 acres of habitat to territorial spotted owl circles. Under the HCP, DNR-designated NRF areas will have a minimum of 101,000 acres of spotted owl NRF habitat at any one time. There are 54 WAUs in which DNR will be developing a total of 14,100 acres of habitat in designated NRF areas where there is now less than 50 percent NRF habitat. As habitat conditions improve over time on both federal reserve lands and in DNR NRF areas, DNR expects these NRF areas to contribute habitat to new spotted owl territories.

Under the provisions of the HCP, DNR will incidentally provide older forests that may meet some of the habitat needs for spotted owls outside of NRF areas. This older habitat will occur in riparian management areas, in potential marbled murrelet habitat that is deferred from harvest during the interim marbled murrelet strategy, and in forest stands that are protected from harvest because they are occupied by marbled murrelets.

[5]Territorial pair or single sites are designated status 1 (pair or reproductive), status 2 (presence of two adult territorial spotted owls, pair status unconfirmed), or status 3 (territorial single) sites using the terminology employed by the Washington Department of Fish and Wildlife in its spotted owl database. Status 4 sites are those at which a spotted owl has been detected, but occupancy of that site is unconfirmed.

Figure IV.6: Contribution of habitat from DNR-managed lands to known spotted owl circles in the five west-side and all east-side planning units



B. Minimization and Mitigation for the Marbled Murrelet in the Five West-side and the Olympic Experimental State Forest Planning Units

Conservation Objective

DNR's objective is to develop a long-term conservation strategy for the habitat of the marbled murrelet that will provide minimization and mitigation for any incidental take of this species. However, attempts to develop such a strategy at this time were unsuccessful because of lack of knowledge about the bird's habitat needs. Instead, this proposal calls for implementation of an interim approach that will lead to a long-term strategy. This approach covers DNR-managed lands in the five west-side planning units and the Olympic Experimental State Forest; the marbled murrelet is not known to inhabit the east-side planning units.

While the amount of scientific information that is available for this species has increased dramatically in recent years, it is still extremely limited. Additionally, no recovery plan for this species has been adopted by the federal government, although a draft proposal has been recently released. A final rule for critical habitat has been published. (See the discussion of these proposals in Chapter II.)

Such factors severely limit a land manager's ability to determine the measures that might best address the marbled murrelet's situation. For example, while it is easy to assume that protection of occupied sites must be a part of any credible long-term strategy, no one knows how to do this with any certainty of success. Consider the following questions:

> Are all occupied sites equally important, or is it possible that murrelets at some sites, such as those below a certain size or farther than some distance from marine waters do not successfully reproduce, making these areas less important to the population?
>
> Once the occupied sites appropriate for protection are identified, exactly what must be done to ensure their longevity? For example, what size protected area is required?
>
> Must a site be a "no entry" area, or can some management activities take place? Must the area be buffered and, if so, how?

Such basic questions remain unanswered for many of the issues that must be considered in a credible long-term strategy. This situation has led DNR to develop an interim approach designed to protect the marbled murrelet on DNR-managed trust lands in the area covered by the HCP while participating in collection of the information needed to develop a long-term conservation strategy.

Interim Conservation Strategy

Step 1. DNR shall identify and defer harvest of any part of a suitable habitat block (see Habitat Definitions below) while conducting Step 2.

Step 2. Within each west-side planning unit and the Olympic Experimental State Forest, DNR shall conduct a two-year habitat relationship study to determine the relative importance, based on murrelet occupancy, of the various habitat types within that particular planning unit.

Step 3. Following completion of the habitat relationship study in each planning unit, marginal habitat types that would be expected to contain a maximum of 5 percent of the occupied sites on DNR-managed lands within each planning unit shall be identified and made available for harvest. However, no know occupied sites will be released; they shall all be protected.

Step 4. In each planning unit, all acreage constituting the higher quality habitat types (i.e., those not identified as available for harvest under Step 3) shall be included in an inventory survey, using Pacific Seabird or other protocol approved by the U.S. Fish and Wildlife Service if available, to locate occupied sites. Outside of Southwest Washington[1], surveyed, unoccupied habitat will be released for harvest if it is not within 0.5 mile of an occupied site and after harvest, at least 50 percent of the suitable marbled murrelet habitat on DNR-managed lands in the WAU would remain. Within Southwest Washington[1], surveyed, unoccupied habitat will **not** be released for harvest unless (a) the long-term plan (see Step 5 below) for the applicable planning units has been completed or, (b) at least 12 months have passed since the initiation of negotiations of the draft long-term plan without completion of those negotiations.

Step 5. After Steps 1-4 are completed for each planning unit, the information obtained during these and other research efforts shall be used to develop a long-term conservation strategy for marbled murrelet habitat on DNR-managed HCP lands within that planning unit. The habitat relationship study, inventory survey, and development of the long-term strategy will occur consecutively within each planning unit - i.e., there will be no time gaps between Steps 2, 3, and 4. Negotiation of the draft long-term conservation strategy for a planning unit will commence with the U.S. Fish and Wildlife Service within 12 months of completion of the inventory surveys for that planning unit. All decisions made in Steps 1-4 above shall be reviewed as part of this process. (For example, it may be that some of the marginal habitat or surveyed unoccupied habitat made available for harvest in Step 3 or Step 4 will be identified as important to protect in the long-term strategy.) Once all individual planning unit plans are complete, a comprehensive review shall be conducted and modifications made if required. DNR will submit its proposal for long-term strategies to the U.S. Fish and Wildlife Service for approval. DNR may convene a multi-agency science team to resolve issues of disagreement over the proposal.

Notes:

(1) While the habitat relationship and inventory surveys described in Steps 1 and 2 above are being conducted, DNR shall participate in cooperative regional research efforts to the extent possible with available funding. Information regarding prioritization of research is included in the federal Draft Recovery Plan (USDI 1995).

(2) Any occupied site identified prior to or during any of the process outlined above shall be protected until the long-term plan is developed and implemented.

Habitat Definitions

For the purposes of DNR's mitigation for the marbled murrelet, terms in italics have special meanings that are defined in this subsection. Suitable marbled murrelet habitat is referred to as a *suitable habitat block*. This

[1]For the purposes of the marbled murrelet strategy, Southwest Washington is defined as that portion of the Columbia Planning Unit west of Interstate 5 and that portion of the South Coast Planning Unit that is located south of Highway 8.

term is used to avoid the word "stand". A single silvicultural "stand" may include areas that do contain the features thought to be important to marbled murrelets as well as areas that do not contain such features. Likewise, a single contiguous area of forest containing structures important to murrelets (i.e., a single suitable habitat block) might consist of all or parts of several silvicultural stands. A suitable habitat block is defined as a *contiguous forested area* meeting all of the following three criteria:

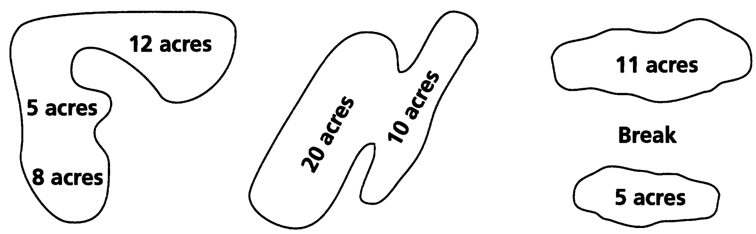
(a) *at least five acres in size* and

(b) containing an average of *at least two potential nesting platforms* per acre and

(c) *within 50 miles of marine waters.*

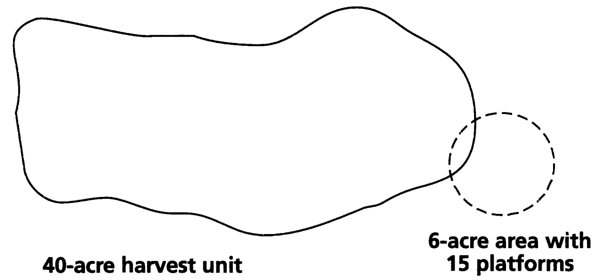
Contiguous forested area — Once a 5-acre area whose characteristics meet the other criteria is identified, all adjoining acres that also contain such criteria would be included in the suitable habitat block until there is a 300-foot or wider "break" (an area that does not meet the criteria) that completely encircles the block. Examples: In diagram A, the 5-acre, 8-acre, and 12-acre areas are part of the same suitable habitat block. Likewise, in diagram B, the 10-acre and 20-acre areas are part of the same suitable habitat block. However, in diagram C, the 5-acre and 11-acre areas are two separate suitable habitat blocks because they are separated by a 300-foot or wider break.

A. B. C.



At least five acres in size — This refers to the size of the suitable habitat block, not to the area of the silvicultural stand or harvest unit that the block is a part of. For example: In diagram D, a 40-acre harvest unit includes part (2 acres) of a 6-acre area that contains 15 platforms. There is a suitable habitat block here because there is a 5-acre or larger area that has an average of at least two platforms per acre. The 2 acres that are part of the 6-acre area are considered suitable habitat. The point being stressed here is that the entire harvest unit should not be evaluated as a whole and considered non-suitable because it does not contain at least 80 platforms. Rather, any suitable habitat blocks wholly or partially contained in the harvest unit must be recognized and protected, or the sale can be redrawn to omit the suitable habitat block.

D.



At least two potential nesting platforms — Nesting platforms are defined as any large limb or other structure, such as a mistletoe broom, at least 50 feet above ground and at least 7 inches in diameter. Platforms are counted only in conifer trees and only if located within the live crown. When trained staff are counting platforms for the number per acre calculation, all platforms fitting this description should be included. Structures should not be excluded from the count because of some perceived usability/non-usability factor such as orientation of the platform, overhead cover of the platform, etc. This follows the method used in collecting the original data from which the two platforms-per-acre figure was obtained (Hamer et al. 1994).

Within 50 miles of marine waters — Distance should be considered from the Pacific coast, from Puget Sound, or from Rice Island (located in the Columbia River upstream from the Astoria bridge), whichever is closest to the site.

Following the completion of the habitat relationship surveys, the habitat definitions may need revision based on new information.

Possible Components of a Credible Long-term Conservation Strategy

This section describes a possible process for developing the long-term conservation strategy for marbled murrelets. This discussion is based on current information that may be subject to change. Because a long-term strategy for the murrelet's habitat does not have to be undertaken until after the habitat relationship models are developed and additional research is completed, detailed management and protection guidelines do not have to be devised immediately. Instead, this subsection discusses the general factors that would likely be considered in developing the long-term strategy and provides an idea of the kinds of approaches expected to be included.

As reviewed in Section B of Chapter III on marbled murrelet ecology, current research indicates that several primary biological factors influencing marbled murrelet populations should be addressed when developing plans to protect occupied sites. Habitat loss appears to be the major cause of population declines (Ralph et al. 1995; USDI 1995; USDI 1992). Additional incremental losses of nesting habitat due to windthrow, fire, and other natural processes will be a persistent problem, even with the benefits of an HCP. Research also indicates that predation at nest sites may be reducing nest success and adult survivorship (USDI 1995; Beissinger 1995; Nelson and Hamer 1995). Furthermore, disturbances at nest sites during the breeding season are known to reduce reproductive success of other alcids, and marbled murrelet nest success is suspected to be affected by forest management activities during certain stages of the nesting cycle (Cummins et al. 1993; Federal Register v. 57, no. 191, p. 45328).

Marbled murrelets are highly social birds, nest semi-colonially, and probably show a high fidelity to nesting areas (Divoky and Horton 1995). Their ability to colonize new habitat or currently suitable unoccupied habitat has not been determined. Due to their dependence on both forest and marine habitats, catastrophic events occurring in either environment (fire, windthrow, clearcut harvesting, oil spills, El Niño) can have significant negative effects on the population. Therefore, protecting multiple colonies within a reasonable distance of each other in each Watershed Analysis Unit and maintaining a well-dispersed population will help overcome and minimize these effects.

On the basis of these current premises, the primary factors and obstacles that may need to be considered when implementing protection strategies for occupied sites will likely include:

- developing a method for defining the perimeter of the breeding area for each occupied site;
- providing sufficient habitat for breeding areas;
- examining the entire landscape within a planning unit to determine which sites are most in need of protection and to consider landscape-level problems;
- reducing fragmentation of remaining nesting habitat;
- providing interior forest conditions;
- providing buffers to minimize the effects of windthrow and micro-climate changes within the habitat, to help increase the amount of interior forest provided, and to reduce the amount of edge which has been associated with certain predator species;
- minimizing disturbance at breeding sites during the nesting season;
- preventing the isolation of breeding colonies and maintaining a well-distributed population; and
- protecting all occupied sites in certain critical planning units that have small populations and little remaining habitat.

The first step in developing a long-term conservation strategy for murrelets will be to assemble a planning team that includes biologists with expertise in the biology and ecology of marbled murrelets, silviculturalists, geographic information system (GIS) specialists, foresters, and planning staff familiar with other components of the HCP. The team will review current literature about marbled murrelets and the survey and research data collected by DNR from each planning unit. The GIS staff will provide maps that depict the size and location of occupied sites on DNR-managed lands and on adjacent ownerships and the location and extent of suitable habitat.

Using this information, the planning team will develop long-term conservation objectives for the protection of occupied sites. These conservation objectives will likely be general in nature but based on current information about the habitat needs of the marbled murrelet. The conservation objectives will likely direct a strategy that will be useful in protecting and maintaining habitat, decreasing the risk of loss of suitable habitat, maintaining or increasing the reproductive success of the marbled murrelet, and increasing adult survivorship. DNR expects to apply the long-term conservation objectives and strategy to each occupied site being protected through site-specific implementation procedures.

Because the long-term conservation objectives and the overall strategy will have already been developed, the site-specific implementation procedures are meant to be relatively easy to prepare. For example, DNR envisions that the implementation procedures for each site could be developed in a few days. A day or two would be spent at the site identifying the current problems, setting future objectives for nesting habitat condition, and outlining the specific silvicultural and forest methods and prescriptions that will be used to achieve the desired objectives. Another two days would be needed to draft the implementation procedures for that site. With such site-specific procedures, nesting habitat conditions for the marbled murrelets on DNR-managed lands will likely improve over time, minimizing and mitigating any take involved in the HCP and contributing to recovery efforts.

While these site-specific implementation procedures are being developed, the team would also make landscape-level management decisions regarding protection of occupied sites. Preventing the isolation of breeding colonies and maintaining a well-distributed population will entail considering the location of occupied sites on adjacent ownerships. Developing landscape-wide management plans in cooperation with adjacent landowners for each planning unit as outlined in the federal Draft Recovery Plan for the Marbled Murrelet (USDI 1995) will be desirable. An optimal outcome of such plans would be to have occupied sites in each Watershed Analysis Unit. If one occupied site were lost, additional habitat for these birds would be available within a reasonable distance, facilitating replacement and establishment of new colonies as the population grows.

The long-term conservation strategy developed by DNR would likely include information on the location of occupied sites, the distribution of habitat in each planning unit, current research results, landscape-level analysis and considerations, and the site-specific management plans developed by DNR. The long term strategy would address such factors as developing habitat where gaps exist, developing or maintaining replacement habitat, and would protect the vast majority of occupied sites. This process should result in a comprehensive, detailed landscape-level plan that would help meet the recovery objectives of the U.S. Fish and Wildlife Service, contribute to the conservation efforts of the President's Northwest Forest Plan, and make a significant contribution to maintaining and protecting marbled murrelet populations in western Washington over the life of the HCP.

Potential Benefits and Impacts to Marbled Murrelets

The marbled murrelet conservation strategy will result in improved conditions for the murrelet over time. All suitable habitat and occupied sites will be retained in the short term through harvest deferral. Known occupied sites will be protected. Surveys will be conducted of all habitat expected to contain up to 95 percent of the occupied sites. This information and additional research about the murrelet's habitat needs will be used to develop a long-term conservation strategy that will conserve the bird's habitat.

However, some specific adverse impacts may also occur. It is impossible at this time to describe completely the potential impacts, positive or negative, of the long-term strategy that will ultimately result from this short-term strategy. In the interim period, adverse impacts to marbled murrelets might occur in the following circumstances:

- If the habitat definition initially used to determine the deferral of proposed harvest areas fails to capture all occupied sites. However, the definition recommended for use is a very conservative one and should minimize adverse impacts. There will likely be a small impact to the population from not including potential habitat on DNR-managed lands beyond 50 miles from marine waters.

- As a consequence of harvest of marginal habitat, which will be released upon completion of the habitat relationship studies in each planning unit. The most marginal habitat will be available for harvest without further survey, except for known occupied sites, all of which will be protected. Data from the habitat relationship studies will be used to ensure that no more than 5 percent of the occupied sites in each planning unit would be expected to occur in the areas released for harvest. This should expose much less than 5 percent of the individual birds to adverse impacts because (a) only a portion of the released area would be expected to be harvested prior to the development of the long-term strategy, and (b) DNR assumes that the number of birds using the more marginal sites is proportionally lower than the number using better quality sites.

- As a consequence of harvest of surveyed unoccupied habitat, if that habitat were later determined to be critical to the survival and recovery of the species.
- If, due to survey error, occupied sites go undetected and are not considered for protection.

C. Minimization and Mitigation for Other Federally Listed Species in All Planning Units

In addition to the northern spotted owl and marbled murrelet, seven species listed by the federal government as threatened or endangered occur, or may occur, on DNR-managed lands in the area covered by the HCP. The geographical ranges or habitats of five of these — the Oregon silverspot butterfly, Aleutian Canada goose, gray wolf, grizzly bear, and Columbian white-tailed deer — are peripheral to DNR-managed forest lands, and DNR management will have little effect on the viability of their populations in Washington. The other two federally listed species, the bald eagle and peregrine falcon, occur in or near DNR-managed forests, and adequate conservation of their habitats is expected to result from adhering to DNR policies, state regulations, and the conservation strategies of this HCP. Nevertheless, DNR seeks protection from prosecution for incidental take of these seven federally listed species throughout the entire area covered by the HCP.

Oregon Silverspot Butterfly

Conservation of Oregon silverspot butterflies and their habitat is currently achieved by DNR policies that mandate general protection for riparian areas, wetlands, and upland wildlife habitat, and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policies Nos. 20, 21, 22, and 23 of the Forest Resource Plan, DNR 1992). DNR complies with state Forest Practices Rules, which currently require a SEPA environmental checklist for harvesting, road construction, aerial application of pesticides, or site preparation, within 0.25 mile of an occurrence of an individual Oregon silverspot that has been documented by the Washington Department of Fish and Wildlife (WAC 222-16-080). Under this HCP, all DNR forest management activities in the area covered by the HCP shall comply with state Forest Practices Rules and state wildlife regulations and shall be consistent with the policies set forth by the Board of Natural Resources.

In addition, DNR will not harvest timber, construct roads, or apply pesticides within 0.25 mile of an individual occurrence of an Oregon silverspot butterfly, documented by the Washington Department of Fish and Wildlife. In places where DNR believes that effective conservation can be provided in a more efficient way, DNR may present to the the U.S. Fish and Wildlife Service a site-specific management plan that provides adequate protection for the species or habitat occurring at that site. If the the U.S. Fish and Wildlife Service does not approve of the plan, then a multi-agency science team will be convened. The team will evaluate the plan and determine if it is adequate, and if it is not, recommend additional measures that should be taken.

Although this species rarely occurs on DNR-managed lands, DNR seeks protection from prosecution for incidental take of Oregon silverspot butterflies. DNR expects that inadvertent incidental take will be minimal because distribution of the species and its potential habitat is peripheral to DNR-managed forest lands and current and proposed management of DNR-managed lands is generally neutral to beneficial to Oregon silverspot habitat.

Aleutian Canada Goose

The conservation of this species is peripheral to DNR's forest management, but some of the foraging and resting habitats that the Aleutian Canada goose uses during its migration will be protected through the HCP riparian conservation strategy which: (1) commits to no overall net loss of naturally occurring wetland acreage and function, and (2) protects lakes and ponds classified as Types 1, 2, or 3 waters.

Although the Aleutian Canada goose may rarely stop on or near DNR-managed lands, DNR seeks protection from prosecution for incidental take of this species. DNR expects that inadvertent incidental take of Aleutian Canada geese will be minimal.

Bald Eagle

Conservation of bald eagles and their habitat is currently achieved by DNR policies that mandate general protection for riparian areas and upland wildlife habitat and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan, DNR 1992) and by compliance with state Forest Practice Rules (WAC 222-16-080) and state wildlife regulations (WAC 232-12-292) to protect nest and communal roost sites. Under this HCP, all DNR forest management activities in the area covered by the HCP shall comply with state Forest Practices Rules and state wildlife regulations and shall be consistent with the policies set forth by the Board of Natural Resources. When developing a site-management plan for bald eagle habitat pursuant to WAC 232-12-292 DNR will, where appropriate, consider perch/pilot trees and foraging areas associated with nesting sites, winter roost trees, and winter feeding concentration areas, in addition to protection of nesting trees and the immediate vicinity.

In the west-side planning units, further conservation of bald eagles and their habitat is likely to result from the HCP riparian conservation strategy and the retention of very large old trees as described in the multispecies strategy on uncommon habitats. These measures should increase abundance and distribution of large trees in streamside areas for nesting and roosting and increase abundance and distribution of favorable salmonid habitat for foraging.

DNR expects that inadvertent incidental take of bald eagles will be minimal because DNR shall actively conserve known sites. Nevertheless, DNR seeks protection from prosecution for incidental take of bald eagles.

Peregrine Falcon

Conservation of peregrine falcons and their habitat is currently achieved by DNR policies that mandate general protection for riparian areas and upland wildlife habitat and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan, DNR 1992). DNR complies with state Forest Practices Rules, which currently require a SEPA environmental checklist for harvesting, road construction, aerial application of pesticides, or site preparation within 0.5 mile of a known active nest site between March 1 and July 30 or within 0.25 mile of the nest at other times of the year (WAC 222-16-080). Known sites are based on documentation by the Washington Department of Fish and Wildlife. Under this HCP, all DNR forest management activities in the area covered by the HCP shall comply with state Forest Practices Rules and state wildlife regulations and shall be consistent with the policies set forth by the Board of Natural Resources.

In the five west-side planning units and the Olympic Experimental State Forest, additional conservation of peregrine falcons on DNR-managed lands will be provided by the generally improved wildlife habitat that will result from the HCP and Olympic Experimental State Forest riparian conservation strategies and from the site-specific conservation of cliff habitat as described in the multispecies strategy on uncommon habitats. In addition, in east- and west-side planning units and the Olympic Experimental State Forest, DNR shall where practicable:

- review and, where necessary, manage public access to DNR-managed lands within 0.5 mile of a known peregrine falcon aerie;
- conduct field review, by staff knowledgeable of peregrine biology and requirements, of all cliffs in excess of 150 feet, and conduct surveys for peregrine falcon aeries at cliffs judged to have likely potential for use;
- protect ledges on cliffs judged suitable for aeries;
- retain trees along the base and top of cliffs judged suitable for aeries, especially perch trees along the top of cliffs; and
- keep the location of peregrine falcon aeries on DNR-managed lands confidential to the extent permitted by law.

Although peregrine falcons rarely nest near DNR-managed lands, DNR seeks protection from prosecution for incidental take of this species. DNR expects that inadvertent incidental take of peregrine falcons will be minimal because most known peregrine sites and potential habitat are far from DNR-managed lands. Management of DNR-managed lands is generally neutral to peregrine falcon habitat, however, DNR shall actively conserve known sites.

Gray Wolf

The status of the gray wolf within the HCP area is unknown. However, it is likely that even if absent now, wolves will emigrate and reside in this area during the permit period. Biologically, the fate of the wolf is linked to that of its prey, which includes large herbivores such as elk and deer, and smaller mammals such as the snowshoe hare. No "recovery areas" have yet been designated for the gray wolf in the Washington Cascades. DNR will evaluate the amount of habitat for preferred wolf prey species and prioritize areas that have a higher likelihood of providing adequate habitat for the preferred prey species.

Conservation of gray wolves and their habitat is currently achieved by DNR policies that mandate general protection for riparian areas and upland wildlife habitat and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan, DNR 1992). DNR complies with state Forest Practices Rules, which currently require a SEPA environmental checklist for harvesting, road construction, or site preparation within 1 mile of a known active den site between March 15 and July 30 or within 0.25 miles of the den at other times of the year (WAC 222-16-080). Known den sites are based on documentation by the Washington Department of Fish and Wildlife. Under this HCP, all DNR forest management activities in the area covered by the HCP shall comply with state Forest Practices Rules and state wildlife regulations and shall be consistent with the policies set forth by the Board of Natural Resources.

DNR believes that the combination of riparian and marbled murrelet strategies in western Washington, and the spotted owl strategy and improved road management plan in both western Washington and the east-side planning units will provide support to gray wolves. Additionally, DNR will attempt to avoid or minimize potential impacts to gray wolves by maintaining habitat in a condition that allows wolves and their important prey species to meet their essential biological needs by providing:

- Den site and rendezvous site protection.

- Within 8 miles of a class 1 wolf observation, DNR shall establish a wolf habitat management area on DNR-managed lands. Class 1 observations are confirmed by a biologist and/or photograph, carcass, track, hair, or food cache (Almack et al. 1993).

- DNR, in cooperation with the U.S. Fish and Wildlife Service, shall develop and implement practicable site-specific plans to limit human disturbance within the wolf habitat management area. If the U.S. Fish and Wildlife Service does not approve of the plans, then a multi-agency science team will be convened. The team will evaluate the plans and determine if they are adequate, and if not, recommend additional measures that should be taken to make them adequate.

- Measures to limit disturbance shall remain in effect until five years after the last class 1 wolf observation in the wolf habitat management area.

- Provisions for Prey Habitat Conditions - Habitat management for wolves is primarily directed at habitat for its prey species (USFWS 1984). The most important prey species in the HCP area are deer and elk. The species use edges between cover (older forest) and forage habitats (stand initiation, shrub/sapling, and younger forest). The creation and maintenance of edge habitat through timber harvest activities will provide adequate habitat for wolf prey species.

- Road Management - DNR will attempt to provide more secure conditions for both prey species and wolves. Minimal contact with humans has been cited as the second most important biological necessity for wolf recovery (USFWS 1984). DNR has been involved in cooperative road closures with the Washington Department of Fish and Wildlife and the U.S. Forest Service to restrict vehicular activity to maintain or increase big game security and reduce hunting pressure. DNR will continue to participate in such cooperative activities. Ungulate fawning/calving and wintering areas are areas where wolves are most likely to occur. To the extent practicable, DNR will schedule forest management activities, including road construction and use, to occur at times of the year when wolves are least likely to be present.

The additional conservation measures described in this HCP should benefit the gray wolf because: the generally older forest cover in riparian ecosystems resulting from the riparian conservation strategies will provide increased travel and hiding opportunities for wolves; the generally lower frequency of disturbance in the spotted owl nesting, roosting, and foraging areas, which are adjacent to gray wolf habitat on federal lands along the Cascade Range, will improve the potential of these areas as habitat; and the measures to reduce disturbance in areas of documented gray wolf use will improve the habitat values of these areas.

Although there have been only three observations of gray wolves on DNR-managed lands in the area covered by the HCP (WDFW PHS GIS Database 1989-93), DNR seeks protection from prosecution for incidental take of gray wolves. DNR expects that inadvertent incidental take of this species will be minimal because very few gray wolf occurrences have been recorded on DNR-managed lands in the area covered by the HCP. In addition, current and proposed management of DNR-managed lands is generally neutral to beneficial to gray wolf habitat, and DNR will actively implement conservation measures in areas where wolves occur.

Grizzly Bear

Conservation of grizzly bears and their habitat is currently achieved by DNR policies that mandate general protection for riparian areas and upland wildlife habitat and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan, DNR 1992). DNR complies with state Forest Practices Rules, which currently require a SEPA environmental checklist for harvesting, road construction, aerial application of pesticides, or site preparation within 1 mile of a known active den site between October 1 and May 30 or within 0.25 mile of a den at other times of the year (WAC 222-16-080). Known sites are based on documentation by the Washington Department of Fish and Wildlife. Under this HCP, all DNR forest management activities in the area covered by the HCP shall comply with state Forest Practices Rules and state wildlife regulations and shall be consistent with the policies set forth by the Board of Natural Resources.

The federal and state wildlife agencies believe that grizzly bears occur, at least occasionally, within the North Cascades Grizzly Bear Recovery Zone (hereafter referred to as the Recovery Zone). The Recovery Zone contains in excess of 6,000,000 acres including approximately 260,000 acres of DNR-managed forest lands. Less than 100,000 acres of the DNR-managed land, representing less than 2 percent of the Recovery Zone, is included within the area covered by the HCP.

The DNR-managed lands covered by the HCP and within the Recovery Zone can be described as occurring in four locations: Skagit Valley, Spada Lake, the west side of the Methow Valley, and a group of separate sections between Wenatchee and Lake Chelan and are surrounded by U.S. Forest Service land. In each of these areas, the DNR-managed lands lie on the periphery of the Recovery Zone between federal ownership and areas of human occupancy and related activity. DNR believes the best use of the lands it manages is to serve as a buffer between the federal ownership, where active recovery efforts are most likely to occur, and the areas of increased public use. DNR believes that this role will be sufficiently supported by the combination of other strategies contained within the HCP.

DNR believes that the combination of riparian and marbled murrelet strategies in western Washington, and the spotted owl strategy and improved road management plan in both western Washington and the east-side planning units will provide support to grizzly bears. In addition, DNR proposes to provide the following site-specific measures:

- Within 10 miles of a class 1 grizzly bear observation, DNR shall establish a grizzly bear habitat management area on DNR-managed lands within the North Cascades Grizzly Bear Recovery Area. Class 1 observations are confirmed by a biologist and/or photograph, carcass, track, hair, dig, or food cache (Almack et al. 1993).

- DNR, in cooperation with the U.S. Fish and Wildlife Service, shall develop and implement practicable site-specific plans to limit human disturbance in the grizzly bear habitat management area.

- Measures to limit disturbance shall remain in effect until five years after the last class 1 grizzly bear observation in the grizzly bear habitat management area.

The additional conservation measures described in this HCP should benefit grizzly bears because: the improved function of riparian ecosystems resulting from the riparian conservation strategies will provide increased foraging, travel, and hiding opportunities for bears; the generally lower frequency of disturbance in the spotted owl nesting, roosting, and foraging areas, which are adjacent to grizzly bear habitat on federal lands along the Cascade Range, will improve the potential of these areas as habitat; and the measures to reduce disturbance in areas of documented grizzly bear use will improve the habitat values of these areas.

Although there has been only one observation of a grizzly bear on DNR-managed lands in the area covered by the HCP (WDFW PHS GIS Database 1990-93), DNR seeks protection from prosecution for incidental take of grizzly bears. DNR expects that inadvertent incidental take of this species will be minimal because only one grizzly bear occurrence has been recorded on DNR-managed lands in the area covered by the HCP. In addition, current and proposed management of DNR-managed lands is generally neutral to beneficial to grizzly bear habitat, and DNR will actively implement conservation measures in areas where grizzlies occur.

Columbian White-tailed Deer

Conservation of Columbian white-tailed deer and their habitat is currently achieved by DNR policies that mandate general protection for riparian areas, wetlands, and upland wildlife habitat and specific commitments to respect state and federal requirements for protection of threatened and endangered species (Policies Nos. 20, 21, 22, and 23 of the Forest Resource Plan, DNR 1992). Although the current range of the Columbian white-tailed deer is peripheral to DNR-managed forest lands, DNR seeks protection from prosecution for incidental take of this species. Under this HCP, all DNR forest management activities in the area covered by the HCP shall comply with state Forest Practices Rules and state wildlife regulations and shall be consistent with the policies set forth by the Board of Natural Resources.

Additional conservation of Columbian white-tailed deer and their habitat on DNR-managed lands will result from the HCP riparian conservation strategy that describes management beneficial for the riparian and tidal forests that are potential habitat for these deer.

DNR expects that inadvertent incidental take of Columbian white-tailed deer will be minimal because:

(a) Columbian white-tailed deer are not currently known to inhabit DNR-managed forest lands.

(b) Current and proposed management of DNR-managed forest lands is generally neutral to beneficial to Columbian white-tailed deer habitat.

(c) DNR-managed forest lands near the range of the Columbian white-tailed deer are currently occupied by black-tailed deer, which are displacing the white-tailed deer through competition in upland sites like those managed by DNR (WDW 1991).

D. Riparian Conservation Strategy for the Five West-side Planning Units

Under this HCP, riparian conservation strategies shall be implemented in the five west-side planning units and the Olympic Experimental State Forest. The riparian conservation strategy for the Olympic Experimental State Forest is different than that to be implemented in the five west-side planning units because:

(1) in the Olympic Experimental State Forest, the emphasis on research and the systematic application of knowledge gained will likely lead to refinements and revisions in the riparian conservation strategy over time, and

(2) the climatic, geological, and physiographic characteristics of the western Olympic Peninsula present special problems for forest management around riparian areas.

See Section E of this chapter for a description of the Olympic Experimental State Forest riparian conservation strategy.

Neither riparian conservation strategy will be applied in the east-side planning units. But riparian management there will continue to follow state Forest Practices regulations and policies of the Board of Natural Resources.

DNR will continue to participate in watershed analysis according to state Forest Practices Rules (WFPB 1994). If watershed analysis indicates that public resources require a greater level of protection than that specified by the HCP, the prescriptions developed through watershed analysis to provide this additional protection shall be implemented. As of the writing of this HCP watershed analysis does not address wildlife, and one of the objectives of the riparian conservation strategy, as discussed below, is the conservation of riparian obligate wildlife. In order to continue to meet this conservation objective, all components of the strategy shall still apply to DNR-managed lands in Watershed Administrative Units for which watershed analysis has been conducted, unless stated otherwise elsewhere in this HCP.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service are prioritizing watersheds for the conservation of salmon. DNR will consider the results of this prioritization when planning its participation in Watershed Analysis.

This section of Chapter IV will discuss the conservation objectives of the riparian conservation strategy for the five west-side planning units, the conservation components of the strategy, the rationale for the conservation components, and the effects of the strategy on salmonids.

Conservation Objectives

DNR identified two conservation objectives for the riparian conservation strategy for the five-west-side planning units:

(1) to maintain or restore salmonid freshwater habitat on DNR-managed lands, and

(2) to contribute to the conservation of other aquatic and riparian obligate species.

As described in Section D of Chapter III titled Salmonids and the Riparian Ecosystem, salmonid habitat includes the entire riparian ecosystem, and therefore, conservation objective (1) requires maintaining or restoring the riparian ecosystem processes that determine salmonid habitat quality. Also, as described in Section D of Chapter III, hydrological and geomorphological processes originating in upland areas may also affect salmonid habitat. Thus, conservation objective (1) further requires that the adverse effects of upland management activities be minimized. Contributions to the conservation of other aquatic and riparian obligate species, conservation objective (2), will occur indirectly through forest management that maintains or restores salmonid freshwater habitat.

Conservation Components

The riparian conservation strategy for the five west-side planning units defines the riparian management zone and describes future forest management with respect to unstable hillslopes, the road network, hydrologic maturity within the rain-on-snow zone, and wetlands.

RIPARIAN MANAGEMENT ZONE

The riparian management zone consists of an inner riparian buffer and an outer wind buffer where needed. (See Figure IV.7.) The principal function of the riparian buffer is protection of salmonid habitat; the principal function of the wind buffer is protection of the riparian buffer. Harvesting can occur within the buffers as long as management activities support these principal functions and are consistent with the conservation objectives.

Riparian Buffers

A riparian buffer shall be applied to both sides of Types 1, 2, and 3 waters (water types are defined in WAC 222-16-030). The width of the riparian buffer shall be approximately equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. For the purposes of this HCP, the height shall be derived from standard site index tables (King 1966), using 100 years as the age at breast height of a mature conifer stand. When determining the width of the buffer, the site productivity used in the derivation will be that occurring in upland portions of the riparian ecosystem for that particular site. The site index table used will be that corresponding to the dominant conifer species occurring in the upland portion of riparian ecosystem. As discussed below, this prescription should result in average riparian buffer widths between 150 and 160 feet.

A riparian buffer 100 feet wide shall be applied to both sides of Type 4 waters. Type 4 waters classified after January 1, 1992, are assumed to be correctly classified. Type 4 waters classified prior to January 1, 1992, must either have their classification verified in the field or be assumed to be Type 3 waters. In general, it is currently standard practice for DNR staff to physically examine the classification of streams within a management unit when preparing the unit for a timber sale. If an area has already been classified post 1992 and prior to the effective date of this HCP, it is likely in a management activity area that is probably sold and/or harvested. Therefore, for all practical purposes, stream typing will be examined or verified in the field whether they were typed before or after 1992.

In the field, the width of the riparian buffer shall be measured as the horizontal distance from, and perpendicular to, the outer margin of the 100-year floodplain.

Figure IV.7: The relationship between the riparian ecosystem and DNR's riparian management zone

Thin lines denote the natural zonation of a forest landscape, i.e., the extent of the riparian ecosystem and the zones within the ecosystem. Thick lines denote areas of special forest management, i.e., the riparian management zone and the buffers within it. At most sites, the wind buffer is applied only as needed to the windward side of a stream. (Modified from Sedell et al. 1989)

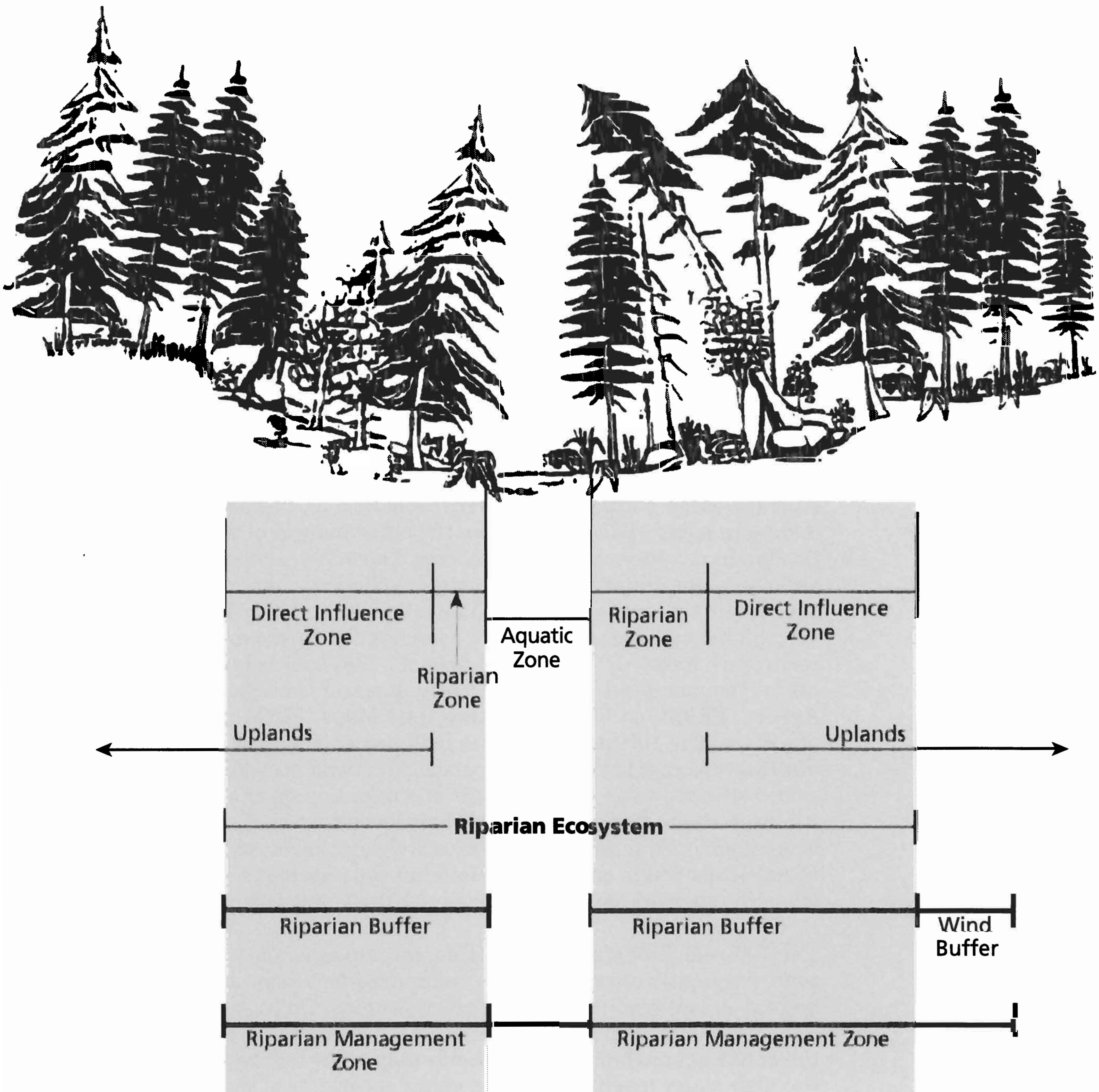


Table IV.5: Expected average widths of interior-core riparian buffers in the Olympic Experimental State Forest

Buffer widths will be determined on a site-specific basis using the proposed 12-step watershed assessment procedure (see text) and might vary locally with landform characteristics. Average widths are not expected to vary significantly, however, because these values are derived from a statistical analysis of buffer protection previously applied to about 55 percent of DNR-managed lands in the OESF. (See text for discussion.) Widths are expressed for each stream type as average horizontal distances measured outward from the 100-year flood-plain on either side of the stream.

Stream type	Width of riparian interior-core buffer (horizontal distances, rounded to the nearest 10 feet)
1	150
2	150
3	100
4	100
5	width necessary to protect identifiable channels and unstable ground (see text)

Average buffer widths are given in Table IV.5 as average horizontal distances measured outward from the outer margin of the 100-year floodplain on either side of the stream. The 100-year floodplain is the valley-bottom area adjoining the stream channel that is constructed by the stream under the present climatic regime and overflowed at times of very high discharge (i.e., flooding associated with storms of a 100-year recurrence interval, (Dunne and Leopold 1987)). One-hundred-year flood-plains commonly are delineated by the Federal Emergency Management Agency (FEMA) on Flood Insurance Rate Maps (FIRM) for each county of a state. The 100-year floodplain includes meandering, braided (i.e., multiple channel braids), and avulsion channels, as well as side channels that transport water from one part of a mainstream channel to another. Avulsion channels are portions of mainstream and side channels that have been abandoned temporarily by lateral displacement of the channel network elsewhere on the floodplain but are expected to be reoccupied when the network migrates back across the valley bottom.

The 100-year floodplain, which often encompasses the channel-migration zone, frequently occupies a several-hundred-foot wide section of the valley bottom on low-gradient, alluvial river systems. On higher-gradient streams in moderate to steep terrain, the 100-year floodplain typically coincides with the active channel margin or extends only a few feet beyond the active (e.g., the high-water mark). The active channel consists of the wetted area and bed or bank surfaces exposed during low flows, as well as portions of the valley bottom nearest the channel that are inundated during typical flood events (i.e. comparable to the two-year recurring flood). Active channel margins commonly are identified in the field by piles of accumulated flood debris, overbank sediment deposits, streamside vegetation altered or damaged by channel flows, bank scour, and the absence of aquatic biota (e.g., algae) normally found in slack-water channels. In the five west-side planning units and the OESF, DNR manages only a few hundred acres on 100-year floodplains of the major river systems. Most floodplain acreage is privately owned or federally managed. FEMA maps indicate that most

100-year floodplains are associated with Type 1 and 2 waters. Collectively, Type 1 and 2 waters represent less than 5 percent of the stream miles on DNR-managed lands. Hence, the impact to DNR management associated with using the 100-year floodplain as the inner margin of riparian management zones is relatively negligible. A method for determining the location of the active channel margin will be described in agency procedures to be developed for this HCP.

If Type 4 and 5 waters without fish become fishbearing upon removal of obstructions, they will be reviewed for proper typing. Type 4 or 5 waters documented to contain fish that are proposed or candidates for federal listing or federal species of concern will be treated as Type 3 waters, if appropriate.

All Type 5 waters that flow through an area with a high risk of mass wasting shall be protected as described in the subsection below titled Unstabled Hillslopes and Mass Wasting. During the first 10 years of this HCP, all other Type 5 waters shall be protected according to Policy No. 20 of the Forest Resource Plan (DNR 1992 p. 35). Under this policy, Type 5 waters are protected "when necessary for water quality, fisheries habitat, stream banks, wildlife, and other important elements of the aquatic system." In addition, during this interim 10-year period, a research program shall be initiated to study the effects of forest management along Type 5 waters located on stable slopes. At the end of the 10 year period, a long-term conservation strategy for forest management along Type 5 waters shall be developed and incorporated into this HCP as part of the adaptive management component.

Type 5 waters classified after January 1, 1992 are assumed to be correctly classified. Type 5 waters classified prior to January 1, 1992, will either have their classification verified in the field or be assumed to be Type 3 waters.

Wind Buffers

An outer wind buffer shall be applied on Types 1, 2, and 3 waters in areas that are prone to windthrow. Physical evidence of windthrow, windthrow models, and the potential for windthrow will guide the placement of wind buffers along riparian buffers. For Types 1 and 2 waters, where there is at least a moderate potential for windthrow, a 100-foot wind buffer shall be placed along the windward side(s). For Type 3 waters wider than 5 feet, where there is at least a moderate potential for windthrow, a 50-foot wind buffer shall be placed along the windward side(s). Where forest stands are subject to strong winds from multiple directions, it may be necessary to put wind buffers along the riparian buffers on both sides of the stream. If no evidence of windthrow exists or models predict a low risk of windthrow, then wind buffers will not be applied. The width and positioning of wind buffers may change as research concerning windthrow in managed forests, especially that conducted in the Olympic Experimental State Forest, finds solutions to the problem of minimizing windthrow. A method for determining on a site-specific basis the placement of the wind buffer will be described in agency procedures to be developed for this HCP.

ACTIVITIES IN THE RIPARIAN MANAGEMENT ZONE

Forest management activities that maintain or restore the quality of salmonid habitat shall be allowed within the riparian management zone. To ensure that this occurs, site-specific forest management activities along all Types 1, 2, 3, and 4 waters shall conform to the following:

(1) No timber harvest shall occur within the first 25 feet (horizontal distance) from the outer margin of the 100-year floodplain. Maintemance of stream bank integrity is the primary function of the

no-harvest area, and therefore, a wider no-harvest area will be established where necessary. DNR anticipates that only ecosystem restoration will occure in this area.

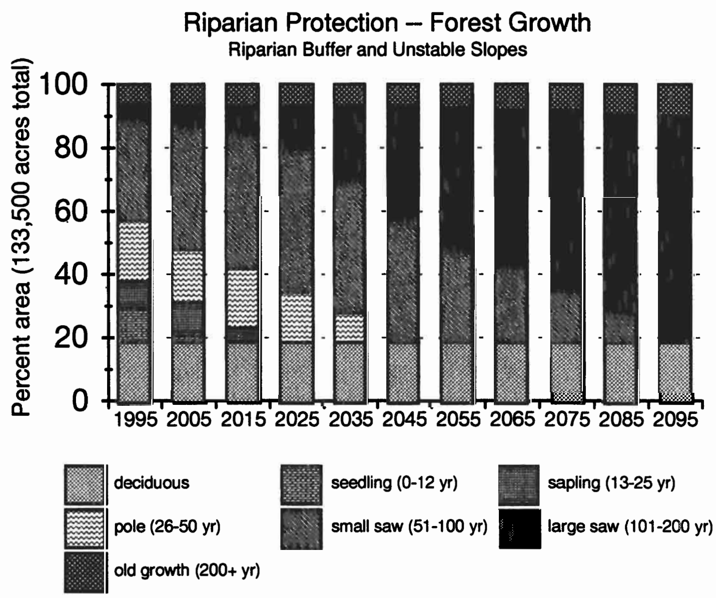
(2) The next 75 feet of the riparian buffer shall be a minimal-harvest area. Activities occurring between 25 and 100 feet (horizontal distance) from the 100-year floodplain must not appreciably reduce stream shading, the ability of the buffer to intercept sediment, or the capacity of the buffer to contribute detrital nutrients and large woody debris. Maintaining natural levels of stream temperature, sediment load, detrital nutrient load, and instream large woody debris is the primary function of the minimal-harvest area, and therefore, a wider minimal-harvest area will be established where necessary. DNR an-ticipates that only two types of silvicultural activities will occur in this area: ecosystem restoration and the selective removal of single trees.

(3) The remaining portion of the riparian buffer (more than 100 feet from the active channel margin) shall be a low-harvest area. DNR anticipates that selective removal of single trees, selective removal of groups of trees, thinning operations, and salvage operations will occur in this area. (See the discussion of salvage operations in the subsection titled Other Management Considerations, in Section A of this chapter on spotted owl mitigation.)

All forest management within riparian management zones will be site-specific, i.e., tailored to the physical and biological conditions at a particular site. All forest management in the riparian buffer shall maintain or restore the quality of salmonid habitat, but because of variation in site conditions, it is anticipated that the intensity of management will vary and that the forest stands which result from management will vary in both composition and structure.

To accommodate the greater flexibility afforded by managing riparian areas on a site-specific basis and the uncertainties surrounding the results of these activities conducted over time, an adaptive-management process will be used to specify management activities within riparian-management areas. Mechanisms used to achieve conservation objectives will vary as new information becomes available.

DNR believes that this strategy will lead, over time, to an age-class distribution within the riparian zones as depicted by the following graph:



Methods for making site-specific, forest-management decisions in the riparian mangement zones and wind buffers will be described in DNR's implementation procedures. These procedures will be developed by DNR and provided to the U.S. Fish and Wildlife Service and National Marine Fisheries Service for their review prior to being implemented. These procedures will, at a minimum:

(a) Describe in detail the conservation objectives.
These objectives will include desired outcomes for such items as maintaining bank stability, water temperature, shade, and natural sedimentation rates; retaining large trees and snags necessary to support viable populations of riparian wildlife and recruit future snags, coarse woody debris (downed logs on land), and large woody debris (in-stream logs); and maintaining the natural capacity of these areas to provide diversity including overstory composition, understory composition, detritus input, and natural pool frequencies.

(b) Define terminology, activities, and prescriptions.
For example, single-tree removal may be defined in terms of distance between removed trees and years between entries and may vary by site. It is expected that additional considerations such as lean of the tree, distance from stream bank, size, soundness, and abundance of other mature conifer would be factors considered during a site-specific analysis. The implementation procedures will provide guidance on how to incorporate those types of considerations. Similarly, the implementation procedures may describe how considerations of the rooting zone may extend the 25-foot no-harvest area on a site-specific basis using canopy diameters or other such indicators. Terms such as restoration, single-tree removal, minimal harvest, low harvest, etc. would be defined for each component of riparian management zones and wind buffers. Prescriptions for placement of yarding corridors and other such activities would also be included.

(c) Detail the monitoring methods to be used in the feedback process for adaptive management designed to ensure riparian-management zones and wind buffers are adequately providing the desired characteristics (e.g., large woody debris, stream stability, water temperature, snag densities, etc.); and

(d) Describe the training to be provided to agency staff.

These procedures will be developed by DNR and presented to the U.S. Fish and Wildlife Service and National Marine Fisheries Service within 12 months of signing the HCP documents. If the U.S. Fish and Wildlife Service and National Marine Fisheries Service do not agree with the procedures developed by DNR, a multi-agency science team will be convened to review the sufficiency of the procedures. Timber harvesting conducted within the riparian management zones and wind buffers prior to agreement on the proposed agency procedures will be subject to the following limitations:

- Within the 25-foot no-harvest area, only commonly accepted restoration activities may occur.

- Within the minimal-harvest area, low-harvest area, and wind buffer, partial harvests may occur that remove no more than 10 percent of the conifer volume and/or 20 percent of the hardwood volume per rotation.

However, if three months have passed since the U.S. Fish and Wildlife Service and National Marine Fisheries Service have received procedures developed by DNR and all three agencies have been unable to reach agreement on their sufficiency, DNR may increase timber harvest within the riparian management zones and wind buffers with the following limits:

(a) Within the 25-foot no-harvest area, only commonly accepted restoration activities may occur.

(b) Within the minimal-harvest area, single-tree or partial harvests may occur that remove up to 10 percent of the volume.

(c) Within the low-harvest area, partial harvests may occur that remove up to 25 percent of the volume.

(d) Within the wind buffer, partial harvests may occur that remove up to 50 percent of the volume.

UNSTABLE HILLSLOPES AND MASS WASTING

Unstable hillslopes will be identified through field reconnaissance or identified with slope geomorphology models (e.g., Shaw and Johnson 1995) and verified through field reconnaissance with qualified staff. If, in the future, timber harvest and related activities can be accomplished without increasing the frequency or severity of slope failure and without severely altering the natural input of large woody debris, sediment, and nutrients to the stream network, then such activity shall be allowed. A method for delineating on a site-specific basis the portions of hillslopes with a high risk of mass wasting will bedescribed in agency procedures to be developed for this HCP. Where slope stability models are less accurate (i.e., Southwest Washington), DNR will also rely on additional information, such as soil type databases.

Harvest operations will at times require that roads pass through areas with a high risk of mass wasting. Roads will be allowed to pass through such areas, but they must be engineered to minimize, to the fullest extent feasible, the risk of mass wasting and be routed through the use of a comprehensive landscape-based road network management process (below).

Road Network Management

On a Watershed Administrative Unit basis, DNR shall minimize adverse impacts to salmonid habitat caused by the road network. With this conservation objective in mind, a comprehensive landscaped-based road network management process shall be developed and instituted. Major components of this process shall include:

- the minimization of active road density;
- a site-specific assessment of alternatives to new road construction (e.g., yarding systems) and the use of such alternatives where practicable and consistent with conservation objectives;
- a base-line inventory of all roads and stream crossings;
- prioritization of roads for decommissioning, upgrading, and maintenance; and
- identification of fish blockages caused by stream crossings and a prioritization of their retrofitting or removal.

Prior to the completion of the landscaped-based road network management process, forest management activities will continue, provided they are consistent with conservation objectives.

BACKGROUND

Impacts from roads have been indicated to be important potential influences on many species of wildlife and fish and their habitats. For example, elk use closed roads as travel corridors (Ward 1976). Also, both elk and deer use of habitat increases with increasing distance from open roads (Lyon and Jensen 1980; Lyon 1979; Perry and Overly 1977).

Grizzly bears generally avoid roads and associated human disturbance, and the Grizzly Bear Recovery Plan recognizes road management as the single most important tool to manage and maintain suitable grizzly habitat (USDI 1993).

Wolf dens and rendezvous sites are often characterized by distance from human activity, and the Rocky Mountain Wolf Recovery Plan states, "Habitat for wolves is an adequate supply of vulnerable prey (ideally in an area with minimal opportunity for exploitation of wolves by humans)" (USDI 1987).

The Washington Department of Fish and Wildlife Draft Bull Trout/Dolly Varden Management and Recovery Plan (WDWF 1992) recommends closing roads permitting public access to spawning areas or access that facilitates poaching. Additional riparian impacts include increased sedimentation from road runoff and increased rates of slope failure caused by improperly constructed or poorly maintained roads (Murphy 1995).

The effects that roads have on the environment are influenced by what happens during the six distinct phases of road development: planning, design, construction, use, maintenance, and abandonment.

The planning phase determines road location across a landscape and has the single most significant impact on road density and road net configuration. In general, road spacing is determined by an economic balance between environmentally sound road transportation costs and environmentally sound yarding costs. At the site level, road spacing is controlled by topography that controls landing locations which are ultimately connected by a road network. Unstable slopes, wetlands, sensitive habitat, and other environmental issues are best addressed at this early stage as the location of a road will likely change very little once the control points are established.

The design phase ensures that a road will be built from one control point to another with sufficient width, usable grades, proper alignment, use of non-erosive surfacing material, adequate water drainage features, and stable cut-and-fill slopes.

Compliance with construction standards ensures that the road is built to the design specifications and ensures that the construction techniques minimize the amount of sediment moving from the road prism. If not carefully controlled, the construction phase can represent a significant percentage of the life cycle contribution of road sediment.

Forest roads are designed to handle traffic at some level of normal operations (road use). Roads are not typically designed to handle excessive loads or high volume traffic during very wet weather or during the thawing cycle associated with cold weather. Uncontrolled traffic can generate the largest percentage of the life cycle contribution of road sediment.

Maintenance operations attempt to keep the road at the designed level of performance. Maintenance primarily deals with keeping drainage structures functional and keeping the running surface usable. Maintenance cannot solve problems associated with a bad location, improper design, poor construction, or misuse.

Abandonment is an alternative to maintenance when the cost of maintaining a road segment is greater than the benefits of keeping the road open and environmentally sound.

DNR'S CURRENT ROAD MANAGEMENT STRATEGY

Current direction for DNR's road construction and maintenance program comes from Forest Practices regulations (WAC-222-24) and the 1992 Forest Resource Plan.

The objectives of DNR's current road management program are to:

(1) minimize further road related degradation of riparian, aquatic, and identified species habitat;

(2) plan, design, construct, use, and maintain a road system that serves DNR's management needs; and

(3) remove unnecessary road segments from the road net.

PLANNING

In general, DNR plans for high lead (800-foot optimum average yarding distance) yarding systems on land with slopes above 40 percent, and ground based systems (1000-foot average yarding distance) below 40 percent. This, together with topography, results in typical road densities between 0.5 to 6.0 miles per square mile.

DESIGN

DNR's design specifications meet or exceed Forest Practices regulations and hydraulic code requirements. Current road design standards call for 100-year flood design levels for water crossing structures, abutments of bridges to be outside the ordinary high water mark of streams, 18-inch minimum cross drain culverts, 12-foot running surfaces with 12-percent adverse and 18-percent favorable grades, and 60-foot minimum curve radius. Backslopes are designed according to soil type and meet or exceed the recommended angles required by Forest Practices regulations. Most Regions require that all roads on land with slopes greater than 40 percent be full bench construction with endhaul of excavated material when slopes exceed 55 percent or when within 100 feet of Type 1, 2 or 3 waters and wetlands. DNR also has minimum requirements for rock hardness and soluble degradation to reduce the amount of surface erosion generated from traffic.

CONSTRUCTION

DNR's road construction specifications meet or exceed the Forest Practices minimums. DNR requires compaction of fills in 2-foot layers, prohibits any woody debris from being incorporated into the fills, and often requires that the subgrade surface be compacted and graded prior to surface application. DNR prohibits construction during inclement weather and generally restricts construction to the dryer summer months.

ROAD USE

DNR currently allows all-season use of roads except for log truck traffic which may be restricted during periods of freeze-thaw cycles. DNR occasionally closes roads in agreement with the Washington Department of Fish and Wildlife for the purpose of game management. DNR also has occasional road closures related to fire control.

MAINTENANCE

DNR road maintenance specifications meet or exceed the Forest Practices minimums. Road maintenance activities focus on four main activities: timber sales, forest management, fire control access, and recreation. All roads are maintained to meet Forest Practices environmental and forest road safety standards. Each type of road has a different driveability standard that is linked to the type of vehicle used for each activity.

ABANDONMENT

When a road segment is determined to be too expensive to maintain, or is no longer needed, it is stabilized and abandoned. DNR is currently building more road per year than it is abandoning. While the number of miles of road per section is getting lower, the need to keep roads open longer coupled with the need to access additional acreage means the road network keeps growing. The need to keep roads open longer is driven by new environmentally sensitive approaches to harvesting, such as partial cutting and staggered settings. These silvicultural techniques dictate the need for multiple entries into a stand over the long term.

DNR'S HCP ROAD MANAGEMENT STRATEGY

In 1994, an analysis of the transportation information contained in the DNR GIS system showed that the average density of roads in the nine HCP planning units ranged from 1.69 to 3.29 miles per square mile although road density varies greatly within each planning unit.

The options available to DNR to reduce the mass wasting and surface erosion impacts to streams primarily focus on the amount and location of problem roads that are currently unnecessary and on how well necessary roads are managed. Road management can best be addressed with improved design, construction compliance, control of use, and maintenance management. Potential problems can best be addressed during a landscape-level planning phase.

DNR will initially focus on improvements in the more sensitive areas of a landscape with priority given to locations on steep slopes with unstable soil and high precipitation, and locations within 100 feet of Type 1, 2, and 3 waters and wetlands.

PLANNING

DNR will ensure that planning processes specifically include the consideration of longer yarding capacity systems whenever faced with placing roads in unstable areas. The alternatives generated during the planning process will be reviewed by an interdisciplinary team of foresters, scientists, and engineers who will evaluate the environmental, silvicultural, public use, and economic benefits and costs of these alternatives, and recommend harvest strategies for these sensitive areas. Alternate locations for new roads will be considered in more sensitive areas where other slope-parallel roads exist. The selection process will emphasize the overall goals of the HCP.

In considering road densities, it is assumed that the current emphasis on small staggered settings with greenup requirements, and partial-cut silvicultural systems designed to achieve environmental objectives will continue. These systems will, by their nature, result in more extensive road systems which will be active for longer periods of time. While expansion is inevitable as new areas are accessed, DNR's goal will be to reduce the additional amount of new roads needed through careful planning and control the overall size of the network by effective abandonment.

DESIGN

(1) In unstable areas, DNR will consider options such as:

(a) road designs by professional engineers;

(b) narrower running surfaces;

(c) less steep cut and fill slopes;

(d) more comprehensive slope revegetation/stabilization systems;

(e) designed slope retaining structures;

(f) larger and more frequent cross drains;

(g) full bench on all roads located on 40 percent or greater side slopes;

(h) endhaul of waste on all sideslopes greater than 55 percent;

(i) subgrade and surfacing matrix enhancers (fabric, lime, concrete);

(j) outsloping where appropriate;

(k) permeable fills to stabilize sub-grades; and

(l) other techniques for road-benching, including sliver-fills, back casting, and multi-benching.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) requiring higher quality rock surfacing specifications or the use of surfacing binders such as asphalt or lining sulfonate;

(b) using more comprehensive cut and fill slope revegetation/ stabilization systems;

(c) designing culverts and bridges for debris capacity as well as 100-year flood hydraulic criteria; and

(d) placing sediment traps to avoid delivery of surface erosion into stream crossings, particularly at sites of through-cuts.

CONSTRUCTION

(1) In unstable areas, DNR will consider options such as:

(a) slope stake design and compliance for road construction on 55 percent sideslopes;

(b) performing a thorough compaction of subgrade;

(c) prohibiting woody debris in all fills;

(d) using compact fills on slopes between 40 percent and 55 percent in 6-inch lifts with compacting machines designed for that purpose;

(e) controlling road construction shutdowns using moisture content indicators;

(f) employing controlled blasting, (e.g., pre-splitting) in order to avoid triggering landslides, especially during wet conditions; and

(g) using a backhoe rather than dozer to reduce ground disturbance.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) performing a thorough compaction of subgrade;

(b) using filter barriers downslope of construction;

(c) fully diverting flowing waters during culvert installation;

(d) installing silt filter devices at outlets of cross drains;

(e) delaying construction during inclement weather; and

(f) limiting the extent of exposed soils adjacent to a watercourse.

(3) Reconstructing necessary roads on unstable soils will be given high priority.

ROAD USE

(1) In unstable areas, DNR will consider options such as closing roads to log truck traffic during high rainfalls.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) closing roads to log truck traffic during high rainfalls;

(b) placing limits on volume hauled per day on marginal road segments;

(c) restricting hauling on some road systems to low pressure tire hauling vehicles (Central Tire Inflation);

(d) closing temporarily inactive road segments with gates; and

(e) installing silt filter devices at outlets of cross drains.

MAINTENANCE

(1) In unstable areas, DNR will consider options such as:

(a) employing road stabilization techniques that reduce the size of the road prism;

(b) stabilizing and armoring cut and fill slopes; and

(c) performing more frequent ditch and drainage structure maintenance.

(2) When within 100 feet of Type 1, 2, or 3 waters or wetlands, DNR will consider options such as:

(a) paving or lignin sulfonate surfacing stabilizers;

(b) performing more frequent ditch and surface maintenance; and

(c) resurfacing projects.

ABANDONMENT

DNR will become more aggressive in abandoning unneeded unstable roads and will increase the level of integrating abandonment of short use spurs in conjunction with timber sale activities.

HYDROLOGIC MATURITY IN THE RAIN-ON-SNOW ZONE

DNR shall minimize the adverse impacts to salmonid habitat caused by rain-on-snow floods. Two-thirds of the DNR-managed forest lands in drainage basins in the significant rain-on-snow zone shall be maintained in forest that is hydrologically mature with respect to rain-on-snow events. This prescription shall be applied to drainage basins that are approximately 1,000 acres or larger in size. A method for delineating the boundaries of drainage basins will be described in agency procedures to be developed for this HCP.

In some 1,000-acre or larger drainage basins there will be little risk of material damage to salmonid habitat during rain-on-snow floods, and in others, because of ownership patterns, DNR's management will not significantly decrease the risk of material damage. Therefore, DNR-managed forest lands need not conform to the basin hydrologic maturity prescription when:

- the basin has less than one-third of its area in the significant rain-on-snow zone; or
- the basin has at least two-thirds of its area in the significant rain-on-snow zone covered by hydrologically mature forests, and there is a reasonable assuraxnce that it will remain in that condition (e.g., forests in National Parks or National Forest Late successional Reserves); or
- the basin has less than one-half of its area in the significant rain-on-snow zone under DNR management, and there is no reasonable assurance that other landowners will contribute hydrologically mature forests (e.g., because land is in mines, farms, or housing developments). In such situations, an interdisciplinary team of scientists will be convened to develop a prescription for DNR-managed land within the drainage basin. Economic considerations will be included in the deliberations.

On the west side of the Cascades, conifer forests reach hydrologic maturity with respect to rain-on-snow events at approximately age 25. For the purposes of this HCP, hydrologically mature is defined as a well-stocked conifer stand at age 25 or older. DNR's geographical information system, which contains information on forest stand ages and tree species composition, will be used to determine the proportion of DNR-managed forest land in the significant rain-on-snow zone that is hydrologically mature.

The basin hydrologic maturity prescription is intended to be a straight forward way to provide a standard level of protection. In some basins, this will not be the most efficient means available to provide effective protection to salmonid habitat. Therefore, in places where DNR believes that effective protection can be provided in a more efficient way, DNR may use the Hydrologic Change Module of Watershed Analysis to develop drainage basin prescriptions. Once the analysis is complete and any necessary prescriptions are developed, the hydrologic maturity prescription specified in this HCP shall be waived.

In the future, DNR may conduct research to determine the relationship between soils within a drainage basin and adverse impacts to salmonid habitat during rain-on-snow floods. If it can be demonstrated, in a scientifically credible manner, that drainage basins consisting of certain soil types or soil parent materials have a low likelihood of adverse impacts to salmonid habitat during rain-on-snow floods, then such basins will not be required to conform to the basin hydrologic maturity prescription.

WETLANDS PROTECTION

Management activities in and around wetlands shall be consistent with the Forest Resource Plan Policy No. 21 (DNR 1992 p. 36), which states that DNR "will allow no overall net loss of naturally occurring wetland acreage and function." The primary conservation objective of the wetlands protection strategy is to maintain hydrologic function. This will be achieved through:

(1) continuously maintaining a plant canopy that provides a sufficient transpiration surface and established rooting;

(2) maintaining natural water flow (e.g., no channelization of surface or subsurface water flow); and

(3) ensuring stand regeneration.

The primary wetland functions that will be protected are the augmentation of stream flow during low-flow seasons and the attenuation of storm peak flows.

Wetlands to receive protection are those that fit the definition used by the state Forest Practices Rules (WAC 222-16-010). All wetlands 0.25 acre or larger shall be protected by a buffer. The minimum size of wetland to be protected was based on operational feasibility because wetlands smaller than this are difficult to locate. Wetlands that are larger than 1 acre shall have a buffer width approximately equal to the site potential height of trees in a mature conifer stand or 100 feet, whichever is greater. For the purposes of this HCP, the height shall be derived from standard site index tables (King 1966), using 100 years as the age at breast height of a mature conifer stand. Wetlands from 0.25 acre to 1 acre shall have a 100-foot-wide buffer. In the field, the width of the wetlands buffer shall be measured as the horizontal distance from, and perpendicular to, the edge of the wetland. Seeps and wetlands smaller than 0.25 acre will be afforded the same protection as Type 5 waters. That is, such features will be protected where part of an unstable hillslope. Research to study the effects on aquatic resources of forest management in and around seeps and small wetlands will be included in research programs for Type 5 waters.

Timber harvest within the forested portions of forested wetlands and wetland buffer areas shall be designed to maintain and perpetuate a stand that:

(1) is as wind-firm as possible;

(2) has large root systems to maintain the uptake and transpiration of ground water; and

(3) has a minimum basal area of 120 square feet per acre.

No road building shall occur in wetlands or wetland buffers without mitigation. Roads constructed within wetlands or wetland buffers shall require on-site and in-kind equal acreage mitigation in accordance with DNR's wetland policy. The effects of roads on natural surface and subsurface drainage shall be minimized.

Forestry operations in wetlands and wetland buffers shall be in accordance with DNR's policy of no overall net loss of wetland function. Forest management in forested wetlands and in buffers of nonforested wetlands will minimize entries into these areas and utilize practices that minimize disturbance, such as directional felling of timber away from wetlands and using equipment that cause minimal soil disturbance (e.g., tractors with low pressure tires). If ground disturbance caused by forest management activities alters the natural surface or subsurface drainage of a wetland, then restoration of the natural drainage shall be required. Soil compaction and rutting usually preclude the use of ground-based equipment in wetland areas. Salvage operations will be allowed within wetland buffers in areas that are not periodically flooded. (For discussion of salvage operations, see subsection titled Other Management Considerations, in Section A of this chapter on spotted owl mitigation.)

Rationale for the Conservation Components

RIPARIAN MANAGEMENT ZONE

The purpose of the riparian management zone is to maintain or restore the ecological functions in riparian and upland areas that directly influence salmonid freshwater habitat. Riparian management zones consist of a riparian buffer and, where appropriate, a wind buffer. Harvesting can occur, as long as management activities are consistent with the conservation objectives.

Riparian Buffers

The width of the riparian buffer is designed to maintain the functions of riparian ecosystem processes that influence the quality of salmonid freshwater habitat. Water temperature, stream bank integrity, sediment load, detrital nutrient load, and the delivery of large woody debris were the principal considerations used for designing the riparian buffer widths.

Large woody debris was considered especially important in the design of buffer widths because of the fundamental role it plays in aquatic ecosystems. Therefore, the primary design criterion of the riparian management zone was to provide the quantity and quality of instream large woody debris that approximates the quantity and quality provided by unmanaged riparian ecosystems. In a managed forest, the amount of large woody debris delivered to a stream from the direct influence zone is principally a function of buffer width and tree heights within the buffer

(Van Sickle and Gregory 1990; McDade et al. 1990). Therefore, in order to satisfy the primary design criterion, the width of the riparian buffer is based on tree height.

In western Washington, the direct influence zone of unmanaged riparian ecosystems typically consists of old-growth conifer forest. These old-growth conifer forests supply strong, large-diameter, long-lasting large woody debris to aquatic ecosystems. Simple geometry shows that instream large woody debris can originate from sites that are up to one tree height from the stream bank (Van Sickle and Gregory 1990). In fact, tree height is one of the main variables used to describe the spatial extent of the direct influence zone. On sites with moderate productivity (site productivity class III), Douglas fir often attain heights exceeding 200 feet. Thus, in a "typical" unmanaged riparian ecosystem, the direct influence zone may extend beyond 200 feet from the stream, and trees within this zone have a potential to become instream large woody debris.

However, the likelihood of falling into the stream is different for every tree and is related to the tree's distance from the stream — the closer a tree is to a stream, the greater the likelihood that it will end up as a log in that stream. The relationship between distance from stream and a tree's likelihood of becoming instream large woody debris is nonlinear. McDade et al. (1990) showed that in old-growth conifer forests, approximately 80 percent of instream large woody debris originates from distances within half an average tree height. The remaining 20 percent of instream large woody debris originates from distances beyond half an average tree height. In the "typical" unmanaged riparian ecosystem, that portion of the direct influence zone within 100 feet of the stream (approximately half an average tree) is critically important for supplying instream large woody debris. Beyond 100 feet, as the distance from the stream increases, the importance of the direct influence zone for contributing large woody debris decreases.

The primary design criterion of the riparian management zone is to provide the quantity and quality of instream large woody debris that approximates that provided by unmanaged riparian ecosystems. Managing the riparian management zone for a natural mix of hardwood and very large diameter conifer trees should provide the same quality of large woody debris as that found in unmanaged ecosystems. In a managed forest, the quantity of instream large woody is determined by the width of the riparian management zone and the amount of timber removed from the riparian management zone.

The width of an unmanaged riparian ecosystem is approximately equal to the site potential height of trees in an old-growth conifer stand. The width of the riparian buffer along Types 1, 2, and 3 waters is based on the site potential height of trees in a mature conifer stand. A mature forest stand is one in which the annual net rate of growth has peaked (Thomas et al. 1993). In general, conifer stands in the Pacific Northwest reach maturity between ages 80 and 100 years (FEMAT 1993; Spies and Franklin 1991). Conifer stands reach the old-growth stage at about 200 years (Spies and Franklin 1988, 1991). The site potential height of trees in a mature forest stand was selected as the basis for the riparian buffer width because Douglas fir and western hemlock, the principal conifer species in DNR-managed forests, obtain 70 to 80 percent of their old-growth height in the first 100 years of growth. Field measurements (McDade et al. 1990) indicate that buffer widths equal to approximately 60 percent of the average tree height will provide 90 percent of the natural level of instream large woody debris. Extrapolating from these results, a buffer width based on the 100-year site potential tree height, which is more than 60 percent of the height of old-growth trees, should provide more than 90 percent of the natural level of instream large woody debris.

Because most DNR-managed forests in riparian ecosystems are currently 60 years old or younger, the definition of tree height must take into account future growth. Site index curves are a practical means to predict future growth. Site index curves are nonlinear regressions of tree height versus breast height age for different site productivities (King 1966; Wiley 1978). The average 50-year site index calculated from DNR's geographic information system database is 106 for the five west-side planning units. Site index curves for Douglas fir (King 1966) and western hemlock predict that a site index of 106 yields a potential height of approximately 150 feet at age 100 years for both species. Based on DNR field data from 1991, the average 50-year site index of DNR-managed forests is 113 for the five west-side planning units. Site index curves for Douglas fir (King 1966) and western hemlock predict that a site index of 113 will yield potential heights of approximately 160 feet at age 100 years for both species.

On the least productive sites, i.e., site productivity class V, the potential heights at age 100 years for Douglas fir and western hemlock are predicted to be 86 feet and 102 feet, respectively. On the most productive sites, i.e., site productivity class I, Douglas fir is predicted to reach a total height at age 100 years of 215 feet, and western hemlock is predicted to reach 205 feet. Because the riparian conservation strategy calls for riparian buffer widths equal to the site potential height of conifers at age 100 or 100 feet, whichever is greater, the implementation of this strategy will result in buffer widths ranging from 100 feet to 215 feet, with an average width of approximately 150 feet to 160 feet.

In the five west-side planning units, Types 4 and 5 waters make up approximately 90 percent (by length) of the stream network on DNR-managed forest lands. Low-order streams (i.e., Types 4 and 5 waters) are the major link between hillslopes and higher order fish-bearing streams (FEMAT 1993; MacDonald and Ritland 1989). Low-order streams provide water, sediment, nutrients, and wood to downstream fish habitat (Swanston 1991; Potts and Anderson 1990; Richardson 1992; Conners and Naiman 1984; Bilby and Bisson 1992). Riparian management zones along all Type 4 and some Type 5 waters are intended to maintain the physical and biological processes that form this linkage.

Type 4 waters range from 2 to 10 feet in width, may not contain significant populations of salmonids, and may be perennial or intermittent (WAC 222-16-010). These small streams are significant because of their influence on downstream water quality (WAC 222-16-010). For the maintenance and restoration of salmonid habitat, current thinking is that Type 4 waters warrant less protection than Types 1, 2, and 3 waters. Under this HCP, a 100-foot-wide riparian buffer is applied to both sides of Type 4 waters. Buffer widths of 100 feet are thought to be effective in maintaining water temperature (Beschta et al. 1987), intercepting sediments (Lynch et al. 1985; Moring 1982), and providing detritus (Erman et al. 1977 as discussed in FEMAT 1993). One hundred feet is approximately 50 percent of the site potential height of old-growth (200-year-old) Douglas fir on a site with the average site productivity of DNR-managed forests. As discussed earlier, according to the results of McDade et al. (1990), the source of 80 percent of instream large woody debris lies within a distance equal to 50 percent of average tree height.

Wind Buffers

The stability and longevity of riparian buffers has been an issue of concern (Steinblums et al. 1984; FEMAT 1993). Windthrow may compromise the intended function of the riparian management zone. A single wind storm could raze entire sections of the riparian buffer, or successive high wind events may, over longer periods, slowly degrade the integrity of the riparian ecosystem. Windthrow is vital to riparian ecosystems — a significant proportion of all instream large woody debris (Murphy and Koski 1989, McDade et al. 1990) is blowdown — but the aerodynamics of the abrupt forest edges which commonly occur between riparian buffers and clearcuts cause more frequent catastrophic windthrow events or accelerated rates of blowdown. Gratowski (1956) measured windthrow along the edges of clearcuts in western Oregon. He reported that most windthrow occurred within 200 feet of the edge between forest and clearcut and was concentrated in first 50 feet. Excluding one extreme case of windthrow beyond 200 feet, Gratowski (1956) found that 77 percent of the blowdown occurred within 100 feet of the edge. Also, Gratowski (1956) observed that the amount of blowdown diminished by one-half for each successive 50 feet from the edge. Gratowski's studies took place only two years post-harvest, and therefore, he could not report on the continuing loss of standing live trees over longer periods of time.

The purpose of the wind buffer is to increase the stability and longevity of the riparian buffer, i.e., to maintain its ecological integrity. There are very few publications on the subject of stable wind buffer design (e.g., Steinblums et al. 1984). While the body of scientific knowledge regarding buffer wind stability is growing (Mobbs and Jones 1995; Sherwood 1993; Rot 1993; Harris 1989), it is currently inadequate for designing a long-term conservation strategy. Thomas et al. (1993) proposed a 100-foot-wide buffer to protect riparian buffers along fishbearing streams from wind and fire, and they did not explicitly propose a buffer to protect riparian buffers along non-fishbearing streams. Their proposal was intended to provide protection until a watershed analysis could be completed that would modify these interim buffer widths according to the characteristics of a given site.

The wind buffer specifications of this HCP should be considered interim. The width of the wind buffer may change as research concerning windthrow in managed forests, especially that conducted in the Olympic Experimental Forest State, finds means of minimizing windthrow. Monitoring the success of wind buffers in maintaining the ecological integrity of the riparian buffer will be an important element of this HCP.

ACTIVITIES IN THE RIPARIAN MANAGEMENT ZONE

In the riparian management zone, forest management activites will be site-specific, i.e., tailored to the physical and biological conditions at a particular site. As previously explained, the width of the riparian buffer is based on site-potential tree height, but because of variations in site-specific conditions, the intensity of forest management in the riparian buffer may vary. It is generally recognized that as the distance between management activities and the active channel margin decreases, the potential for adverse impacts to salmonid habitat increases. With this in mind, the no-harvest, minimal-harvest, and low-harvest areas of the riparian buffer were developed to guide management activities.

The no-harvest area is intended to maintain stream bank integrity by (1) eliminating disturbances to fragile stream banks and (2) protecting the vital contribution of tree roots to stream bank integrity. Root strength of conifers is thought to decline greatly at distances greater than a tree crown radius (FEMAT 1993). Crown radii are mainly a function of stand density and vary widely. Using a simple stand model that assumes maximum stand density, one can show that crown radii of Douglas fir rarely exceed 25 feet. Therefore, within 25 feet of the stream bank, all trees should be retained to achieve the maximum level of soil stabilization provide by root systems.

Buffer widths of 100 feet are thought to be effective in maintaining water temperature (Beschta et al. 1987), intercepting sediment (Lynch et al. 1985; Moring 1982), and providing detritus (Erman et al. 1977 as discussed in FEMAT 1993). The specifications for the minimal-harvest area, which extends to 100 feet from the active channel margin, were based on these research results and recommendations and are intended to maintain natural instream levels of these three key elements of salmonid habitat. The same results and recommendations are the basis for the 100-foot minimum width of the riparian buffer along Type 4 waters.

One hundred feet is approximately 50 percent of the site potential height of old-growth (200-year-old) Douglas fir on a site with the average site productivity of DNR-managed forests. According to the results of McDade et al. (1990), the source of approximately 80 percent of instream large woody debris lies within a distance equal to 50 percent of average tree height. Based on these research results, forest management in the minimal-harvest area should retain most, and at some sites all, of the standing trees (dead or live) to serve as a source of large woody debris.

DNR anticipates that only two types of activities will occur in the minimal-harvest area: ecosystem restoration and selective removal of single trees. The principal conservation objectives of riparian ecosystem restoration will be to achieve a more natural mix of hardwood and conifer species and to enhance the development of old conifer forests. One means of addressing this objective may be to accelerate forest succession through the selective removal of hardwoods (e.g., red alder) and the replanting of conifer species. Another means may be to accelerate tree growth through precommercial or commercial thinning.

The low-harvest area of the riparian buffer (i.e., beyond 100 feet from the active channel margin) is important for contributing large woody debris, intercepting sediment on steep slopes (Broderson 1973), and in some places, maintaining natural levels of stream shading (Steinblums et al. 1984). A process will be developed for assessing site-specific conditions and determining the silvicultural activities that may occur that meet the conservation objective "to maintain or restore the quality of salmonid habitat." For the leeward side of streams where there is no wind buffer, the low-harvest area must serve the additional function of maintaining forest health. Clearcuts change the microclimate of adjacent forest stands (Chen et al. 1995). These changes may exert a physiological stress on trees that may result in their increased susceptibility to pests and diseases. To maintain the ecological integrity of the riparian ecosystem, the low-harvest area will be managed to mitigate microclimatic changes in the minimal- and no-harvest areas.

Yarding through the riparian management zone creates a break in the vegetation and disturbs stream banks. This could lead to short-term increases in water temperature and sediment. However, road construction results in long-term increases in water temperature, sediment, and alteration of basin hydrology. Therefore, in general, yarding logs through riparian areas is less damaging to aquatic resources than new road construction.

UNSTABLE HILLSLOPES AND ROADS

A clearcut on an unstable slope increases the likelihood of landslides (Swanson and Dyrness 1975; Swanson et al. 1987). Landslides resulting from timber harvest are considered a significant source of sediment input into streams (Wu and Swanston 1980; Chesney 1982; Everest et al. 1987; Sidle 1985). In the Pacific Northwest, roads appear to cause more landslides than does clearcutting; however, this pattern varies substantially among areas (Sidle et al. 1985) and seems to be highly dependent on watershed characteristics (Duncan and Ward 1985).

Typically, landsliding occurs where soil pore water pressure increases to a degree that the friction between soil particles is inadequate to bind them together and the soil consequently slides downslope under the force of gravity. Timber harvest affects the local soil pore water pressure in at least two ways until the new trees reach hydrologic maturity. First, transpiration decreases following tree removal. Decreased transpiration increases soil moisture, thus increasing the risk of slope failure. Second, because the forest canopy intercepts precipitation, the amount of precipitation reaching the forest floor per unit time increases after harvest, and this too causes an increase in soil moisture. Also, tree harvest ultimately results in the decay of tree roots. Living tree roots add strength to the soil, but as roots of harvested trees decay, this strength is lost, and the likelihood of landsliding increases until new root systems are established.

Roads in upland areas have significant detrimental impacts on salmonid habitat. Only rarely can roads be built that have no negative effects on streams (Furniss et al. 1991). Roads are a major source of management-related sedimentation in streams (Cederholm and Reid 1987). The contribution of sediment per unit area from roads is often greater than that from all land management activities combined (Furniss et al. 1991). In northern coastal California, haul roads and tractor skids were found to alter the drainage network and sediment yield of water basins (Swanson et al. 1987). Cederholm et al. (1981) reported a significant positive correlation between fine sediment in spawning gravels and the percentage of basin area with roads. Forest roads can increase the incidence of mass soil movements (i.e., landslides) by 30 to 300 times as compared to undisturbed forests (Furniss et al. 1991).

HYDROLOGIC MATURITY IN THE RAIN-ON-SNOW ZONE

The strategy for managing the amount of hydrologically mature forest is intended to prevent damage to salmonid habitat during peak flows associated with rain-on-snow events. (See Section C of Chapter III titled Salmonids and the Riparian Ecosystem.) The strategy follows the principles used to develop the 1991 emergency state Forest Practices rule on rain on snow.

A subbasin in western Washington that is completely within the significant rain-on-snow zone is estimated to yield an additional inch of water during a 10-year 24-hour rain-on-snow event if one-third of the subbasin is in a hydrologically immature condition. The implicit assumption used to develop WAC 222-16-046 is that peak flows caused by the addition of more than 1 inch of water to the amount accumulated in a 10-year 24-hour storm, i.e., a storm of moderate intensity, present an unacceptable level of risk to public resources.

The appropriate size of the drainage basin for the hydrologically mature forest prescription was based on guidelines in the hydrology module of watershed analysis (WFPB 1994) and their current application by hydrologic analysts. In watershed analysis, increases of peak flow greater than

10 percent may adversely affects public resources. Also, it is generally recognized that the precision of flow measurements is on the order of 10 cubic feet per second. Therefore, 100 cubic feet per second (a 10 percent change of 100 cubic feet per second equals 10 cubic feet per second) seems to be a reasonable level of peak flow from which to derive the appropriate drainage basin size. Bankfull discharge is a geomorphologically effective discharge that causes long-term channel erosion and sediment transport (especially bedload movement). A regression equation relating bankfull discharge to drainage basin area for the Puget Lowland and western Cascades (Frederick and Pitlick 1975, and Parson 1976 as discussed in Dunne and Leopold 1978 p. 616-617) shows that approximately 100 cubic feet per second of bankfull flow can be generated by a drainage basin having an area of approximately 1,220 acres.

In addition, a poll of watershed analysis reports shows that most hydrologic analysis units (defined through the watershed analysis process to calculate peak flows) are greater than 900 acres. In a few instances, the hydrologic analysis units are as small as 350 acres, but these are fragment areas between basins of significant creeks. Most hydrologic analysts involved in watershed analysis delineate hydrologic analysis units that are 1,000 acres or more.

In some 1,000-acre or larger drainage basins there will be little risk of material damage to salmonid habitat during rain-on-snow floods. For example, as discussed previously, in basins with less than one-third of the area in the significant rain-on-snow zone, the estimated additional yield caused by rain-on-snow during a 10-year 24-hour storm is less than 1 inch. For similar reasons, in basins with at least two-thirds of the area in the significant rain-on-snow zone covered by hydrologically mature forests that are reasonably assured of remaining in that condition (e.g., forests in National Parks or National Forest Late successional Reserves), there is little risk of material damage to salmonid habitat. In some basins, because of ownership patterns, DNR's management will not significantly decrease the risk of material damage. Consider a basin with exactly half of its area in the significant rain-on-snow zone under DNR management. If other landowners did not manage for hydrologically mature forest and DNR maintained two-thirds of its forest lands in a hydrologically mature condition, then only one-third of the area in the significant rain-on-snow zone would be hydrologically mature forest. During a 10-year 24-hour rain-on-snow event, the estimated additional yield of water due to the hydrologically immature area would be 2 inches. DNR management in this case would not significantly decrease the risk of material damage because a 2 inch additional yield would likely cause material damage to salmonid habitat.

WETLANDS PROTECTION

In many watersheds, wetlands have a profound influence on hydrology and water quality. The conservation strategy for wetlands is intended to maintain the wetland functions of moderating stream flows and enhancing water quality.

Through the process of evapotranspiration, plants move water from the ground to the atmosphere. Evapotranspiration affects water table and soil moisture levels, and consequently timber harvest in and around a wetland can affect the hydrologic regime of the wetland. The principal organs of evapotranspiration are leaves, and a minimum leaf area per acre is necessary to maintain the hydrologic regime of a forested wetland. Leaf area is measured by leaf area index, and a leaf area index of 30 should maintain at least 95 percent of the potential evapotranspiration in a forest stand (U.S. Environmental Protection Agency 1980). Through an allometric relationship, stand basal area may be used as a surrogate for leaf area index (USEPA 1980). A basal area of 120 square feet per acre corresponds to a leaf area index of 30 (USEPA 1980).

Because of the wet soils and shallow tree rooting typical of forested wetlands, trees in such areas are more susceptible to windthrow. The harvest of trees from areas in and around wetlands often results in even wetter soils and a consequent increase in the potential for windthrow. Furthermore, after harvest, the lower stem density of the residual stand provides less shelter from strong winds. The cumulative effects of harvest on the hydrologic regime of the wetland continue through time as trees are lost through windthrow. Therefore, it is important that trees left after harvest be among the most wind-firm in the forest stand.

Effects of the Riparian Conservation Strategy on Salmonid Habitat

Many factors, both human-caused (fisheries management, hydropower dams, agriculture, and municipal development) and natural (El Niño), affect salmonid populations, and these are beyond the control of DNR. The role that DNR, or any forest manager, has in the fate of a particular salmonid population is difficult to gauge, but the effects that a forest manager has on the quality of salmonid freshwater habitat can be shown. Therefore, salmonid freshwater habitat will be used as a proxy to evaluate the effects of the riparian conservation strategy on salmonids.

The forest management described in the riparian conservation strategy will result in improved salmonid habitat on DNR-managed lands. The improvement will occur as:

(1) deciduous and young conifer forests within riparian ecosystems develop into older conifer forests;

(2) young forests on unstable hillslopes develop greater root strength and reach full hydrologic maturity; and

(3) the adverse impacts of roads are reduced through comprehensive landscape-based road network management.

Prescriptions for the significant rain-on-snow zone and wetlands should minimize the potential adverse impacts of forest management on winter peak-flows and summer low-flows.

At present, 49 percent of forests in riparian buffers of the riparian management zone are even-aged conifer forest younger than 60 years old, 25 percent are deciduous forest, and 26 percent are conifer forest older than 60 years. Much of the riparian deciduous forest on DNR-managed lands developed naturally following timber harvesting. Therefore, as a result of forest management, more than half of the riparian ecosystems on DNR-managed lands do not contain the large conifer trees essential for providing instream large woody debris, which is one of the most important elements of salmonid habitat. Also, in some harvest units, the current riparian management zones along Types 3 and 4 waters may not be adequate to maintain stream bank integrity and natural levels of stream shading, sediment load, and detrital nutrient load.

Under this HCP, the riparian buffer will be managed to maintain or restore salmonid habitat. Given this conservation objective, the no-harvest and minimal-harvest areas of the buffer are anticipated to develop into forest with old-growth characteristics, i.e., large old trees, multilayered canopy, and numerous snags and logs. The low-harvest area will be managed according to the same conservation objective, but its distance from water may permit more harvest, and therefore it is anticipated that in most instances the low-harvest area will eventually have a range of uneven-aged mature forest characteristics. The low-harvest area is intended to provide some large woody debris to the aquatic and riparian zones, and therefore, large trees will be retained for this purpose. The width of the riparian buffer and the management within it should be adequate to maintain stream bank integrity and natural levels of stream shading, sediment load, and detrital nutrient load.

At present, DNR has no standard practices for the protection of riparian management zones from windthrow. Under the HCP, the ecological integrity of the riparian buffer, and the salmonid habitat contained therein, will be protected by wind buffers. Management within the wind buffers will be largely experimental, and therefore, the forest conditions within the wind buffer cannot be accurately predicted.

Unstable hillslopes are estimated to occupy an additional 5 to 10 percent of DNR-managed lands outside the riparian management zone. At present, 30 percent of these areas are in even-aged conifer forests younger than 40 years old, 13 percent are in deciduous forest, and 47 percent are in older conifer forest. Under this HCP, harvest in these areas and other areas identified as having a high risk of mass wasting will be deferred until it can be demonstrated that such activity can be accomplished without increasing the frequency or severity of slope failure. As the forests in these areas develop, the frequency of mass-wasting events on DNR-managed lands should decrease.

Roads have been proven to cause significant adverse impacts to salmonid habitat. Under this HCP, the road network will improve, but improvements are anticipated to occur gradually because of the tremendous costs. DNR has already begun a shift toward more ecologically sensitive road management, and the incorporation of road network management into the riparian conservation strategy demonstrates DNR's commitment to a continual improvement of the road network.

Road network management will be at a landscape level. Road inventories, routing, cumulative effects analysis, and the prioritization of construction, maintenance, and decommissioning will consider an entire landscape. Road network management will consider multiple-use objectives and constraints, identify road uses and users, establish a long-term planning horizon, and maintain a timeline for each road, from construction to periodic maintenance and eventual decommissioning.

The riparian conservation strategy should result in high quality salmonid habitat in the fishbearing waters on DNR-managed lands. Nevertheless, during the term of this HCP, adverse impacts to salmonid habitat will continue to occur because past forest practices have left a legacy of degraded riparian ecosystems, deforested unstable hillslopes, and a poorly planned and maintained road network. The frequency and severity of these adverse impacts will decrease as forests develop and the road network improves. The riparian conservation strategy, which includes active restoration of some riparian ecosystems and improvements to the road network, will serve to minimize and mitigate the adverse impacts of past management.

Forest management entails a myriad of activities, and many of these can have an adverse impact on salmonid habitat. Timber harvesting, road building, road use, site preparation, herbicide application, mineral extraction, power line rights-of-way, fire control, and other lawful forest management activities will continue to occur and may have an adverse impact on salmonid habitat. In addition, during the first 10 years of this HCP, Type 5 waters not associated with unstable slopes will be protected only "when necessary for water quality, fisheries habitat, stream banks, wildlife, and other important elements of the aquatic system" (DNR 1992 p. 35). However, the riparian management zone along Types 1, 2, 3, and 4 waters will minimize the adverse impacts of timber harvesting, site preparation, and herbicide application on salmonid habitat. Logs may still be yarded across streams and roads built over streams, but the impacts from these activities will be infrequent and localized. Changes in drainage basin forest cover will continue to affect the water available for runoff and water yields, but the components of the riparian strategy addressing management in the significant rain-on-snow zone and wetlands should minimize and mitigate these adverse impacts.

Some components of the riparian conservation strategy require on-site management decisions, and adverse impacts to salmonid habitat may occur inadvertently. For example, timber harvesting in the riparian buffer must "maintain or restore salmonid habitat", but, at present, the amount of timber harvesting in riparian ecosystems compatible with high quality salmonid habitat is unknown. In the early stages of this HCP, the amount of timber harvested from the riparian buffer or the methods used for its extraction may harm salmonid habitat. The same can be said for the management of the wind buffer or harvest on unstable slopes. Through research, monitoring, and systematic application of the knowledge gained, adverse impacts should decrease in frequency and severity.

E. Olympic Experimental State Forest Planning Unit

Integrated Approach to Production and Conservation

UNZONED FOREST

As discussed in the section in Chapter I titled Why the Olympic Experimental State Forest [the OESF or the Experimental Forest] is Unique, the goal of the OESF is to learn how to integrate production and conservation across the landscape. To achieve this goal, the northern spotted owl conservation strategy in the Experimental Forest is based on an "unzoned forest" concept, i.e., a forest in which no special zones are set aside exclusively for either species conservation or commodity production. The intent is to have a forest that includes a full range of forest conditions in order to ensure that trust revenues are produced, quality timber is available for harvest, and native species have sufficient habitat. In this approach, harvestable timber and habitat for northern spotted owl, marbled murrelet, and salmon become outputs of a well-managed, unzoned forest.

The goal of maintaining an unzoned forest will guide management activities and research. In the context of long-term forest management, the unzoned approach will define desired outcomes of activities conducted on the landscape. One desired outcome, for example, is the eventual development of older stands that are well distributed throughout the OESF as part of the forest mix. The unzoned forest is an experimental approach, which is why research, monitoring, and systematic application of the knowledge gained will be so important.

However, the distinction between zoned and unzoned is not absolute, because there is a physical and biological zonation in forest landscapes that must be respected and that links directly to the processes and functions the OESF seeks to understand. The riparian areas, which provide the foundation for the conservation strategies, will be treated almost like "zones", because they are linked to relatively fixed physical features on the landscape. However, these riparian management areas will be tailored to the unique characteristics of each stream in the landscape, and research and experimentation will help managers determine what type and degree of resource use can be allowed within these areas. Thus over time, the riparian management zones may begin to blend more with adjacent areas, although this will not be expected to occur until well into the future.

Within this general approach, several conservation objectives can be identified for the Experimental Forest conservation strategies:

(1) To protect, maintain, and aid natural restoration of riparian systems on DNR-managed lands in the OESF, while promoting a long-term integration of resource use and conservation.

(2) To rely on the riparian strategy to provide the physical and biological foundation around which management activities and upland conservation strategies are constructed, recognizing the vital role of watersheds in supporting the web of life.

(3) To look to natural disturbance regimes for the keys to understanding how to achieve restoration and maintenance of natural systems.

(4) To learn to integrate older forest ecosystem values and their functions with commercial forest activities assuming, as a working hypothesis, that landscapes managed for a fairly even apportionment of forest cover among stands in all stages of development, from stand initiation to old growth (Oliver and Larson 1990) will support desirable levels of both commodities and ecosystem functions.

(5) To consider the spatial arrangement of habitat and other conservation values being provided on federal lands when developing habitat within the Experimental Forest.

(6) To fill critical information gaps related to aquatic, riparian, and upland ecosystems and the links between these and forest management activities in order to enhance DNR's decisions and check assumptions behind management strategies and techniques.

MANAGEMENT PROCESSES

The unzoned forest approach complements the OESF management objectives, which include integrating production and conservation. For effective implementation of this integration and of the experimental approach to conservation, six processes are recommended as part of the Experimental Forest management approach:

(1) research and monitoring,

(2) planning from a landscape perspective,

(3) silvicultural techniques that integrate production and conservation,

(4) systematic application of knowledge gained,

(5) efficient information management, and

(6) effective communication.

Research and Monitoring

For an experiment on the scale being attempted in the OESF, carefully planned, focused information-gathering activities and information-management infrastructure are essential. A broad range of formal research, case studies, and monitoring of operations and conditions are included under the heading of research and monitoring. Information-gathering activities carried out in the Experimental Forest, including activities traditionally described as "management experiments", "operational trials", "field evaluations", "case studies", and "demonstrations", will be part of the research and monitoring activities. (See the sections titled Monitoring and Research in Chapter V.)

The following five objectives underlie the research and monitoring component of the OESF:

(1) Acquire new information that will allow DNR managers to (a) meet trust obligations through timber production, (b) conserve and protect public resources (e.g., wildlife, fish, water), and (c) ensure the long-term health and productivity of the forest ecosystem.

(2) Monitor implementation of the HCP and evaluate the effectiveness of activities in meeting the Experimental Forest objectives.

(3) Ensure that information-gathering activities are carried out in a scientifically credible manner, allowing confident use of results in management decisions.

(4) Ensure that information-gathering activities are well coordinated and that the results of different investigations are integrated to achieve OESF objectives.

(5) Ensure that new information is rapidly incorporated into management of the Experimental Forest and, as appropriate, other DNR-managed lands.

Two categories of research and monitoring will occur within the OESF:

(1) research and monitoring required for HCP compliance with the Endangered Species Act; and

(2) information gathering and analysis required to investigate hypotheses and acquire new knowledge needed to accomplish the mission of the Experimental Forest. To the greatest extent possible, research and monitoring conducted in the first category will contribute directly to the information needs in the second category. It is the second category that directly supports the needs of the OESF and provides the scientific foundation for systematically applying new knowledge to managing the forest. (See also the sections in Chapter V titled Monitoring and Research.)

Landscape-level Planning

Planning from a landscape perspective will be the initial basis for integrating production and conservation in the Experimental Forest, moving from current landscape-level patterns to different patterns at specific points in the future. This is consistent with the emphasis on cumulative effects that landscape planning allows. Activities and the resulting landscape-level conditions can be projected and evaluated across space and time to ensure the forest condition is moving in the desired direction through a dynamic process.

DNR's Olympic Region has set preliminary boundaries related to watersheds for landscape planning throughout the region. Eleven of these landscapes lie within the OESF. (See Map IV.9.) Most of the landscapes range in size from 10,000 to 30,000 acres; the largest is 56,000 acres (Upper Clearwater). Boundaries may be adjusted over time during implementation of this plan. It will take time and funding to conduct landscape planning in these landscapes.

Silviculture as an Integration Tool

One of the underlying hypotheses of integrating production and conservation in the Experimental Forest is that it is possible to produce quality commercial timber and provide and protect ecological values in a managed forest by maintaining an arrangement of forest structure and stand diversity. Through silviculture, a forester works in harmony with natural forest growth to achieve desired structural outcomes, whether for habitat, production, or some other objective.

Forest stands have an arrangement or structure that is three dimensional. On the horizontal plane, various configurations and sizes of open and closed spaces, trees, and other species are all part of structure. Vertically, the quantity of vegetation layers from ground to the upper forest stand canopy is also a part of the stand structure. Configurations of structure are a result of disturbance, either natural or human-caused action. But forests are also dynamic and changing as individual trees grow, die, and are replaced and are commonly described as having four basic stages or structures:

(1) stand initiation, an open condition with new regeneration (also called "open");

(2) stem-exclusion, with tree competition and mortality (also called "closed");

(3) understory reinitiation, with undergrowth development and some tree regeneration (also called "understory"); and

(4) old growth.

A transitional structure (sometimes called "layered") is also sometimes recognized when second growth is being manipulated to create old-growth features and there is greater structural diversity than understory and somewhat less than classic old growth. Silviculture in the OESF is a means to manipulate and produce a variety of possible stand structures based on specific objectives.

Silvicultural techniques are applied at the stand level. However, the results are expressed at both stand and landscape levels. Because of this, silviculture is linked closely with the landscape planning process and is one of the tools essential for integrating production and conservation. A landscape, in an ecological sense, is a large area that is composed of various interacting patterns of stand structure and function going through alterations over time. Natural events, such as the 1921 windstorm on the Olympic Peninsula, can have tremendous effects through the years, altering large areas. Pattern size, patch isolation or connectivity, and edge contrast have profound effects on wildlife and implications for forest utilization planning (Diaz and Apostol 1992). Within this variability however, influencing patterns across the landscape can be planned. Activities that emphasize both commodity production and ecological function can be designed at the stand level with attention to what is retained as well as what is removed and at the landscape level with attention to the arrangements of structures to be developed in and across multiple stands to meet desired patterns. Simulated outcomes of these silvicultural operations across landscapes based on today's ecological conditions can provide glimpses of the future forest. This will provide direction for stand-level prescriptions to meet the desired long-term landscape condition. (See also Section H of this chapter titled Forest Land Management Activities.)

Systematic Application of Knowledge Gained

Integration of new knowledge is to be a scientific, information-based process in the Experimental Forest. In a generic sense, a prudent manager monitors the results of management activities and then adapts future actions based on what has been learned from those results. However, systematic application of knowledge gained has a more focused approach. The basic task is to define a program of experiments that can, over the course of the planning horizon, identify or verify potential avenues for successfully meeting targets for commodity production and ecosystem conservation within the unzoned forest context. The assumptions and hypotheses will be tested through implementation, intentional testing and learning, and making adjustments as activities are conducted and feedback loops provide new information. Such intentional learning should increase the potential benefits of an experimental approach and allow managers to make decisions with greater confidence. The scientifically credible basis for decisions and actions should reduce the risk to the trusts of taking an experimental approach to managing the forest.

Information Management

Information management is used in its broadest sense to include the full scope of computerized and non-computerized information flow. It is in this realm that the research and monitoring activities link directly with the communication and education activities and with operations and decision-making.

Communication Outreach

While research and monitoring focus on acquiring and applying new information, communication and education focus on sharing this new information with trust-land managers and others in a variety of ways, with an emphasis on two-way discussion and learning. Communication can be grouped into five categories: (1) public information, (2) research communications support, (3) technical information exchange, (4) public involvement, and (5) education. A basic premise of the OESF is that by sharing, brainstorming, and working creatively with emerging information, new possibilities and techniques can be discovered for achieving production and conservation goals and can contribute to resolving forest management issues for the trusts and the state.

Experimental Forest communication should be more than a casual sharing of information. The expectations are to identify needs or common goals and work toward them. The communication and education effort envisioned for the OESF will be put into place over time as funding allows. The vision for these efforts can be described as follows:

> Dynamic exchange of ideas internal and external to DNR will contribute to effective problem solving and creative management of the OESF, helping achieve the purpose behind creating the Experimental Forest: to benefit the trusts by integrating production and conservation across the landscape.
>
> Internal mechanisms for effective management response and adaptation to new knowledge will be highly visible and functional, serving the interests of the trusts and providing a well-respected and internationally recognized model for businesses and other government agencies for applying new learning to management.
>
> The Experimental Forest will become a world-renowned site for ecological, forest management, and harvest technology research in a commercially viable forest and for adult and youth education programs built around this emerging knowledge.
>
> Researchers, tourists, recreating visitors, and college and K-12 students will come from throughout the country and around the world to participate in these programs. Laboratories, convention and classroom facilities, trail systems, and field sites will support a broad range of study and research activities. Recreational and tourist activities will link closely with the research and education programs through a joint partnership with peninsula communities and travel organizations.
>
> Modern communication technology will link the activity centers with computer databases and satellite telecommunication networks and provide interactive education experiences.

Partnerships with research and educational organizations throughout the state, nation, and world will help support these programs. Partnerships, participant fees, and external grants will strengthen the core financial base provided by DNR's management account and the state general fund.

SUMMARY

The Experimental Forest conservation strategies are based on current knowledge and are expressed as hypotheses to be tested experimentally. However, DNR recognizes that current knowledge can not answer all the questions about how to achieve integration of conservation and production effectively and economically. Research and monitoring will focus on answering these questions in the OESF. As new information and understanding emerge, feedback loops will allow DNR to apply this knowledge, adjusting management activities and techniques and revising assumptions and hypotheses. This process of intentional learning and systematic application to management should be supported through focused communications and education activities, which can help facilitate discussion, evaluation, problem solving, and decision making that are important parts of the internal and external feedback loops.

Because the Experimental Forest has a special mission of learning how to integrate timber production and habitat conservation across the landscape, the spotted owl, riparian, and multispecies conservation strategies for the OESF Planning Unit are unique, with more emphasis than in the other planning units on experimentation, research, monitoring, and systematic application of new knowledge. The interim conservation strategy for the marbled murrelet is the same as for the five west-side planning units. (See Section B of this chapter.) The conservation strategy for other listed species is the same as for all planning units. (See Section C of this chapter.)

Conservation Strategy for the Northern Spotted Owl in the Olympic Experimental State Forest

INTRODUCTION

The strategy proposed for conservation of the northern spotted owl on DNR-managed lands in the Olympic Experimental State Forest is unique because of the physical and biological conditions and land ownership of the area and because of the experimental approach to integrated management for forest commodity and ecosystem values that is the mission of the OESF. This strategy proposes objectives for restoring a level of habitat capable of supporting spotted owls on DNR-managed lands in the Experimental Forest rather than prescribing forest management activities for those lands. Management to achieve these objectives will be adaptive — that is, it will develop and test a variety of methods to integrate spotted owl habitat and commercial forest management and will apply those methods that are most effective and efficient.

CONSERVATION OBJECTIVES

The objectives for spotted owl conservation on DNR-managed lands in the OESF reflect both the requirements of the Endangered Species Act for approvable habitat conservation plans and the mission of the Experimental Forest. Those conservation objectives are to:

(1) Develop and implement land-management plans that do not appreciably reduce the chances for the survival and recovery of the northern spotted owl sub-population on the Olympic Peninsula.

(2) Develop, implement, test, and refine management techniques for forest stands that integrate older forest ecosystem values — including the stands' functioning as dispersal, foraging, roosting, and nesting habitat for spotted owls — with commercial objectives for those stands.

(3) Develop, implement, test, and refine landscape-level forest management techniques that support a wide range of forest ecosystem values in commercial forests, including their occupancy by successfully reproducing spotted owls that are a functional segment of the Olympic Peninsula sub-population.

The latter two of these conservation objectives may also be thought of as expressions of the primary working hypothesis of the OESF: that DNR can discover and implement forest management practices at the stand and landscape levels that allow for greater integration of natural resource commodity production and ecosystem support than is provided by current practices.

CONSERVATION STRATEGY

The conservation strategy proposes to achieve the objectives listed above, proposes to learn how to achieve these objectives in the most effective and efficient manner, and seeks to avoid explicit, long-term prescriptions for forest management. This is consistent with the OESF management process of systematically applying knowledge gained from research. However, it is necessary, both for evaluation of the strategy and application of new knowledge, to propose managing toward some explicitly stated conditions. These should be considered expressions of hypotheses based on current knowledge and conditions relevant to spotted owl conservation in the Experimental Forest, and they should be expected to change with further knowledge or changing conditions.

The strategy of conserving spotted owls by restoring habitat capability is proposed as a working hypothesis regarding the necessary quality, quantity, and distribution of potential habitat, accompanied by an approach for managing toward those conditions. The strategy is to be implemented in two phases, one of habitat restoration followed by one of maintaining and enhancing a mosaic of habitat that shifts over time as guided by analyses and plans for individual landscape planning units.

Integrating Forest Management and Spotted Owl Conservation: A Working Hypothesis

Management for desired owl habitat conditions will be planned and implemented at the scale of landscape planning units. As discussed earlier in the subsection titled Integrated Approach to Production and Conservation, landscape planning units are watershed-based and contain between 10,000 and 56,000 acres of DNR-managed lands. The objectives of landscape-level management are directed at developing landscapes that produce a mix of commercial products and ecosystem outputs across the entire OESF. Spotted owl conservation will primarily be derived from the integrated, ecosystem-oriented management, rather than direct the management.

A principal working hypothesis of the OESF is that landscapes managed for a fairly even apportionment of forest cover among stands in all stages of development, from stand initiation to old growth (Oliver and Larson 1990), will support desirable outputs of both commodities and ecosystem functions. Mid-aged and older forest stands in the stem-exclusion to old-growth stages support a broad range of commodity and ecosystem functions, including that of spotted owl habitat.

On the basis of current understanding of the responses of spotted owls to forest stands and landscapes (Horton in press), an approach to the integrated management of the Experimental Forest for timber production and spotted owl habitat is proposed. This approach can be stated and implemented as a working hypothesis for evaluation and systematic application and refinement: DNR can meet its objectives for commodity production and spotted owl conservation in the OESF by managing each landscape planning unit to maintain or restore threshold proportions of potential habitat. Those proportions are:

(1) at least 20 percent of DNR-managed lands in the landscape planning unit in the understory-reinitiation to old-growth stages that are potential old-forest habitat (after Hanson et al. 1993); and

(2) at least 40 percent of DNR-managed lands in the landscape planning unit in the stem-exclusion to old-growth stages that are potential old-forest, sub-mature, or young- forest marginal spotted owl habitat types (Hanson et al. 1993), including any old-forest habitat described in (1) above.

The threshold levels for habitat quality and proportion were selected because:

(1) There is substantial concurrence that 30-50 percent habitat at spatial scales from spotted owl ranges to landscapes can support reproductive owl pairs (e.g., Forsman and Meslow 1985; Bart and Forsman 1992; Carey et al. 1992; Lehmkuhl and Raphael 1993; Holthausen et al. 1994; Bart 1995).

(2) A conservation objective of the OESF is to support old-forest ecosystem functions, including that of spotted owl habitat, partly through providing a shifting mosaic of stands that are managed to retain or develop structural complexity. Some of the spotted owl habitat in the Experimental Forest is expected to be provided by these managed stands. There is considerable support among ecologists and silviculturalists that such techniques can be effective (e.g., USDI 1992, Appendix F; Franklin 1992).

(3) There is some uncertainty as to the ability of landscapes devoid of older forests to support successfully reproducing spotted owls. The hypothesized threshold amount of old-forest habitat is based on observations of significantly greater occupancy and productivity by owls in areas with greater than 20 percent cover of older forest than in those with less (Bart and Forsman 1992).

(4) A primary, overall goal of the OESF is integrated management for forest commodities and ecosystem functions. The proposed threshold proportions of spotted owl habitat are at the low end of the range of observed values in order to allow managers and researchers the greatest flexibility in arriving at effective and efficient solutions, but they are consistent with the recommendations of the U.S. Fish and Wildlife Service and Bart's (1995) conclusions as to the proportion of suitable habitat necessary to maintain site or population stability.

The currently proposed threshold proportions of potential spotted owl habitat are not intended to be targets for management; rather, they are minimum standards that reflect the current understanding of forest-ecosystem processes. The quantity and quality of potential spotted owl habitat will ultimately vary among landscape planning units with their physical and biological conditions and other management objectives for commodities and experimentation.

Current Conditions in the OESF

Forest cover on 58 percent of DNR-managed lands in the Experimental Forest is dominated by young stands that have regenerated following timber harvesting during the past 30 years. Structure and composition, not age, best predict the capability of forest stands as spotted owl habitat. However, stand age is correlated with structure and composition and provides a simple estimate of the area of the OESF currently in stands that are potential owl habitat. DNR's inventory (DNR GIS April 1995) shows that 19 percent of the Experimental Forest is in stands over 100 years old; most of these fit the Hanson et al. (1993) description of old-forest habitat. An additional 11 percent of the OESF is covered by stands 51-100 years old (including stands originating from a major 1921 windstorm); many of these stands fit the Hanson et al. (1993) description of young-forest marginal or sub-mature habitat.

An estimate of forest structure and composition (WDFW 1994) using satellite imagery obtained in 1991 generally concurs with the DNR inventory-based estimates for old-forest habitat (18 percent cover of old-growth and large sawtimber) and for sub-mature and young-forest marginal habitat (14 percent cover of small sawtimber). The Washington Department of Fish and Wildlife (1994) estimate of 32 percent total potential spotted owl habitat exceeds the DNR GIS (April 1995) estimate of 30 percent probably for two reasons: some harvesting of potential habitat has occurred in the four years since the satellite images were acquired; and the Washington Department of Fish and Wildlife (1994) estimates based on structure and composition appear to assign some stands to more highly structured categories at ages younger than those used to subdivide the DNR inventory, e.g., some 60-year-old stands were classified as large sawtimber, some 35-year-old stands as small sawtimber.

Both the age-based (DNR GIS April 1995) and structure-based (WDFW 1994) estimates of habitat probably overestimate the amount of younger forest habitat types. Field assessments by Washington Department of Fish and Wildlife and DNR biologists frequently categorize younger, simply structured stands of small sawtimber as not potential spotted owl habitat. By any measure, current amounts and distribution of potential spotted owl habitat across the OESF are decidedly sub-threshold.

Amounts of potential owl habitat vary widely among the 11 landscape planning units (Map IV.9). DNR's inventory estimates from 3 to 30 percent cover of stands more than 100 years old (potential old-forest habitat), 7 to 35 percent cover of stands more than 70 years old (potential old-forest and sub-mature habitat), and 12 to 57 percent cover of stands more than 50 years old (potential old-forest, sub-mature, and young-forest marginal habitat). See Table IV.6. These estimates of the abundance of potential habitat based on stand age are not perfect. For example, some stands not much older than 100 years would be classified as sub-mature habitat based on their structure and composition, just as some 75-year-old stands with a substantial component of older trees would be classified as old-forest habitat. But it is likely that estimates of the abundance of old-forest habitat are relatively unbiased, that is, some stands estimated to be old-forest habitat are really sub-mature and some stands estimated to be sub-mature are really old-forest. Similarly, estimates of the abundance of sub-mature habitat are likely to be relatively unbiased. However, the abundance of young-forest marginal habitat is likely overestimated based on the abundance of stands currently over 50 years old. The structure and composition of some of these

Table IV.6: Two estimates of the current abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest

Landscape planning unit[1]	Acres		Estimated stand condition on DNR-managed land[2] (percent)			
	All ownerships	DNR-managed	Old forest[3] Inv./TM	Sub-mature[4,6] Inv./TM	Y-f marg[5,6] Inv./TM	Non-hab[7] Inv./TM
Sekiu	109,260	10,620	3/9	4/15	5/15	88/76
Clallam	79,470	18,374	3/14	32/21	16/21	51/65
Dickodochtedor	111,442	27,842	14/14	16/12	1/12	69/72
Sol Duc	84,035	18,465	5/23	18/22	33/22	45/45
Reade Hill	15,809	8,898	27/27	11/19	0/19	64/54
Goodman	66,251	24,639	21/18	6/11	0/11	75/71
Willy/Huel	51,965	38,963	22/23	3/14	2/14	73/63
Kalaloch	54,420	18,492	18/13	3/12	1/12	81/75
Clearwater	58,329	57,073	30/25	0/11	0/11	73/64
Coppermine	44,244	19,904	16/16	3/13	0/13	83/71
Queets	34,329	22,295	23/16	5/12	2/12	72/72

[1]See Map IV. 9 for location of landscape planning units.

[2]The percentage of DNR-managed land estimated to meet definitions of spotted owl habitat (Hanson et al. 1993) in each landscape planning unit. Two methods of estimation were used: DNR's stand inventory (DNR GIS 1995), column sub-heading "Inv."; and supervised classification of Landsat Thematic Mapper scenes taken July 1991 (WDFW 1994), column sub-heading "TM".

[3]Old forest = stands with origin dates estimated or measured as 1894 or older (Inv.), or old-growth and large-saw cover as estimated by supervised classification of Landsat Thematic Mapper (TM).

[4]Sub-mature= stands with origin dates estimated or measured as 1895-1924 (Inv.), or small-saw cover as estimated by supervised classification of Landsat Thematic Mapper scenes (TM).

[5]Y-f. marg = young-forest marginal habitat. Stands with origin dates estimated or measured as 1925-1945 (Inv.), or small-saw cover as estimated by supervised classification of Landsat Thematic Mapper scenes (TM).

[6]The same TM estimate of small saw is shown in both sub-mature and young-forest marginal columns because TM estimates of small sawtimber probably encompass both sub-mature and young-forest marginal habitat types. This estimate should be counted only once when totaling amounts of habitat by landscape planning unit.

[7]Non-hab = not suitable for habitat. Stands with origin dates estimated or measured as 1946-1995 (Inv.), or pole, sapling, and open-cover classes as estimated by supervised classification of Landsat Thematic Mapper scenes (TM).

stands are such that they would offer too few opportunities for foraging and roosting to be classified as young-forest marginal habitat. It is likely that the current abundance of young-forest marginal habitat is some proportion of the abundance of forest stands between 51 and 70 years of age and that proportion varies among landscape planning units with stand-level and landscape-level features that are unique within landscapes. Currently, potential spotted owl habitat[1] probably does not constitute much more than 40 percent of any landscape planning unit, although old-forest habitat appears to be at or above the 20 percent threshold in several landscape planning units (Table IV.6).

Management During the Restoration Phase

Spatially explicit forest growth models predict that all landscape planning units within the Experimental Forest will meet or exceed the 40 percent threshold for total old- and young-forest spotted owl habitat types in 40 to 60 years. These models demonstrate that time until restoration depends on natural and silviculturally aided successional processes in the abundant young stands and is independent of the level of retention of existing habitat (Table IV.7). This 40- to 60-year period during which existing young stands are developing the characteristics of young-forest marginal and sub-mature habitat is defined as the restoration phase of the proposed conservation strategy for the OESF. The longer period following the restoration phase that is required for threshold amounts of old-forest habitat to develop in all landscape planning units is defined as part of the maintenance and enhancement phase. Management during this phase will be discussed in the next subsection.

Management of the Experimental Forest will be planned and implemented at the level of individual activities within the framework of specific plans for each landscape planning unit. These landscape plans will focus and direct the integration of ecosystem, commodity, and information goals. Several elements of landscape plans will indirectly support the maintenance or restoration of spotted owl habitat. A primary objective for the conservation strategies of the OESF is to maintain and aid the natural restoration of the composition, structure, and function of aquatic and riparian ecosystems. This will likely result in the maintenance or restoration of older forests in streamside areas and on unstable hillslopes. (See the subsection titled the Riparian Conservation Strategy for the Olympic Experimental State Forest.) These streamside forests are of great value to spotted owls and many of their potential prey (Carey et al. 1992; Carey and Johnson 1995), as well as to the function of the aquatic and riparian ecosystems.

Commitments to the conservation of marbled murrelets will be also incorporated into landscape plans. The long-term conservation strategy for murrelets has not yet been developed, but the interim strategy is to defer the harvest of most potential murrelet habitat until after the development of the long-term strategy. (See Minimization and Mitigation for the Marbled Murrelet, in Section B of this chapter.) There is likely to be a high degree of overlap among potential murrelet and spotted owl habitats, thus the probable result of the interim murrelet strategy will be to defer harvest of much potential spotted owl habitat.

Landscape plans will help integrate diverse goals, in part by mapping and scheduling timber harvests and other silvicultural activities so that their influence on ecosystem processes can be assessed in advance. Harvests of currently suitable, potential spotted owl habitat will be planned, scheduled,

[1]In discussions regarding northern spotted owls and the OESF, the term "potential spotted owl habitat is used to generally characterize forest stands that, because of their structure and composition, are similar to those described as young- or old-growth forest spotted owl habitat by Hanson et al. (1993). The adjective "potential" is used to acknowledge that not all such stands will actually be used (become habitat) by owls, for a variety of reasons including that they occur in landscapes dominated by clearcuts and young plantations and are thus incapable of supporting owls.

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1]

Decade	Percent of landscape in cover type: Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	Total habitat[6]
Sekiu Landscape Planning Unit					
0	88	5	4	3	12
1	75	18	4	3	25
2	69	21	6	4	31
3	54	34	7	5	46
4	33	51	11	5	67
5	23	42	29	6	77
6	33	18	36	12	67
7	37	10	39	15	63
8	34	16	27	22	66
9	31	17	19	33	69
10	28	20	15	37	72
Clallam Landscape Planning Unit					
0	49	16	32	3	51
1	46	9	42	3	54
2	55	14	28	3	45
3	50	32	6	12	50
4	50	28	6	15	50
5	48	18	18	17	52
6	45	20	18	17	55
7	30	24	25	21	70
8	17	31	21	31	83

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1] *(continued)*

Decade	Percent of landscape in cover type: Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	Total habitat[6]
Clallam Landscape Planning Unit *(continued)*					
9	17	19	28	35	83
10	29	12	21	37	71
Dickodochtedor Landscape Planning Unit					
0	70	1	15	14	30
1	64	6	14	16	36
2	68	13	3	16	32
3	57	23	1	18	43
4	40	40	3	17	60
5	25	40	18	17	75
6	35	19	30	16	65
7	36	13	35	16	64
8	38	17	25	20	62
9	40	15	19	26	60
10	42	11	15	32	58
Sol Duc Landscape Planning Unit					
0	44	34	18	5	56
1	24	42	28	6	76
2	31	26	35	7	69
3	67	9	14	9	33
4	67	9	13	11	33

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1] *(continued)*

Decade	Percent of landscape in cover type: Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	Total habitat[6]
Sol Duc Landscape Planning Unit *(continued)*					
5	58	18	10	15	42
6	55	16	9	20	45
7	47	16	17	21	53
8	13	48	16	23	87
9	10	39	23	28	90
10	15	8	42	35	85
Reade Hill Landscape Planning Unit					
0	62	0	11	27	38
1	67	2	11	20	33
2	49	29	3	19	51
3	37	40	1	22	63
4	42	26	10	22	58
5	34	24	20	22	66
6	29	19	29	23	71
7	26	16	24	34	74
8	27	10	23	40	73
9	19	17	20	45	81
10	23	19	10	49	77
Goodman Landscape Planning Unit					
0	73	0	6	21	27
1	75	0	6	19	25

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1] *(continued)*

Decade	Percent of landscape in cover type: Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	Total habitat[6]
Goodman Landscape Planning Unit *(continued)*					
2	73	7	2	19	27
3	53	26	1	20	47
4	29	50	2	19	71
5	17	48	16	19	83
6	25	20	37	19	75
7	30	7	44	19	70
8	41	6	28	24	59
9	44	8	16	32	56
10	42	14	7	37	58
Willy-Huel Landscape Planning Unit					
0	73	2	3	22	27
1	74	3	3	20	26
2	67	10	3	19	33
3	48	31	1	20	52
4	27	48	6	19	73
5	18	41	21	20	82
6	23	18	38	20	77
7	30	6	40	24	70
8	35	5	28	33	65
9	35	9	14	42	65
10	35	12	6	48	65

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1] *(continued)*

Decade	Percent of landscape in cover type				Total habitat[6]
	Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	
Kalaloch Landscape Planning Unit					
0	78	1	3	18	22
1	77	1	3	19	23
2	72	8	2	19	28
3	50	30	1	19	50
4	25	54	3	18	75
5	24	46	17	13	76
6	31	18	39	13	69
7	40	5	40	15	60
8	44	6	28	22	56
9	47	10	10	32	53
10	35	22	6	37	65
Clearwater Landscape Planning Unit					
0	70	0	0	30	30
1	74	0	0	26	26
2	71	3	0	26	29
3	54	20	0	26	46
4	24	49	1	26	76
5	12	49	13	26	88
6	13	22	38	26	87
7	20	6	47	27	80
8	28	2	36	33	72

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1] *(continued)*

Decade	Percent of landscape in cover type: Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	Total habitat[6]
Clearwater Landscape Planning Unit *(continued)*					
9	33	4	15	47	67
10	34	9	3	54	66
Coppermine Landscape Planning Unit					
0	81	1	3	16	19
1	81	1	3	16	19
2	77	6	1	16	23
3	52	31	1	17	48
4	28	53	2	17	72
5	16	47	20	17	84
6	22	22	39	17	78
7	25	7	50	19	75
8	35	6	34	25	65
9	40	7	16	37	60
10	34	14	7	45	66
Queets Landscape Planning Unit					
0	71	2	5	23	29
1	74	2	5	19	26
2	67	12	2	19	33
3	53	27	0	20	47
4	39	41	2	19	61
5	22	41	18	19	78

Table IV.7: An estimate of the future abundance of potential spotted owl habitat in proposed landscape planning units of the Olympic Experimental State Forest and the forest at large based on one set of harvest regimes[1] *(continued)*

Decade	Percent of landscape in cover type: Non-habitat[2]	Young-forest marginal[3]	Sub-mature[4]	Old forest[5]	Total habitat[6]
Queets Landscape Planning Unit *(continued)*					
6	29	23	29	19	71
7	40	10	31	20	60
8	47	7	27	20	53
9	42	14	21	23	58
10	47	12	7	34	53

[1]Estimates are based on harvest assessments for the OESF unzoned alternative presented to the Board of Natural Resources on June 6, 1995, and represent one possible set of regimes for illustrative purposes only. Actual harvest levels will be determined through the landscape planning process. Old-forest habitat will not be reduced in amount if it comprises 20 percent or less of a landscape planning unit. See Map IV.9 for location of proposed landscape planning units.

[2]Non-habitat is assumed to be either a) untreated stands 50 years old or younger, or b) stands that were 71 years old or older when they were partially-harvested within the past 10 years.

[3]Young-forest marginal habitat is estimated to be either a) untreated stands 51-70 years old, or b) stands that were 71 years old or older when they were partially-harvested within the past 11-30 years.

[4]Sub-mature habitat is estimated to be either a) untreated stands 71-100 years old, or b) stands that were 71 years old or older when they were partially-harvested within the past 31-50 years.

[5]Old-forest habitat is estimated to be either a) untreated stands 101 years old or older, or b) stands that were 71 years old or older when they were partially-harvested over 51 years ago.

[6]Total habitat is the sum of young-forest marginal, sub-mature, and old-forest habitat.

and implemented using the following guidelines as a filter to determine what is allowable:

(1) Harvests of young- or old-forest habitat will support riparian ecosystem and marbled murrelet conservation as set forth in other sections of this HCP.

(2) Harvest activities will maintain the proportion of old-forest habitat at or above 20 percent of each landscape planning unit and will not further reduce sub-threshold proportions. In this phase, harvest activities in young-forest habitat may occur independent of the 40 percent threshold if consistent with other elements of the HCP.

(3) Plans for harvest of young- or old-forest habitat will recognize the importance of interior old-forest conditions to overall ecosystem function and will maintain or develop these conditions in accordance with landscape plans.

(4) Harvests of available young- and old-forest habitat will be evenly distributed over the duration of the restoration phase. Available habitat will be calculated for each landscape planning unit, and harvests of that habitat will be scheduled and conducted so that they are evenly distributed by decade over the duration of the restoration phase of the HCP.

(5) Harvests of available young- and old-forest habitat will be scheduled in consideration of the value of individual owl sites to conservation, research, and validation monitoring in the Experimental Forest. DNR will consider the recommendations of the U.S. Fish and Wildlife Service when scheduling these harvests during the first decade of the HCP.

(6) Harvests of available young- or old-forest habitat will take advantage of opportunities to learn new silvicultural techniques for retaining old-forest ecosystem functions, including those providing spotted owl habitat. This is an important conservation goal of the Experimental Forest, although not all harvests will necessarily be for research in silvicultural options.

Habitat restoration will also proceed under landscape plans. Harvesting, silvicultural activities, and other activities (e.g., road building, maintenance, etc.) in areas that are not currently suitable habitat will be planned, scheduled, and implemented using the following guidelines as a filter to determine what is allowable:

(1) All activities will support riparian ecosystem and marbled murrelet conservation as set forth in other sections of this HCP.

(2) Activities will restore at least 20 percent cover of old-forest habitat to each landscape planning unit, including the development of some interior old-forest conditions.

(3) Harvests and other silvicultural activities in young (0- to 30-year-old) stands will promote development of young- or old-forest spotted owl habitat so that the restoration phase is expedited.

(4) Harvests and other silvicultural activities in young (0- to 30-year-old) stands will be take advantage of opportunities to learn new silvicultural techniques for accelerating the development of old-

forest ecosystem functions, including those providing spotted owl habitat. This is an important conservation goal of the OESF, although not all such activities will necessarily be for research in silvicultural options.

Activities that precede thorough landscape analyses and plans will be conducted in accord with the above guidance and will proceed cautiously to avoid foreclosing options for commodity production, ecosystem support, and research.

Management During the Maintenance and Enhancement Phase

The maintenance and enhancement phase of the HCP for the Experimental Forest covers the remainder of the permit period and follows the restoration of threshold amounts of total spotted owl habitat in each landscape planning unit. During this phase, some stands will continue developing the characteristics of old-forest habitat to meet conservation needs for riparian ecosystems, as well as possibly for marbled murrelets and spotted owls and for other ecosystem functions. Other stands will receive a variety of silvicultural treatments including clearcut harvests where appropriate, but total spotted owl habitat will make up at least 40 percent of each landscape planning unit. Current estimates are that those landscape planning units that contain less than the threshold amounts of old-forest habitat will attain the threshold level over the next 20 to 80 years. Thus, restoration of the entire OESF to conditions that are currently hypothesized to support desired outputs of commodity and ecosystem products is predicted to take as long as 80 years. This restoration depends on natural and silviculturally aided successional processes, in both young-forest habitat types and the abundant young stands. Conditions and knowledge will likely change substantially over this time, altering strategies and tactics; however, some discussion of the current proposal for management follows.

Activities will likely continue to be planned and implemented at a scale larger than forest stands, but the base units for planning may differ from the current landscape planning units. It is also likely that these plans will continue to integrate diverse goals, in part by mapping and scheduling timber harvests and other silvicultural activities so that their influence on ecosystem processes can be predicted. Activities for this phase should be planned, scheduled, and implemented using the following guidelines as a filter to determine what is allowable:

(1) Activities will support necessary riparian ecosystem or marbled murrelet conservation.

(2) Activities will maintain or enhance at least 20 percent cover of old-forest habitat in each landscape planning unit, including the maintenance or development of interior old-forest conditions in each unit.

(3) Harvest activities will maintain the proportion of young- and old-forest habitat at or above 40 percent of each landscape planning unit.

(4) New research goals will evolve to ensure the success of this phase.

RATIONALE FOR THE SPOTTED OWL CONSERVATION STRATEGY

The non-specific nature of the conservation objectives acknowledges the incomplete understanding of spotted owl population dynamics within the context of the overall mission of the Experimental Forest. Not enough information is available about the numbers, distribution, and demographic performance necessary to maintain the current chances for survival and recovery of the sub-population of spotted owls on DNR-managed lands in the OESF. Nor is it known what management regimes best support that goal. It may be possible to maintain the chances for survival and recovery with very small contributions to spotted owl habitat from the Experimental Forest. However, an important part of the OESF mission is to learn how to manage commercial forests for integrated outputs of commodity and ecosystem products, including those ecosystem products that derive from the workings of older forests. Spotted owls are a visible, measurable output of older forest ecosystems. Management of the Experimental Forest that restores and supports a reproducing segment of the spotted owl population would be an important conservation goal of the OESF whether spotted owls were listed as threatened or not.

The conservation strategy was developed in light of current physical and biological conditions and the land-ownership and land-management context in the northwestern portion of the range of the northern spotted owl. Seven key items were considered:

(1) the physical geography and land-cover patterns of the region;

(2) the size and trends of the spotted owl sub-population on the Olympic Peninsula (see Section A of Chapter III for a discussion of biological data for spotted owls on the Olympic Peninsula);

(3) the current distribution of spotted owls and their habitat on the Olympic Peninsula (see Section A of Chapter III);

(4) patterns of land ownership and current objectives of forest managers (see the section in Chapter I titled Land Covered by the HCP);

(5) recent trends in occupancy by spotted owls on DNR-managed lands in the Experimental Forest and current habitat conditions there;

(6) current knowledge and hypotheses regarding spotted owls and managed forests; and

(7) the mission of the OESF to discover effective approaches for integrated management of commercial forests.

Consideration of these key items led to several conclusions that guided the development of the conservation strategy. Geography and land-use patterns have isolated spotted owls on the Olympic Peninsula from other significant sub-populations in western Washington and Oregon. Recent studies suggest that the sub-population is substantially larger than was formerly believed, is interconnected, and is either stable or declining slowly (Holthausen et al. 1994; Burnham et al. 1994). Currently, the vast majority of spotted owls and potential habitat are found on federal lands in the Olympic National Forest and Olympic National Park. These federal lands border a substantial portion of DNR-managed lands in the Experimental Forest. Management objectives for the federal lands include supporting the recovery of a viable, well-distributed population of spotted owls (USDA and USDI 1994b). Thus, while the conservation of spotted owls on the Olympic Peninsula is of particular concern, the population size, distribution, and status, as well as the substantial commitment to habitat protection and recovery by the Olympic National Forest and Olympic National Park, appear to provide a population and habitat base that allows considerable flexibility in developing a conservation strategy for DNR-managed lands.

The amount and distribution of potential spotted owl habitat on DNR-managed lands in the OESF is currently sufficient to support only a few spotted owl pairs. Recent observations on those lands have found a substantial proportion of sites formerly occupied by spotted owl pairs to be either intermittently occupied by unpaired spotted owls or vacant. Apparently, significant demographic support to the spotted owls on the western Olympic Peninsula from the Experimental Forest must await the development of habitat conditions in the abundant young stands on these lands.

The current understanding is that both the structure and composition of forest stands and the composition and pattern of forested landscapes determine their capability as spotted owl habitat (Horton in press). Some management techniques currently exist to maintain or restore spotted owl habitat capability; many others are hypothesized (e.g., USDI 1992, Appendix F). DNR intends to implement, evaluate, and refine techniques such as these in the OESF. Thus, there is reason to believe that meaningful contributions to spotted owl conservation can result from management of the Experimental Forest.

The conservation strategy is based primarily on the restoration of habitat capability for spotted owls and assumes a level of risk because it allows some reduction in the amount of potential spotted owl habitat in the near term. The level of risk may be acceptable because:

(1) current habitat conditions allow so few spotted owl pairs to occupy these lands successfully that only marginal losses to the Olympic Peninsula sub-population are likely;

(2) the levels of near-term habitat removal are fairly low; and

(3) the overall status of the Olympic Peninsula spotted owl sub-population and habitat appears to be reasonably secure within the context of management plans for federal lands (Holthausen et al. 1994; see the section in Chapter II on the Reanalysis Report for the Spotted Owl on the Olympic Peninsula and Section A of Chapter III on biological data for the spotted owl on the Olympic Peninsula for a brief discussion of Holthausen et al. 1994).

POTENTIAL BENEFITS AND IMPACTS TO SPOTTED OWLS

DNR proposes to manage the OESF as a commercial forest, and simultaneously, to restore a greater level of habitat capability for spotted owls than currently exists there. DNR anticipates that during the life of the HCP, some spotted owls may be displaced and forest management activities may degrade habitat conditions for some individual spotted owls or owl pairs to the point where the habitat is temporarily incapable of supporting them. These activities may constitute incidental take of spotted owls as defined by the Endangered Species Act. The HCP was designed to minimize and to mitigate for this take within the context of its objectives. In fact, it is intended that management of the Experimental Forest will result in spotted owl habitat that is more abundant and widely distributed than it is at present.

Benefits

The HCP for the OESF will potentially benefit spotted owls in several ways:

(1) by deferring older stands (potential old-forest habitat) from harvest to meet (a) riparian or marbled murrelet conservation strategies,

(b) the 20 percent per landscape planning unit threshold for old-forest spotted owl habitat, or (c) harvest scheduling objectives;

(2) by deferring mid-aged forest stands (potential young-forest marginal, sub-mature, or occasionally, old-forest habitat) from harvest to meet (a) conservation strategies for riparian ecosystems or marbled murrelets, (b) harvest scheduling objectives, or (c) the 40 percent per landscape planning unit threshold for young-forest marginal, sub-mature, or old-forest spotted owl habitat; and

(3) by developing spotted owl habitat in young stands. A description of how these three measures will benefit the spotted owl during the restoration phase of the HCP for the Experimental Forest follows.

Preliminary analyses suggest that about 30 percent of the older forests are near stream channels or on unstable hillslopes and an additional 10 percent are in potentially wind-prone areas near streams. Because these older forests will be managed to meet the objectives of the OESF riparian conservation strategy (see the next subsection), DNR expects to maintain the potential of these stands as old-forest habitat for spotted owls. The long-term conservation strategy for murrelets has not yet been developed, but the interim strategy is to defer harvest of most potential murrelet habitat at least until the development of the long-term strategy. (See Section B of this chapter on the marbled murrelet strategy.) Preliminary examination of raw data from a two-year study of upland habitat relationships of murrelets in the OESF suggests that there will be a high degree of overlap among potential murrelet habitat and potential old-forest habitat for spotted owls. Thus, the likely result of the interim murrelet strategy will be to defer harvest of much potential old-forest habitat.

In order to support the 20 percent old-forest habitat threshold for each landscape planning unit, harvest is proposed to be deferred in those forests for 50-80 years in six landscape planning units in which amounts of that cover type are hypothesized to be insufficient. These deferrals will benefit the spotted owl. In the five landscape planning units in which old-forest cover is estimated to be greater than 20 percent, about 8,000 acres are in excess of the threshold amount. The retention of at least 20 percent old-forest cover in these landscapes will benefit the spotted owl. To the extent that harvest of supra-threshold old-forest habitat in these areas does not conflict with conservation strategies for riparian ecosystems or marbled murrelets, DNR proposes harvest be evenly distributed over the duration of the restoration phase of the HCP. Gradual harvest of about 12 percent of the existing old-forest habitat over 40 or more years (while some mid-aged stands are becoming old-forest habitat) will also benefit the spotted owl.

Preliminary analyses suggest that about 20 percent of mid-aged forests are near stream channels or on unstable hillslopes and an additional 10 percent are in potentially wind-prone areas near streams. Because these forests will be managed to meet the objectives of the riparian ecosystem conservation strategy (see the next subsection), DNR expects to maintain or enhance the potential of these stands as habitat for spotted owls. The long-term conservation strategy for murrelets has not yet been developed, but the interim strategy is to defer harvest of most potential murrelet habitat at least until the development of the long-term strategy. (See the earlier section in this chapter on the marbled murrelet strategy.) Preliminary examination of raw data from a two-year study of upland habitat relationships of murrelets in the Experimental Forest suggests that there will be some overlap among potential murrelet habitat and potential sub-mature habitat for spotted owls. Thus, the likely result of the interim murrelet strategy will be to defer harvest of some potential sub-mature habitat. DNR proposes that harvest of other mid-aged forests be evenly distributed over the duration of the restoration phase of the HCP. This gradual harvest of perhaps as much as 20,000 acres of young-forest marginal and sub-mature habitat over 40 or more years while over 100,000 acres of younger forests are becoming young-forest marginal and sub-mature habitat will also benefit the spotted owl.

Preliminary analyses suggest that approximately 130,000 acres of forest stands in the OESF are between 11 and 50 years old (DNR GIS 1995). Currently, these stands provide little if any young-forest marginal habitat for spotted owls. However, during the 40- to 60-year restoration phase of the HCP, most of these stands will, through natural or silviculturally-aided processes, develop into young-forest marginal, sub-mature, and old-forest habitat. (See Table IV.7.) Most of the habitat that will develop during this phase will be of the young-forest marginal and sub-mature types, with more and higher quality habitat developing in the latter half of the restoration phase. The development of young-forest marginal and sub-mature owl habitat while existing, similar habitat is harvested will serve to benefit the spotted owl.

The mission of the Experimental Forest is to learn how to conduct integrated forest management for commodity and ecosystem outputs. One facet of this mission is to learn how to manage commercial forest landscapes such that they support successfully reproducing spotted owls that are a functional segment of the Olympic Peninsula sub-population. DNR expects this to result from several outcomes of proposed management of the OESF:

(1) providing owl habitat during a significant proportion of the management cycle in some forest stands;

(2) providing owl habitat fairly continuously in some forest stands;

(3) supporting older forest ecosystem processes, including spotted owl survival and reproduction, through management of forest landscapes;

(4) learning effective and efficient techniques for supporting spotted owls in commercial forests and conveying this information to forest scientists and managers so that it can potentially be employed elsewhere. A description of how these four measures will benefit the spotted owl during the life of the HCP for the Experimental Forest follows.

Forest stand management in the OESF will increasingly focus on retention of elements of existing stands to promote diversity within each stand and the development of owl habitat at earlier ages than might be achieved without such retention. (See Section H in this chapter titled Forest Land Management Activities.) For example, a regime that harvested 90-year-old stands, retaining one-third of their volume, and conducted intermediate harvests that maintained or enhanced structural diversity may be hypothesized to provide at least young-forest marginal and sub-mature habitat between 50 and 90 years post-harvest (44 percent of the management cycle for the stand). This regime has been used to represent a median silvicultural regime for the Experimental Forest and was the basis for the harvest assessment presented at the Board of Natural Resources Workshop on October 3, 1995. Other silvicultural regimes will develop stands with multiple age classes and large structural elements from previous stands. (See Section H of this chapter titled Forest Land Management

Activities.) Such stands may be hypothesized to provide both younger forest and possibly even old-forest habitat types during portions of the management cycle. An estimate of the rate of development of potential owl habitat in landscape planning units of the OESF is presented in Table IV.7, which shows that substantially more potential habitat that is more widely distributed potential habitat will be developed during the life of the HCP than currently exists. Silvicultural practices that provide owl habitat in commercial forest stands during significant portions of the management cycle and result in substantially more habitat than currently exists result in significant benefits to spotted owls.

Some forest stands will be managed such that they provide owl habitat fairly continuously. Many of these stands will be in or near riparian areas or on unstable areas in the uplands. Silvicultural practices in these areas are currently hypothesized to include: minimal or no harvest; thinnings and light partial harvests designed to enhance structural diversity and thus wind-firmness; and conversion of some streamside areas, which were invaded by deciduous trees or shrubs following timber harvest, to conifer stands in order to better support riparian ecosystem functions. (See the OESF riparian strategy and Section H of this chapter titled Forest Land Management Activities.) It is predicted more than 20 percent of the Experimental Forest will be managed by such methods, and it is predicted that most of these areas will either remain or become potential old-forest habitat for spotted owls. An estimate of the rate of development of potential old-forest habitat in landscape planning units of the OESF is presented in Table IV.7, which shows that substantially more, and more widely distributed, potential old-forest habitat will be developed toward the end of the HCP period than currently exists. Management practices that increase the amount and broaden the distribution of old-forest habitat relative to what currently exists result in significant benefits to spotted owls.

Reproducing spotted owl pairs need substantial areas of potential habitat. The proposed management of forest landscapes to achieve at least threshold qualities and quantities of potential habitat is intended to provide these substantial areas of habitat. An estimate of the rate of development of potential young-forest marginal, sub-mature, and old-forest habitat in landscape planning units of the OESF is presented in Table IV.7. Note that preliminary landscape management regimes used in developing the harvest assessment from which the table was derived result in all landscape planning units surpassing hypothesized threshold qualities and quantities of owl habitat. Management practices that increase the amount and broaden the distribution of young-forest marginal, sub-mature, and old-forest habitat such that the capabilities of forest landscapes to support spotted owls are greater than their current capabilities constitute significant benefits to spotted owls.

Learning how to manage commercial forests effectively and efficiently for ecosystem and commodity values requires a significant commitment to research, monitoring, and information exchange. (See the earlier subsection in this chapter titled Integrated Approach to Conservation and Production as well as the sections in Chapter V titled Monitoring and Research.) It is difficult to predict how much of what is learned in the Experimental Forest will be used to manage other commercial forests so that they provide a greater level of support to the regional population of northern spotted owls. But, given the commitment to such learning, then to the extent that information derived is applied by other forest scientists and managers and produces positive results, those results also constitute benefits to spotted owls.

Impacts

It may be argued that the degradation of spotted owl habitat which occurs during the earlier restoration phase of the HCP is possibly more significant than that which occurs during the later maintenance and enhancement phase because, during that later phase, the harvest and development of potential spotted owl habitat will be more or less at equilibrium and, hypothetically, landscapes will have more or less stable occupancy by owls. This suggests that measures to minimize habitat degradation during the restoration phase are of potentially greater importance than they might be during the maintenance and enhancement phase and that measures to mitigate for take are likely of roughly equal importance during both phases because mitigation during the restoration phase is predicted to enable the equilibrium among harvest and development of habitat that is intended during the maintenance and enhancement phase.

Riparian Conservation Strategy for the Olympic Experimental State Forest

INTRODUCTION

The riparian conservation strategy proposed for the Olympic Experimental State Forest is distinct from that for other HCP planning units because of the unique physical and ecological features of the western Olympic Peninsula. The need for special protective measures stems from a high potential throughout the Experimental Forest for:

(1) mass wasting (i.e., landslides, debris torrents, channel-bank collapse), due to highly erosive, weathered bedrock and overlying glacial deposits, heavy annual precipitation, and steep terrain, and

(2) tree blowdown, due to alignment of major river valleys with the prevailing wind directions, fully saturated soils during the winter months, and edge effects associated with clearcutting adjacent to mature timber stands.

Of the many factors affecting habitat for salmonids and riparian-dependent species, mass wasting and windthrow exert the greatest short- and long-term influences. Hence, this conservation strategy explicitly addresses these two driving factors by creating riparian buffers designed to minimize mass wasting and windthrow. A principal working hypothesis of this approach is that buffers designed to minimize mass wasting and blowdown will be sufficient to protect other key physical and biological functions of riparian systems.

This riparian strategy is unique because it incorporates experimentation as a means of developing and evaluating new methods of integrating forest-commodity production with protection of riparian-ecosystem health. This emphasis reflects the primary mission of the OESF. In addition, the riparian conservation strategy cannot be separated from other conservation and forest management measures for the OESF. All conservation, research, and management strategies were designed in concert to achieve an integrated management approach. Conservation measures for upland species, hence, rely in part on the riparian conservation strategy to meet their short- and long-term objectives. For example, proposed buffers on streams and stream-side habitat account for more than 50 percent of habitat projected for the northern spotted owl on DNR-managed lands within the Experimental Forest.

As in the conservation proposal for the northern spotted owl in the OESF, the riparian strategy sets objectives for protecting and restoring functional species habitat, rather than prescriptions for forest practices within proposed riparian-buffer areas. Currently, scientific understanding is incomplete with regard to riparian processes, the complex interactions between physical and biological parameters within riparian ecosystems, and the long-term impacts of forest management activities on these processes. Riparian buffers, therefore, are proposed as the present best means for protecting a number of important habitat features, such as stream bank stability and coarse woody debris inputs, in lieu of a scientifically proven method for protecting all aspects of riparian ecosystems. A central mission of the OESF is to explore these relationships through research and monitoring, in order to acquire a better understanding of riparian ecosystems in managed landscapes. The type and intensity of management activities within proposed riparian buffers will depend on their ability to achieve riparian objectives in the short and long term. Management approaches will be adaptive, to incorporate new insights obtained from experiments and other sources into effective management strategies.

Conservation Objectives

DNR-managed lands within the OESF shall be managed to:

(1) maintain and aid restoration of the composition, structure, and function of aquatic, riparian, and associated wetland systems which support aquatic species, populations, and communities;

(2) maintain and aid restoration of the physical integrity of stream channels and floodplains;

(3) maintain and aid restoration of water to the quantity, quality, and timing with which these stream systems evolved (i.e., the natural disturbance regime of these systems);

(4) maintain and aid restoration of the sediment regime in which these systems evolved, and

(5) develop, use, and distribute information about aquatic, riparian, and associated wetland-ecosystem processes and on their maintenance and restoration in commercial forests.

These objectives reflect the requirements for maintaining habitat that is capable of supporting viable populations of salmonid species, as well as for other non-listed and candidate species dependent on in-stream and riparian environments. The riparian conservation objectives also incorporate the OESF mission. Objective 5, in particular, seeks the implementation of a structured and credible program of research, experimentation, and monitoring to aid forest management and the scientific understanding of riparian systems in managed landscapes.

The principal underlying theme of these objectives is the need to conserve habitat complexity afforded by natural disturbance regimes on the western Olympic Peninsula. Habitat complexity includes (e.g., see Bisson et al. 1992):

(1) variations in stream-flow velocity and stream depth created by structural obstructions to channel flow;

(2) physical and biological interactions between a channel and its floodplain;

(3) aquatic and riparian structures that provide cover from predators;

(4) a variety of stream substrates that includes gravel for fish spawning and macro-invertebrate habitat;

(5) sufficient storage area within channels and floodplains for sediment and organic matter; and

(6) diversity of riparian vegetation that provides adequate sources of woody debris and nutrients to channels and that moderates water and air temperatures within the riparian corridor.

Habitat complexity is maintained by natural events such as landslides, debris flows, peak stream-flows (floods), fires, forest-disease outbreaks, and vegetation changes associated with forest competition, all of which periodically deliver sediment, wood, nutrients, and water to riparian areas from upslope and floodplain sources (Pringle et al. 1988; Benda et al. 1992; Naiman et al. 1992).

Riparian Ecosystem Defined

For the purposes of this riparian conservation strategy, riparian areas are defined as three-dimensional zones of direct interaction between terrestrial and aquatic environments. They encompass the forest canopies, floodplains, wetlands, open bodies of water (e.g., ponds, lakes, estuaries, and nearshore marine environments), channel banks and beds, surface waters, and ground water zones that connect channels with adjacent hillslopes and floodplains (Swanson et al. 1982; FEMAT 1993).

Aquatic systems are considered part of the riparian ecosystem for the purposes of the OESF. Aquatic systems directly influence, and are influenced by, riparian zones and upland areas that contribute water, organic matter, sediment, detrital nutrients, prey (e.g., macro-invertebrates), heat, and energy to a stream channel (Figure IV.8).

The aquatic system of the northwestern Olympic Penisula encompasses estuarine and near-shore marine environments that are occupied during a life stage of anadromous organisms and that influence the nutrient and mineral exchange, water quality, and morphology and dynamics of Olympic coastal channels. DNR recognizes the importance of minimizing impacts to estuarine and near-shore environments associated with forest practices on DNR-managed lands, although the cumulative effects of such impacts are derived as well from management activities on lands not managed by DNR. The OESF riparian conservation strategy, therefore, contains no explicit measures for protecting estuarine and near-shore environments, other than to minimize sedimentation and declines in water quality related to forest practices on DNR-managed lands.

CONSERVATION STRATEGY

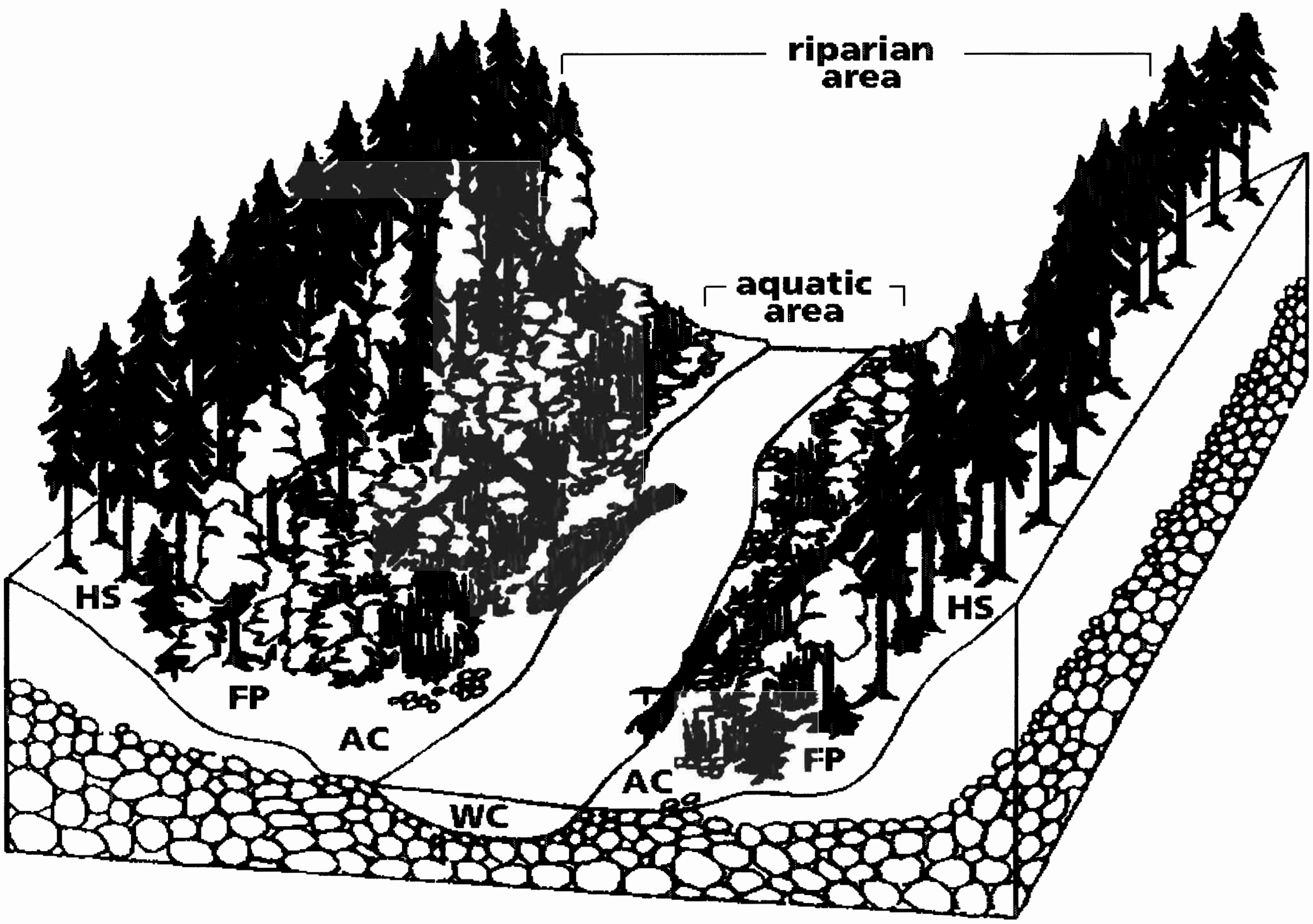
The riparian conservation strategy for the OESF seeks to meet the stated objectives by establishing:

(1) interior-core buffers on all stream types (although not on all streams — see discussion titled Interior-core Buffers regarding buffers for Type 5 streams),

(2) exterior wind buffers on all stream types (although not on all streams — see discussion titled Exterior Buffers regarding use of wind buffers),

Figure IV.8: Geomorphic features associated with riparian areas

The active channel (AC) includes the wetted channel (WC) and active channel surface exposed during low flow. Floodplains (FP) are located between the active channel and hillslope (HS); they support mosaics of herbs, shrubs, and deciduous trees. Conifers dominate riparian forests on lower hillslopes. (Modified from Gregory et al. 1991)



(3) comprehensive road-maintenance plans,

(4) protection of forested wetlands, and

(5) a research and monitoring program integrated with on-the-ground riparian protection.

These five components are described below.

Interior-core Buffers

Interior-core riparian buffers are intended to minimize disturbance of unstable channel banks and adjacent hillslopes (i.e., potential areas of mass wasting) in order to protect and aid natural restoration of riparian processes and functions. Harvesting in interior-core buffers can occur, provided that management activities are consistent with the conservation objectives. The ability of management, conservation, and restoration activities to meet the conservation objectives will be evaluated through landscape-level assessments of the physical and biological conditions of riparian forests (discussed later in the subsection titled Implementing the Riparian Conservation Strategy).

DNR's working hypothesis, based on current knowledge, is that riparian conservation objectives are best met by establishing buffers on streams and riparian forests in order to effectively maintain key physical and biological functions until streams recover sufficiently from past disturbances to allow greater integration of commodity production and conservation. The width of riparian buffers will be determined on a site-specific basis, according to the assessment procedure described later in this section. Although buffers will be established based on landscape-level field evaluations, DNR expects that buffer widths will be, on average, comparable to those in Table IV.5. (See Chapter IV, Section D, pg. IV.58.) The buffer widths for each stream type, as shown in Table IV.5, have been calculated based on average buffer dimensions that were used by DNR's Olympic Region from 1990 through 1994 to protect unstable ground in the Experimental Forest. Buffer widths established once the Experimental Forest is under way, therefore, are not expected to vary substantially from those in Table IV.5 because they reflect current practices for protecting unstable ground.

Average buffer widths are given in Table IV.5 as average horizontal distances measured outward from the outer margin of the 100-year floodplain on either side of the stream. The 100-year floodplain is the valley-bottom area adjoining the stream channel that is constructed by the stream under the present climatic regime and overflowed at times of very high discharge (i.e., flooding associated with storms of a 100-year recurrence interval (Dunne and Leopold 1987)). One-hundred-year floodplains commonly are delineated by the Federal Emergency Management Agency (FEMA) on Flood Insurance Rate Maps (FIRM) for each county of a state. The 100-year floodplain includes meandering, braided (i.e., multiple channel braids), and avulsion channels, as well as side channels that transport water from one part of a mainstream channel to another. Avulsion channels are portions of mainstream and side channels that have been abandoned temporarily by lateral displacement of the channel network elsewhere on the floodplain but are expected to be reoccupied when the network migrates back across the valley bottom.

The 100-year floodplain, which often encompasses the channel-migration zone, frequently occupies a several-hundred-foot wide section of the valley bottom on low-gradient, alluvial river systems. On higher-gradient streams in moderate to steep terrain, the 100-year floodplain typically coincides with the active channel margin or extends only a few feet beyond the active (e.g., the high-water mark). The active channel consists of the wetted area and bed or bank surfaces exposed during low flows, as well as portions of the valley bottom nearest the channel that are inundated during typical flood events (i.e. comparable to the two-year recurring flood). Active channel margins commonly are identified in the field by piles of accumulated flood debris, overbank sediment deposits, streamside vegetation altered or damaged by channel flows, bank scour, and the absence of aquatic biota (e.g., algae) normally found in slack-water channels. In the five west-side planning units and the OESF, DNR manages only a few hundred acres on 100-year floodplains of the major river systems. Most floodplain acreage is privately owned or federally managed. FEMA maps indicate that most 100-year floodplains are associated with Type 1 and 2 waters. Collectively, Type 1 and 2 waters represent less than 5 percent of stream miles on DNR-managed lands. Hence, the impact to DNR management associated with using the 100-year floodplain as the inner margin of riparian management zones is relatively negligible.

Analysis of channel-floodplain geography in the Experimental Forest suggests that the combined interior-core and exterior buffers (to be described in the next subsection) are sufficient to protect the key physical and ecological functions of floodplains. (See Rationale for the Riparian Conservation Strategy later in this section). DNR manages only a few acres on the 50- to 100-year floodplains of the major river systems on the western Olympic Peninsula; most of this floodplain acreage is privately owned. Only 3 percent of the stream network on DNR-managed lands in the OESF is classified as Type 1 streams, and only 2 percent is Type 2 streams. (Stream types are defined in WAC 222-16-030.) On these streams, the 100-year floodplains typically are narrower than the proposed OESF riparian buffers, or the channels are incised deeply through glacial terraces, thereby limiting the stream's ability to migrate laterally or form extensive floodplains.

Widths of the interior-core buffer (Table IV.5) are given as average values because the lateral extent of riparian corridors varies locally with channel size, valley confinement, and landform characteristics. Furthermore, these widths should not be interpreted as maximum or minimum target values because site conditions might call for enlarging or reducing the buffer locally based on the extent of unstable ground. Each interior-core buffer will be designed to accommodate all channel, floodplain, and hillslope areas susceptible to mass wasting. Such protection would include channel-bed and floodplain surfaces that have the potential for trapping sediment and other materials carried downstream by debris flows and associated dam-burst floods. Riparian buffers that have been adjusted on the ground to accommodate site-specific physical conditions and conservation objectives, however, should be comparable in width to the recommended average buffers presented in this strategy. This follows from the fact that the recommended widths were derived statistically from actual riparian buffers that have been implemented to protect unstable ground in the OESF.

All Types 1 through 4 streams will be protected with interior-core buffers (Table IV.5). A separate protocol is warranted for Type 5 channels because of the abundance and variety of intermittent streams found on the western Olympic Peninsula. Management objectives in the Experimental Forest are to protect all Type 5 streams that cross unstable ground and occupy stable ground but have identifiable channels with evidence of water discharge or material transport. An identifiable channel is one in which the channel banks are well defined and measurable (Chorley et al. 1984). In the OESF, approximately 90 percent of Type 5 streams occupy unstable ground and directly contribute materials to the channel network. About 5 percent have identifiable channels on stable ground. The remaining 5 percent exert a negligible influence on aquatic or riparian habitat and, thus, require no special protection. Channels in this last group include those not connected to the watershed stream-network (e.g., sinks, seasonal wet areas excluding forested wetlands), slope depressions with no identifiable banks (e.g., swales with a continuous groundcover), and artificial channels that do not support aquatic habitat (e.g., ditches, yarding trails).

There are no available quantitative models or databases that specify which Type channels require buffer protection. Hence, determinations of location and size of riparian buffers on Type 5 streams will be made on a case-by-case basis in the field, using a 12-step watershed-assessment procedure described later in this chapter. The objectives-based nature of this riparian conservation strategy requires that assessments and proposals for manipulative research or management be reviewed by a qualified physical scientist. In addition, streams listed as Type 9 (unclassified) or streams not in DNR's hydrology databases will be treated similarly. Type 4 or 5 streams documented to contain fish that are proposed or candidates for federal listing will be treated as Type 3 waters. Type 5 channels with a potential for delivering water, wood, sediment, nutrients, and energy to the channel network will be protected from the active channel margin outward tot he topographic break in slop on either side of the channel, as well as upstream to the channel initiation point and downstream to the channel confluence. (See Figure IV.9).

Figures IV.10, IV.11, and IV.12 demonstrate one of several potential scenarios for the adjustment of riparian-buffer widths to meet site conditions. These buffer configurations are based on mass-wasting inventories and field assessments of physical and ecological riparian conditions. Figure IV.10 shows the application of the expected average interior-core and exterior buffer widths to a segment of the Clallam River and its tributaries. Figure IV.11 compares the expected average riparian buffer widths for the same area and buffers designed solely on the basis of mass-wasting inventories. Figure IV.12 shows one potential example of a buffer configuration that would include mass-wasting sites and meet riparian conservation objectives for maintaining physical and ecological functions of the riparian system.

Exterior Buffers

Exterior riparian buffers are intended to protect the integrity of interior-core buffers from damaging winds. Exterior buffers will also help maintain channel-floodplain interactions, moderate riparian microclimate, shield the inner core from the physical and ecological disturbances of intensive management on upslope sites, and maintain diverse habitat for riparian-dependent and upland biota.

This riparian strategy treats the design and the layout of the exterior buffer in two ways:

(1) it intends light partial harvests, tailored to local landform and meteorological conditions, as an initial management approach (see discussion below);

(2) it relies on experiments, from which DNR can gain new knowledge to improve management techniques in riparian forests.

Although tree blowdown is recognized as a significant problem for timber management on the western Olympic Peninsula, the exact relation between timber harvest and tree blowdown is not well understood or documented. Hence, the purpose of the experiments in the exterior buffer will be to determine, for representative site conditions, the optimum buffer width and long-term management strategies for maintaining wind-firm streamside forests. Harvest and other management activities in the experimental exterior buffers, therefore, could follow any one of a series of experimental designs that will be replicated across the landscape to ensure statistical significance of experiment results.

Widths for the exterior buffers were estimated by qualitatively evaluating historical patterns of windthrow resulting from average winter storms in the OESF and by reviewing the limited information available from local wind-buffer trials. As a starting hypothesis, the average width of exterior buffers will be 150 feet for Type 1 through 3 streams and 50 feet for Type 4 and 5 streams (Table IV.8), measured in horizontal distances laterally from the outer edge of the interior-core buffer on either side of the stream. These

Figure IV.9: Example of management protection (riparian buffer) placed on Type 5 channel system

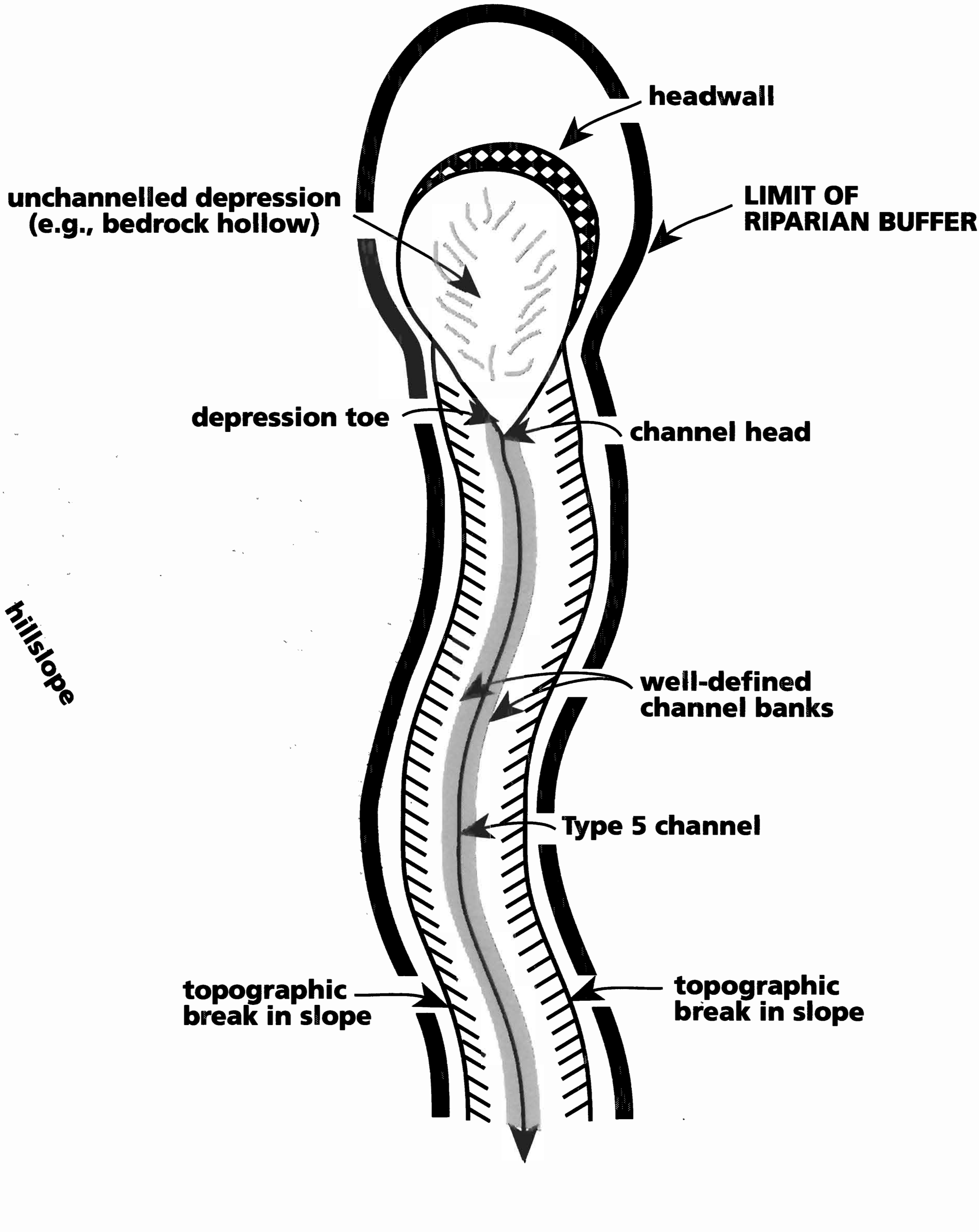
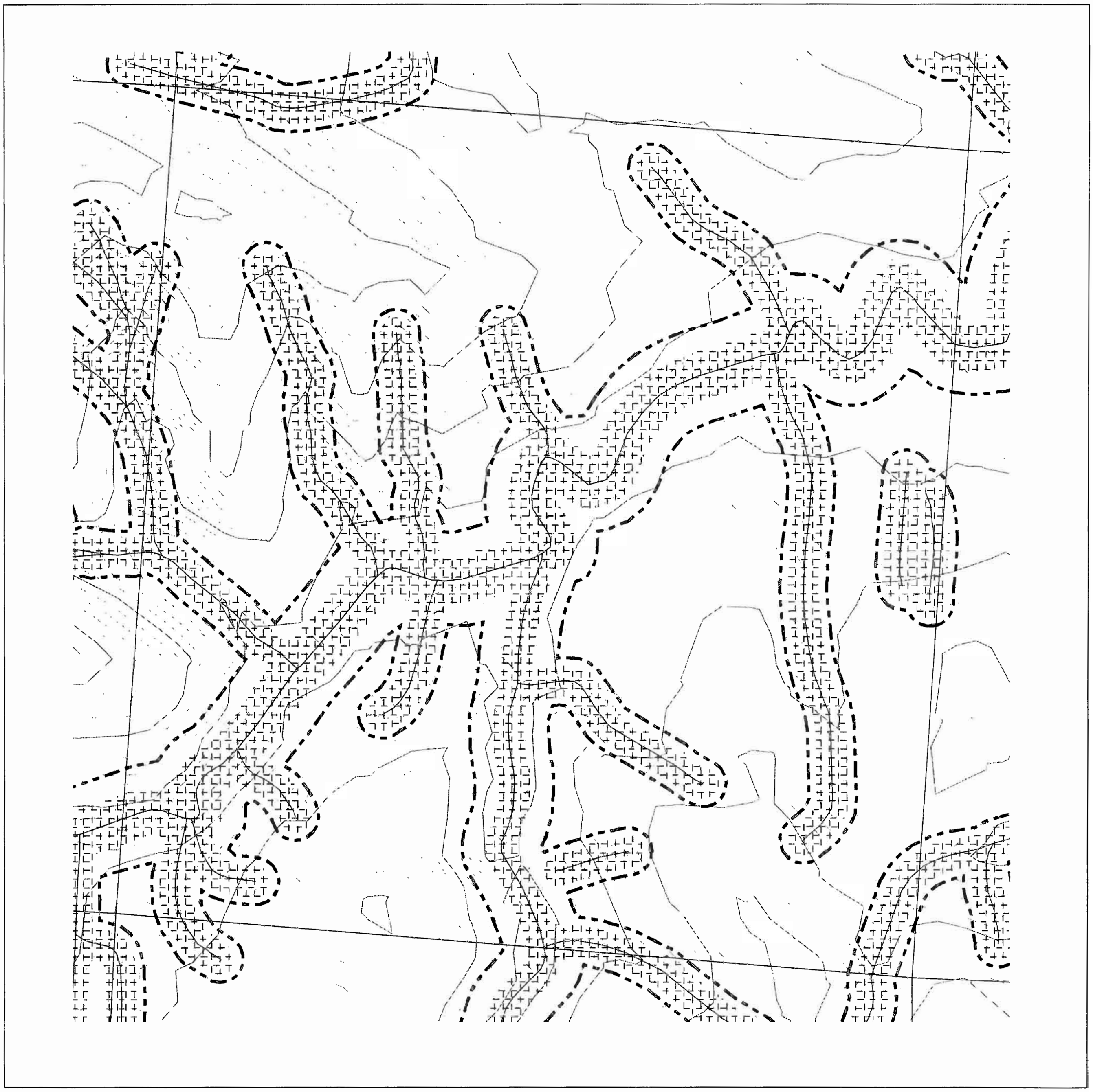


Figure IV.10: Application of expected average interior-core and exterior buffer widths to a segment of the Clallam River and its tributaries

These buffers have not been adjusted to meet site-specific requirements for unstable slopes. For purposes of simplicity, this figure assumes all Type 5 streams are buffered. However, that is not how the strategy will be implemented. See text.



External riparian buffer

Interior-core riparian buffer

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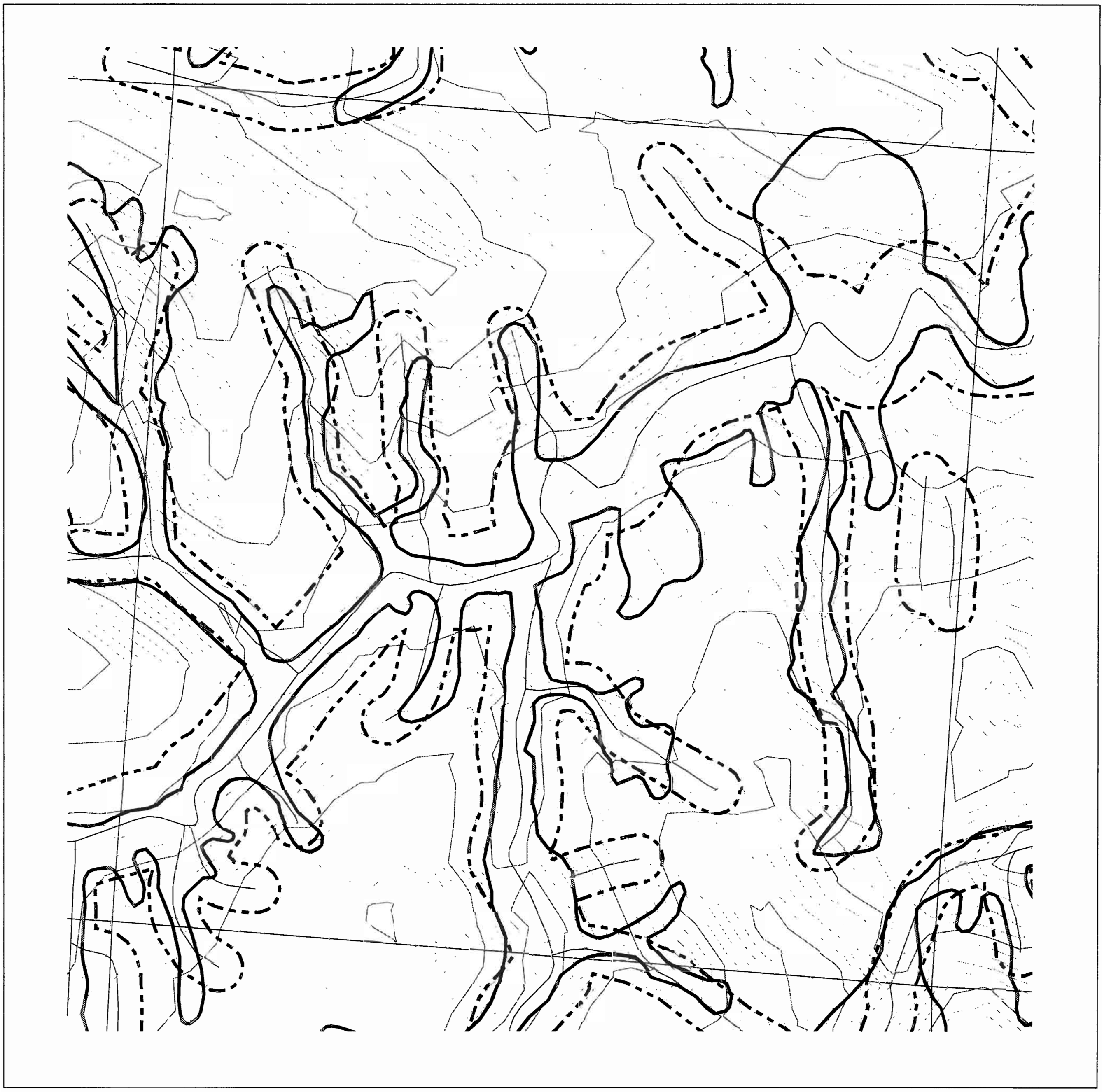
Scale 1:12,000
Contour Interval = 40 feet
September 18, 1995

Figure IV.11: Comparison of expected average riparian buffer widths and buffers applied to protect only mass-wasting sites for a segment of the Clallam River and its tributaries



External riparian buffer

Mass-wasting buffer

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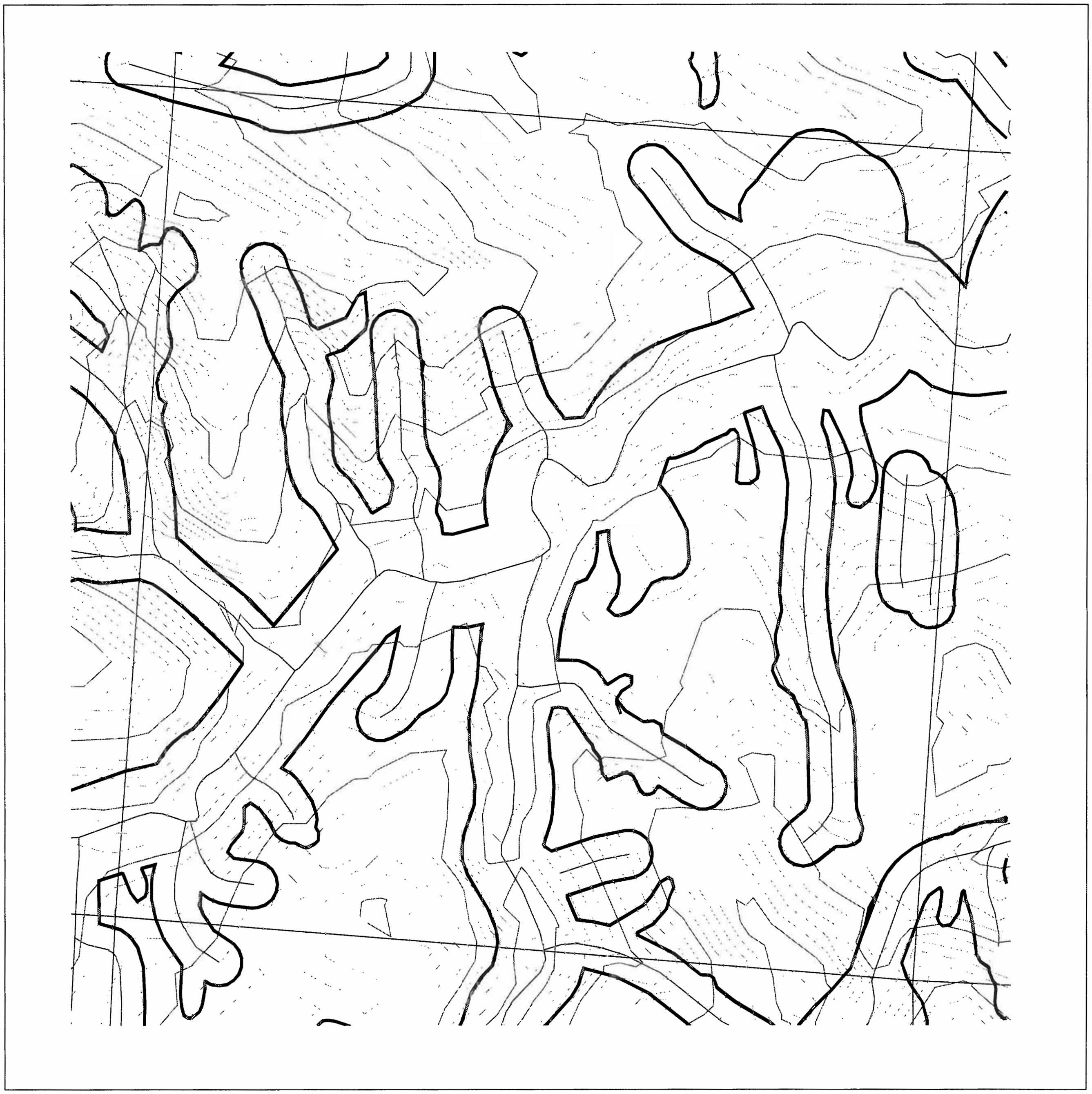
Scale 1:12,000
Contour Interval = 40 feet
September 18, 1995

Figure IV.12: Application of expected average riparian buffer widths adjusted for mass-wasting sites for a segment of the Clallam River and its tributaries: one potential scenario

This buffer configuration meets riparian conservation objectives for maintaining physical and ecological functions of the riparian systems.



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Scale 1:12,000
Contour Interval = 40 feet
September 18, 1995

are average, rather than absolute, values because the size and configuration of wind buffers must vary locally to accommodate terrain and stand characteristics. Management to achieve wind-firm riparian stands will be adaptive, in order to test a variety of strategies and apply those strategies that are most effective in the long term.

Table IV.8: Proposed average widths of exterior riparian buffers in the Olympic Experimental State Forest

Widths are expressed as average horizontal distances measured outward from the interior-core buffer on either side of the stream. Widths are proposed as a working hypothesis and are based on local knowledge of windthrow behavior. Buffer widths and design will be evaluated through experiments in buffer design in the OESF. Buffers will be applied where necessary (see text).

Stream type	Width of riparian exterior buffer (horizontal distance, rounded to the nearest 10 feet)
1	150
2	150
3	150
4	50
5	50

Exterior buffer widths (Table IV.8) will be applied to interior-core buffers through a standard procedure or an experimental approach as follows:

(1) Standard procedure: To achieve the objective of wind-firm riparian forest, wind buffers will be placed on all riparian segments for which stand wind-firmness cannot be documented by historical information, windthrow modeling (e.g., Tang 1995), or other scientific means. Thirty-three percent or less, by volume, of the riparian trees in the designated exterior buffer may be removed for commercial purposes (i.e., excluding pre-commercial thinning and restoration activities) per rotation, until research is available supporting more frequent entry. This percentage corresponds to the lightest intensity partial harvest currently used in the Experimental Forest to produce forest stands that are robust and diverse, both structurally and compositionally. The spacing of tree removal will be determined in the field from an assessment of physical and biological conditions of each site (see Implementing the Riparian Conservation Strategy later in this section), windthrow potential, and the stated objectives of the riparian conservation strategy for the OESF. Exterior buffers within a landscape planning unit will not be harvested a second time until the conservation objectives of the riparian strategy are met in that landscape planning unit.

(2) Experimental approach: Foresters and managers will select from a number of experimental designs for the exterior buffer and apply the chosen design to the management area of interest. The designs for the outer buffer will be developed by DNR with input from others such as the Olympic Natural Resources Center and Timber-Fish-Wildlife Agreement cooperators and approved by DNR. The intent is to create a number of viable experimental designs for each of

several distinct riparian configurations in the Experimental Forest, identified on the basis of their landform, orographic, vegetational, and meteorological characteristics. The process will be documented and monitored closely to ensure that unsuccessful experimental designs are discarded, riparian disturbances are minimized, and adequate numbers of replicated experiments are performed to yield statistically meaningful results.

Not all riparian areas lend themselves to experiments because many forest stands have been fragmented by previous harvest activities. Fragmented forests in the OESF principally contain late successional stands, old-growth remnants, or trees that regenerated after the widespread windstorm in 1921 (referred to as "1921-blow" stands). Management activities in these forests should be consistent with the stated objectives of the riparian conservation strategy and with other conservation efforts that require stands in older age classes to achieve forest-wide biodiversity and suitable habitat (e.g., for species like the northern spotted owl).

DNR anticipates that the standard practice for implementing exterior buffers, as described above, will be applied on approximately 75 to 85 percent of the riparian areas in the OESF. In the remaining acreage, exterior buffers will be established via the experimental procedure. Experimental designs may range from no exterior buffer in wind-firm stands meeting the stated objectives of the riparian conservation strategy to buffers several hundred feet wider than those recommended (Table IV.8) in sites highly susceptible to windthrow. Experiments will be tracked through the OESF research and monitoring program. (See the sections titled Monitoring and Research in Chapter V.) Experiments will be conducted such that the protection and restoration objectives of this riparian strategy will not be knowingly compromised, recognizing that there is some risk of habitat alteration and incidental take associated with conducting experiments in riparian buffers.

Comprehensive Road-Maintenance Plans

The objectives of a comprehensive road-maintenance plan are to:

(1) ensure annual inventories of road conditions;

(2) maintain existing roads to minimize drainage problems and stream sedimentation;

(3) stabilize and close access to roads that no longer serve a management function or that cause intractable management or environmental problems;

(4) assure sound construction of any new roads;

(5) guarantee that additional new roads are built only where no other operationally or economically viable option exists for accessing management areas by existing roads or alternative harvest methods (e.g., full-suspension yarding);

(6) minimize active road density;

(7) prioritize roads for decommissioning, upgrading, and maintaining; and

(8) identify fish blockages caused by stream crossings and prioritize their retrofitting or removal.

No absolute threshold exists for acceptable road densities within drainage basins because the maximum carrying capacity for roads in a watershed depends on the topography, geology, climate, and competing ecological and land-use objectives, as well as road use, type, location, and construction method. Cederholm and Reid (1987) reported that 2.5 miles per square mile or less constitutes the optimum number of road miles for the Clearwater River basin. Roads on flatter ground than the Hoh-Clearwater terrain, however, are less likely to deliver sediment to streams; therefore, comparatively more roads might be possible without degrading water quality. Hence, optimum road densities must be determined on a watershed basis.

The riparian conservation strategy seeks to use landscape-planning tools to analyze the projected needs for roads over the long term (i.e., greater than 100 years) and use this information to minimize the total road density within each watershed. The Clallam River Landscape Plan (DNR Olympic Region 1995) represents one of several prototypes for how DNR envisions carrying out this objective in the 11 landscape planning units in the Experimental Forest. This method or other similar ones would be used to address road densities elsewhere in the Experimental Forest. The specific methods or models used, however, will vary as new technologies become available.

As an example, the Clallam River Landscape Plan covers approximately 16,000 acres in the northern portion of the Experimental Forest. The plan features conservation strategies similar to those proposed for the entire Experimental Forest and seeks to schedule management activities over multiple decades consistent with the dual objectives of sustaining long-term commodity production and ecological values. The present and future transportation network was evaluated through the use of a computer model (i.e., Scheduling and Network Analysis Program, Sessions and Sessions 1994) that analyzes proposed harvest units and road networks for a given landscape unit on the basis of constraints imposed by the conservation objectives and inventoried watershed conditions. The analysis was projected 100 years into the future so that the model would create all possible management units and road networks within the planning area. The resulting road network represented the maximum road density that hypothetically would be necessary at any time in the future. The analysts then systematically evaluated each road in the transportation layer to identify roads that could be eliminated because they duplicated access by other means or, in the case of existing roads, would not be used in the future. This analysis resulted in a comprehensive, long-term (i.e., 100-year) road plan for all essential new construction, abandonment, and relocation.

Protection of Forested Wetlands

The objective of forested-wetlands protection in the Experimental Forest is to maintain and aid natural restoration of wetland hydrologic processes and functions. The wetland strategy for the OESF seeks to achieve this objective by:

(1) retaining plant canopies and root systems that maintain adequate water transpiration and uptake processes;

(2) minimizing disturbance to natural surface and subsurface flow regimes;

(3) ensuring stand regeneration.

In addition, wetlands in areas susceptible to blowdown would be treated comparably to stream buffers, with maintenance of wind-firm stands as a primary conservation objective. Harvest-design experiments to achieve sturdy buffers should be considered in these instances.

Wetlands, as defined by the state Forest Practices Board Manual (WFPB 1993a), will be protected in the OESF. Forested wetlands larger than 0.25 acre and bogs larger than 0.1 acre will be protected with buffers and special management considerations. This is consistent with Policy No. 21 of DNR's Forest Resource Plan, which calls for "no net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36). Series of smaller wetlands will be protected if they function collectively as a larger wetland. In addition to meeting the requirements stated in WAC 222-30-020(7) (WFPB Manual 1993a), nonforested wetlands will receive buffer protection consistent with DNR's wetlands policy quoted above.

Table IV.9 describes the level of buffer protection proposed for forested and nonforested wetlands in the Experimental Forest. Average buffer widths are measured from the outer edge of the forested wetland, as defined by the U.S. Fish and Wildlife Service. (See Bigley and Hull 1993.) The recommended buffer width for wetlands greater than 5 acres is equal to the average site potential tree height for riparian forests in the OESF. For wetlands between 0.25 and 5 acres, the recommended buffer width averages two-thirds of the site potential tree height. Site-potential tree heights are determined from Wiley (1978) for dominant conifer species; see discussion related to coarse woody debris in Summary: Benefits of the Riparian Conservation Strategy later in this section.

Table IV.9: Proposed protection of forested and nonforested wetlands in the Olympic Experimental State Forest

Average buffer widths are measured from the outer edge of the forested wetland. Average buffer widths for forested wetlands: 150 feet for wetlands greater than 5 acres;100 feet for wetlands 0.25 to 5 acres.

Harvest within forested wetlands and their buffers	▮ Retain at least 120 square feet basal area ▮ Take appropriate steps to maintain wind-firm buffers, as per recommendations for exterior riparian buffers
Harvest within forested buffers of nonforested wetlands	▮ No harvest within 50 feet of wetland edge ▮ Harvest within buffers beyond 50 feet designed to maintain stand wind-firmness, as per recommendations for exterior riparian buffers ▮ Leave trees should be representative of the dominant and co-dominant species in the intact forest edge of the wetland

DNR estimated that retaining 120 square feet basal area in forested wetlands would maintain a minimum level of hydrologic function in wetland trees. This estimate is derived from models of leaf area recovery following harvest. Basal area is assumed to be an adequate surrogate for leaf area index in predicting the impacts of partial harvest on tree evapotranspiration and canopy interception. Predictions of leaf area index response (Kimmins 1993; McCarthy and Skaggs 1992) indicate that improvements in leaf area index with time should compensate for some modifications of wetland hydrology associated with tree removal. (See Section D of this chapter titled Riparian Strategy for the Five West-side Planning Units for additional discussion of the leaf area.)

Integration of Research and Monitoring

The riparian conservation strategy is integrated with the research and monitoring strategy for the OESF described in Chapter V. All experiments performed in riparian areas, particularly those to evaluate windthrow behavior in riparian forests, will be carried out according to research protocols established for the Experimental Forest. Watershed conditions will be monitored over time through:

(1) the monitoring method described in Standard Methodology for Conducting Watershed Analysis (WFPB 1995);

(2) the monitoring program established for the Hoh River, Kalaloch Creek, and Nolan Creek drainages (Hoh Tribe and DNR, Memorandum of Understanding, 1993); and

(3) the monitoring strategy for the Experimental Forest, implemented through the landscape planning program or the proposed 12-step watershed-assessment procedure. (See Implementing the Riparian Conservation Strategy later in this section.)

RATIONALE FOR THE RIPARIAN CONSERVATION STRATEGY

The effects of forest management activities on the physical and biological condition of riparian ecosystems, particularly with regard to the loss of habitat complexity, have been documented locally on the Olympic Peninsula (e.g., Cederholm and Lestelle 1974; Cederholm and Salo 1979; Schlichte et al. 1991; Benda 1993; Shaw 1993; Quinn and Peterson 1994; DNR and U.S. Forest Service 1994; DNR, Olympic Region 1995; McHenry et al. 1995; DNR and U.S. Forest Service, Sol Duc Watershed Analysis, in progress), as well as throughout the Pacific Northwest (e.g., Harr et al. 1975; Bisson and Sedell 1984; Grant 1986; Swanson et al. 1987; Bisson et al. 1992). Management-related modifications of riparian habitat occur, regardless of who owns or manages the land, as a consequence of the terrain characteristics, soil properties, rainfall regimes, and other natural phenomena that increase susceptibility to mass wasting and changes in channel morphology. The principal causes for loss of habitat complexity in the OESF are:

(1) channel erosion and sedimentation associated with landslides and related channel disturbances (e.g., debris flows and dam-burst floods);

(2) reduction in stream shade and delivery of organic debris to the channels due to alteration of the structure and composition of streamside forests; and

(3) channel-bank erosion and loss of long-term sources of coarse woody debris due to past management practices and extensive windthrow disturbances.

The dimensions of the interior-core buffers have been set on the basis of locally documented requirements for protecting channel margins and hillslopes susceptible to mass wasting. DNR chose this physical rationale because relatively more quantitative information exists regarding landforms and geomorphic processes than for ecological processes affecting riparian areas within the Experimental Forest. (See supporting evidence and discussion concerning current riparian practices in the Experimental Forest in the Draft EIS that accompanies this HCP.) Buffers wider than currently mandated by state-regulated Riparian Management Zones (WFPB 1993a) are frequently needed to incorporate unstable ground in the OESF. For example, most Types 4 and 5 streams in proposed harvest areas with slopes exceeding approximately 70 percent are protected by no-harvest buffers because of the recurrence and severity of landslides and debris flows that originate in the headwalls of these drainages (Benda 1993; Hoh Tribe and DNR 1993; O'Connor and Cundy 1993; Shaw 1993; DNR, Olympic Region, 1995; McHenry et al. 1995). Type 5 channels are a special concern in the Experimental Forest because they are the primary conduit for delivering material from upslope areas to fish-bearing stream reaches. Furthermore, current practices in DNR's Olympic Region commonly provide greater protection than state-regulated Riparian Management Zones in low-gradient alluvial stream systems (i.e., Types 1-3) because state-regulated Riparian Management Zones frequently do not adequately protect incised channel margins, unstable terrace and hillslope margins, and floodplain wetlands.

The dimensions of the exterior buffer represent DNR's best understanding of what might be required to protect the integrity of the interior-core buffers. A number of site factors promote susceptibility to windthrow on the western Olympic Peninsula, but there are no proven management techniques for successfully minimizing potential windthrow. The conservation strategy, which really is a working hypothesis, will lead toward better understanding of windthrow in managed forests through experimentation and systematic application and refinement of knowledge gained.

Although the riparian conservation buffers have been established on the basis of physical arguments, DNR expects that these buffers will contribute to the maintenance and recovery of ecological habitat complexity in aquatic and riparian systems. This hypothesis derives from the current understanding of the dynamics and processes of these systems. For that reason, research and monitoring can improve scientific knowledge and management practices in the Experimental Forest.

Table IV.10 compares the average buffer widths proposed for mass-wasting and windthrow protection in the OESF with those recommended in the literature for key physical and ecological parameters that are essential for creating and maintaining riparian and aquatic habitat in the OESF. This is not an exhaustive list of the ecological variables in riparian areas, but rather those key parameters about which enough is currently known to guide the development of best management practices in riparian areas. The importance of these parameters for salmonids is discussed generally in Section D of Chapter III titled Salmonids and the Riparian Ecosystem. The benefits of the riparian conservation strategy with regard to these parameters are summarized in the next paragraphs.

Table IV.10: Comparison of average riparian buffer widths expected as a result of applying the Olympic Experimental State Forest riparian conservation strategy and buffer widths proposed in the literature for several key watershed parameters

Buffer widths are given as average horizontal distances (or range of averages) outward from the active channel margin.

Key watershed parameter	Buffer width by stream type - proposed for the OESF				
	1	**2**	**3**	**4**	**5**
Mass wasting	150 ft all Type 1 streams will be protected	150 ft all Type 2 streams will be protected	100 ft all Type 3 streams will be protected	100 ft all Type 4 streams will be protected	0-500+ ft; depends on size of contribution area[1] and amount of unstable ground[2]
Mass wasting and windthrow combined	150 ft inner, 150 ft outer[3]	150 ft inner, 150 ft outer[3]	100 ft inner, 150 ft outer[3]	100 ft inner, 50 ft outer[3]	variable inner, 50 ft outer[3]

Key watershed parameter	Buffer width by stream type - proposed in the literature[4]				
	1	**2**	**3**	**4**	**5**
Coarse-woody-debris recruitment[5]	108-168 ft	108-168 ft	105-153 ft	105-153 ft	105-153 ft
Stream shade availability[5]	108-168 ft	108-168 ft	105-153 ft	105-153 ft	105-153 ft
Riparian forest microclimate[6]	300 ft	300 ft	250 ft for >5-ft-wide channels	125 ft	
Channel bank stability	Commensurate with mass-wasting buffer protection on stream channels.				
Lateral channel migration	Commensurate with combined mass-wasting and windthrow protection on stream channels.				
Water quality[5]	108-168 ft	108-168 ft	105-153 ft	105-153 ft	105-153 ft
Water quantity	Unknown. Objectives of proposed buffers are to help moderate peak-flow discharges related to removal of vegetation (e.g., harvest) by ensuring hydrologic maturity of forests, as per Washington Forest Practices Board (1994).				
Windthrow	Unknown. Objectives of proposed buffers are to enhance stand wind-firmness by decreasing tree height/diameter ratios, fetch distances in adjacent harvest units, and edge effect.				
Surface and road erosion	Variable, depending on site conditions. Objectives are to minimize erosion through implementation and comprehensive road-maintenance plans for each landscape unit (see text).				

[1] "Contribution area" refers to upslope channel heads, bedrock hollows, unchannelized valleys, and topographic depressions; see discussion of OESF Type 5 drainages in the Draft EIS associated with this HCP.

[2] Refer to discussion of Type 5 drainages in the Draft EIS associated with this HCP.

[3] Exterior (wind) buffer, where harvest and management activities are allowed. On Type 5 streams, exterior buffers will only be applied as necessary where there are interior-core buffers. See text.

[4] See discussion in this section of the text for citations of current literature.

[5] Buffer widths are based on available literature citing one site potential tree height for each stream type as the ecologically appropriate measure; see discussion in text.

[6] Buffers widths are recommended by FEMAT (1993) and Cederholm (1994).

Recruitment of Coarse Woody Debris

The probability that a tree will fall into a stream is greatest where the slope distance from the tree base to the active channel margin is less than one site potential tree height (i.e., as defined in Section D of this chapter titled Riparian Conservation Strategy for the Five West-side Planning Units; FEMAT 1993). The interior-core buffer widths for each stream type on the OESF are greater than or approximately equal to the site potential tree height for a 50-year growing cycle and 70 to 90 percent of the site potential tree height for a 120-year growing cycle. Representative site potential tree heights for each stream type were calculated by identifying streams of known type on soil survey maps registered by orthophotos, determining average site indices for growth potential from survey data for soils commonly found on stream banks and floodplains, and employing tree-height tables published in Wiley (1978). Estimated site potential tree heights for the Experimental Forest are: for Types 1 and 2 streams, 108 feet for a 50-year growing period, 155 feet for a 100-year period, and 168 feet for a 120-year period; and for Types 3 through 5 streams, 105 feet for a 50-year growing period, 153 feet for a 100-year period, and 165 feet for a 120-year period. Field measurements (McDade et al. 1990) indicate that buffer widths equal to approximately 60 percent of the average tree height will provide 90 percent of the natural level of instream large woody debris. Extrapolating from these results, a buffer width equal to approximately the 100-year site potential tree height, which is more than 60 percent of the 200-year site potential tree height (i.e., 60 percent of an old-growth tree height), should provide more than 90 percent of the natural level of instream large woody debris.

Stream Shade Availability

Shade regulates stream water temperatures throughout the year. Shade is supplied primarily by the forest canopy above and adjacent to the channel. Shade, however, varies with the type, height, and density of streamside vegetation, as well as local topography and diurnal changes in position of the sun relative to channel orientation (Naiman et al. 1992). The probability that a tree will provide shade is greatest where the slope distance from the tree base to the active channel margin is equal to or less than one site potential tree height. Limited studies in the western Pacific Northwest suggest that riparian buffers about 100 feet wide supply shade equivalent to undisturbed late successional or old-growth forests (Steinblums 1977; Beschta et al. 1987). Steinblums et al. (1984) reported that buffers between 75 feet and 125 feet wide maintain 60 to 80 percent of the undisturbed canopy density and, hence, the potential for stream shading. These widths are commensurate with, or less than, those recommended for recruitment of coarse woody debris. The proposed interior-core buffers, hence, are expected to be wide enough to provide 80 to 100 percent of stream shade, provided that streamside canopies are dominated by mature conifers. In the OESF, hardwood-dominated riparian forests offer insufficient shade following seasonal loss of foliage to moderate winter water temperatures (e.g., Hatten and Conrad 1995). Goals of the OESF riparian conservation strategy, therefore, are to maintain sufficient buffers in mature stands to moderate water temperatures year round and to manage for conifer succession in hardwood-dominated stands and young plantations. Because 70 percent of the riparian areas on DNR-managed lands in the OESF are hardwood-dominated or young stands, however, recovery of full stream-shade potential will take several decades.

Nutrient Input to Streams

Riparian vegetation regulates the food-energy base of aquatic ecosystems by supplying plant and animal detritus to the stream and forest floor. Dissolved nutrients and litter derived from flowers and fruits, leaves, needles, wood, and insects provide essential food for aquatic invertebrates and fish (Gregory et al. 1991; Bilby and Bisson 1992). The Forest Ecosystem Management Assessment Team (1993) suggests that input of plant litter and other organic particulates from streamside forests decreases beyond a distance of about one-half tree height from the active channel margin. Other information relating probability of nutrient input to slope distance from the channel margin is scarce. Hence, the working hypothesis for the OESF is that sufficient forest-generated nutrients will be supplied from the area of interior-core buffers to maintain nutrient delivery to streams. The Experimental Forest will provide a forum for testing these hypotheses.

Alders, in particular, are important components of the aquatic and riparian ecosystem because they fix nitrogen and are significant sources of nitrogen as a dissolved nutrient. Although a goal of the Experimental Forest is to aid regeneration of conifers in hardwood-dominated stands, it is also the intent to maintain a conifer-hardwood mix characteristic of natural disturbance regimes, including alders as dominant and co-dominant species where ecologically appropriate within the riparian system.

Riparian Microclimate

Riparian forests moderate climatic conditions in the transitional areas between terrestrial and aquatic environments. Riparian ecosystems support more aquatic, terrestrial, and amphibious species than upland habitats, in part because streams and streamside forests create a more humid microclimate, have higher transpiration rates, are cooler in summer and warmer in winter, and maintain moister soils and greater air movement (Brown 1985). The ability of a riparian forest to ameliorate microclimate is diminished significantly where vegetation is removed from both sides of the stream. Few data are available from the western Olympic Peninsula or elsewhere in the Pacific Northwest pertaining to the effects of forest management on riparian microclimates. The primary working hypothesis of the OESF riparian conservation strategy, therefore, is that riparian microclimate will be improved by minimizing edge effects associated with proximity of harvest units to channels and their orientation with respect to prevailing wind directions. The exterior riparian buffer reduces wind disturbances of streamside forests and shields the riparian core from edge effects associated with intensive management on adjacent ground. Part of the experimental approach in establishing exterior buffers will be to situate adjacent harvest units and employ harvest designs (e.g., partial cuts, small clearcut units, uneven-aged stands) that reduce the potential for progressive loss of riparian-buffer function by edge-effect processes (e.g., blowdown).

Characteristic riparian microclimates may also be maintained by placing buffers on both sides of a stream that are sufficiently wide to insulate water and soils from direct radiation, reduce wind velocities in riparian forests and retain soil and air humidities.

Water Quality

The riparian conservation strategy seeks to maintain and aid natural restoration of water quality in order to meet state water-quality standards for all existing characteristic uses (e.g., aquatic habitat and domestic and municipal water supplies). The principal causes of declining water quality in the Experimental Forest are water temperatures that exceed state and federal standards and turbidity associated with stream sedimentation on commercial forest lands. According to current scientific understanding, the best method to deal with temperature and turbidity problems is to place buffers on streams that are wide enough to:

(1) maintain natural background sediment-delivery rates and minimize management-related input of sediments to streams;

(2) provide enough shade to regulate water temperatures; and

(3) assure long-term sources of coarse woody debris that will trap sediment and moderate flow.

The riparian conservation strategy seeks to reduce stream turbidity by:

(1) protecting all mass-wasting and surface-erosion sites that have a potential for delivering sediment to streams;

(2) maintaining roads and limiting road densities (i.e., potential new sources of surface erosion) through comprehensive road-maintenance plans; and

(3) restoring long-term sources of coarse woody debris. This strategy also provides for maintaining and restoring stream shade. (See previous discussion of stream shade availability in this section.)

Water Quantity

Increased surface runoff to streams can result from vegetation removal (Likens et al. 1970; Eschner and Larmoyeux 1963; Blackburn et al. 1982; WFPB 1994) and increased numbers of road drainages delivering water to streams. Precipitation conditions on the western Olympic Peninsula that lead to increases in the frequency and volume of peak flows are rain-on-snow events, rainfall of high intensity and long duration typical of winter months, and heavy rain on frozen ground, which can occur during January and February. The potential for these conditions to affect seasonal and annual water quantity is influenced by the type, age, and density of forest vegetation. Approximately 19 percent of DNR-managed lands in the OESF, mostly in the Hoh and Clearwater drainages, lie in the rain-on-snow zone as defined by state forest practices regulations (WFPB 1994). The state addresses the cumulative effects of rain-on-snow events by regulating the percent area in Type 3 basins with greater than 70 percent forest-crown closure and less than 75 percent hardwood or shrub canopies.

DNR recommends using the methods for analyzing rain-on-snow and peak-flow events given in the Standard Methodology for Conducting Watershed Analysis (WFPB 1994). In addition, DNR expects that limiting the amount of new road construction and improving drainages on existing roads will reduce the potential for augmenting peak flows. Furthermore, the unzoned-forest approach to conserving habitat for listed species likely will lead to forest conditions, within about 35 years, that will assure hydrologic maturity in at least 70 percent of each Type 3 basin. Because current knowledge is incomplete, a priority research direction for the OESF is to investigate the relationships between forest management and hydrology in order to improve scientific understanding leading to effective management of water quantity.

IMPLEMENTING THE RIPARIAN CONSERVATION STRATEGY

The OESF riparian conservation strategy will be in effect throughout the life of this HCP. Landscape plans are the vehicle for implementing commodity production and conservation strategies in the Experimental Forest. Riparian buffers will serve as the foundation for landscape plans, around which forest management, conservation, and research activities will be designed. A primary objective of the Experimental Forest will be to support natural restorative processes of streams and streamside forests by whatever means necessary, so that riparian environments can recover suf-ficiently to sustain both commercial forest enterprises and healthy ecosystems.

Prior to landscape planning in each of the 11 landscape planning units in the Experimental Forest, watershed conditions will be evaluated and monitored through a 12-step watershed assessment procedure (described later). Results from assessments of physical and biological conditions obtained from the regulatory watershed-analysis process (WFPB 1994) will be used where possible, in lieu of those assessments required in the 12-step process. Therefore, following the implementation of the OESF, preliminary assessments and management activities will occur before landscape planning in most landscape planning units.

Landscape Planning

Methods and procedures for landscape planning will likely be similar to those developed for the Clallam River Landscape Plan, which was designed for 16,000 acres of state land in the northern part of the Experimental Forest (DNR Olympic Region 1995). In this prototype landscape plan, management, economic, conservation, and recreation objectives were evaluated simultaneously. Maps of riparian buffers, designed to protect unstable ground and key ecological features, served as the primary planning layer around which other management and conservation strategies evolved. The riparian layer was built into a harvest planning model so that designs for harvest units, logging settings, and roads took into account the conservation objectives for and requirements of riparian protection. In addition, economic analyses and harvest level projections factored in the long-term costs and benefits of protecting riparian areas.

Watershed-assessment techniques used during landscape planning might include those found in the "Forest Agreement Related to the Hoh River, Kalaloch Creek and Nolan Drainages" (Hoh Tribe and DNR, Memorandum of Understanding 1993) and Standard Methodology for Conducting Watershed Analysis (WFPB 1994) and designed for the 12-step watershed assessment (described below). The agency may wish to sponsor a regulatory watershed analysis in lieu of some or all parts of the 12-step process. However, given the watershed concerns in the OESF, DNR likely will go beyond the state Forest Practices Board (WFPB 1994) methods in order to account for issues not addressed in the Forest Practices Board manual. Therefore, additional analyses for any given landscape planning unit might include water quality, wildlife habitat, nontimber commodity production, urban influences, estuarine/near-shore marine conditions, or other relevant issues.

Twelve-step Watershed Assessment Procedure

The objectives of the OESF riparian conservation strategy are to maintain and aid restoration of riparian functions at the watershed scale, rather than at the site-specific level. Implementing these objectives, therefore, requires an evaluation procedure by which the aquatic and streamside conditions at a given site can be assessed in relation to the known influences of physical, biological, and land-use factors throughout the watershed. Effective management and conservation strategies are dictated not only by site conditions but also by cumulative effects of management activities both upstream and downstream of the site. Consequently, the watershed assessment should assure that connectivity between riparian segments is accounted for in the design of long-term management, conservation, and research strategies.

No specific restrictions on management activities are given in the riparian conservation strategy, other than on road-building (described later). Adhering to the objectives of the riparian conservation strategy and implementing the watershed assessment procedure likely will identify specific activities that can be performed with minimum impact to the ecosystem. For example, the number of trees that can be removed from a riparian buffer in a particular watershed will be determined by assessing the potential for that buffer to continue providing coarse woody debris, stream shade, wind-firm stands, nutrients, sediment storage, streamflow moderation, and aquatic and terrestrial habitat for sensitive species.

Figure IV.13 outlines the assessment procedure for meeting riparian management and conservation objectives in the Experimental Forest. The intent is that managers, foresters, and scientists work together through the 12 steps to assure that proposed timber management or research activities do not conflict with the objectives of the riparian conservation strategy. This process will begin with the implementation of the OESF and will occur before landscape planning. The assessment methods may also be used during landscape planning. The steps are:

(1) Initiate the decision making procedure. The need for this procedure is triggered when DNR timber management (i.e., cutting trees, building roads) or manipulative research is proposed within a given Type 3 or larger watershed in the Experimental Forest. Manipulative research includes the removal, alteration, or addition of aquatic or riparian features, including live or dead vegetation, water, aquatic and riparian biota, sediments, bedrock, and artificial structures.

(2) Recognize the conservation objective of managing riparian and aquatic systems in the OESF: to maintain and aid natural restoration of riparian and aquatic functions and processes. Commodity production and riparian research are allowed as long as they are consistent with the conservation objective.

(3) Conduct preliminary assessment of physical and biological watershed conditions using results from the regulatory watershed-analysis process, where available. Table IV.11 lists the components of this assessment, some or all of which might be included in the analysis. Methods and guidelines would be established in agency procedures developed for the OESF. Where advantageous, methods described in the Standard Methods for Conducting Watershed Analysis (WFPB 1994) would be employed. Where possible, methods would yield quantitative data for analysis and future monitoring needs. The assessment would include an evaluation of the probable impact of proposed management or research activities on watershed conditions. This assessment would serve as a baseline for evaluating subsequent activity proposals and cumulative effects in the watershed by providing written record of conditions, decisions, activities, and results of management, research, and conservation efforts; and a scientifically sound rationale for the chosen management, research, and conservation strategies.

(4) Evaluate the degree to which watershed conditions meet the needs for maintaining viable riparian and aquatic processes and functions. Refer to objectives of the riparian conservation strategy, buffer-width recommendations, and Table IV.10.

Figure IV.13: Twelve-step watershed assessment procedure for meeting riparian conservation and management objectives in the Olympic Experimental State Forest

See discussion of each step in the text.

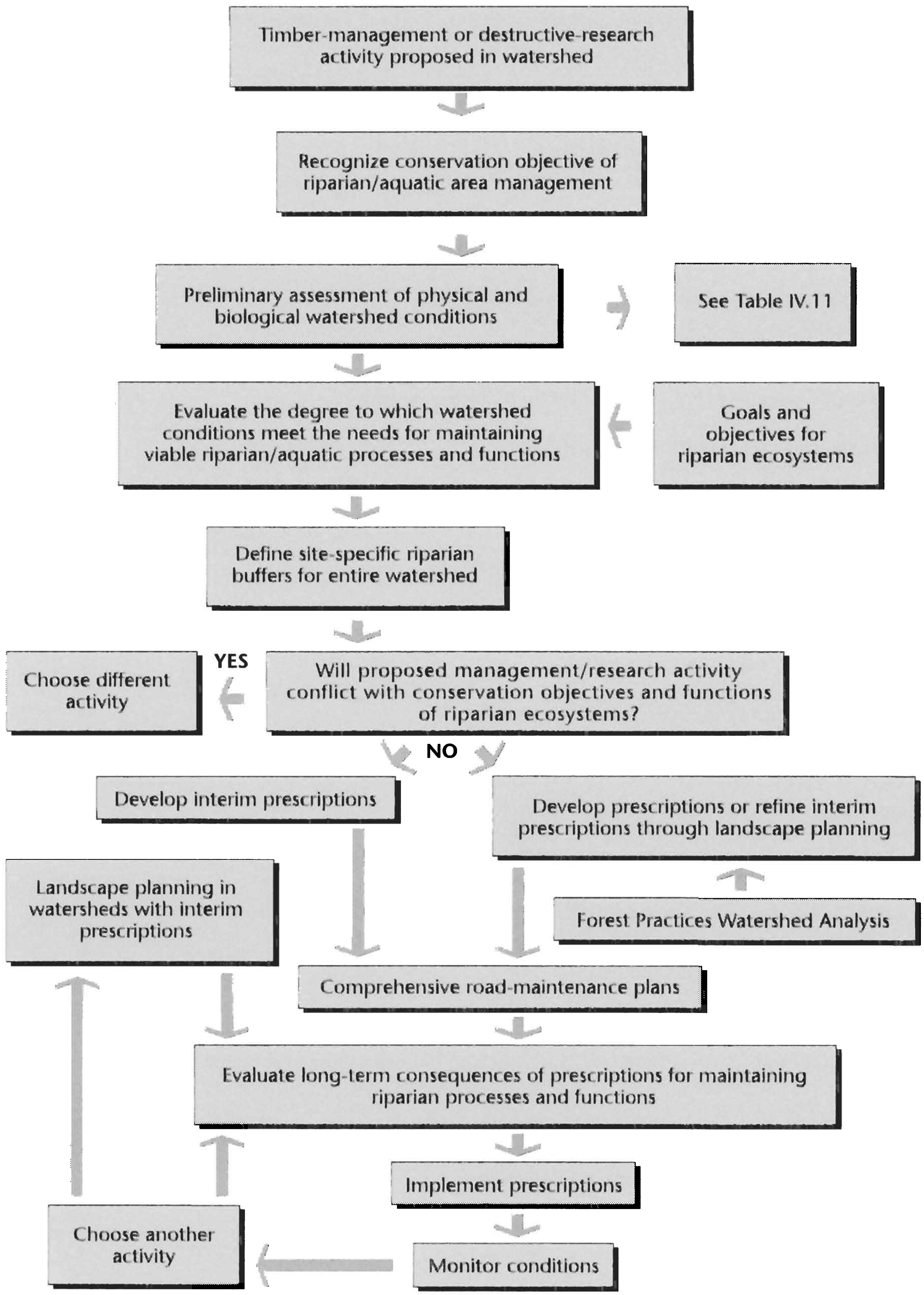

Table IV.11: Components of a preliminary assessment of physical and biological watershed conditions for the 12-step watershed assessment procedure for the Olympic Experimental State Forest

Some or all components might be evaluated, depending on watershed characteristics and the availability of analytical techniques. Methods will be outlined in agency procedures for implementation of the OESF. See step (3) in the text.

Mass wasting — existing and potential sites
Surface erosion — existing and potential sites
Road network densities
Road conditions — use, location, sidecast, and other problems
Road drainage structures — presence and condition
Hillslope hydrology processes (e.g., changes in channel-forming flows, rain-on-snow potential)
Water quality and quantity (e.g., temperatures, turbidity, supply)
Physical stream-channel conditions and processes
Floodplain and channel interactions ▪ physical interactions (e.g., bank erosion, lateral channel migration, hydrology) ▪ biological interactions (e.g., nutrient productivity)
Riparian microclimate (e.g., shade, ambient temperatures)
Coarse-woody-debris recruitment potential
Riparian plant community structure and composition
Riparian forest health
Habitat distribution, quality, and quantity for fish
Habitat distribution, quality, and quantity for fish prey (e.g., macro-invertebrates)
Habitat distribution, quality, and quantity for key riparian-dependent species[1]
Wildlife use of riparian areas (e.g., migration routes, foraging, predation potential)
Wind disturbance patterns (e.g., windthrow potential)
Past and proposed land-use practices (e.g., influence on biological/physical riparian processes)

[1]Key species currently are defined as those that are listed, or are candidates for listing, under the Endangered Species Act or by the Washington Department of Fish and Wildlife, or are listed as threatened, rare, or in need of monitoring by the Department of Natural Resources Natural Heritage Program. Habitat for other unlisted riparian-obligate species will be considered indirectly through consideration of habitat for listed and candidate species.

(5) Using information gathered in the preceding steps, delineate riparian buffers for each stream segment in the watershed so that: (a) conservation objectives for aquatic and riparian protection are met; (b) buffers protect local physical and biological features; and (c) the probable influence of adjacent land-use practices on riparian forests are considered.

(6) Determine whether the proposed management or research activity would conflict with the objectives of the riparian conservation strategy. Choose another management strategy if the proposed activity cannot be accomplished without compromising the long-term sustainability of riparian functions and processes. If no proposed management activity has a high probability of meeting the riparian objectives, then management or manipulative-research activities will be postponed until watershed conditions improve.

(7) Develop interim prescriptions (or long-term prescriptions if this procedure is used as the watershed assessment for landscape planning). Short-term and long-term management and manipulative-research plans would be documented, including proposed schedules for site re-entry and the nature of activities proposed for each entry. Prescriptions might be refined during landscape planning to accommodate new information and technological advances. The riparian conservation strategy will remain in place through the development and implementation of management prescriptions and landscape plans.

(8) Develop a comprehensive road-maintenance plan. In most instances, this plan will be developed for a landscape planning unit prior to landscape planning because the 11 landscape planning units will be evaluated sequentially over the course of several years.

(9) Evaluate the long-term consequences of management prescriptions for each site in maintaining watershed-wide riparian processes and functions, particularly where multiple entries are planned.

(10) Implement interim prescriptions pending landscape plans. On-the-ground implementation will be reviewed by qualified technical experts to assure that conservation objectives are being met.

(11) Monitor riparian conditions on a regular basis (e.g., every two to five years) to evaluate whether conservation objectives continue to be met. Failure to meet these objectives would require restorative or corrective measures and modification of management activities.

(12) Choose another management or research activity in the assessed watershed. Additional proposals will be evaluated using information from the preliminary watershed assessment, landscape planning, monitoring in the watershed, and field investigations of site-specific conditions. Implementing these activities will depend on satisfactory completion of steps (6) and (9) above.

Management activities most likely to occur in the interior-core buffers in the OESF are:

- selective harvest of hardwoods to encourage long-term sources of coniferous woody debris and channel-bank stabilization; harvest would occur on stable ground, where silviculturally feasible and ecologically sound;

- thinning of young stands to promote wind-firm trees;
- restoration efforts, including habitat-enhancement projects;
- research projects, provided that they maintain or improve habitat for aquatic and riparian-dependent species;
- tree pruning to diversify forest structure; and
- single-tree removals, if the number and size of trees removed do not reduce the long-term functions and processes of riparian ecosystems.

Management activities in the interior-core buffers, or forested wetland and their buffers, would exclude herbicide release and new road construction in riparian areas unless, in the case of riparian buffers, stream crossings are essential. Roads in wetlands or their buffers will require on-site and in-kind wetland replacement, in accordance with the Forest Resource Plan (DNR 1992). Crossings will be designed to take the most direct route possible across streams, in order to minimize obstructions to fish passage, peak flows, bank destabilization, and sediment delivery.

Management activities most likely to occur in exterior buffers in the OESF are:

- partial cuts of 33 percent or less by volume, per rotation, aggregated or dispersed, depending on the operational objectives for maintaining wind-firm stands;
- experiments designed to promote wind-firmness of the interior-core buffer; and
- forest-structure modifications, including thinning, pruning, and tree-topping to improve stand wind-firmness.

SUMMARY: BENEFITS OF THE RIPARIAN CONSERVATION STRATEGY

The riparian conservation strategy will benefit the future health of riparian forests in the OESF in several ways:

- Riparian areas will be managed primarily to protect and restore physical and biological processes while allowing some extraction of forest commodities. The conservation's intent is to sustain habitat that is capable of supporting viable populations of salmonids and other aquatic and riparian-dependent species.
- Buffers described in the riparian conservation strategy will be applied to all stream types[2] and on all DNR-managed lands in order to minimize stream sedimentation, stabilize channel banks, reduce windthrow potential, enhance long-term recruitment of coarse woody debris, and protect other key physical and biological functions that maintain habitat complexity for aquatic and riparian-dependent species.
- This strategy ensures that the structural and compositional complexity of riparian habitat will be improved. A goal of this strategy will be to manage hardwood stands such that they regain a conifer-to-hardwood ratio more characteristic of naturally disturbed riparian forests. Approximately 70 percent of riparian areas on

[2]Buffers will be applied to all stream types but not necessarily to all Type 5 streams. See discussions in subsections titled Interior-core Buffers and Exterior Buffers.

DNR-managed lands in the Experimental Forest are dominated by hardwoods or conifer plantations less than 15 years old. The remaining 30 percent are mature second-growth, late successional, or old-growth stands that are highly fragmented; many are susceptible to wind disturbances because they cross exposed hillslopes or valley terraces. Young conifer plantations in riparian areas will be manipulated to promote robust and structurally diverse riparian forests. Management activities will restore long-term sources of coarse woody debris, improve year-round shade potential to streams, diversify riparian habitat, strengthen bank and floodplain stability, and increase wind-firmness of streamside forests.

- This strategy likely will benefit physical and biological conditions of near-shore marine habitat by reducing sediment loads carried from upland sites by river systems and deposited in estuarine and near-shore environments. Estuarine conditions influence salmonid smolting and can govern species survival (e.g., Bisson et al. 1992). Near-shore habitats, including eel-grass and kelp beds, provide shelter and forage for anadromous species and their prey.

- Protecting forested wetlands can improve water quality and aquatic habitat by: (1) minimizing the probability of soil compaction; (2) protecting unstable ground within and adjacent to wetlands; (3) moderating peak and low flows in watersheds; (4) conserving wetland biodiversity; (5) minimizing windthrow; (6) decreasing sediment delivery to wetlands; and (7) providing viable off-channel habitat for salmonids during channel peak-flow events.

Future Riparian Conditions in the OESF

The riparian conservation strategy constitutes a plan for the future in the OESF. Aquatic ecosystems will derive their greatest benefits from restoration of functional forest cover on previously logged, unstable hillslopes and in streamside forests, rather than from concentrating protection measures in existing, mature conifer stands. The intent is to restore riparian areas such that they can be incorporated in the general management strategies for unzoned future forests (see previous discussion in the OESF subsection titled Integrated Approach to Production and Conservation) that will be capable of sustaining both timber production and riparian ecosystem functions. The need for defined buffers will diminish as riparian forests regain the ability to sustain ecological and physical functions without management assistance. Available studies (e.g., Schlichte et al. 1991; Benda 1993; Shaw 1993), however, suggest that this recovery will take several decades to centuries for many river systems in the Experimental Forest.

Statistical analyses of implementing the proposed riparian buffers indicate that approximately 22 percent of the OESF land base will fall inside the interior-core buffer (Table IV.12). DNR currently treats an average of about 18 percent of the land base as no-cut riparian buffers. Therefore, implementing the interior-core buffer strategy on all DNR-managed lands in the OESF will incorporate an additional 4 percent of the land base. For a Type 3 watershed in steep, unstable terrain, this might amount to as much as a 60 percent increase in land placed within the interior-core buffer. However, in contrast with the current no-cut riparian buffers, management activities will be allowed in the OESF riparian buffers as long as these activities are consistent with the conservation objectives. In addition, DNR currently is required to protect all such areas under the Class IV-Special regulations of the state Forest Practices Act (WFPB 1993b). Applying the average recommended exterior riparian buffers increases the acreage in

Table IV.12: Number of acres and percent of land base projected in the Olympic Experimental State Forest riparian interior-core buffer, exterior buffer, and combined (total) buffer, by forest age class

Land base in the OESF totals approximately 264,000 acres. Figures for the total buffer were calculated assuming 33 percent average timber volume removal from the exterior riparian buffer. (See text.)

Forest age class (years)	Interior buffer		Exterior buffer		Total buffer	
	acres	percent	acres	percent	acres	percent
200+	520	0.20	397	0.16	917	0.36
101-199	9,254	3.62	5,164	2.02	14,418	5.64
71-100	3,181	1.24	2,143	0.84	5,324	2.08
51-70	2,369	0.93	1,382	0.54	3,751	1.47
41-50	1,410	0.55	873	0.34	2,283	0.89
31-40	3,265	1.28	1,891	0.74	5,156	2.02
21-30	9,249	3.61	4,985	1.95	14,234	5.56
11-20	16,815	6.57	8,735	3.42	25,550	9.99
0-10	10,653	4.16	5,855	2.29	16,508	6.45
Total	**56,716**	**22.16**	**31,425**	**12.30**	**88,141**	**34.46**

riparian management zones by an estimated 12 percent, although certain harvest activities can occur in these areas (e.g., maximum timber volume removal of 33 percent).

Table IV.12 shows the number of acres and percent of land base in each buffer category, by forest age class, out of 264,000 total acres of DNR-managed land in the OESF. Approximately 35 percent of the total acres, therefore, will contribute to maintaining and restoring riparian functions and processes. These acres also will provide more than 50 percent of the proposed habitat for northern spotted owls and a significant percentage of habitat for marbled murrelets.

Multispecies Conservation Strategy for Unlisted Species in the Olympic Experimental State Forest

INTRODUCTION

It is central to the mission of the Olympic Experimental State Forest to learn how to manage commercial forests that integrate commodity production and species conservation. Management that maintains or restores habitat for populations of native flora and fauna on the Olympic Peninsula is fundamental to the OESF. Plant and animal species for which there is some concern about population viability and features on the landscape that serve important functions as habitat for those species will receive special attention.

The multispecies conservation strategy for DNR-managed lands in the Experimental Forest is different from that for the five west-side planning units because the OESF strategy is based in large part on the unique conservation strategies in the OESF for riparian ecosystems and northern spotted owls and because of the experimental approach to integrated management for forest commodity and ecosystem values that is the mission of the Experimental Forest. (The multispecies conservation strategy for the five west-side planning units is discussed in Section F of this chapter. Neither multispecies strategy will be applied in the east-side planning units under this HCP.)

The strategy proposes conservation objectives for maintaining or restoring a level of habitat capability for unlisted species on DNR-managed lands in the OESF. To achieve these conservation objectives, DNR will develop and test a variety of methods that integrate commercial forest management and maintenance or restoration of habitat for unlisted species and will apply those methods that are most effective and efficient. This habitat management will be planned and implemented at the landscape level. Objectives of this landscape-level management are directed at developing landscapes that produce a mix of robust commercial products and ecosystem outputs across the entire Experimental Forest.

Conservation of habitat for unlisted species will primarily be derived from the integrated, ecosystem-oriented management rather than direct the management. This approach can be stated and implemented as a working hypothesis for evaluation and systematic application and refinement: DNR can meet its objectives for conservation of habitat for unlisted species in the OESF by managing stands and landscapes to meet its conservation objectives for riparian ecosystems, spotted owls, and marbled murrelets and by implementing additional site- or species-specific conservation measures in response to certain circumstances.

The multispecies conservation strategy discusses provision of habitat for animal species of concern and other unlisted species and special landscape features identified as uncommon habitats or habitat elements. For the purposes of the HCP, species of concern are federally listed, state-listed, federal candidate, and state candidate animal species. Federally listed species are addressed in the sections of this chapter on the marbled murrelet (see Section B), other listed species (see Section C), and in the OESF strategy for the northern spotted owl (see earlier in this Section E). The other species of concern are addressed in this subsection, except anadromous salmonids and bull trout, whose habitat is conserved through the OESF riparian conservation strategy (see earlier in this Section E). Other unlisted species include other animal species that may become listed or candidates for listing in the future. Uncommon habitats and habitat elements are talus fields, caves, cliffs, and large, structurally unique trees. (See the subsection titled protection of Uncommon Habitats in Section F of this chapter.)

Within the OESF, 33 animal species are considered species of concern because information indicates they face some risk of at least local extinction: six are federally listed, 10 are federal species of concern, five are state candidates with no federal status, four are sensitive species,and bull trout and seven species of anadromous salmonids have been or are under review for listing by the federal goverment. (The federally listed species are shown in Table III.8,the salmonids in Table III.11, and the other species in Table III.14.) Other species will probably be added to this list in the coming decades, but it is difficult to predict which species are, or will be, at the brink of "at risk."

Federal guidelines (e.g., spotted owl circles) and state rules (WAC 232-12-292, WAC 222-16-080) place species-specific constraints on forest practices for the benefit of federally listed and state-listed species. But, given the large and probably expanding array of listed and candidate species, species-specific forest practices have become an inefficient and impractical means of attaining wildlife conservation objectives and providing income to the trusts. Within the confines of a managed forest, the most effective means for the conservation of wildlife is to provide functional habitat. The Experimental Forest will contribute to the survival of species of concern and other unlisted species through forest management that provides a variety of well-distributed, interconnected habitats.

The multispecies strategy discusses the objectives for conservation of habitat for unlisted species of concern and other unlisted species. Then the benefits to habitat for unlisted species through the other OESF and the marbled murrelet conservation strategies are described. The multispecies strategy closes with a description of conservation of habitat for specific unlisted species of concern and a summary of types of habitat provided on DNR-managed lands in the Experimental Forest.

CONSERVATION OBJECTIVES

The objectives of the strategy for conservation of habitat for unlisted species are:

(1) to develop and implement land-management plans that do not appreciably reduce the likelihood of survival and recovery of unlisted species on the Olympic Peninsula;

(2) to learn to integrate the values of older forest ecosystems and their functions with commercial forest activities; and

(3) to fill critical information gaps related to the composition, structure, and function of aquatic, riparian, and upland ecosystems and the links between these, forest management activities, and conservation of habitat for unlisted species.

DNR anticipates that meeting these objectives will entail a significant effort in forest management, research, and monitoring over an extended period of time. (See the sections titled Monitoring and Research in Chapter V.) Management practices in the near term will be directed by current knowledge and hypotheses, but in time, as knowledge, techniques, and hypotheses change, management practices will adapt to those new circumstances. This is consistent with the mission of the Experimental Forest.

A description of proposed management practices related to conservation of habitat for unlisted species and unique habitat elements follows. Some deviations from these practices will occur in the near term as formal, experimental studies designed to address information needs related to integrating conservation and production. It is also likely that some of the practices may change in the long term as new information, techniques, and other circumstances warrant. Thus, these descriptions are intended to be straightforward ways to characterize a standard level of commitment to conservation while reserving the option to achieve conservation objectives by other means.

For certain species, additional conservation measures are proposed for known nesting, denning, and/or roosting sites. Under this HCP, DNR shall not be required to survey for nests, dens, roosts, or individual occurrences of unlisted species. Currently, baseline data on many of these species are recorded in the Washington Department of Fish and Wildlife Non-game Database.

The habitats most critical for the conservation of unlisted species on DNR-managed lands in the OESF contain elements of late successional coniferous forest, riparian areas and wetlands, or both. The aggregate landscape-level effects of the Experimental Forest riparian and spotted owl conservation strategies and the HCP marbled murrelet conservation strategy, as described below, are expected to provide habitat for most unlisted species. However, some unlisted species require special landscape features or habitat elements that may not be adequately conserved by the species-specific strategies. Thus, special conservation measures for talus fields, caves, cliffs, large snags, and large, structurally unique trees may be important to these species. The protection of uncommon habitats and habitat elements is described in Section F of in this chapter titled Multispecies Conservation Strategy for Unlisted Species in the Five West-side Planning Units. The specific discussion in that section to be applied in the OESF is called Protection of Uncommon Habitats.

CONSERVATION STRATEGY

The Experimental Forest multispecies conservation strategy is proposed as an outcome of landscape-level management in the OESF. Central to the planning and implementation of landscape management are the proposed conservation measures for riparian ecosystems, spotted owls, and marbled murrelets. The aggregate effect of these conservation strategies is the creation of landscapes centered on healthy riparian ecosystems that contain interconnected patches of late successional, mid-aged, and young forests. Late successional forests consist of both mature (80-200 years old) and old-growth (greater than 200 years old) forest age classes (Thomas et al. 1993; FEMAT 1993; Spies and Franklin 1991).

Riparian Conservation Strategy

(See the earlier part of this section on the Experimental Forest titled Riparian Conservation Strategy.)

The principal components of the riparian conservation strategy are forested buffers to protect stream channels and unstable hillslopes. Management activities within these buffers will be governed by the following conservation objectives:

(1) to maintain and aid restoration of the composition, structure, and function of aquatic, riparian, and associated wetland systems;

(2) to maintain and aid restoration of the physical integrity of stream channels and floodplains;

(3) to maintain and aid restoration of water to the quantity, quality, and timing with which these systems evolved;

(4) to maintain and aid restoration of the sediment regime in which these systems evolved; and

(5) to develop, use, and distribute information on aquatic, riparian, and associated wetland ecosystem processes.

The riparian strategy will result in complex, productive aquatic habitats in streams and wetlands and late successional conifer forest as the predominant cover type along streams and on unstable hillslopes. As a result, this strategy will benefit nearly all aquatic, wetland, riparian obligate, and upland species on DNR-managed lands in the OESF.

The riparian strategy will be implemented by establishing interior-core buffers that minimize disturbance of unstable channel banks and adjacent hillslopes and by establishing exterior buffers that protect the interior-core buffers from wind damage. Additionally, DNR will continue its commitment to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36). Interior-core buffers are estimated to cover 56,000 acres (22 percent) of DNR-managed land in the OESF. Exterior buffers may cover up to (31,000 acres) 12 percent of DNR-managed land in the Experimental Forest.

Management within the exterior (wind) buffer will be largely experimental, and the forest conditions allowed to develop within the exterior buffer will be based on their efficacy in minimizing windthrow. DNR currently hypothesizes that structurally diverse, mature conifer forests that sustain varying degrees of harvest will be the long-term outcome of management in many of the exterior buffers.

Suitable habitat for aquatic and riparian obligate species should be provided in the interior-core riparian buffers, especially as their functions are maintained by exterior buffers. Wetland species will be protected because DNR maintains no overall net loss of naturally occurring wetland acreage and function. For upland species, the long-term benefit of riparian ecosystem conservation is a network of late successional forests in streamside areas and on unstable hillslopes that serve as habitat for nesting, foraging, or resting.

Marbled Murrelet Conservation Strategy

(See Section B of this chapter for the marbled murrelet conservation strategy.)

Landscape conditions outside riparian areas and not on unstable hillslopes will be enhanced by management for marbled murrelets. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some marbled murrelet nesting habitat, and this will increase the amount of late successional forest available to other species.

Spotted Owl Conservation Strategy

(See the earlier part of this section on the OESF titled Conservation Strategy for the Northern Spotted Owl.)

The unzoned spotted owl conservation strategy sets a minimum standard of at least 40 percent of each landscape in young-forest marginal (as defined by Hanson et al. 1993) or better quality habitat and at least half of this, or 20 percent of each landscape planning unit, in old forest (Hanson et al. 1993). Because of the riparian conservation strategy alone, four of the 11 landscape planning units (Reade Hill, Willy-Huel, Upper Clearwater, and Copper Mine — see Map IV.9) are expected to exceed the minimum standard for spotted owl conservation. In the other seven landscape planning units (Kalaloch, Sadie Creek, Clallam, Upper Sol Duc, Goodman Creek, Dickodochtedor, and Queets), the riparian strategy makes a significant contribution toward meeting the spotted owl minimum standard.

DNR-managed lands outside of riparian areas in these landscape planning units will be managed on harvest rotations that provide enough habitat to meet the landscape minimums.

Forest Management in the OESF

The working hypothesis of the OESF is that it is possible to manage forest stands and landscapes for integrated outputs of commodity and ecosystem products. In conjunction with the conservation strategies described for spotted owls, marbled murrelets, riparian ecosystems, and uncommon habitats, a variety of forest stand management prescriptions will be implemented. (See Section H of this chapter titled Forest Land Management Activities.) Some stands may be managed under an even-aged regime of short rotations (50 to 60 years). Other stands may be managed by a series of light, partial cuts that retain the composition, structure, and function of late successional forests throughout all or most of the management cycle. Individual activities will be planned and implemented within the framework of specific landscape-wide plans for each landscape planning unit. These landscape plans will focus and direct the integration of commodity, ecosystem, and information outputs, in part, by mapping and scheduling timber harvests and other silvicultural activities so that their influence on ecosystem processes can be assessed in advance.

After stand-regenerating disturbances such as fire or clearcutting, stand development proceeds through a series of identifiable successional stages. Various systems have been used to describe forest succession. The system of Brown (1985) is based on the structural condition of the stand and identifies six stages: grass/forb, shrub, open sapling/pole, closed sapling/pole/sawtimber, large sawtimber, and old growth. Large sawtimber is approximately equivalent to mature forest. Mature and old-growth forests are considered to be late successional (Thomas et al. 1993). Conifer forest stands are often in the closed sapling/pole/sawtimber stage between about 30 and 80 years of age (Brown 1985), and stands exhibiting such conditions are generally considered to be young forest (Spies and Franklin 1991). Forests subjected to even-aged management and relatively short rotations should provide suitable habitat for species that utilize grass/forb, shrub, open sapling/pole, and closed sapling/pole/sawtimber stages of forest succession. Forests managed under less conventional regimes, e.g., various forms of uneven-aged management, should provide late successional habitat over some portion of the management cycle.

SPECIES BY SPECIES CONSERVATION FOR UNLISTED SPECIES OF CONCERN

Fish

(Habitat for bull trout and anadromous salmonids will be provided through the OESF riparian conservation strategy detailed earlier in this section.)

OLYMPIC MUDMINNOW

The riparian conservation strategy should protect the spawning and rearing habitats of the Olympic mudminnow through:

(1) commiting to “no overall net loss of naturally occurring wetland acreage and function” (DNR 1992 p. 36);

(2) protecting lakes and ponds classified as Types 1, 2, or 3 waters; and

(3) protecting Types 1, 2, 3, and 4 rivers and streams. Additional protection of aquatic habitat will occur through the prohibition of timber harvest on unstable hillslopes and road network management.

Amphibians

VAN DYKE'S SALAMANDER

Van Dyke's salamanders occur primarily in rock rubble near small streams and headwall seepages in the OESF. The interior-core buffers of the riparian conservation strategy are designed to protect these naturally unstable areas. Exterior buffers will protect the functions of interior-core buffers where necessary. Protection of riparian areas and unstable hillslopes as described in the Experimental Forest riparian conservation strategy should provide adequate protection for Van Dyke's salamander habitat within the OESF.

TAILED FROG

Tailed frogs require cool, clean, well-aerated water and a stable microclimate. They primarily inhabitat smaller streams with relatively steep gradients in the OESF. Interior-core buffers of the Experimental Forest riparian conservation strategy were designed to protect these areas from damage to their channel banks or from mass-wasting events at higher elevations in watersheds. Exterior buffers will protect the functions of interior-core buffers where necessary. The OESF riparian conservation strategy should provide adequate protection for tailed frog habitat within the OESF.

CASCADES FROG

Cascades frogs are known both from elevations above DNR-managed lands and from lower elevations in and around the OESF. These frogs occur in and near wetlands and other slow-flowing waters away from the main channels of streams. The OESF riparian conservation strategy is designed to maintain or restore the composition, structure, and function of aquatic, riparian, and associated wetland ecosystems; it incorporates current DNR wetlands policy that states there will be no overall net loss of naturally occurring wetland acreage and function (DNR 1992 p. 36). The OESF riparian conservation strategy and the current DNR policy on wetlands should provide adequate protection for Cascades frog habitat within the OESF.

Birds

HARLEQUIN DUCK

OESF riparian conservation will contribute to the viability of harlequin ducks on the Olympic Peninsula in two ways. First, the maintenance or restoration of mature and old-growth forests within riparian zones, especially along Types 1, 2, and 3 waters, should shelter nest sites from disturbance. Second, the principal foods of the harlequin duck are benthic macro-invertebrates, whose diversity and abundance the riparian conservation strategy is expected to enhance.

NORTHERN GOSHAWK

Under the unzoned spotted owl conservation strategy, at least 40 percent of DNR's forested lands within each landscape planning unit will be young-forest marginal (Hanson et al. 1993) or better quality habitat, and at least 20 percent of DNR's forest lands will be old forest (Hanson et al. 1993) or better. The riparian interior-core and unstable slope protection established under the riparian strategy constitutes, on average, 22 percent of each landscape planning unit, and this will eventually become late successional coniferous forest. These conditions exceed the landscape prescriptions recommended by Reynolds et al. (1992) for northern goshawks. Thus, the combined outcomes of the riparian and spotted owl conservation strategies should provide adequate protection for goshawk habitat within the OESF.

GOLDEN EAGLE

Golden eagles nest in large trees or on cliffs. These uncommon habitats and habitat elements will be protected as described earlier in the discussion on uncommon habitats in the section of this chapter titled Multispecies Conservation in the Five West-side Plannning Units. The combination of the riparian conservation strategy and forest management in the OESF should provide breeding, foraging, and resting habitat for the golden eagle. Many forests on unstable hillslopes will not be harvested and some of these areas will contain large trees. Management within the interior-core riparian buffer is expected to result in the development of late successional forest containing large live trees. Even-aged forest management throughout the OESF will continue to provide openings for foraging habitat.

Golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668, Revised 1978). Under this act, it is unlawful to molest or disturb golden eagles and their nests. RCW 77.16.120 of the Wildlife Code of Washington prohibits destroying the nests of protected wildlife. Consistent with these regulations, trees or snags that contain known active golden eagle nests shall not be harvested. Thus, current laws, regulations, and proposed conservation strategies should provide adequate protection for golden eagles within the OESF.

VAUX'S SWIFT

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies should provide forest conditions suitable for Vaux's swift breeding, foraging, and resting habitat. In concert, these three strategies promote the development of landscapes containing significant amounts of older forests and large trees that will provide nesting, roosting, and foraging habitat. Other foraging habitat will result from general management of upland forests.

Conservation measures for large, structurally unique trees (described in the discussion of uncommon habitats in Section F of this chapter titled Multispecies Conservation Strategy in the Five West-side Planning Units) will retain habitat for nesting and roosting. Consistent with RCW 77.16.120, trees or snags that are known to contain active Vaux's swifts nests shall not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

Additional Mitigation

Trees or snags known to be used by Vaux's swifts for nesting or roosting shall not be harvested, except as formal, experimental studies designed to address information needs related to integrating conservation and production or as other, exceptional circumstances warrant. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

PILEATED WOODPECKER

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies should provide forest conditions suitable for pileated woodpecker breeding, foraging, and resting habitat. In concert, these three strategies promote the development of landscapes containing significant amounts of older forests and large trees that will provide nesting, roosting, and foraging habitat. Other foraging habitat will result from general management of upland forests.

Conservation measures for large snags and large, structurally unique trees (described in the discussion of uncommon habitats in Section F of this chapter titled Multispecies Conservation Strategy in the Five West-side Planning Units) will retain structural elements required by pileated woodpeckers for nesting and roosting. Additional conservation measures for snags (also described in Section F of this chapter) will increase the density of snags, and consequently, opportunities for foraging.

Consistent with RCW 77.16.120, trees or snags that are known to contain active pileated woodpecker nests will not be harvested. In addition, trees or snags that are known to have been used by pileated woodpeckers for nesting will not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

OLIVE-SIDED FLYCATCHER

There are no established management recommendations for the olive-sided flycatcher. The creation of forest edges through clearcutting probably benefits the species, but extensive clearcutting with short harvest rotations would eliminate the mature forests and tall snags which this species requires. The combination of the riparian, spotted owl, and marbled murrelet conservation strategies should provide forest conditions suitable for olive-sided flycatcher breeding, foraging, and resting habitat. In concert, these three strategies promote the development of landscapes containing significant amounts of older forests and large trees that will provide nesting, roosting, and foraging habitat. Other habitat will result from general management of upland forests. The landscape conditions projected for the OESF are expected to adequately provide for the habitat needs of the olive-sided flycatcher.

LITTLE WILLOW FLYCATCHER

In the OESF, even-aged forest management should provide the type of nesting habitat that the species requires. The landscape conditions projected to occur in the OESF should provide adequately for the nesting, foraging, and other habitat needs of little willow flycatchers.

Mammals

MYOTIS BATS

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies should provide forest conditions suitable for myotis bat breeding, foraging, and resting habitat. In concert, these three strategies promote the development of landscapes containing significant amounts of older forests and large trees for nesting, roosting, and foraging habitat, and productive riparian and wetland ecosystems for foraging habitat. Other habitat will result from general management of upland forests.

Talus fields, cliffs, and caves have been designated priority habitats by the Washington Department of Fish and Wildlife (1995a). Talus fields, cliffs, and caves will be protected (as described in the discussion of uncommon habitats in Section F of this chapter titled Multispecies Conservation Strategy in the Five West-side Planning Units), and DNR will also protect very large old trees as described in that same section.

Additional Mitigation

Live trees or snags that are known to be used by myotis bat species as communal roosts or maternity colonies shall not be harvested, except as formal, experimental studies designed to address information needs related to integrating conservation and production or as other, exceptional circumstances warrant. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

TOWNSEND'S BIG-EARED BAT

There are no confirmed breeding sites for this bat on the western Olympic Peninsula. The species requires caves for nursery colonies and hibernacula. No caves are known to exist in the OESF. Therefore, forest management in the OESF is expected to have little or no impact on Townsend's big-eared bats. In the event that a cave is discovered, it will be protected as described in the discussion on uncommon habitats (found in Section F of this chapter titled Multispecies Conservation Strategy in the Five West-side Planning Units).

FISHER

The aggregate landscape level effects of the riparian, spotted owl, and marbled murrelet conservation strategies, will provide more than 68,000 acres of contiguous fisher habitat across the Willy-Huel, Kalaloch, Copper Mine, Upper Clearwater, and Queets landscape planning units. (See Map IV.9.) This habitat area will also provide a connection between the main body of the Olympic National Park and the National Park's coastal strip. The Olympic National Park contains over 284,300 acres of fisher habitat. The Olympic National Forest currently contains 241,100 acres of fisher habitat and under the President's Forest Plan, it should have approximately 334,200 acres by the year 2074 (Holthausen et al. 1994). The contiguous fisher habitat in the OESF is seen as adjunct to this high-quality habitat on federal land.

DNR-managed roads are routinely closed for cost-effective forest management and protection of public resources, including wildlife (DNR 1992 p. 41). Road closures benefit the fisher population by limiting human disturbance and reducing the likelihood of accidental trapping. Road closures will continue on DNR-managed lands and will be consistent with cost-effective forest management and policies set forth by the Board of Natural Resources.

Additional Mitigation

DNR shall place restrictions in its contracts for sales of timber and other valuable materials, as well as in its grants of rights of way and easements, to prohibit activities within 0.5 mile of a known active fisher den site between February 1 and July 31 where such activities would appreciably reduce the likelihood of denning success.

SUMMARY OF HABITAT TYPES PROVIDED ON DNR-MANAGED FOREST LANDS IN THE OLYMPIC EXPERIMENTAL STATE FOREST

See Table IV.7 for an estimate of different habitat types provided in the OESF based on one set of harvest regimes. Refer to footnotes 2-5 of that table for brief explanations of the habitat types.

F. Multispecies Conservation Strategy for Unlisted Species in the Five West-side Planning Units

Introduction

The multispecies conservation strategy for the five west-side planning units is directed at providing habitat for animal species of concern and other unlisted animal species and at special landscape features identified as uncommon habitats or habitat elements. For the purposes of this HCP, species of concern are federally listed, state-listed, federal candidate, and state candidate animal species. (See Table III.7 for the federally listed species and Table III.13 for the other species of concern excluding anadromous salmonids and bull trout. Those are named in Table III.10.) Other unlisted species include other animal species that may use the types of habitat found within the five west-side planning units and that may become listed or candidates for listing in the future. For the purposes of this HCP, uncommon habitats on DNR-managed lands are talus fields, caves, cliffs, oak woodlands, large snags, balds, mineral springs, and large, structurally unique trees.

Under this HCP, multispecies conservation strategies shall be implemented on DNR-managed lands in the five west-side planning units and the Olympic Experimental State Forest (OESF). The multispecies conservation strategy for the OESF is discussed in Section E of this chapter. Briefly, the OESF strategy differs somewhat from that for the five west-side planning units because:

(1) the emphasis in the OESF on research and systematic application and refinement of knowledge gained to achieve effective and efficient integration of commodity production and conservation will likely lead to changes in conservation strategies over time; and

(2) the conservation strategies for salmonids and the northern spotted owl, which are the foundation of the multispecies conservation strategies, are different for the OESF. (See Section E of this chapter for a complete discussion of the OESF conservation strategies.)

Neither multispecies conservation strategy will be applied in the east-side planning units. But all DNR management activities there will still comply with state Forest Practices Rules and applicable state wildlife regulations and will be consistent with the policies set forth by the Board of Natural Resources.

DNR will continue to participate in watershed analysis according to state Forest Practices Rules (WFPB 1994). If watershed analysis indicates that public resources require a greater level of protection than that specified by the HCP, the prescriptions developed through watershed analysis to provide this additional protection shall be implemented. However, because (as of the writing of this HCP) watershed analysis does not address wildlife, the HCP multispecies conservation strategy shall continue to apply to DNR-managed lands in Watershed Administrative Units (WAU) for which watershed analysis has been conducted, unless stated otherwise elsewhere in this HCP.

For uncommon habitats and certain species of concern, the multispecies conservation strategy specifies special management prescriptions and/or additional mitigation. The management prescriptions and mitigation are intended to be straightforward ways to provide a standard level of protection. In some instances, these will not be the most efficient means available to provide effective wildlife conservation. Therefore, in places where DNR believes that effective conservation can be provided in a more efficient way, DNR through cooperation with the U.S. Fish and Wildlife Service, may develop a site-specific management plan that provides adequate protection for the species or habitat occurring at that site. When a management plan approved by the U.S. Fish and Wildlife Service is in place, the special management prescriptions and/or additional mitigation specified in this HCP shall be waived.

If, however, DNR discovers some active nesting, denning, or roosting sites in the course of forest management activities, or through voluntary surveys, or such sites are documented by the Washington Department of Fish and Wildlife on DNR-managed lands, DNR shall provide the special protection described in the subsection titled Species by Species Conservation. At the time a new species is proposed for listing, and a written request to add that species to the permit is made by DNR, DNR will evaluate and consider additional protection measures such as seasonal restrictions and protection of nesting/denning sites.

Within the five west-side planning units, 62 animal species are considered species of concern because information indicates they face some risk of extinction: nine are federally listed, two, including the bull trout, are federal candidates, 23 are federal species of concern, two are listed by the state but have no special federal status, 12 are state candidates with no special federal status, seven are sensitive species, and seven species of anadromous salmonids have been or are under review by the federal government for listing. (The federally listed species are shown in Table III.8, the salmonids in Table III.11, and the other species in Table III.14.) Other species will probably be added to this list in the coming decades, but it is difficult to predict which species are at the brink of "at risk."

Federal guidelines (e.g., spotted owl circles) and state rules (WAC 232-12-292, WAC 222-16-080) place species-specific constraints on forest practices for the benefit of federally listed and state-listed species. But, given the large and probably expanding array of listed and candidate species, species-specific forest practices have become an inefficient and impractical means of attaining wildlife conservation objectives and providing income to the trusts. Within the confines of a managed forest, the most effective means for the conservation of wildlife is to provide functional habitat. Under this HCP, DNR will contribute to the survival of species of concern and other unlisted species through forest management that provides a variety of well-distributed, interconnected habitats.

The multispecies strategy discusses the objectives for conservation of habitat for unlisted species of concern and other unlisted species. Then the benefits to habitat of unlisted species through the other HCP conservation strategies are described, followed by a discussion of protection of uncommon habitats. The strategy closes with a description of conservation for habitat of specific unlisted species of concern and a summary of habitat types provided on DNR-managed lands in the five west-side planning units.

Conservation Objectives

DNR had identified three conservation objectives for its multispecies strategy on DNR-managed lands in the five west-side planning units to provide habitat that:

(1) helps maintain the geographic distribution of unlisted species that have small annual or breeding-season home range areas;

(2) contributes to demographic support of populations of unlisted species with large home ranges on federal forest reserves (National Parks, National Forest Wilderness Areas, National Forest Late successional Reserves, etc.); and

(3) facilitates the dispersal of these wide-ranging species among federal forest reserves.

Maintenance of geographic distribution means supporting the continued presence of the species, or its habitat, over as much of its historic range as possible. Therefore, objective (1) requires that habitat supporting the life needs of unlisted species with small ranges be provided throughout the range of the species on DNR-managed lands in the five west-side planning units. Demographic support refers to the continued viability of populations through the reproductive contribution of individuals. Therefore, objective (2) requires that habitat capable of supporting the successful reproduction of wide-ranging unlisted species be provided on DNR-managed lands in the five west-side planning units near federal reserves. Dispersal entails the movement of individuals from one subpopulation to another. Therefore, objective (3) requires that foraging and resting habitat of wide-ranging unlisted species be provided on DNR-managed lands in the five west-side planning units between blocks of federal reserves.

The habitats most critical for the conservation of unlisted species on DNR-managed lands in the five west-side planning units contain elements of late successional coniferous forest, riparian areas and wetlands, or both. The aggregate landscape-level effects of the HCP riparian, spotted owl, and marbled murrelet conservation strategies, as described below, are expected to provide habitat for most unlisted species. However, some unlisted species require special landscape features or habitat elements that may not be adequately conserved by the species-specific strategies. Thus, the special protection of talus fields, caves, cliffs, oak woodlands, and very large old trees are considered necessary to provide conservation for these species. Furthermore, some unlisted species are known or thought to be highly sensitive to human disturbance, and therefore, in the context of a managed forest, special management to reduce human disturbance is warranted.

Conservation Strategy

The HCP multispecies conservation strategy is built upon conservation measures directed at providing habitat for three taxa: salmonids (the riparian strategy), the northern spotted owl, and the marbled murrelet. (See Sections C, A, and B, respectively, of this chapter for more detail on each strategy.) The aggregate effect of this species-specific conservation is the creation of landscapes containing interconnected patches of late successional forest. Late successional forests consist of both mature (80-200 years old) and old-growth (greater than 200 years old) forest age classes (Thomas et al. 1993; FEMAT 1993; Spies and Franklin 1991). In addition, the other managed forests will provide early and mid-seral stage forest habitat.

RIPARIAN CONSERVATION STRATEGY

This strategy benefits nearly all aquatic, wetland, riparian obligate, and upland species that may occupy DNR-managed lands. The riparian management zones established along all Types 1, 2, 3, and 4 waters should provide suitable habitat for aquatic and riparian obligate species. Wetland species will be protected through DNR's continued commitment to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36). For upland species, the long-term benefit of salmonid conservation is a network of riparian corridors connecting upland patches of late successional forest on unstable hillslopes.

The riparian buffer of the riparian management zone is estimated to occupy 69,000 acres along Types 1, 2, 3, and 4 waters (6 percent of DNR-managed forest lands in the five west-side planning units). The riparian management zone will be managed to maintain or restore salmonid habitat. Given this objective, most of the no-harvest and minimal-harvest areas (58,000 acres) in the riparian management zone will likely develop into forest that has old-growth characteristics. The low-harvest area (11,000 acres) is managed according to the same objective, but its distance from water may permit more management activities, and therefore, in most places, the low-harvest area will likely eventually contain forests with a range of late successional characteristics. Unstable hillslopes are estimated to occupy an additional 5 to 10 percent of DNR-managed forest land outside the riparian management zone. Unstable areas will be managed to minimize the risk of mass wasting, and it is likely that little harvest will occur there. Unstable hillslopes should add another 60,000 to 120,000 acres of late successional forest, with some portion being old growth.

Overall, salmonid and riparian conservation is expected to result in the maintenance or restoration of 129,000 to 189,000 acres of forest with mature and old-growth characteristics (11 to 16 percent of the five west-side planning units). However, natural disturbances will cause the amount to vary over time. Approximately 9 percent of these areas are currently in a late successional stage, and 84 percent are expected to be in a late successional stage by the year 2195. The ubiquity of streams, particularly Type 4 waters and Type 5 waters on unstable hillslopes, will ensure connectivity among patches of late successional forest.

Management within the wind buffers of the riparian management zone will be largely experimental, and therefore, the forest conditions within the wind buffer cannot be accurately predicted. Wind buffers may occupy up to 1 percent (10,000 acres) of DNR-managed forest land in the five west-side planning units.

MARBLED MURRELET CONSERVATION STRATEGY

Landscape conditions outside riparian areas and not on unstable hillslopes will be enhanced by management for marbled murrelets. Preliminary estimates of marbled murrelet habitat suggest that between 47,000 and 108,000 acres of habitat exists outside riparian management zones and not on unstable hillslopes — another 4 to 9 percent of the west-side planning units. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some marbled murrelet nesting habitat, and this will increase the amount of late successional forest available to other species.

NORTHERN SPOTTED OWL CONSERVATION STRATEGY

In the five west-side planning units, the spotted owl strategy designates 163,000 acres to be managed as nesting, roosting, and foraging (NRF) habitat for the spotted owl. There will be two 300-acre nest patches per 5,000 acres of managed forest in NRF management areas, for a total of approximately 20,000 acres. These nest patches will consist of high quality spotted owl nesting habitat with old-growth forest characteristics. The nest patches will occur within a larger, contiguous 500-acre area, of which the remaining 200 acres shall be sub-mature forest (as defined in Hanson et al. 1993) or higher quality habitat. At least 50 percent of the designated NRF management area in each WAU (including the nest patches) will be sub-mature forest or higher quality habitat.

The riparian conservation strategy will result in 11 to 16 percent of the NRF management area in a late successional condition. High-quality spotted owl nesting habitat in nest patches will occupy 12 percent of NRF management areas, but portions of the nests patches will be in riparian areas or on unstable hillslopes. The nest patches are estimated to occupy 10 percent of the NRF management area outside those areas protected by the riparian conservation strategy. The marbled murrelet strategy will contribute additional late successional forest, but an accurate estimate of amount cannot be made at this time. Nest patches and the riparian conservation strategy will result in late successional forest over 21 to 26 percent of designated NRF management areas. Therefore, on average, another 24 to 29 percent of the area designated for NRF management in each WAU will need to be submature forest or better to meet the 50 percent requirement for each WAU with designated NRF habitat.

A working hypothesis of the spotted owl conservation strategy is that the development of spotted owl habitat may be accelerated through special forest management. The calculation of harvest rotations are based on the assumption that managed forests can attain sub-mature characteristics at approximately age 70 years. Designated NRF management areas may be managed under an even-aged regulated forest system, and under such management, the 50 percent sub-mature forest prescription would require a harvest rotation of at least 100 years. Consequently, an additional 14 to 21 percent of the area designated for NRF management in each WAU will be mature forest (i.e., more than 80 years old). On average, 40 to 42 percent of the designated NRF management area in each WAU will be late successional forest, with some portion possessing old-growth characteristics.

In the five west-side planning units, the spotted owl strategy designates 117,000 acres to be managed as spotted owl dispersal habitat, which supports the movement of juvenile spotted owls among sub-populations on federal reserves. Dispersal habitat must provide foraging and roosting opportunities in amounts adequate to promote the survival of spotted owls. At least 50 percent of the designated dispersal management areas in each WAU will meet the minimum specifications for dispersal habitat.

Using the average site productivity of DNR-managed forests on the west side, dispersal habitat characteristics are estimated to be attained at approximately 40 years of age. Dispersal habitat areas will be managed under an even-aged regulated forest system, and therefore, the 50 percent prescription will require a harvest rotation greater than 40 years. The riparian conservation strategy will result in 11 to 16 percent of the land base in a late successional forest. The marbled murrelet strategy will contribute additional late successional forest, but an accurate estimate of amount cannot be made at this time. To meet the 50 percent prescription, another 34 to 39 percent of the land base must be dispersal or higher quality owl habitat, and therefore, a harvest rotation between 65 and 70 years is necessary.

OTHER MANAGED FORESTS

In conjunction with the conservation strategies described for spotted owls, marbled murrelets, riparian ecosystems (salmonids), and uncommon habitats, DNR will continue with a wide range of forest land management activities. (See Section H of this chapter, titled Forest Land Management Activities, for more discussion.) Typically, even-aged management is based on either an economic rotation or a maximum volume rotation. Currently, the most widely used harvest age is based on the economic rotation, which is approximately 50 to 60 years in west-side forests. Maximum volume rotations are approximately 80 to 100 years, the age at which stands reach maturity.

After a natural disturbance, such as fire, a stand regenerates and develops through a succession of seral stages. Managed forests often follow a similar, yet altered, pattern of sucession after a clearcut timber harvest. Various systems have been used to describe forest succession. The system used by Brown (1985) is based on the structural condition of the stand and identifies six stages: grass/forb, shrub, open sapling/pole, closed sapling/pole/sawtimber, large sawtimber, and old growth. Large saw timber is approximately equivalent to mature forest. Mature and old-growth forests are considered to be late successional (Thomas et al. 1993). Conifer forest stands develop closed sapling/pole/sawtimber structural conditions at approximately 30 to 80 years of age (Brown 1985), and stands exhibiting such conditions are generally considered to be young forest (Spies and Franklin 1991). Forests managed on an economic or maximum volume rotation should provide suitable habitat for species that utilize grass/forb, shrub, open sapling/pole, and closed sapling/pole/sawtimber stages of forest succession.

Benefits of the Species-Specific Strategies to Unlisted Species

A population's extinction risk, or conversely, its viability, is primarily a function of population size. Larger populations are more resilient to adverse environmental changes, whether such changes are natural or human-caused. Reductions in a species' habitat quality or quantity are necessarily followed by a decrease in population size, and a substantial decrease in population size increases the risk of extinction. Improving habitat quality or quantity should, in theory, lead to a larger population and decreased risk of extinction.

Geographic distribution is also a factor in risk of extinction. Maintaining a species over a large geographic area decreases the risk of extinction caused by environmental change. Over a sufficiently large area, it is unlikely that catastrophic disturbances (e.g., forest fires), harsh weather, or disease will directly affect all sub-populations. Ecological distribution may also play a role in long-term population viability. Exposing sub-populations to a range of ecological conditions maintains the genetic variation in a population. Genetic variation at the population level is essential for adaptation to changing environmental conditions.

DNR-managed forests on the west side are distributed from the Canadian border to the Columbia River Gorge and from the Cascade crest to the Pacific Coast. The five west-side planning units include portions of five physiographic provinces (Northern Cascades, Southern Washington Cascades, Puget Trough, Olympic Peninsula, and the Coast Ranges — see Map III.1), three major vegetational zones (Sitka spruce, western hemlock, and silver fir — see discussion in the section of Chapter I titled Land Covered by the HCP), and a range of climatic conditions (Franklin and Dyrness 1973; see also section of Chapter I titled Land Covered). This mix of soils, vegetation, and climate exposes sub-populations to a range of ecological conditions. The large geographic area covered by the five west-side planning units and the range of ecological conditions within them will contribute to the long-term viability of unlisted species populations.

The conservation strategies for salmonids and marbled murrelets should serve to reduce the risk of extinction for many unlisted species, in particular those that have small home ranges and depend on riparian/wetland ecosystems or late successional forests. The riparian (salmonid) strategy will maintain or restore the quantity, quality, and geographic distribution of riparian/wetland habitats. The murrelet strategy is expected to result in the retention of a significant amount of late successional forest. Even-aged forest management will provide habitat for species that utilize young forests. Some unlisted species depend on special landscape features or habitat elements that have yet to be addressed. The conservation measures for talus fields, caves, cliffs, oak woodlands, large snags, balds, mineral springs, and large, structurally unique trees described later in this section are intended to provide habitat for these species.

The spotted owl conservation strategy positions large landscapes of mature and old-growth forest within 2 miles of federal reserves (National Parks, National Forest Wilderness Areas, National Forest Late successional Reserves, etc.). For wide-ranging species (northern goshawk, Pacific fisher, California wolverine, grizzly bear, gray wolf), the conservation benefits of this HCP are seen as adjunct to those provided by federal reserves. Wildlife populations on federal lands will benefit from the proximity of additional riparian and late successional forests on DNR-managed lands. The HCP conservation strategies will broaden the geographic distribution of late successional forest and improve connectivity between noncontiguous blocks of federal land. For those unlisted species sensitive to human disturbance, special management as described below will enhance the reproductive success of individuals.

Protection of Uncommon Habitats

The conservation strategies for salmonids, spotted owls, and marbled murrelets protect habitat for many unlisted species, particularly those associated with late successional forests or riparian ecosystems. For species that rely on uncommon habitats or habitat elements, additional measures are necessary to meet the conservation objectives of the HCP. These measures specifically address talus, caves, cliffs, oak woodlands, large snags, and large, structurally unique trees. The protection of talus, caves, cliffs, and oak woodlands is important because once altered or destroyed, these habitats are difficult to restore or recreate. Large snags and large, structurally unique trees are essential habitat elements that are generally scarce in managed forest

TALUS

Talus has been designated a priority habitat by the Washington Department of Fish and Wildlife (WDFW 1995). It is a homogenous area of rock rubble ranging in size from 1 inch to 6.5 feet (WDFW 1995a; Herrington and Larsen 1985). Naturally occurring talus fields often develop at the base of cliffs or steep hillslopes as gravitational forces act upon disintegrating rock. As more rock accumulates, talus fields expand into adjacent areas of vegetation. Organic soils and pioneering vegetation may also begin to appear in some portions of talus fields in the primary stage of forest succession.

The Larch Mountain salamander requires talus in upland areas (Leonard et al. 1993). Dunn's and Van Dyke's salamanders are also known to inhabit the moist spaces between and under the rocks in talus fields (WDW 1991). Several bat species of concern use rock crevices in large talus for solitary roosts (Christy and West 1993; Holroyd et al. 1994). The microclimatic conditions and shelter provided in the spaces between and under rocks are the elements that make talus an important habitat. Because talus with a high soil content lacks such spaces, it is less important as habitat.

The rock rubble that forms talus fields accumulates where the slope is less than the angle of repose. Although talus provides habitat for some species, the talus fields are also used as road beds and the rocks are used to build roads. (Forty-seven percent is the average angle of repose for unconsolidated materials). The stability of these areas, as evidenced by these accumulations, often make them highly suitable for road beds. Routing roads around all talus fields to preserve them as habitat would mean building on less stable parts of a hillslope, creating the potential for mass wasting and sedimentation. This would be contrary to the riparian conservation strategy, which seeks to reduce the adverse impacts of roads on salmonid habitat.

Much talus is composed of hard rock, which may be suitable material for road construction. Mining talus fields for road construction can result in both short-term and long-term minimization of adverse impacts to salmonid habitat. Heavy trucks hauling construction materials can cause a short-term increase in road erosion and stream sediment concentrations, which can be lessened by using rocks from nearby talus fields (Cederholm et al. 1981). In addition, the use of construction materials inferior to hard rock talus can lead to increased risk of road failure and long-term increases in stream sedimentation caused by surface erosion. Therefore, the protection of all talus fields would conflict with the riparian conservation strategy, which requires that the adverse affects of upland management activities on salmonid habitat be minimized. Besides which, the hauling of materials to a road construction site can be prohibitively expensive compared to the mining of talus.

The conservation objectives for the talus habitat are to maintain its physical integrity and minimize microclimatic change. To meet these objectives, avoid conflict with the conservation of salmonid habitat, and promote cost effective forest management, naturally occurring talus fields shall be protected as follows:

(1) Nonforested Talus - defined as exposed talus with 30 percent or less canopy closure.

- No timber harvest will occur in talus fields greater than or equal to 1 acre.

- No timber harvest will occur in talus fields greater than 1/4 acre in spotted owl NRF and dispersal habitat management areas in the Columbia Planning Unit, except for the western half of the Siouxon Block and 2 isolated sections near Highway 12 where no timber harvest will occur in talus fields greater than 1 acre.

- A 100-foot-wide timber buffer will be applied around talus fields identified above. The buffer will be measured from the edge of the nonforested talus field, i.e. where canopy closure first exceeds 30 percent.

- Timber harvest in the buffer must retain at least 60 percent canopy closure. Any yarding within the buffer will protect the integrity of the talus field.

(2) Forested Talus - defined as exposed talus with greater than 30 percent canopy closure.

- Timber harvest may not remove more than one-third of standing timber volume each harvest rotation from forested talus not located in talus buffers.

(3) Nonforested and Forested Talus

- Road construction through talus fields and buffers will be avoided, provided that the routing of roads will be accomplished in a practicable and economically feasible manner, that is consistent with other objectives of a comprehensive landscape-based road network planning process.

- The mining of rock from talus fields and buffers for road construction will be avoided, provided construction materials can be acquired in a practicable manner, consistent with other objectives of a comprehensive road network planning process.

If a functional relationship between relative density and canopy closure can be demonstrated, then relative density can be substituted for canopy closure in the above definitions of talus.

CAVES

The Washington Department of Fish and Wildlife (1995) defines cave as "a naturally occurring cavity, recess, void, or system of interconnected passages which occurs under the earth in soils, rock, ice, or other geological formations, and is large enough to contain a human." This landscape feature has been designated a priority habitat by the Washington Department of Fish and Wildlife (1995a). Caves possess unique microclimates: constant high humidity levels, low evaporation rates, stable temperatures, and an absence of light. The archetypal cave possesses three zones: entrance zone, twilight zone, and dark zone. The entrance zone receives direct light and commonly has a vegetative component. The twilight and dark zones lie beyond the entrance zone in cave passages, i.e., the corridors and chambers that constitute a cave. The twilight zone receives no direct light, but light is detectable. Shade tolerant plants may inhabit this zone. The dark zone is devoid of light and photosynthetic plant life. In terms of species richness, the cave ecosystem is relatively simple, and therefore it is more vulnerable to environmental disturbances.

Species associated with caves in western Washington include the Larch Mountain salamander (WDW 1991), Townsend's big-eared bat (WDW 1991), long-legged myotis, long-eared myotis, fringed myotis, and Yuma myotis (Christy and West 1993). Only six caves are known on DNR-managed land (WDFW Priority Habitats Database 1995). Most caves in western Washington are lava tubes, which are long passages typically close to the surface.

The Washington Department of Fish and Wildlife definition of a cave is extraordinarily broad, and it is unlikely that all geomorphological features that fit this definition are important to wildlife. Under this HCP, when a cave is found, DNR shall determine, in cooperation with the the U.S. Fish and Wildlife Service, whether it is important to wildlife habitat, and only those caves identified as important habitat shall be protected. The conservation objectives for such caves are to:

(1) maintain the microclimate at the cave entrance;

(2) maintain the physical integrity of cave passages; and

(3) minimize human disturbance to bat hibernacula and maternity colonies.

Caves and cave passages that have been identified as important wildlife habitat shall be protected as follows:

- A 250-foot-wide buffer shall be established around cave entrances. No disturbance of soils or vegetation shall occur within these buffers.

- Where surface activities may disturb a cave passage, a 100-foot-wide buffer shall be established on both sides of the cave passage. No disturbance of soils or vegetation shall occur within these buffers.

- Roads shall not be constructed within 0.25 mile of a cave entrance, provided that the routing of roads around caves can be accomplished in a practicable manner, consistent with other objectives of a comprehensive landscape-based road network planning process.

- Where surface activities may disturb a cave passage, roads shall not be constructed within 300 feet of the cave passage, provided that the routing of roads around caves can be accomplished in a practicable manner, consistent with other objectives of a comprehensive landscape-based road network planning process.

- Newly discovered caves shall be explored and mapped before forest management activities in their vicinity may commence. Explorations will be timed to avoid active maternity colonies or hibernacula.

- The location of caves will be kept confidential by DNR, to the extent permitted by law.

CLIFFS

Cliffs are steep, vertical, or overhanging rock faces; those greater than 25 feet tall and below 5,000 feet in elevation are considered a priority habitat by Washington Department of Fish and Wildlife (1995a). Ledges provide important nesting sites for peregrine falcons. Fissures and overhanging rock provide roosting and hibernation sites for several unlisted bat species of concern (Sarell et al. 1993).

Cliffs are often composed of hard rock that is suitable for road construction. The occasional proximity of cliffs to road construction reduces the hauling distance of road construction materials. The use of construction materials inferior to hard rock can lead to increased risk of road failure and long-term increases in stream sedimentation caused by surface erosion. Furthermore, the acquisition and hauling of materials to a road construction site can be prohibitively expensive compared to the mining of cliffs.

The conservation objectives for cliff habitat are to minimize disturbance to geomorphic features and to protect species that inhabit cliffs. However, few management practices have been specifically developed for cliffs in managed forests. Therefore, management prescriptions to meet these objectives shall be developed on a site-specific basis with consideration given to the following:

(1) During planning for harvest activities around cliffs greater than 25 feet tall and below 5,000 feet in elevation, DNR shall evaluate the cliff to determine if use by wildlife is likely (e.g., are fissures/overhangs present suitable for bats, are ledges/perch trees present suitable for nesting raptors, etc.) and, if so, provide adequate protection measures including, but not limited to:

   a. protection of integrity of cliffs judged suitable and likely for wildlife use (e.g., during felling/yarding, logs should not be allowed to disturb cliff face);

   b. retention of trees on cliff benches and along the base and top of cliffs judged suitable for nesting raptors, especially perch trees along the top of cliffs; and

   c. avoidance of damage to significant cavities, fissures, and ledges.

(2) All cliffs in excess of 150 feet in height will be evaluated for peregrine falcon use as described elsewhere in this HCP (see Minimization and Mitigation for Other Federally Listed Species in All Planning Units)

(3) All cliffs with known peregrine falcon aeries will be protected according to Forest Practice regulations and the commitments contained in this HCP for peregrines (see Minimization and Mitigation for Other Federally Listed Species in All HCP Planning Units).

The mining of rock from cliffs for road construction shall be avoided, provided construction materials can be acquired in a practicable manner, and is consistent with other objectives of a comprehensive landscape-based road-network planning process.

OAK WOODLANDS

Oak woodlands have been designated a priority habitat by the Washington Department of Fish and Wildlife (1995a). Oregon white oak (*Quercus garryana*) is the only native oak in Washington. The center of its range is the Willamette Valley of Oregon; the northern limit of its range is along the lower east slopes of the central Washington Cascades. Scattered Oregon white oak woodlands occur in the Puget Trough, the Columbia Gorge, and along the east slope of the southern Washington Cascades (Franklin and Dyrness 1973). Oregon white oak is also an important component of some ponderosa pine stands along the east slope of the southern and central Washington Cascades (Franklin and Dyrness 1973). In the area covered by the HCP, DNR manages about 4,000 acres of oak woodland (e.g., where oak is the primary tree species) and an additional 7,000 acres of mostly ponderosa pine stands in which oak is a significant associate (e.g., where oak is a secondary or tertiary tree species), but only about 500 acres of oak woodland are in the five west-side planning units (DNR GIS 1995).

Fire is believed to have had a crucial role in the maintenance of oak woodlands by limiting and reducing the number of encroaching conifers. Fire may also stimulate sprouting in Oregon white oaks and enhance the growth of seedlings by removing competing herbaceous vegetation. Without natural wildfires or managed periodic burns, the vegetative composition of the woodland changes. Douglas fir becomes established, and within three to four decades, the rapidly growing conifer overtops the oak, at which point the plant community may be irreversibly altered.

Oak woodlands are a rare plant community in Washington and provide important habitat for several high priority species, including Lewis' woodpecker and the western gray squirrel, which is listed by the state as threatened. Species that find significant habitat in these areas are primarily those that are at the center of their ranges farther south.

The conservation objectives for this habitat are to:

(1) maintain the current quality and distribution of oak habitat to the extent possible considering air quality, fire management, and other constraints; and

(2) restore the quality and distribution of oak habitat where consistent with the above constraints.

Oak woodlands shall be managed as follows:

(1) Partial harvest may occur in oak woodlands. Such harvest will:

- retain all very large dominant oaks (greater than 20 inches dbh);
- maintain 25 to 50 percent canopy cover;
- remove encroaching conifers, except western white pine; and
- retain standing dead and dying oak trees.

(2) Prescribed underburns shall be conducted where appropriate.

(3) Road construction through oak woodlands shall be avoided, provided that the routing of roads around oak woodlands can be accomplished in a practicable manner, consistent with other objectives of a comprehensive landscape-based road network planning process.

LARGE, STRUCTURALLY UNIQUE TREES

Very large trees with certain structural characteristics are important habitat elements in conifer forests of western Washington. Individual trees most valuable for wildlife possess large strong limbs, open crowns, large hollow trunks, and broken tops or limbs. Many live trees that exhibit such characteristics are described by foresters as "deformed" or "defective". These trees provide important, perhaps essential, nesting and/or roosting habitat for two listed species, the marbled murrelet and bald eagle, and several bird species of concern including Vaux's swift, and the pileated woodpecker, as well as forest bats. In western Washington, three species of trees attain enormous size, are very long-lived, and are generally quite wind-firm persisting through numerous disturbances — Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), and western redcedar (*Thuja plicata*). According to Waring and Franklin (1979), on "better sites" in the Pacific Northwest, Douglas fir, Sitka spruce, and western redcedar can attain typically large diameters, from 60 to 87 inches, 70 to 90 inches, and 60 to 118 inches, respectively. In a managed forest, the largest examples of such trees are sometimes referred to as old-growth remnants.

The conservation objectives for this habitat element are to:

(1) retain very large trees with certain structural characteristics important to wildlife, and

(2) retain large trees that may develop these structural characteristics.

Research on animal species using large, structurally unique trees provides guidance for retention criteria. In western Washington, the mean diameter of Douglas fir used for nesting by bald eagles was 50 inches dbh (n = 70) and ranged from 24 to 90 inches dbh (Anthony et al. 1982). Bald eagles used Sitka spruce that ranged from 41 to 109 inches dbh and averaged 75 inches dbh (n = 17) (Anthony et al. 1982). Raley et al. (1994) found more than two-thirds of the roost trees used by radio-tagged pileated woodpeckers were large hollow western redcedars (mean diameter = 81 inches dbh). Vaux's swifts have been found roosting and nesting in hollow western redcedars similar to those used by pileated woodpeckers. Hamer and Nelson (1995) found that in Washington, marbled murrelets nest in trees that average 60 inches dbh (n = 6) and range in size from 35 to 87 inches dbh.

DNR shall conserve the habitat elements provided by large, structurally unique trees as follows:

- When selecting trees for retention, a preference shall be shown for large trees with structural characteristics important to wildlife, or those considered to be old-growth remnants.

- At least 1 tree per acre selected for retention shall belong to the largest diameter class of living trees in the management unit before harvest (by 2-inch increments). At least 1 other tree per acre shall belong to the dominant crown class.

- The trees selected for retention will be left in the harvest unit where practicable, and may be clumped to improve wildlife habitat, protect trees from severe weather, or facilitate operational efficiency, but where practicable, the density of clumps may not be less than 1 clump per 5 acres.

- Trees selected for retention will pose no hazard to workers during harvest operations per the safety standards of the Washington Department of Labor and Industries (WAC 296-54).

SNAGS

DNR shall conserve the habitat elements provided by large snags as follows:

- At least three snags shall be retained for each acre harvested, on average. DNR will try to leave all snags where safe and practical.

- If available, snags retained will be at least 15 inches dbh and 30 feet tall. DNR will try to leave all snags where safe and practical.

- Priority for retention will be given to large hollow snags, hard snags with bark, and snags that are at least 20 inches dbh and 40 feet tall.

- At least five live trees shall be retained permanently for each acre harvested, on average. Two of these trees will be as described in the section on large, structurally unique trees. The other three trees per acre will belong to the dominant, codominant, or intermediate crown classes, and, when available, will have at least one-third of their height in live crown.

- Priority for retention will be given to tree species which have a propensity to develop cavities (e.g., maple), but the stand tree species diversity after harvest should be generally representative of the tree species diversity prior to harvest.

- If fewer than three snags per acre are available prior to harvest, or if fewer than three snags can be left because of safety concerns, additional live trees will be retained so that the total number of stems per acre retained after harvest is, on average, at least 8 per acre. If additional live trees belong to the co-dominant or intermediate crown classes, and when available, will have at least one-third of their height in live crown. If intermediate crown-class trees are retained, shade-tolerant species with at least one-third of their height in live crown will be selected.

- Snags and trees selected for retention within the harvest units may be clumped to improve wildlife habitat, protect trees from severe weather, or facilitate operational efficiency, but where practicable, the density of clumps may not be less than one clump per five acres.

- Snags and trees selected for retention will pose no hazard to workers during harvest operations per safety standards of the Washington Department of Labor and Industries (WAC 296-54).

BALDS

Road construction through balds shall be avoided, provided that the routing of roads around balds can be accomplished in a practicable manner and is consistent with other objectives of a comprehensive landscape-based road network planning process.

MINERAL SPRINGS

Mineral springs provide important resources for certain animal species, e.g., the band-tailed pigeon (*Columbia fasciata*). To prevent or reduce adverse impacts to this landscape feature and the wildlife species associated with it, DNR will cooperate with the U.S. Fish and Wildlife Service in planning management activities within 200 feet of known mineral springs. Such activities will be designed to: (1) retain adequate trees for perching; and (2) maintain berry, fruit, and mast producing shrubs and trees, particularly in openings near mineral springs. Trees harvested near mineral springs will be felled away from the spring. DNR will avoid crossing mineral springs with yarding equipment and will prohibit the crossing of mineral springs by ground-based logging equipment. Residual large green trees and snags within 25 feet of mineral springs will be left, and either clumped or scattered depending upon operational feasibility. In addition, DNR will continue to minimize the use of herbicides as directed by Forest Resource Plan Policy No. 33.

Species by Species Conservation for Unlisted Species of Concern

Habitat for these species will be protected through the conservation strategies for the northern spotted owl and the marbled murrelet, and particularly through the riparian conservation strategy. Please refer to the full descriptions of these strategies as discussed in Sections A, B, and C, respectively, of this chapter for more details.

MOLLUSKS

Newcomb's Littorine Snail

DNR manages several parcels of land near the southern shores of Grays Harbor. The riparian conservation strategy of the HCP is expected to provide protection of the estuarine and wetland habitats considered important to the Newcomb's littorine snail. This protection will be achieved primarily through:

(1) the application of the riparian management zone to estuaries, all of which are shorelines of the state (RCW 90.58.030) and therefore Type 1 waters; and

(2) riparian buffers along Types 1, 2, 3, and 4 waters. Riparian buffers will mediate the delivery of sediment, detrital nutrients, and large woody debris from inland areas to estuaries.

Furthermore, although no specific HCP strategies have been designed for the protection of estuarine areas, some additional protection is expected through DNR's compliance with the Shoreline Management Act (RCW 90.58) and the guidelines for forest management practices promulgated under this Act (WAC 173-16-060).

California Floater and Great Columbia River Spire Snail
DNR expects the riparian conservation strategy of the HCP to protect the rivers and large streams (Types 1, 2 and 3 waters) considered important to the California floater and the great Columbia River spire snail.

ARTHROPODS

Beller's Ground Beetle, Long-horned Leaf Beetle, and Hatch's Click Beetle
DNR expects the riparian conservation strategy of the HCP to protect the sphagnum bog habitat in which these three species of beetles occur through a commitment to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p 36). Sphagnum bogs associated with low-elevation lakes will be provided further protection when the lake is a Type 1, 2, or 3 water.

Fender's Soliperlan Stonefly and Lynn's Clubtail
DNR expects the riparian conservation strategy of the HCP to protect the aquatic habitats considered important to the Fender's soliperlan stonefly and Lynn's clubtail. The riparian conservation strategy should facilitate the redevelopment of riparian plant communities and the natural variability of the aquatic environment. The natural mix of conifer and deciduous species within the riparian buffer should occur through ecosystem restoration. Also, natural disturbances, such as floods and channel migration will continue to create the silty waters that Lynn's clubtail uses for breeding.

FISH

Olympic Mudminnow
The riparian conservation strategy is expected to protect the spawning and rearing habitats of the Olympic mudminnow through:

(1) committing to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36);

(2) protecting lakes and ponds classifies as Types 1, 2, and 3 waters;

(3) protecting Types 1, 2, 3, and 4 rivers and streams; and

(4) treating Type 4 and 5 waters documented to contain fish that are proposed candidates for federal listing as Type 3 waters, if appropriate.

Additional protection of aquatic habitat will occur through the prohibition of timber harvest on unstable hillslopes and road network management that minimizes adverse impacts to salmonid habitat.

Pacific Lamprey and River Lamprey

The riparian conservation strategy as described above for the Olympic mudminnow should protect the spawning and rearing habitats of the Pacific and river lampreys.

Green Sturgeon

Green sturgeon spawning and juvenile rearing habitats are not known to occur in Washington, and thus are out of the bounds of the area covered by the HCP. However, some adult habitat occurs in Grays Harbor, Willapa Bay, and along the Columbia River and its estuaries. This habitat would receive some protection through the riparian conservation strategy as described above for Newcomb's littorine snail.

AMPHIBIANS

Larch Mountain Salamander

This species is strongly associated with talus. Talus fields that are 1 acre or larger in size will be protected as previously described in the subsection titled Protection of Uncommon Habitats. Also, DNR expects the riparian conservation strategy to protect talus fields within or immediately below unstable areas because no harvest will occur on hillslopes with a high risk of mass wasting. In addition, the riparian management zone along Types 1, 2, 3, and 4 waters may encompass some talus fields.

Dunn's and Van Dyke's Salamanders and the Tailed Frog

The riparian conservation strategy is expected to protect the breeding, foraging, and resting habitats of Dunn's and Van Dyke's salamanders and the tailed frog. Riparian buffers along Types 1, 2, and 3 waters will be approximately equal to the site potential height of trees in a mature conifer stand, or 100 feet, whichever is greater. A riparian buffer 100 feet wide will be applied to both sides of Type 4 waters. Management of the no-harvest and minimal-harvest areas of the riparian buffer is anticipated to maintain or restore forests with mature or old-growth characteristics.

Some seeps will be protected through Type 5 stream protection. Type 5 waters that flow through an area with a high risk for mass wasting will be protected under the riparian conservation strategy, and other Type 5 waters will be protected where necessary for key nontimber resources, such as water quality, fish, wildlife habitat, and sensitive plant species (DNR 1992 p. 35).

Dunn's and Van Dyke's salamanders are occasionally found in upland talus (WDW 1991). Talus fields that are 1 acre or larger will be protected as described previously in the subsection titled Uncommon Habitats.

Northern Red-legged Frog, Cascades Frog, and Spotted Frog

The riparian conservation strategy is expected to protect the breeding, foraging, and resting habitats of the northern red-legged, Cascades, and spotted frogs through:

(1) committing to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36);

(2) protecting lakes and ponds classified as Types 1, 2, or 3 waters; and

(3) protecting Types 1, 2, 3, and 4 rivers and streams.

The riparian conservation strategy should facilitate the redevelopment of riparian plant communities and the natural variability of the aquatic environment. The natural mix of conifer and deciduous species within the riparian buffer should occur through ecosystem restoration.

REPTILES

Northwestern Pond Turtle

The riparian conservation strategy is expected to protect the breeding, foraging, and resting habitats of the northwestern pond turtle through:

(1) committing to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36);

(2) protecting lakes and ponds classified as Types 1, 2, or 3 waters; and

(3) protecting Types 1, 2, 3, and 4 rivers and streams.

In addition, under WAC 222-16-080 of the state Forest Practices Rules, harvesting, road construction, aerial application of pesticides, or site preparation within 0.25 mile of a known individual occurrence, documented by the Washington Department of Fish and Wildlife, of a northwestern pond turtle are Class IV-Special forest practices and require an environmental checklist in compliance with the State Environmental Policy Act. The environmental checklist may indicate a need for further protection of the species' critical wildlife habitat.

California Mountain Kingsnake

The California mountain kingsnake occupies oak and pine forests. Oak woodlands have been designated a priority habitat by the Washington Department of Fish and Wildlife (1995a). Oak woodlands will be protected as described previously in the subsection titled Protection of Uncommon Habitats.

The riparian conservation strategy is expected to provide protection of the habitat of the California mountain kingsnake. No harvest will occur on hillslopes with a high risk of mass wasting, and some oak forest exists within unstable areas. The riparian management zone along Types 1, 2, 3, and 4 waters may also encompass some oak forest.

BIRDS

Harlequin Duck

The riparian conservation strategy is expected to protect the breeding, foraging, and resting habitats of the harlequin duck. Buffers along Types 1, 2, and 3 waters will be approximately equal to the site potential height of trees in a mature conifer stand, or 100 feet, whichever is greater. A riparian buffer 100 feet wide will be applied to both sides of Type 4 waters. Management of the no-harvest and minimal-harvest areas of the riparian buffer is anticipated to maintain or restore forests with mature or old-growth characteristics.

Forest management in the riparian buffer must maintain or restore the quality of salmonid habitat, and the resulting conditions should also be conducive to natural densities of aquatic macro-invertebrates upon which the Harlequin duck feeds. The adverse impacts of human disturbance will be minimized by the riparian buffer, which is estimated to have an average width of 150 to 160 feet. Human disturbance will be further reduced by the wind buffer that will be placed where needed along the windward side of many reaches of Types 1, 2, and 3 waters.

ADDITIONAL MITIGATION

DNR shall place restrictions in its contracts for sales of timber and other valuable materials, as well as in its grants of rights of way and easements, to prohibit activities within 165 feet of a known active harlequin duck nest site between May 1 and September 1 where such activities would appreciably reduce the likelihood of nesting success.

Northern Goshawk

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies is expected to provide forest conditions suitable for northern goshawk breeding, foraging, and resting habitat. In concert, these three strategies ensure the development of large landscapes of mature and old-growth forest. In spotted owl NRF management areas, there will be two 300-acre nest patches per 5,000 acres of managed forest. These nest patches will consist of high quality spotted owl nesting habitat that has old-growth characteristics. The nest patches will occur within a larger, contiguous 500-acre area, of which the remaining 200 acres shall be sub-mature forest or higher quality habitat. At least 50 percent of the designated NRF management areas in each WAU (including the nest patches) will be sub-mature forest (as defined in Hanson et al. 1993) or higher quality habitat. On average, 40 to 42 percent of the designated NRF management area in each WAU will be mature or old-growth forest. The landscape conditions in the NRF management areas will meet or exceed the habitat recommendations made by Reynolds et al. (1992) for northern goshawks.

In the five west-side planning units, the spotted owl strategy designates 117,000 acres to be managed as spotted owl dispersal habitat, which supports the movement of juvenile spotted owls among sub-populations on federal reserves. It is likely the availability of this habitat will enhance the survival of dispersing juvenile goshawks as well. At least 50 percent of the designated dispersal management areas in each WAU will meet the minimum specifications for spotted owl dispersal habitat.

Outside the spotted owl NRF management areas, the riparian and murrelet conservation strategies will protect goshawk breeding, foraging, and resting habitat. Management within the riparian buffer, particularly in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics. Mature and old-growth forests will also exist on hillslopes with a high risk of mass wasting. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some late successional forest. Consistent with RCW 77.16.120, outside NRF management areas, trees or snags that are known to contain active goshawk nests will not be harvested.

To meet the objective of providing habitat for demographic support of goshawk populations on federal forest reserves, additional mitigation is necessary to ensure the reproductive success of goshawk breeding pairs in

DNR-managed forests. In particular, special management is necessary to minimize human disturbance around active nest sites.

ADDITIONAL MITIGATION

DNR shall place restrictions in its contracts for sales of timber and other valuable materials, as well as in its grants of rights of way and easements, to prohibit activities within 0.55 mile of a known active northern goshawk nest site located in a NRF management area between April 1 and August 31 where such activities would appreciably reduce the likelihood of nesting success. A circle of radius 0.55 mile will circumscribe the entire post-fledgling family area (600 acres).

Sandhill Crane and Black Tern

The riparian conservation strategy is expected to protect the wetland habitats of the sandhill crane and black tern through: (1) committing to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36), and (2) protecting lakes and ponds classified as Types 1, 2, or 3 waters.

In addition, under WAC 222-16-080 of the state Forest Practices Rules, harvesting, road construction, aerial application of pesticides, or site preparation within 0.25 mile of a known active nesting area, documented by the Washington Department of Fish and Wildlife, of a sandhill crane are Class IV-Special forest practices and require an environmental checklist in compliance with the State Environmental Policy Act. The environmental checklist may indicate a need for further protection of the species' critical wildlife habitat.

Olive-sided Flycatcher

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies should provide forest conditions suitable for olive-sided flycatcher breeding, foraging, and resting habitat. In concert, these three strategies ensure the development of large contiguous landscapes of mature and old-growth forest. At least 50 percent of the designated NRF management areas in each WAU (including the spotted owl nest patches) will be sub-mature forest (as defined in Hanson et al. 1993) or higher quality habitat. On average, 40 to 42 percent of the designated NRF management area in each WAU will be mature or old-growth forest.

Outside spotted owl NRF management areas, the riparian and murrelet conservation strategies will protect breeding, foraging, and resting habitat. Management within the riparian buffer, particularly in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics. Mature and old-growth forests will also exist on hillslopes with a high risk of mass wasting. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some late successional forest.

Little Willow Flycatcher

The riparian conservation strategy and forest management in the five west-side planning units are expected to provide breeding, foraging, and resting habitat for the little willow flycatcher. Buffers along Types 1, 2, and 3 waters will be approximately equal to the site potential height of trees in a mature conifer stand, or 100 feet, whichever is greater. A riparian buffer 100 feet wide will be applied to both sides of Type 4 waters. The natural mix of conifer and deciduous species should occur through ecosystem restoration. Also, natural disturbances such as floods, and channel migration will continue to create the alder and willow riparian habitat preferred by this species.

Even-aged forest management throughout the five west-side planning units will continue to provide shrubby habitats in regenerating clearcuts and sapling stands.

Common Loon

The riparian conservation strategy is expected to protect the loon's lake habitat. The adverse impacts of human disturbance will be minimized by the riparian buffer, which is estimated to have an average width of 150 to 160 feet and will be applied along the shoreline of Types 1, 2, and 3 lakes and ponds. Human disturbance will be further reduced by the wind buffer that will be placed where needed along the riparian buffer on the windward side of Types 1, 2, and 3 waters. In order to meet the conservation objectives, further mitigation is required to reduce the adverse affects of human disturbance.

ADDITIONAL MITIGATION

DNR shall place restrictions in its contracts for sales of timber and other valuable materials, as well as in its grants of rights of way and easements, to prohibit activities within 500 feet of a known active common loon nest site between April 1 and September 1 where such activities would appreciably reduce the likelihood of nesting success.

Golden Eagle

Golden eagles nest in large trees or on cliffs. These uncommon habitats and habitat elements will be protected as described earlier in this section. The combination of the riparian conservation strategy and forest management in the five west-side planning units should provide breeding, foraging, and resting habitat for the golden eagle. Many forests on unstable hillslopes will not be harvested and some of these areas will contain large trees. Buffers along Types 1, 2, and 3 waters will be approximately equal to the site potential height of trees in a mature conifer stand, or 100 feet, whichever is greater. A riparian buffer 100 feet wide will be applied to both sides of Type 4 waters. Management within the riparian buffer is expected to result in the development of late successional forest containing large live trees. Even-aged forest management throughout the five west-side planning units will continue to provide openings for foraging habitat.

Golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668, Revised 1978). Under this Act, it is unlawful to molest or disturb golden eagles and their nests. RCW 77.16.120 of the Wildlife Code of Washington prohibits destroying the nests of protected wildlife. Consistent with these regulations, trees or snags that contain known active golden eagle nests shall not be harvested.

Vaux's Swift

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies is expected to provide forest conditions suitable for Vaux's swift breeding, foraging, and resting habitat. In concert, these three strategies ensure the development of large contiguous landscapes of mature and old-growth forests containing large live tree and snags. In spotted owl NRF management areas, there will be two 300-acre nest patches per 5,000 acres of managed forest. These nest patches will consist of high quality spotted owl nesting habitat, which will have old-growth forest characteristics. The nest patches will occur within a larger, contiguous 500-acre area, of which the remaining 200 acres shall be sub-mature forest or higher quality habitat. At least 50 percent of the designated NRF management areas in each WAU (including the nest patches) will be sub-mature forest or higher quality habitat.

Even-aged forest management will provide a full range of seral stages for foraging. No harvest will occur on unstable hillslopes with a high risk of mass wasting, and some of these areas will contain large live trees and large snags. Management activities within the riparian buffer are expected to result in the development of late successional forest containing large live trees.

Outside the NRF management areas, the riparian and murrelet conservation strategies will protect breeding and resting habitat. Management within the riparian buffer, particularly in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics. Mature and old-growth forests will also exist on hillslopes with a high risk of mass wasting. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some late successional forest.

Large, structurally unique trees and large hollow snags will be protected as described previously in the subsection titled Protection of Uncommon Habitat. In addition, consistent with RCW 77.16.120, trees or snags that are known to contain active Vaux's swift nests shall not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

ADDITIONAL MITIGATION

Live trees or snags that are known to be used by Vaux's swifts as night roosts shall not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

Lewis' Woodpecker

Oak woodlands are used for breeding, foraging, and resting habitat by Lewis' woodpecker. Oak woodlands have been designated a priority habitat by the Washington Department of Fish and Wildlife (1995a) and will be protected as described previously in the subsection titled Protection of Uncommon Habitats. The riparian conservation strategy is expected to guarantee some protection of this habitat within unstable areas because no harvest will occur on hillslopes with a high risk of mass wasting areas. The riparian management zone along Types 1, 2, 3, and 4 waters may also encompass some oak forests.

The riparian conservation strategy should protect some deciduous riparian habitat. Buffers along Types 1, 2, and 3 waters will be approximately equal to the site potential height of trees in a mature conifer stand. A riparian buffer 100 feet wide will be applied to both sides of Type 4 waters. DNR expects this management to result in the development of late successional forest containing large snags. The natural mix of conifer and deciduous species should occur through ecosystem restoration, and natural disturbances, such as floods, and channel migration will continue to create the cottonwood riparian habitat preferred by this species.

Pileated Woodpecker

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies is expected to provide forest conditions suitable for pileated woodpecker breeding, foraging, and resting habitat. In concert, these three strategies ensure the development of large contiguous landscapes of mature and old-growth forest containing large live tree and snags. At least 50 percent of the NRF management area in each WAU will be submature forest (as defined in Hanson et al. 1993) or higher quality. There will be two 300-acre nest patches per 5,000 acres of managed forest in NRF management areas. These nest patches will consist of high quality spotted owl nesting habitat, which has old-growth forest characteristics. The nest patches will occur within a larger, contiguous 500-acre area, of which the remaining 200 acres shall be sub-mature forest or higher quality habitat. On average, 40 to 42 percent of the designated NRF management area in each WAU will be mature or old-growth forest.

Outside of spotted owl NRF management areas, the riparian and murrelet conservation strategies will protect breeding and resting habitat. Management within the riparian buffer, particularly in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics. Mature and old-growth forests will also exist on hillslopes with a high risk of mass wasting. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some late successional forest.

Snags will be retained according to state Forest Practices Rules. Under WAC 222-30-020(11), three wildlife reserve trees (typically snags) are left for each acre harvested in western Washington. The wildlife reserve trees must be 10 or more feet in height and 12 or more inches dbh. These minimum sizes do not guarantee that wildlife trees suitable for pileated woodpeckers will be retained. The retention of large, structurally unique trees, as described previously in the subsection titled Protection of Uncommon Habitats, will provide a source for large snags.

Conservation measures for large snags and large, structurally unique trees will retain structural elements required by pileated woodpeckers for nesting and roosting. Additional conservation measures for snags will increase the density of snags, and consequently, opportunities for foraging.

Consistent with RCW 77.16.120, trees or snags that are known to contain active pileated woodpecker nests will not be harvested. In addition, trees or snags that are known to have been used by pileated woodpeckers for nesting will not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

Purple Martin

The riparian conservation strategy is expected to protect the open riparian/wetland habitat of purple martins through:

(1) committing to "no overall net loss of naturally occurring wetland acreage and function" (DNR 1992 p. 36); and

(2) the protection of lakes and ponds classified as Types 1, 2, or 3 waters.

Conservation measures for large snags and large, structurally unique trees will retain structural elements required by purple martins for nesting.

In addition, consistent with RCW 77.16.120, trees or snags that are known to contain active purple martin nests will not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

Western Bluebird

Even-aged forest management throughout the five west-side planning units will continue to provide openings suitable for breeding, foraging, and resting habitat. Conservation measures for large snags and large, structurally unique trees will retain structural elements required by western bluebirds for nesting.

In addition, consistent with RCW 77.16.120, trees or snags that are known to contain active western bluebird nests will not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

MAMMALS

Myotis Bats

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies should provide forest conditions suitable for myotis bat breeding, foraging, and resting habitat. In concert, these three strategies ensure the development of large contiguous landscapes of mature and old-growth forest. On average, 40 to 42 percent of the designated NRF management area in each WAU will be mature or old-growth forest.

Outside of spotted owl NRF management areas, the riparian and murrelet conservation strategies will protect breeding and resting habitat. Management within the riparian buffer, particularly in the no-harvest and minimal-harvest areas, should eventually result in forests with mature and old-growth characteristics. Mature and old-growth forests will also exist on hillslopes with a high risk of mass wasting. The long-term murrelet conservation strategy is not yet developed, but it will quite likely entail the preservation of some late successional forest.

Talus fields, cliffs, and caves will be protected as described previously in the subsection titled Protection of Uncommon Habitats, and DNR will also protect large, structurally unique trees and large snags as described in the same subsection.

ADDITIONAL MITIGATION

Live trees or snags that are known to be used by myotis bat species as communal roosts or maternity colonies shall not be harvested. Green tree and snag retention are subject to the safety standards of the Department of Labor and Industries (WAC 296-54).

Townsend's Big-eared Bat

Caves will be protected as described previously in the subsection titled Protection of Uncommon Habitats.

California Wolverine

There is very little montane forest on DNR-managed lands. But some parcels of DNR-managed forest are positioned adjacent to federal wilderness areas and federal Late successional Reserves that may serve as refugia for wolverines. Therefore, it is possible that wolverines could now or in the future be present in DNR-managed forests. The combination of the riparian, spotted owl, and marbled murrelet conservation strategies is expected to provide forest conditions suitable for wolverine breeding, foraging, and resting habitat. In concert, these three strategies should ensure the development of large landscapes of mature and old-growth forest. Forest management will create a range of habitat types from grass-forb to late-successional forest.

To meet the objective of providing habitat for demographic support of populations on federal forest reserves additional mitigation is necessary to ensure the reproductive success of breeding adults in DNR-managed forests. In particular, special management is necessary to minimize human disturbance around active den sites and eliminate trapping mortality.

DNR-managed roads are routinely closed for cost-effective forest management and protection of public resources, including wildlife (DNR 1992 p. 41). Road closures benefit the wolverine population by limiting human disturbance and reducing the likelihood of accidental trapping. Road closures will continue on DNR-managed lands and will be consistent with cost-effective forest management and policies set forth by the Board of Natural Resources.

ADDITIONAL MITIGATION

DNR shall place restrictions in its contracts for sales of timber and other valuable materials, as well as in its grants of rights of way and easements, to prohibit activities within 0.5 mile of a known active wolverine den site located in a spotted owl NRF management area between January 1 and July 31 where such activities would appreciably reduce the likelihood of denning success.

Pacific Fisher

The combination of the riparian, spotted owl, and marbled murrelet conservation strategies is expected to provide forest conditions suitable for fisher breeding, foraging, and resting habitat. In concert, these three strategies ensure the development of large landscapes of mature and old-growth forest. At least 50 percent of the designated NRF management areas in each WAU (inclusive of the nest patches) will be sub-mature forest (as defined in Hanson et al. 1993) or higher quality habitat. The high-quality owl nesting habitat in nest patches will have old-growth forest characteristics. On average, 40 to 42 percent of the designated NRF management area in each WAU will be mature or old-growth forest.

In the five west-side planning units, the spotted owl strategy designates 117,000 acres to be managed as spotted owl dispersal habitat. At least 50 percent of the designated dispersal management area in each WAU will meet the minimum specifications for spotted dispersal habitat. The purpose of dispersal habitat is to support the movement of juvenile spotted owls between sub-populations on federal reserves, and it is likely the availability of this habitat may also enhance the survival of dispersing juvenile fishers.

The geographical distribution of areas managed for spotted owl breeding habitat will maintain some of the elevational range of fisher habitat. DNR-managed forests are generally located at a lower elevation than federal lands. To meet the objective of providing habitat for demographic support of populations on federal forest reserves, additional mitigation is necessary to ensure the reproductive success of breeding adults in DNR-managed forests. In particular, special management is necessary to minimize human disturbance around active den sites and eliminate trapping mortality.

DNR-managed roads are routinely closed for cost-effective forest management and protection of public resources including wildlife (DNR 1992 p. 41). Road closures benefit the fisher population by limiting human disturbance and reducing the likelihood of accidental trapping. Road closures will continue on DNR-managed lands and will be consistent with cost-effective forest management and policies set forth by the Board of Natural Resources.

Conservation measures for large snags and large, structurally unique trees will retain structural elements required by fishers for denning and resting.

ADDITIONAL MITIGATION

DNR shall place restrictions in its contracts for sales of timber and other valuable materials, as well as in its grants of rights of way and easements, to prohibit activities within 0.5 mile of a known active fisher den site located in a spotted owl NRF management area between February 1 and July 31 where such activities would appreciably reduce the likelihood of denning success.

Western Gray Squirrel

Oak woodlands are the breeding, foraging, and resting habitat of the western gray squirrel. Oak woodlands have been designated a priority habitat by the Washington Department of Fish and Wildlife (1995a), and will be protected as described previously in the subsection titled Protection of Uncommon Habitats.

The riparian conservation strategy is expected to provide some protection of the breeding, foraging, and resting habitat of the western gray squirrel. No harvest will occur on hillslopes with a high risk of mass wasting, and some oak forest will exist within unstable areas. The riparian management zone along Types 1, 2, 3, and 4 waters may also encompass some oak forest.

In addition, under WAC 222-16-080 of the state Forest Practices Rules, the Forest Practices Board may adopt rules pertaining to management activities which impact western gray squirrels. These rules would provide further protection of the species' critical wildlife habitat.

Lynx

Although the lynx may potentially occur in the area covered by the HCP, it is not known to occur in the five west-side planning units. Therefore, it is not discussed in this section.

California Bighorn Sheep

Although the California bighorn sheep may potentially occur in the area covered by the HCP, it is not known to occur in the five west-side planning units. Therefore, it is not discussed in this section.

Summary of Habitat Types Provided on DNR-managed Lands in the Five West-Side Planning Units

The type and distribution of habitat available during the term of this HCP will be the result of commitments under the HCP, natural events, forest management policies of the Board of Natural Resources and DNR, technological developments that influence management practices, and land transactions.

HABITATS TO BE MAINTAINED OR RESTORED UNDER THE HCP

Spotted Owl Nesting, Roosting, and Foraging (NRF) Areas

Two types of habitat are required within designated NRF areas:

(1) high quality nesting habitat; and

(2) areas that, at a minimum, meet the sub-mature habitat definition.

In every 5,000 acres, there shall be two 300-acre nest patches of high quality spotted owl nesting habitat that has old-growth characteristics. These nest patches will occur within a larger, contiguous 500-acre area, of which the remaining 200 acres shall be sub-mature forest or higher quality habitat. At least 50 percent of the designated NRF management areas in each WAU (Watershed Administrative Unit) shall be sub-mature, including the nest patches.

See Section A of Chapter IV on spotted owl mitigation for a full description of these habitats, their distribution, and the amount required. The definitions of these habitats are summarized below:

- High quality nesting habitat (average condition over a 300-acre nesting habitat patch)
  - at least 31 trees per acre greater than or equal to 21 inches dbh with at least 15 trees per acre greater than or equal to 31 inches dbh;
  - at least three trees from the above group of 31 trees have broken tops;
  - at least 12 snags per acre larger than 21 inches dbh;
  - a minimum of 70 percent canopy closure; and
  - a minimum of 5 percent ground cover of large woody debris.
- Sub-mature habitat (applied as average stand conditions)
  - forest community dominated by conifers or in mixed conifer/hardwood forest, the community is composed of at least 30 percent conifers (measured as stems per acre dominant, co-dominant, and intermediate trees);
  - at least 70 percent canopy closure;
  - tree density of between 115 and 280 trees per acre greater than 4 inches dbh;

- dominant and co-dominant trees at least 85 feet tall;
- at least three snags or cavity trees per acre that are at least 20 inches dbh; and
- a minimum of 5 percent ground cover of large down woody debris.

Spotted Owl Dispersal Areas

Within designated spotted owl dispersal areas, 50 percent of the area shall be maintained in stands that meet the dispersal habitat definition. See Section A of Chapter IV on spotted owl mitigation for a full description of this habitat. The definition of dispersal habitat is summarized below:

- canopy cover of at least 70 percent;
- quadratic mean diameter of at least 11 inches dbh for the 100 largest trees in a stand;
- top height of at least 85 feet; and
- at least four trees per acre from the largest size class retained for future snag and cavity trees.

Marbled Murrelet Habitat Blocks

The interim conservation strategy for the marbled murrelet calls for deferring harvest on suitable habitat blocks while studies are conducted to provide information for developing a long-term conservation strategy. The amount of habitat required for murrelets in the long-term strategy is expected to be less than is identified using the current definition. See Section B of Chapter IV for a complete discussion of the mitigation for marbled murrelets. Suitable marbled murrelet habitat that will be used for identifying blocks to be deferred is defined as a contiguous forested area meeting all of the following three criteria:

- at least five acres in size;
- containing an average of at least two potential nesting platforms per acre; and
- within 50 miles of marine waters.

Riparian Management Zones

Management activities allowed within riparian management zones will influence the type of habitat provided. The requirements for no harvest within the first 25 feet of the active channel margin and minimal harvest in the next 75 feet will tend to leave, or develop over time, timber stands with a range of mature to old-growth characteristics. Through restoration efforts consistent with the riparian conservation objective of maintaining or restoring salmonid freshwater habitat on DNR-managed lands, most riparian management zones will be coniferous with minor hardwood components. Hardwoods will be maintained on sites that are not environmentally suited to conifers. See Section D of Chapter IV for a detailed discussion of riparian management zones.

Wetlands

DNR will allow no overall net loss of naturally occurring wetland acreage or function. This applies to nonforested and forested wetlands. See Section D of Chapter IV on the riparian conservation strategy for a detailed discussion of wetland management activities and habitat. For forested wetlands and buffers of nonforested wetlands, timber harvests shall be designed to maintain the perpetuate stands that:

- are as wind-firm as possible;
- have large root systems to maintain the uptake and transpiration of ground water; and
- have a minimum basal area of 120 square feet per acre.

Uncommon Habitats

See Section F of Chapter IV on the multispecies conservation strategy for a discussion of uncommon habitats on DNR-managed lands. The following uncommon habitats will be identified and protected:

- cliffs;
- caves and cave passages that have been identified as important wildlife habitat;
- oak woodlands

  (Oak woodlands are very limited in the five west-side planning units. Where they occur, they will be managed to maintain the current quality and distribution of the habitat to the extent possible considering air quality, fire management, and other constraints and to restore the quality and distribution of this habitat where consistent with these constraints.); and
- talus fields that are one acre or larger.

HABITATS PROVIDED ON DNR-MANAGED LANDS

After a natural disturbance, such as fire, a stand regenerates and develops through a succession of seral stages. Managed forests follow a similar pattern of succession following clearcut timber harvest. A variety of wildlife habitats on DNR-managed lands will occur in the different seral stages (Brown 1985) described below:

- Grass/forb

  Grass/forb-dominated areas develop quickly on cleared lands and are common for a few years after harvest or site preparation activities. In cases where a significant shrub layer existed under the timber that was harvested, a grass/forb condition frequently will not develop. Generally, a grass/forb condition exists at the time sites are planted or develops shortly after planting.
- Shrub

  Shrubs develop on a site following harvests, including thinnings, or start developing at the same time as grasses and forbs. However, shrubs generally take a few years to develop to the point of dominating a site. The length of time shrubs dominate an area depends primarily on the development of trees. Tree seedlings are generally present on these sites but are not tall enough to impact the shrubs.

- **Open sapling/pole**
  In the open sapling/pole condition, shrubs are frequently the dominant vegetation, but trees are tall enough to prevent being suppressed by shrubs.

- **Closed sapling/pole/sawtimber**
  This condition is marked by very dense tree canopies which limit all ground vegetation. Thinning commonly opens the canopy sufficiently to allow shrubs to redevelop.

- **Large sawtimber**
  Large sawtimber is frequently defined as stands with an average diameter greater than 21 inches. In managed stands, trees often have a relatively uniform size and may approach the tree sizes found in old-growth stands. However, these stands generally lack characteristics such as snags, down woody debris, and the two or more canopy layers that are found in old-growth stands.

- **Old growth**
  Old-growth stands are characterized by the presence of snags, down woody debris, and two or more canopy layers that develop as a result of the mortality of overstory trees. Stand diameters may be similar to or larger than large sawtimber stands.

Table IV.13 lists the types of habitat expected to be provided under the HCP on DNR-managed lands in the five west-side planning units. Examples of representative species that might use that habitat type, management activities that may be conducted, potential negative impacts that may result from the management activities, and benefits expected to accrue from the HCP are given for each habitat type. Additional details regarding the management activities are included in Section H (Forest Land Management Activities) of this chapter.

Table IV.13: Habitats and representative wildlife species covered by this HCP for the west-side planning units

(Source: Brown 1985, Thomas et al. (1993), Parsons et al. (1991), and Pyle (1989)).

Type of habitat	**Representative species that can use these habitat types**
Spotted owl high quality nesting habitat	dusky shrew, long-eared myotis, northern flying squirrel, Pacific fisher, wood duck, northern goshawk, barred owl, pileated woodpecker, olive-sided flycatcher, northern spotted owl, hoary bat, bushy-tailed woodrat, red tree vole, harlequin duck, marbled murrelet, Vaux's swift, red-breasted nuthatch, Dunn's salamander, Larch Mountain salamander, Van Dyke's salamander, tailed frog, pine white butterfly, Johnson's hairstreak butterfly, *Acalypta saudersi* (a lace bug), *Cychrus tuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle)
Spotted owl sub-mature habitat	dusky shrew, long-legged myotis, northern flying squirrel, Pacific fisher, wood duck, hairy woodpecker, northern goshawk, barred owl, olive-sided flycatcher, northern spotted owl, hoary bat, bushy-tailed woodrat, red tree vole, red-breasted nuthatch, Dunn's salamander, northwestern salamander, Van Dyke's salamander, tailed frog, northern alligator lizard, pine white butterfly, coral hairstreak butterfly, California hairstreak butterfly, *Cychrus tuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle)
Spotted owl dispersal habitat	Douglas' squirrel, sharp-shinned hawk, Swainson's thrush, evening grosbeak, dusky shrew, northern spotted owl, long-legged myotis, mountain beaver, creeping vole, bobcat, elk, Vaux's swift, orange-crowned vireo, northern alligator lizard, rubber boa, long-toed salamander,

Table IV.13: Habitats and representative wildlife species covered by this HCP for the west-side planning units *(continued)*

Type of habitat	Representative species that can use these habitat types
Spotted owl dispersal habitat *(continued)*	*Cychrus tuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle)
Marbled murrelet habitat	dusky shrew, long-legged myotis, northern flying squirrel, Pacific fisher, wood duck, northern goshawk, barred owl, hairy woodpecker, Oliver-sided flycatcher, marbled murrelet, hoary bat, bushy-tailed woodrat, red tree vole, harlequin duck, Vaux's swift, red-breasted nuthatch, Dunn's salamander, Larch Mountain salamander, Van Dyke's salamander, tailed frog, pine white butterfly, Johnson's hair-streak butterfly, *Acalypta saudersi* (a lace bug), *Cychrus tuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle)
Conifer-dominated riparian ecosystems	long-legged myotis, Pacific fisher, mink, wood duck, sharp-shinned hawk, ruffed grouse, olive-sided flycatcher, purple martin, Dunn's salamander, Van Dyke's salamander, salamander, tailed frog, dusky shrew, Trowbridge's shrew, southern red-backed vole, river otter, Barrow's goldeneye, band-tailed pigeon, long-eared owl, red-breasted sapsucker, hermit thrush, evening grosbeak, Cascade frog, bull trout, coho salmon, steelhead salmon, mayflies, stoneflies, caddisflies, midges, arborvitae hair-streak butterfly
Hardwood-dominated riparian ecosystems	long-legged myotis, mink, wood duck, purple martin, northwestern pond turtle, common garter snake, Dunn's salamander, northern red-legged frog, ruffed grouse, dusky shrew, shrew mole, yellowpine chimunk, river otter,

Table IV.13: Habitats and representative wildlife species covered by this HCP for the west-side planning units *(continued)*

Type of habitat	**Representative species that can use these habitat types**
Hardwood-dominated riparian ecosystem *(continued)*	Barrow's goldeneye, Cooper's hawk, band-tailed pigeon, downy woodpecker, black-headed grosbeak, Olympic salamander, Olympic mudminnow, mayflies, stoneflies, caddisflies, dreamy duskywing butterfly, western tiger swallowtail
Nonforested wetland	northern harrier, common snipe, northwestern pond turtle, northern red-legged frog, spotted frog, Beller's ground beetle, long-horned leaf beetle, Hatch's click beetle, mallard, mink, dusky shrew, Pacific shrew, coast mole, Yuma myotis, long-tailed vole, American bittern, little willow flycatcher, common loon, sandhill crane, black tern, coho salmon, Olympic mudminnow, dragonflies, damselflies, sonora skipper butterfly
Forested wetland	long-legged myotis, Pacific fisher, ruffed grouse, sharp-shinned hawk, barred owl, olive-sided flycatcher, purple martin, Van Dyke's salamander, northern red-legged frog, mink, spotted frog, dusky shrew, water shrew, bushy-tailed woodrat, common merganser, band-tailed pigeon, northern saw-whet owl, red-breasted sapsucker, western toad, dragonflies, flies, cad-disflies, pale tiger swallowtail butterfly
Cliffs	fringed myotis, long-legged myotis, Yuma myotis, mountain goat, peregrine falcon, turkey vulture, black swift, cliff swallow, western fence lizard, bushy-tailed woodrat, golden eagle, wasps, shorttailed black swallowtail butterfly

Table IV.13: Habitats and representative wildlife species covered by this HCP for the west-side planning units *(continued)*

Type of habitat	Representative species that can use these habitat types
Caves	Townsend's big-eared bat, fringed myotis, long-legged myotis, Yuma myotis, coyote, California wolverine, mountain lion, bobcat, black swift, Larch Mountain salamander, crickets
Oak woodland	western gray squirrel, Lewis' woodpecker, California mountain kingsnake, Propertius' duskywing butterfly, Oregon green hairstreak butterfly
Talus	Cascade golden-mantled ground squirrel, mountain goat, Pacific fisher, California wolverine, bobcat, white-tailed ptarmigan, common nighthawk, rosy finch, western fence lizard, Larch Mountain salamander, Dunn's salamander, Van Dyke's salamander, wolf spiders, jumping spiders, small-footed myotis
Grass/forb forest stage	coast mole, vagrant shrew, Townsend's vole, coyote, long-tailed weasel, black-tailed deer, common nighthawk, white-crowned sparrow, northwestern garter snake, western fence lizard, northwestern salamander, western bluebird, wolf spiders, grasshoppers, mariposa copper butterfly, silvery blue butterfly, Blackmore's blue butterfly, western meadow fritillary butterfly, *Oncocnemis dunbari* (a moth), *Formica neorufibarbis* (an ant)
Shrub forest stage	coast mole, Townsend's vole, mountain beaver, coyote, long-tailed weasel, black-tailed deer, common nighthawk, blue grouse, rufous hummingbird, hermit thrush, white-crowned sparrow, rufous-sided towhee, northwestern garter snake, western fence lizard,

Table IV.13: Habitats and representative wildlife species covered by this HCP for the west-side planning units *(continued)*

Type of habitat	**Representative species that can use these habitat types**
Shrub forest stage *(continued)*	northwestern salamander, western bluebird, Pacuvius' duskywing butterfly, satyr anglewing butterfly
Open sapling/pole forest stage	coast mole, Douglas' squirrel, mountain beaver, black-tailed deer, long-tailed weasel, coyote, blue grouse, rufous hummingbird, American robin, hermit thrush, rufous-sided towhee, western fence lizard, western bluebird, Phoebus parnassian butterfly, golden hairstreak butterfly, western tailed blue butterfly, bobcat, snowshoe hare
Closed sapling/pole/sawtimber forest stage	Douglas' squirrel, sharp-shinned hawk, Swainson's thrush, evening grosbeak, dusky shrew, long-legged myotis, mountain beaver, creeping vole, bobcat, elk, Vaux's swift, orange-crowned vireo, northern alligator lizard, rubber boa, long-toed salamander, *Cychrustuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle)
Large sawtimber forest stage	dusky shrew, long-legged myotis, northern flying squirrel, Pacific fisher, wood duck, hairy woodpecker, northern goshawk, barred owl, olive-sided flycatcher, hoary bat, bushy-tailed woodrat, red tree vole, red-breasted nuthatch, Dunn's salamander, northwestern salamander, Van Dyke's salamander, tailed frog, northern alligator lizard, coral hairstreak butterfly, pine white butterfly, California hairstreak butterfly, *Cychrus tuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle)

Table IV.13: Habitats and representative wildlife species covered by this HCP for the west-side planning units *(continued)*

Type of habitat	Representative species that can use these habitat types
Old-growth forest stage	Johnson's hairstreak butterfly, pine white butterfly, *Acalypta saudersi* (a lace bug), *Cychrus tuberculatus* (a carabid beetle), *Lobosoma horridum* (a weevil), *Omus dejeani* (a tiger beetle); and see list for spotted owl high quality nesting habitat

Provision of a Range of Forest Types Across the HCP Landscape

DNR management activities that will occur under the HCP will ensure a range of forest types in adequate amounts to provide for multi-species conservation across the landscape covered by the HCP. DNR has modeled the age-class distribution that will likely result from expected management under the HCP and existing policies. Results from this modeling have been used to develop a table (see Table IV.14) of expected percentages of each of several forest habitat/structural types, using age-class as a surrogate, that would likely exist 100 years following implementation of such management.

Table IV.14: DNR HCP stand structure objectives at year 100 (in percent of land area)

Stand Stage[1]	West-side Planning Units Excluding the OESF	OESF Planning Unit
Open (0-10 Years)[2]	5-10	5-15
Regeneration (10-20 years)[2]	5-15	5-15
Pole (20-40 years)[2]	15-25	5-15
Closed (40-70 years)[2]	25-35	5-15
Complex (at least 70 years)[2]	25-35	60-70
Fully Functional	(At least 150 years)	(At least 200 years)
(Subset of Complex)	10-15	10-15

[1]Stand stages are defined as:
Open- earliest seral stage; overstory has been removed; dominated by herbs and shrubs with some young conifer and deciduous trees present.

Regeneration-shrubs and saplings; branches beginning to intertwine; dense canopies from ground-level upwards.

Pole - early stages of stem exclusion; stems closely spaced and numerous; little understory; limited self-pruning; and insufficient canopy lift to allow larger birds to penetrate.

Closed - have undergone some stem exclusion and competition mortality; have achieved some canopy lift from self-pruning; have well-developed, deep canopies; and lacking complex structural characteristics of older types.

Complex - stocked with large trees with a variety of diameters and heights evident; mortality within the stand (or residual trees, snags, and logs) provides cavities in standing snags, downed logs, deformities in standing live trees; large horizontal branches; and a complex canopy with conifer establishment occurring under opening in the canopy.

Fully Functional - a subset of complex forests but more mature and structurally complex.

[2]Age-classes shown are a surrogate for stand structure. If and when it can be shown that appropriate structure can be obtained at a different age, different age classes may be used.

The information in the above table was derived from modeling that contained assumptions based on the Forest Resource Plan policies. These assumptions are described in Appendix 5 of the Final EIS (available from DNR). The FRP states that the goal for average rotation age for west-side conifer dominated forests will be 60 years. At present, DNR expects to continue this policy and information regarding the average rotation age will be provided to the U.S. Fish and Wildlife Service and the National Marine Fisheries Service at scheduled inter-agency HCP reviews. However, as long as DNR can show that reaching the stand structure objectives is likely, other rotation ages may be used. Additionally, DNR maintains the flexibility to harvest specific stands at an earlier age to address specific silvicultural situations (i.e., a 30- to 35-year old stand that was not thinned at an appropriate age may be more quickly converted into a healthy, productive stand by clear-cutting the stand and "starting over").

Subsequent to the modeling exercise, DNR, the U.S. Fish & Wildlife Service and the National Marine Fisheries Service negotiated a 70-year term for this HCP, with provisions for up to three, 10-year extensions. (See the Implementation Agreement in Appendix B of this document.) Such extensions could occur at DNR's option if commitments of the HCP are met at year 70, or at the U.S. Fish and Wildlife Service's option if commitments have not been met at year 70. Currently no projections are available for the forest structure expected at year 70. However, during the first year following approval of the HCP, additional modeling will be conducted by DNR. The modeling will be by decade and the results will be provided to the U.S. Fish and Wildlife Service at, or by, the first annual review. These decadal projections will be used by DNR as part of its monitoring process.

The projections for year 70 will be a part of the U.S. Fish and Wildlife Service's evaluation of whether DNR has met the commitments of the HCP at year 70. In that evaluation, the U.S. Fish and Wildlife Service will also review DNR's progress in meeting the conservation objectives included in Chapter IV of this HCP. DNR's HCP provides for the conservation of both listed and unlisted species. Detailed, specific conservation measures are described elsewhere in this chapter for the northern spotted owl and a long-term strategy will be developed for the marbled murrelet. Additional important, but more limited, measures will be described for certain other listed species. Conservation measures affecting the unlisted species include those undertaken for listed species with additional measures described for certain important habitat types. The most important conservation measures affecting unlisted species are those associated with the riparian conservation strategy.

Of the HCP's three primary conservation components (spotted owl conservation strategy, marbled murrelet conservation strategy, and riparian conservation strategy), the marbled murrelet strategy is the only one that is interim in nature. A long-term strategy will not be developed for a number of years. An adequate and appropriate means of evaluating commitments for the marbled murrelet at year 70 cannot be described, at this time, except in terms of compliance with the strategy described in Chapter IV.

The riparian conservation strategy will be implemented in the five west-side planning units and the OESF. DNR's compliance and effectiveness monitoring plan for the riparian areas should provide sufficient information for the U.S. Fish and Wildlife Service to determine whether commitments in this area have been met at year 70.

The spotted owl conservation strategy sets specific goals for developing and maintaining NRF and dispersal habitat in specific amounts and locations (by WAU). Approximately 200,000 acres are designated for a NRF habitat role and 125,000 of those acres (62.5 percent) are in WAUs that are already at or above the goals set in this HCP. The conditions in the WAUs that are not currently at or above the goal, will be reviewed by the U.S. Fish and Wildlife Service at year 70, when evaluating whether DNR has met its obligations under the HCP.

As described above, the 70 year term should be sufficient for all species based upon the anticipated habitats resulting from the HCP management strategies. Riparian areas and uncommon/special habitats (e.g., talus, caves, wetlands) are expected to provide improved wildlife habitat over the life of the plan. Older stand structures (i.e., structurally complex forests and fully functional forests) increase or remain constant when comparing the current conditions with those anticipated at the end of the permit period. Healthy riparian systems, mature forest with structure, and uncommon/special habitats comprise the major concerns regarding adequacy of habitats. Younger forests (between 40 and 70 years) will continue to be provided as a result of timber management. In addition, the long-term plan for murrelets will be developed in consideration of the 70-year permit term to ensure its adequacy. Finally, as mentioned above in this section, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service will review DNR's progress in meeting the conservation objectives and may require an extension of the HCP if it can be demonstrated that DNR failed to achieve the commitments of the HCP.

G. Conservation Assessments for Federally Listed Plant Species, Candidate Plant Species, and Plant Species of Concern

In general, the federally listed and proposed endangered and threatened plant taxa described below have very limited ranges and narrow habitat requirements and are restricted to very small areas. Because of these factors, it is anticipated that they can be effectively managed while meeting other land-management objectives. DNR maintains a database on these species, including both site-specific and species-specific information, that will be useful in locating and protecting known sites and potential habitat. However, no comprehensive inventories of these species exist for DNR-managed lands.

Federally Listed Plant Species

Brief statements about each species are provided below; additional information can be obtained from either the U.S. Fish and Wildlife Service's Endangered Species Office in Olympia or DNR's Natural Heritage Program.

ARENARIA PALUDICOLA

Swamp sandwort was historically known to occur in "swamps near Tacoma" but has not been seen or collected in Washington since the late 1800s. Reports from several other western Washington locations have been determined to be misidentifications. However, additional inventory in Washington is needed, primarily in wetlands within the Puget Lowlands. The only known extant site in the world is found in a brackish wetland in California. However, this species could occur in wetlands near the Pacific Coast, Willapa Bay, or Puget Sound. The HCP for the five west-side planning units and the OESF would likely provide better protection of this species' habitat because of their better overall wetland and riparian protections.

HOWELLIA AQUATILIS

Water howellia is an aquatic annual generally found in vernal ponds or portions of ponds in which there is a significant seasonal draw down of the water level. All known ponds have a deciduous tree component around their perimeters; most have conifers as well. The species is currently known to occur in Washington, Idaho, and Montana. In Washington, it has been found in Clark, Pierce and Spokane Counties. Historically it was also known to occur in Thurston and Mason Counties, as well as in Oregon and California. There has been no inventory of water howellia on DNR-managed lands, but if water howellia does occur in the planning area, then the HCP would reduce adverse effects because it offers better overall wetlands protection.

LOMATIUM BRADSHAWII

Bradshaw's lomatium was thought to be endemic to the Willamette Valley in Oregon until 1994, when it was discovered in Clark County, Washington. The one site in Washington is a seasonally flooded wetland dominated by grasses, sedges and rushes. As far as is now known within the HCP planning area, this species is restricted to wetlands in flood-plain habitats at low elevations in the Columbia Planning Unit. Although not known to occur on DNR-managed lands, some DNR-managed lands may provide potential habitat. The HCP provides better protection of this species' habitat because of its better overall wetland and riparian protections. The OESF would have no effect, as the species is not known or expected to occur in the planning unit.

SIDALCEA NELSONIANA

Nelson's checkermallow was also thought to be restricted to Oregon until relatively recently. There are known sites in Cowlitz and Lewis counties, Washington. These sites are in low elevation, moist meadows within the South Coast and Columbia HCP planning units. These sites may qualify as wetlands. There is a limited amount of DNR-managed land that contains suitable habitat. There is expected to be no change regarding the effects of management on this species due to its restriction to open, moist meadow habitats.

Plant Species Proposed for Federal Listing

CASTILLEJA LEVISECTA

Golden paintbrush occurs from Thurston County northward to Vancouver Island. Historically it was also known to occur in the Willamette Valley in Oregon and in Clark County, Washington. The species is restricted to grasslands and areas dominated by a mixture of grasses and shrubs. Although this species occurs in grasslands, it could be affected by timber harvest through road building, yarding, or decking logs on adjacent grasslands. Where conifers invade *C. levisecta* habitat, the removal of trees is beneficial to the species. There are only 10 known sites with *C. levisecta* in the world, eight of which are in Washington and one of these is a DNR-managed natural area preserve. All sites are quite small in area and are subject to a variety of threats, the most serious of which is the invasion by a mixture of Douglas-fir, Scot's broom, blackberries, and roses. It is not known to occur, nor is it expected to occur within the OESF. There is little to no DNR-managed land adjacent to sites that harbor this species. The HCP is not expected to have any effect on this species.

Federal Candidate Plant Species

There is one vascular plant species that is a candidate for listing (as of February 1996) under the federal ESA which is known to occur, or is reasonably suspected of occurring, within the HCP planning area. Additional information about this species can be obtained from DNR's Natural Heritage Program.

SIDALCEA OREGANA VAR. CALVA

This taxon is restricted to the Chelan Planning Unit. It may occur on DNR-managed forest land. It can occur along small riparian areas and some of the sites would qualify as wetlands. The HCP can be expected to provide better protection due to the overall better riparian zone and wetlands protections. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

Plant Species of Concern

There are a number of vascular plant taxa that are species of concern to the U.S. Fish and Wildlife Service (as of February 1996) which are known to occur, or are reasonably suspected of occurring, within the HCP Planning Area. Additional information about these species can be obtained from DNR's Natural Heritage Program.

ABRONIA UMBELLATA SSP. ACUTALATA

This taxon is thought to be extirpated from the state of Washington. The historic locations were coastal sand dunes. Timber management under the HCP and OESF would have no effect.

ARTEMISIA CAMPESTRIS SSP. BOREALIS VAR. WORMSKIOLDII

This taxon is restricted to areas immediately adjacent to the Columbia River in Grant and Klickitat counties. The areas do not support conifers and are far enough removed from DNR forest management that management activities are not likely to have any impact.

ASTER CURTUS

This taxon is restricted to grassland habitats in the lowlands of the Puget trough. It may occur in grasslands adjacent to DNR-managed forest land. It is not known nor expected to occur on the OESF. Because the plant is generally restricted to nonforested habitats, the HCP and the OESF are expected to have little effect on this species.

ASTRAGALUS AUSTRALIS VAR. OLYMPICUS

This taxon is restricted to relatively high elevations in the northeastern portion of the Olympic Peninsula. It is only known to occur in the Olympic National Park and Olympic National Forest.

ASTRAGALUS PULSIFERAE VAR. SUKSDORFII

In Washington, this taxon is restricted to the Klickitat Planning Unit and occurs in somewhat open ponderosa pine stands with a relatively sparse understory. The one known site of *A. pulsiferae* on DNR-managed land is within a designated dispersal habitat management area. Higher harvest levels may provide better habitat protection for this taxon than lower harvest levels. However, increased harvest levels may not be a recommended method for enhancing the habitat for this taxon; prescribed burns, or allowing natural fires to burn, would likely be a preferable method. The OESF would not be affected, as the taxon is not known or expected to occur there.

ASTRAGALUS SINUATUS

This taxon does not occur within the HCP Planning Area. It is restricted to a very small range east of the planning area in Chelan County.

BOTRYCHIUM ASCENDENS

This taxon appears to have a fairly broad ecological amplitude and wide geographic range. However, there is insufficient information available regarding its response to timber harvest activities to evaluate the HCP and its effects.

CALOCHORTUS LONGEBARBATUS VAR. LONGEBARBATUS

In Washington, this taxon is restricted to the Klickitat Planning Unit. It could occur on DNR-managed lands. It occurs primarily in open grasslands, but occasionally extends into open forest stands. Within the Yakama Indian Reservation, it can be found within harvested units and along roadway openings. Although this taxon could benefit from timber harvest in areas adjacent to meadow openings, it is anticipated that there will be no change regarding the effects of management on this species. The OESF will have no effect since the taxon is not known or expected to occur on the OESF.

CASTILLEJA CRYPTANTHA

This taxon does not occur and is not expected to occur, on DNR-managed lands within the HCP Planning Area. It is restricted to subalpine and alpine meadows around the northern perimeter of Mt. Rainier.

CIMICIFUGA ELATA

This taxon occurs in DNR Dispersal management areas and potentially within NRF management areas. The taxon occurs within the North Coast, Straits, South Puget, South Coast, and Columbia planning units. The HCP is expected to be beneficial due to the lower timber harvest levels in NRF and Dispersal management areas. The OESF would have no effect, since the taxon is not known or expected to occur on the OESF.

CORYDALIS AQUAE-GELIDAE

This taxon occurs primarily along Types 3 through 5 waters, including small seeps, and is restricted to the Columbia Planning Unit. It could occur on DNR-managed lands. The HCP is expected to provide better protection due to the overall better riparian zone protections.

CYPRIPEDIUM FASCICULATUM

This taxon occurs within a variety of coniferous stands within the Klickitat, Yakima, and Chelan planning units. It could occur on DNR-managed lands. There is insufficient information available regarding this species' response to timber harvest activities to evaluate the HCP and its effects.

DELPHINIUM LEUCOPHAEUM

This taxon is essentially a grassland species and is restricted to the South Coast Planning Unit. It could occur on DNR-managed lands. The HCP is expected to have no effect on this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

DELPHINIUM VIRIDESCENS

This taxon is restricted to the Chelan and Yakima planning units. It may occur on DNR-managed lands. It can occur along small riparian areas and some of the sites would qualify as wetlands. The HCP can be expected to provide better protection due to the overall better riparian zone and wetlands protections. The OESF is expected to have no effect since the taxon is not known or expected to occur on the OESF.

DODECATHEON AUSTROFRIGIDUM

In Washington, this taxon is currently known only to occur in the Mt. Colonel Bob Wilderness Area of the Olympic National Forest. However, in Oregon it is known to occur in lower elevation riparian areas. The HCP and the OESF would presumably provide better protection due to overall better riparian zone protections.

ERIGERON HOWELLII

In Washington, this taxon is restricted to the Columbia Planning Unit. It generally occurs in open areas. Canopy removal is not expected to have a negative impact, but ground-disturbing activity might. There is insufficient information to analyze how the HCP would affect this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

ERIGERON OREGANUS

In Washington, this taxon is restricted to the Columbia Planning Unit. It occurs within owl dispersal habitat; however, it is found primarily on exposed rock. Canopy removal will not generally have a negative impact. There is probably no change regarding the effects of management on this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

FILIPENDULA OCCIDENTALIS

In Washington, this taxon is restricted to river and creek banks in southwest Washington, in the Columbia and South Coast HCP planning units. Some DNR-managed land is relatively close to known sites for this taxon. It is expected that the HCP could provide more protection because of its better riparian protections. The deferrals and protections for the marbled murrelet provided by the HCP could also benefit this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

HACKELIA VENUSTA

This taxon is restricted to the Chelan Planning Unit. All known sites are on U.S. Forest Service lands. Some DNR-managed land occurs within the range of this species. Canopy removal would not have a negative impact and in fact might be beneficial. However, ground-disturbing activities could have a negative impact. At present, there is insufficient data to analyze the HCP and its potential effects on this species.

LATHYRUS TORREYI

This taxon was thought to be extirpated from the state of Washington. The historic locations were scattered in Clark and Pierce counties. The only extant site is at McChord Air Force Base, where it inhabits a mature conifer stand with an open understory. Timber management on DNR-managed lands under the HCP and OESF is unlikely to have an adverse effect.

LOMATIUM SUKSDORFII

In Washington, this taxon is restricted to the Klickitat Planning Unit. It may occur on DNR-managed lands. It can occur within riparian areas, but it is not restricted to such areas. It occurs on slopes that may support scattered individual conifers, on the edges of conifer stands, or in stand openings. There is likely no change regarding the effects of management on this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

LOMATIUM TUBEROSUM

This taxon is restricted to talus slopes, mostly in nonforested areas, although there can be trees adjacent to the talus. Conservation measures for talus slopes will benefit this species. Within the HCP Planning Area, this taxon is known only to occur within the Yakima Planning Unit.

LUPINUS SULPHUREUS VAR. KINCAIDII

This taxon is essentially a grassland species and, in Washington, is restricted to the South Coast Planning Unit. It is unlikely to occur on DNR-managed lands. The HCP is expected to have no effect on this species. The OESF is expected to have no effect since the taxon is not known or expected to occur on the OESF.

MECONELLA OREGANA

This taxon occurs in grasslands, sometimes adjacent to forested areas, although generally in somewhat savannah-like conditions. It is expected that there would no change regarding the effects of management on this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

MIMULUS JUNGERMANNIOIDES

This taxon was historically known to occur in the Klickitat Planning Unit, but is currently thought to be extirpated from the state of Washington. It is restricted to seepage areas in exposed basalt. It is unlikely to occur on DNR-managed lands. The HCP is not expected to have any impact on this taxon. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

PENSTEMON BARRETTIAE

This taxon occurs primarily on exposed basalt in Washington and is known to occur only in the Klickitat Planning Unit. It may occur on DNR-managed lands. It may occur within riparian areas, although it is not restricted to riparian areas. There is expected to be no change regarding the effects of management on this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

PETROPHYTUM CINERASCENS

This taxon is within the very eastern edge of the Chelan Planning Unit. In fact, it is restricted to rock outcrops adjacent to the Columbia River.

RANUNCULUS RECONDITUS

This taxon is known to occur in Klickitat County, but not within the HCP planning area.

RORIPPA COLUMBIAE

This taxon is restricted to the immediate shores of the Columbia River and islands in the Columbia River along the Hanford Reach and in Skamania County. No DNR-managed lands are known to harbor this species and timber management under the HCP is not expected to have an impact.

SILENE SEELYI

This taxon is restricted to cracks in exposed rock in a small portion of the Chelan, and maybe the Yakima, planning units. Although it is not known to occur on DNR-managed lands, some DNR-managed lands are in close proximity to known locations for this species. The species is probably not affected to any great degree by canopy removal. It is expected that there would be no change regarding the effects of management on this species.

SISYRINCHIUM SARMENTOSUM

In Washington, this taxon is restricted to the Klickitat Planning Unit. It may occur on DNR-managed lands. It occurs in moist meadows and small forest openings, and it may be occur in riparian and/or wetland areas. The HCP can be expected to provide better protection due to the better riparian and wetland protections. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

SULLIVANTIA OREGANA

In Washington, this taxon is known to occur only in the Columbia Planning Unit and occurs within waterfall spray zones and seepage areas. A site with *S. oregana* is located in a DNR-managed natural area preserve, and other sites may occur in DNR-managed parcels adjacent to the preserve. The HCP is expected to provide better protection because of its better riparian and wetland protections The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

TAUSCHIA HOOVERI

This taxon is restricted to lithosolic, nonforested habitats. It is known to occur on DNR-managed land. It occurs mostly east of the HCP Planning Area, although some sites are within the Yakima and perhaps the Klickitat planning units.

TRIFOLIUM THOMPSONII

This taxon is known to occur only in the Chelan Planning Unit. It is a grassland species, but it also occurs on the edge of forest stands. Fire is important in maintaining its habitat. This species is known to occur on DNR-managed lands. There is expected to be no change regarding the effects of management on this species. The OESF would have no effect since the taxon is not known or expected to occur on the OESF.

H. Forest Land Management Activities

Introduction

This section describes common forest practices that will occur during the first decade on DNR-managed lands in the area covered by the HCP. Ranges of the level of the various activities are estimated. Some forest management activities described herein reflect the silvicultural regimes used in the harvest simulator model that projected estimates of harvest levels for DNR-managed lands under the HCP[1]. Other forest management activities described are not part of those silvicultural regimes used for harvest calculations but are important elements of forest management under the HCP.

The level of activity estimated in this section should not be confused with the minimization and mitigation required in the HCP. Rather, these forest management activities will be used to achieve the habitat goals that constitute the minimization and mitigation under the HCP as well as to increase the productivity and value of forest products from DNR-managed lands in the area covered by the HCP.

The ranges of activity level (summarized in Table IV.15 at the end of this section) are based upon (1) historical levels, (2) estimates of activity required to achieve conservation objectives in the harvest simulator model, (3) evaluation of current criteria for selecting potential forest stands for various silvicultural treatments, and (4) estimates from DNR Regions of the level of activity that could occur operationally over the next decade. Harvest calculations are based upon typical silvicultural regimes, estimated to achieve the habitat objectives described in the conservation strategies as well as to increase the commercial productivity of DNR-managed lands in the area covered by the HCP.

However, it is neither practical nor prudent to commit to specific levels of silvicultural practices as part of this HCP. Optimizing silvicultural investments is a process that is ongoing and subject to site-specific evaluation of alternatives for limited management fund investments.

Forest land management activities on DNR-managed lands will be guided by the various applicable state and federal regulations, DNR policies such as the Forest Resource Plan of 1992, and the provisions of this plan and the incidental take permit. These guiding regulations and policies shape DNR's forest land management priorities and budget. The priorities, pace, and level of activity will depend upon, among other things, the level of budget available.

The discussion in this section describes first, activities common to all planning units and then, those specific to each of the three major planning areas covered by the HCP: the east-side planning units, the five west-side planning units, and the Olympic Experimental State Forest (OESF) Planning Unit, as defined in the section in Chapter I titled Organization of the Planning Area. (See also Map I.4.)

Activities Common to All Planning Units

Many forest land management activities are common to all of the planning areas. Management of special use areas such as Natural Resource Conservation Areas, Natural Area Preserves, DNR-managed recreation sites and other public use areas will continue under current policies and regulations.

[1] DNR projected harvest levels based on the HCP conservation strategies, using a set of forest regimes to model stand growth. These projections were presented to the Board of Natural Resources on October 10, 1996.

LANDSCAPE PLANNING

DNR expects landscape planning to be part of the process for implementing conservation strategies on DNR-managed lands in the permit area. DNR's Forest Resource Plan of 1992 (Policy No. 16, p. 30) established landscape planning as a management approach. While the landscape planning process described in the Forest Resource Plan will be an ongoing process, only a few plans will be completed at the time the HCP is implemented. However, landscape assessments utilizing the concepts of landscape planning can be useful and successful at many levels. For example, a plan based on a landscape assessment can be as simple as a computerized geographic information system report that displays resource information that indicates forest stands available for various silvicultural activities, or as complex as a detailed documentation of the physical, natural, and cultural resources along with a specific schedule of activities through time to reach highly focused, multiple objectives.

During the first decade of the permit, DNR will base management of forest lands in the permit area on some level of landscape assessment in designated dispersal and nesting, roosting, and foraging areas. The priority and complexity of landscape assessment will depend upon the needs of DNR and availability of budget. The most efficient and precise application of the conservation strategies will be accomplished through landscape planning.

RESOURCE INFORMATION

In order to apply the conservation strategies efficiently, accurate updated information will be required. Forest resource information in the permit area will be continually updated, verified, and documented during the first decade of the permit.

Activities carried out on DNR-managed lands that change the forest condition, such as road building, harvesting, precommercial thinning and reforestation, will be tracked and documented in DNR's geographic information system.

DNR intends to finish its new Forest Resource Inventory during the first decade of the permit. The Forest Resource Inventory will provide, for the first time, computerized information on various forest structures important for wildlife conservation, such as snags, vegetative ground cover, and certain noncommercial plant species.

Field verification of habitat will occur as a part of landscape planning during the first decade of this permit. Current conditions will be verified for designated nesting, roosting, and foraging habitat and dispersal habitat for spotted owls. Changing habitat conditions over time will be tracked.

LAND REPOSITIONING

Land transactions are carried out to increase the asset value of the trusts or to move lands into more appropriate use, such as parks, Natural Area Preserves, or Natural Resource Conservation Areas, with compensation to the trusts. Over the last decade, an active era for land transactions, DNR disposed of about 259,000 acres and acquired about 234,000 acres. DNR will continue to pursue land repositioning in order to meet these objectives at a level that will meet the needs of the trusts. The rate of land transactions will be influenced by opportunity and funding. (See the Implementation Agreement.) Land transactions are not expected to increase the level of take for any species covered by the incidental take permit. DNR commits to maintaining the conservation objectives described in Chapter IV of the HCP in the course of its land disposition program, as outlined in the

Implementation Agreement. In the event that a land disposition increases the level of take, or if land disposed of by DNR does not remain subject to the HCP and the cumulative impact of the disposition would have a significant adverse effect on a particular species, DNR will follow the process for making a major amendment to the HCP and the Incidental Take Permit as outlined in the Implementation Agreement. The land transaction program is not intended to alter DNR's obligations for mitigation as set forth in this HCP.

NONTIMBER RESOURCES

All planning units will continue to be managed for nontimber resources, guided by applicable regulations, DNR policies such as the Forest Resource Plan of 1992, and the conditions of the HCP and the permit. DNR markets nontimber resources that include but are not limited to road use permits, sand and gravel sales, sales of special forest products such as boughs and brush, prospecting leases and mining contracts, oil and gas leases, grazing permits and leases, electronic site leases, and other special permits, licenses, sales, and leases. At the 1996 level of these activities, no take, or insignificant (i.e., *de minimis*) take is occurring. Beginning no later than January 1, 1999, new/renewed permits, contracts, or leases for such activities will include the commitments of the HCP, such that they will not increase the level of take beyond a *de minimis* level. The level of impact resulting from these activities will be reviewed by DNR and the U.S. Fish and Wildlife Service and National Marine Fisheries Service during the annual meetings as described in subsection 16.2b of the Implementation Agreement. DNR will monitor the level of such activities and provide this information to the U.S. Fish and Wildlife Service and National Marine Fisheries Service prior to their annual meetings.

Many nontimber resource activities are subject to review under SEPA (WAC 197-11). Except for those actions that are categorically exempt (WAC 197-11-800), other government agencies and interested parties are notified of proposed actions as required by SEPA. As a matter of course, DNR notifies the Washington Department of Fish and Wildlife, Washington Department of Ecology, and the appropriate county and tribal governments. Government agencies and interested parties are notified by issuing either a determination of nonsignificance, a mitigated determination of nonsignificance, a public scoping notice, or a draft EIS. Agencies and interested parties can comment on and appeal the findings of the SEPA determination.

Current DNR nontimber resource uses are described, including the current level of each activity, below:

Rights-of-way - Policy No. 26 of the Forest Resource Plan addresses granting public rights-of-way. It says:

> "The department will grant rights of way to private individuals or entities when there is an opportunity for enhancing trust assets and when detriments are offset."

Easements for rights-of-way are granted for roads, powerlines, and pipelines. During the 9-year period between 1983 and 1991, approximately 2,100 rights-of-way were issued. These involved approximately 105 miles of new road construction and removed approximately 2,500 acres from timber production. Typically, these roads are part of the same road network used for forest management and would be subject to the same conservation measures for design, construction, use, maintenance, and abandonment described in the HCP. Large powerline and pipeline rights-of-way are subject to review under SEPA.

DNR has adopted the following SEPA policy for granting rights-of-way (WAC 332-41-665):

> "Recognizing that construction and/or reconstruction under upland right of way grants can create adverse impacts to the elements of the environment, it is the policy of the department to condition grants where necessary:
>
> (i) to protect all surface resources including but not limited to soil and water, through authorized right of way operation on public lands, and to cause rehabilitation or reestablishment on a continuing basis the vegetative cover, soil stability, and water condition appropriate to intended subsequent use of the area;
>
> (ii) to meet air quality standards; and
>
> (iii) to protect recreational and special use areas under lease by requiring mitigating action."

Special Forest Products - Policy No. 8 of the Forest Resource Plan addresses special forest products. It says:

> "The department will encourage and promote the sale of special forest products where appropriate and will market them in a manner consistent with the overall policies of this plan."

WESTERN GREENS — (salal, beargrass, huckleberry, rushes, ferns, mosses)
Currently there are approximately 65 leases covering 30,000 acres (average 460 acres/lease) and 240 one-year individual, nonexclusive permits for designated blocks of DNR-managed land. Over the term of the HCP, it is expected that individual permits will slightly increase and the amount of leased acreage will decrease. The long-term decrease in leased acreage is projected from the current trend in decreasing the U.S. share of the international market in floral greens. Collection of branches from salal, evergreen huckleberry, and ferns is a self-limiting process because only part of the foliage of any plant meets commercial quality standards. Thus, harvesting practices result in retention of most of the plant, and consequently a photosynthetic base for the regeneration of new foliage (Amaranthus and Pilz 1996). No significant environmental damage has been observed as a result of DNR leases, though no formal assessment has been conducted. The long-term ecological effects of floral green collection are unknown. Monitoring of such activities would allow for adjustment of lease conditions should adverse environmental impacts be documented. Collection of moss has potential negative environmental impacts (FEMAT 1993). Collection of moss from DNR-managed lands is not currently a large program. Should this situation change, however, some monitoring of effects of moss collection and/or regulation of moss collection may be needed. Leases for brush picking are categorically exempt from SEPA review (WAC 197-11-800). Actions or activities that are categorically exempt are those that would not normally have significant adverse environmental impacts. An action or activity that is categorically exempt may be subject to review under SEPA if it occurs in an environmentally sensitive area. For example, a categorically exempt action occurring in a wetland or in an area with a state listed species may be subject to review under SEPA.

CHRISTMAS GREENS — (cut noble fir, silver fir, white pine, red cedar, and Douglas fir boughs)

There are 14 current 1- to 3-year sales involving 9,000 acres total and three, 10-year leases involving 3,000 acres total. Additionally, small volumes under $1,000 in value and involving less than 1,000 acres are permitted to approximately 15 individuals or small companies per year. A determination of non-significance was issued under SEPA for the collection of Christmas greens.

MUSHROOMS

No commercial harvesting is allowed. Recreational harvesting is allowed with restrictions on quantity. Recreational harvest is limited to 3 gallons per person per day of a single species and no more than 9 gallons per person per day total. Compliance is not currently monitored and some commercial-scale harvest may be occurring on DNR-managed lands. Most mushroom harvesting on DNR-managed lands occurs in the South Puget Sound Planning Unit, with some occurring on the Olympic Peninsula and in the western portion of the Klickitat Planning Unit. Individual commercial permits are currently under consideration. Over the term of the HCP, it is expected that harvest from the wild will increase. It is likely that access to lands for mushroom collection will diminish due to road closures. Mushroom collection does not appear to occur very distant from roads. Most edible mushrooms are the fruiting bodies of ectomycorrhizal fungi, which play important roles in forest ecosystem processes, including providing forage for northern flying squirrels, which are an important prey item of spotted owls. The long-term ecological effects of mushroom collection are unknown (FEMAT 1993). No environmental impact assessment of mushroom collection has been conducted specifically on DNR-managed lands. It is thought that the highest potential for negative damage to the resource could come from disruptive collection methods such as raking (Amaranthus and Pliz 1996). This type of collection method has not been widely observed on DNR-managed lands. Monitoring of mushroom collection levels and utilization of any relevant research on the ecological effects of mushroom harvesting would assist in HCP implementation.

CHRISTMAS TREES

There are currently 5 leases to grow Christmas trees on DNR-managed lands covering less than 600 acres. All current leases expire within the next 8 years. It is not expected that this program will expand in the future, and may be eliminated altogether due to lack of market demand. Leases for Christmas tree harvesting are categorically exempt from SEPA review (WAC 197-11-800).

MEDICINALS

DNR is not involved in any medicinal research or management at this time. There are 1 to 2 small-value annual permits (for example, cascara bark).

FIREWOOD

The Revised Code of Washington (RCW 76.20) requires that DNR offer free firewood, up to 6 cords per person per year, and authorizes direct sales and bid/auction sales. In most Regions, demand for free personal use firewood is greater than supply. The Regions make available what they can and there is no estimate available for the amount of material removed or the acreage involved. Wood collected as personal use firewood is generally down logs located near roads or landings. Over the course of the HCP, it is expected that firewood removal will decrease due to more restrictions on woodstove use in urban areas and concerns for wildlife and biomass loss. At present, licenses or approvals for firewood removal are categorically exempt from SEPA review (WAC 197-11-800).

Valuable Material Sales- Sand and gravel sales are handled under sale contracts. Current contracts cover approximately 30 to 40 acres each and total less than 1,000 acres. Most commercial contracts do not apply to forested areas. However, 15 to 20 commercial contracts are in forested areas, including some smaller pits that are primarily for DNR use but from which occasional loads are sold to other forest land managers. If the sand or gravel material is sold, then the activity is subject to review under SEPA, and the purchaser is responsible for obtaining all necessary permits. DNR has adopted a SEPA policy for surface mining (WAC 332-41-665), described below, that applies to sand and gravel mines which are subject to SEPA.

Water quality in the vicinity of sand and gravel mines is protected through the National Pollutant Discharge Elimination System Permit Program (NPDES) (WAC 173-220). The Washington Department of Ecology administers this program and issues NPDES permits only to facilities that can meet the surface and groundwater standards described in WAC 173-201A and WAC 173-200, respectively.

The purchaser must file a plan of operations that is reviewed by the DNR administrative Region. Under the HCP, the plan of operations would be reviewed to ensure compliance with the commitments of the HCP. Exploration holes drilled on DNR-managed land in search of sand and gravel deposits are plugged and the site restored. For example, if the site was used for timber production before exploration, then, where feasible, the site is restored for continued timber production. The reclamation of surface mines, excluding those used for on-site forest road construction or maintenance, is regulated by the Surface Mining Act (RCW 78.44), which is enforced by DNR.

Prospecting Leases/Mining Contracts - A mineral prospecting lease permits the lessee to prospect for metallic and industrial (nonmetallic) minerals. The lease must be converted to a mining contract before mine development or operations commence. There are 13 existing leases in the HCP Planning Area. Most prospecting leases are 500 to 600 acres. Activities conducted under mineral prospecting leases are exempt from SEPA requirements, unless it is determined that a specific activity needs to undergo a SEPA review. The lessee is responsible for obtaining all necessary permits, although there are limited permits required for exploration. Before any surface disturbing work is conducted on a leased area, the lessee must file a plan of operations that is reviewed by the DNR administrative Region. Under the HCP, the plan of operations would be reviewed to ensure compliance with the commitments of the HCP. Exploration holes drilled on DNR-managed land in search of mineral deposits are plugged and the site restored. Roads may be constructed during mineral exploration. Typically, these roads are part of the same road network used for forest management and would be subject to the same conservation measures for design, construction, use, maintenance, and abandonment described in the HCP.

There are 17 mining contracts in the HCP Planning Area, but there are no active open-pit metallic or open-pit industrial mineral mines or underground mines on DNR-managed land. The only activity occuring under these contracts is exploration. Conversion of a mineral prospecting lease to a mining contract requires a phased review under SEPA. This review is phased since the location and scope of future activities is not known. An EIS may be required if large-scale mining is contemplated. DNR has adopted the following SEPA policy for surface mining (WAC 332-41-665):

"To provide that the usefulness, productivity, and scenic values of all lands and waters involved in surface mining within the state will receive the greatest practical degree of protection and restoration, the following aspects of surface mining may be conditioned:

(i) Proposed practices to protect adjacent surface resources;

(ii) Specifications for surface gradient restoration to a surface suitable for the proposed subsequent use of the land after reclamation is completed, and proposed method of accomplishment;

(iii) Matter and type of revegetation or other surface treatment of disturbed areas;

(iv) Method of prevention or elimination of conditions that will create a public nuisance, endanger public safety, damage property, or be hazardous to vegetative, animal, fish, or human life in or adjacent to the area;

(v) Method of control of contaminants and disposal of surface mining refuse;

(vi) Method of diverting surface waters around the disturbed areas;

(vii) Method of restoration of stream channels and stream banks to a condition minimizing erosion and siltation and other pollution."

Any mining activities would comply with the commitments of the HCP.

Water quality in the vicinity of underground and open pit mines is protected through the NPDES Permit Program (WAC 173-220). The Washington Department of Ecology administers this program and issues NPDES permits only to facilities that can meet the surface and groundwater standards described in WAC 173-201A and WAC 173-200, respectively.

Metals mining and milling is regulated by the Metals Mining and Milling Operations Act (RCW 78.56), which is mainly enforced by the Washington Department of Ecology. An EIS is required for any proposed metal mining and milling operation. Any tailings facility must be designed to prevent the release of pollution and a waste rock management plan that emphasizes pollution prevention must be approved by the Washington Department of Ecology (RCW 78.56.100). In Washington, there is a moratorium on the use of heap leach extraction processes and a prohibition on in situ extraction processes (RCW 78.56.160).

Another type of mining that could occur on DNR-managed forest land over the term of the HCP is placer mining. There are no commercial placer mines on DNR-managed forest lands, nor are there any commercial placer prospecting leases or mining contracts. But, recreational placer mining is growing in popularity. Recreational prospecting permits are issued by DNR (RCW 79.01.651). DNR establishes the rules for the location, equipment, methods, and other appropriate permit conditions of recreational prospecting on DNR-managed lands. Commercial placer prospectors and miners must obtain a hydraulic project approval permit from the Washington Department of Fish and Wildlife (WAC 220-110), a NPDES permit from the Washington Department of Ecology, a permit from the U.S. Army Corps of Engineers, and the action is subject to review under SEPA.

Oil and Gas Leases - There are approximately 77 existing leases and most are in the Puget Sound lowlands. Some are small leases but most leases cover full legal sections. The total acreage affected by all oil and gas leases is approximately 20,000 to 25,000 acres. Much oil and gas exploration is accomplished through a process known as "thumping." Thumping is the measurement of seismological tremors caused by the dropping of extremely large weights or the detonation of explosives. Exploration may also be acomplished through drilling. The on-site operations of exploratory wells can generally be contained in 5 acres or less. Historically, surface disturbance on these sites has been minimal. Only two wells have been drilled on DNR-managed land. One of these wells is currently being used for active exploration, and the other well has been abandoned and plugged. No oil or gas is currently produced on DNR-managed land. In fact, no oil or gas is currently produced in the state of Washington. All oil and gas leases go through a phased review under SEPA before the parcel is auctioned.

Potential adverse impacts of exploration for and extraction of oil and gas on air and water are regulated by the Washington Department of Ecology. Water quality in the vicinity of underground and open pit mines is protected through the NPDES Permit Program (WAC 173-220). The Washington Department of Ecology administers this program and issues individual permits only to facilities that can meet the surface and groundwater standards described in WAC 173-201A and WAC 173-200, respectively.

Oil and gas wells are regulated through the Oil and Gas Conservation Act (RCW 78.52) which is enforced by DNR. Sufficient safeguards to minimize hazards of pollution of all surface and ground waters is required. If acceptable safeguards cannot be provided, then a drilling permit is is not issued (RCW 78.52.125). Exploration holes drilled in search of oil or gas deposits must be plugged in a manner as to prevent the pollution of fresh water supplies (RCW 78.52.150). DNR would also require that the site be restored. For example, if the site was used for timber production before exploration, then, where feasible, the site would be restored for continued timber production.

Because the location and scope of eventual activities are not known, the initial SEPA review does not include details (i.e., the management of riparian zones), but subsequent phased reviews would occur if and when additional activities are planned, and the depth of the review would depend on the activities planned. Before any surface disturbing work is conducted on a leased area, the lessee must file a plan of operations that is reviewed by the DNR administrative Region. Under the HCP, the activities would be reviewed to ensure compliance with the commitments of the HCP. Roads may be constructed during oil and gas exploration or extraction. Typically, these roads are part of the same road network used for forest management and would be subject to the same conservation measures for design, construction, use, maintenance, and abandonment described in the HCP. Oil or gas produced at a well site may be transported by truck or by pipeline. Pipeline construction is also subject to SEPA review.

Grazing Permits - There are approximately 15 permit and 6 leased ranges located in Yakima and Klickitat counties (approximately 100,000 acres) and the Methow Valley (approximately 5,000 acres). Grazing occurs only on DNR-managed lands east of the Cascade crest where DNR is not applying for unlisted species agreements.

Electronic Site Leases - There are 427 leases with 100 sites, totaling 106 acres, currently extant. Hence, electronic sites average only about 1 acre in size. Approximately 80 percent of the sites are on non-forested mountain tops and the remaining 20 percent are on second-growth highway corridors. Roads are constructed to access electronic sites, but these roads are part of the same road network used for forest management and would be subject to the same conservation measures for design, construction, use, maintenance, and abandonment described in this HCP. Occasional disturbance to wildlife may occur during periodic visits for maintenance and improvements. On DNR-managed lands the impacts of electronic site leases relative to the impacts of timber management are *de minimus*.

Recreational Sites - Policy No. 29 of the Forest Resource Plan addresses recreation on state forest lands. It says:

> "The department will allow recreation on state forest land when compatible with the objectives of the Forest Resource Plan. As part of its efforts, the department will continue to comply with the Statewide Comprehensive Outdoor Recreation Plan."

There are approximately 150 total sites, most affecting less than 20 acres, and 2 to 3 large (300 to 600 acres), leased sites. Acreage by DNR administrative Region: Olympic = 141 acres, Central = 696 acres, South Puget Sound = 315 acres, Southwest = 159 acres, Northwest = 515 acres, Northeast =783, and Southeast = 630 acres. Total area of recreational sites is 3,239 acres. Many, if not most, recreational sites have been built in riparian areas. Under the HCP, future development of recreation sites would adhere to the riparian conservation strategy. (See HCP Chapter IV.D.) Recreational activities conducted in DNR-managed forests include hiking, biking, horseback riding, skiing, off-road vehicle use (e.g., motorcycles, snowmobiles, 4-wheel drive trucks), and camping. Some trails, including those used by off-road vehicles, are located within riparian areas. DNR is concerned about damage to aquatic resources caused by recreational activity in high use areas, and has undertaken a program in the Tahuya State Forest to develop and monitor measures that will mitigate these impacts. In general, on DNR-managed lands the impacts of recreational activity relative to the impacts of timber management are *de minimus*.

TRANSPORTATION SYSTEM MANAGEMENT

DNR prioritizes transportation system management by activities such as storm damage repair, current use for commercial hauling of forest products, and public use. Use is regulated through blockage, where practical, and through restricted use agreements with the Washington Department of Fish and Wildlife, tribes, and others. Regular maintenance and replacement activities are scheduled to accommodate access and use needs.

New road construction may occur in conjunction with timber sale activity and other land management needs. Construction decisions will be consistent with mitigation and conservation strategies in the HCP. Reasonable expectations for new, permanent road construction during the first decade are for between 50 and 100 miles in the east-side planning units, 700 and 800 miles in the five west-side planning units, and 80 and 100 miles in the OESF.

PUBLIC USE

Public use of DNR-managed forest lands in the permit area will continue to be guided by applicable regulations and DNR policies. Within this framework, public use may occur at designated sites or in a more dispersed fashion throughout the ownership. Under certain conditions, public use may be restricted or denied, as provided for in applicable regulations and policy. Public use may be addressed in landscape plans or as separate actions required to meet the needs of DNR.

Activities in the East-side Planning Units

This subsection describes typical silvicultural activities that may occur on DNR-managed forest lands covered by the HCP within the range of the northern spotted owl east of the Cascade crest. All of the silvicultural activities described in this section will be guided by state Forest Practice Rules, DNR policies such as the Forest Resource Plan (DNR 1992), and the conditions of the permit.

FOREST HEALTH

Activities that address forest health issues have the potential to become an increasingly important aspect of forest management in the east-side planning units. Examples of these activities are under-burning, applying pesticides, controlling root rot, and salvaging.

Under-burning may be prescribed as a way to reduce fuel loading, encourage regeneration, and control stocking of appropriate tree species. At the writing of this HCP, technical development of under-burning is still under way, and its feasibility and effectiveness are still uncertain. About 500 acres per year of DNR-managed lands in the east-side planning units are currently being under-burned. DNR Regions estimate approximately 2,000 acres per year could benefit from under-burning. However, the developmental nature of this program along with funding limitations will probably limit the program to between 3,000 and 10,000 acres in the east-side planning units during the first decade of the permit. Other silvicultural activities, such as vegetation management, precommercial thinning, and commercial thinning, may be used to achieve the same forest health objectives as under-burning.

Application of biological or chemical agents to control forest insect pests may be required during the first decade of this permit. Insects that may cause major damage to forest stands are monitored annually. Low background levels of loss are accepted as part of a normal condition. When losses build to unacceptable levels, and analysis predicts the persistence of an insect population, a control project may be planned. All projects are required to go through an environmental assessment as a Class IV-Special application under state Forest Practices Rules. These activities may be done as part of a multi-landowner cooperative effort or unilaterally by DNR. The level of these activities is extremely difficult to predict because of variations in natural cycles. However, current insect populations indicate it is reasonable to expect between 2,000 and 15,000 acres of treatment in the east-side planning units during the first decade. Appropriate treatment might include site-specific application of insecticides. At some of these sites the application of insecticides could result in the incidental take of federally listed invertebrate species. Such activities shall be covered under the Incidental Take Permit except for aerial application of pesticides, which shall be covered upon the U.S. Fish and Wildlife Service's approval of a site-specific plan presented by DNR. If the U.S. Fish and Wildlife Service disapproves such a plan, or if approval of such a plan is not forthcoming within 30 days of the U.S. Fish and Wildlife Service's receipt of the plan, a multi-agency science team may be convened to resolve questions regarding the biological basis of the U.S. Fish and Wildlife Service's decision.

Root-rot control is often required in certain stands in the east-side planning units. Direct control commonly consists of pulling or pushing over infected stumps, followed by planting with a conifer species not susceptible to root rot. This activity is expensive and is done only if other alternatives are unavailable. Based on historical levels for this activity, it is reasonable to expect between 1,000 and 5,000 acres will be treated in the east-side planning units during the first decade of the permit. The application of fertilizer has also been demonstrated to reduce the impacts of root rot. It is estimated that between 4,000 and 10,000 acres will be fertilized during the first decade.

To help restore forest health, salvage of trees killed by fire, insects, or disease is a common silvicultural activity in the east-side planning units. The amount of salvage is, to a large extent, unpredictable. Fires or insect outbreaks can create large acreages to be salvaged in any given year. Based on past history, if there are no catastrophic events, it is reasonable to expect between 5,000 and 10,000 acres of salvage logging to occur during the first decade of the permit.

TIMBER HARVESTING

Timber harvesting on DNR-managed lands in the east-side planning units is carried out in the context of a silvicultural prescription designed to ensure forest productivity and perpetuate or restore forest health. Clearcutting, shelterwood cuts, and selective harvest are all employed in these planning units. Clearcut harvesting removes the trees from a harvest site. According to state Forest Practices Rules and DNR policies, some "leave trees" are left in clumps, along streams, or scattered throughout the harvest unit. Clearcut harvesting prepares the site for reforestation. Planting with bare root stock of a species appropriate for the site, natural regeneration by seeding from adjacent stands, or a combination of both methods are common after clearcut harvesting. Shelterwood harvesting is increasingly used as a way to prepare for regeneration of forest stands. This method leaves and protects a number of trees per acre (usually 10 to 30) to provide a seed source and shade protection for young trees. Once reforestation is complete, the shelterwood trees can be removed in a commercial harvest or they can be retained to provide structural diversity as the stand ages. These trees may be left standing through the entire rotation, providing large-diameter trees in the next harvest. By far the most common of the timber harvesting prescriptions is selective harvesting, which can have important impacts on forest health and may be done with the objective of improving the overall health of the forest by removing certain trees or tree species.

During the first decade of the permit, there will be between 3,000 and 6,000 acres of clearcut harvesting, between 1,000 and 5,000 acres of shelterwood harvesting, and between 25,000 and 35,000 acres of selective harvesting. These harvest levels are consistent with HCP estimated harvest levels and historic harvest patterns. The range of acres for shelterwood is slightly greater than recent experience based on anticipated management through the next decade.

REGENERATION

Re-establishing or regenerating forest stands after fire, disease, insect infestation, or harvest is a part of the silvicultural practices in the east-side planning units. This practice is conducted under a prescription to ensure forest health and productivity in a cost-effective manner. Planting of bare root stock and natural seeding from adjacent stands, from seed trees left in the harvest unit, or from trees remaining after a selective harvest are all successful methods of regeneration in the east-side planning units. By far the most common method is natural seeding from trees remaining after a selective harvest.

It is reasonable to expect between 6,000 and 20,000 acres of planting during the first decade of the permit. Planting levels have historically been at the lower end of this projection. The upper end of the range is based on the opportunity to increase productivity on understocked forest land by more fully utilizing these sites. The increase also reflects supplemental planting in areas that will naturally regenerate in order to ensure a better distribution of seedlings, restock areas in a shorter time, and increase species diversity. Natural seeding is expected to regenerate the balance of harvested acres.

COMMERCIAL THINNING

Thinning young stands so that remaining trees can develop faster and with less competition is employed when favorable markets allow cost-effective operations. Commercial thinning can also benefit forest health and the development of certain types of wildlife habitat. Because harvest operations often combine selective tree harvest with commercial thinning, depending upon the particular stand condition in the harvest area, it is difficult to estimate how many acres of commercial thinning may occur during the first decade of the permit. However, it is reasonable to expect between 4,000 and 10,000 acres of commercial thinning in the east-side planning units in the first 10 years. This increase from historic levels can be attributed to DNR's current emphasis on identifying and commercially thinning stands that would benefit from reduced densities and to the current demand for smaller wood than was historically marketable.

PRECOMMERCIAL THINNING

Precommercial thinning is a silvicultural practice prescribed to space overstocked, even-aged stands of young trees so the remaining trees will have less competition for light and water and thereby have the potential for better growth. If the market will not support the sale of the trees cut from these stands, the operation is termed precommercial. Most forest stands in the east-side planning units are of uneven age and, therefore, do not require precommercial thinning. It is reasonable to expect a range of 3,000 to 10,000 acres of precommercial thinning to be prescribed during the first decade of the permit in the east-side planning units. The lower end of this range represents historic levels. Thinning has tended to be sporadic, varying from no activity to a maximum of about 1,200 acres in a single year. However, DNR Region staff have indicated, on the basis of stand growth and economic evaluation, that thinning about 1,500 acres per year would benefit the trusts. The upper end of the range reflects an expanded program to meet a portion of this potential opportunity.

OTHER SILVICULTURAL ACTIVITIES

Some silvicultural activities not usually associated with east-side forest management are expected to increase significantly in the next decade. These may include site preparation in advance of reforestation, vegetation management designed to reduce competition to young trees from brush, and fertilization calculated to enrich nutrient-poor soils. Although these and other silvicultural activities are unpredictable in scale and timing, DNR expects during the first decade of the permit period to do 2,500 to 14,000 acres of site preparation and 5,000 to 15,000 acres of vegetation management.

Other silvicultural activities may be prescribed in the east-side planning units during the first decade of the permit that are not commonly applied now or that have not been developed. These might include pruning of young trees or certain stand or tree manipulations designed to enhance wildlife habitat. It is not reasonable to speculate on the quantity or description of these potential activities. Research or demonstration projects on silvicultural techniques may also be done during this time period.

SPOTTED OWL DISPERSAL AND NESTING, ROOSTING, AND FORAGING HABITAT

An important forest management objective in the east-side planning units is the creation or maintenance of habitat for spotted owls (discussed in Section A of this chapter titled Minimization and Mitigation for the Northern Spotted Owl). On landscapes where these conservation objectives are applied, silvicultural practices will be designed to meet the habitat objective as well as the other forest management objectives detailed above. For example, tree selection in partial harvest can move total landscape conditions toward a specified habitat objective by ensuring that remaining stands have specific tree species, spacing, and diameter distribution. All silvicultural practices described for the east-side planning units may be employed to achieve habitat objectives under the permit. At the end of the first decade, it reasonable to expect approximately 25,000 acres of dispersal habitat and approximately 34,000 acres of nesting, roosting, and foraging (NRF) habitat in the east-side planning units.

Activities in the Five West-side Planning Units

This subsection describes typical silvicultural activities that may occur on DNR-managed forest lands covered by the HCP within the range of the northern spotted owl west of the Cascade crest, except in the Olympic Experimental State Forest (described in the next subsection). All of the silvicultural activities described in this section will be guided by state Forest Practices Rules, DNR policies such as the Forest Resource Plan (DNR 1992), and the conditions of the permit.

FOREST HEALTH

Forest health activities are usually limited to protection from wildfire and treatment of root rot. Rarely is control of forest defoliators (leaf-eating insects) required. Healthy forests are usually maintained by controlling tree species on specific sites.

Wildfire is the largest single threat to forest health in the five west-side planning units. Wildfire can have many different ignition sources, although human-caused fires are increasingly common. It is reasonable to expect no significant change in the level of loss from fire during the first decade of the permit.

Stump pushing has been used to control root rot in a few areas. However, the most common situation is to treat root-rot patches in forest stands by clearcut harvesting the affected area and reforesting with an alternate species not susceptible to root rot. This is normally done as part of a timber sale that is not solely targeted at disease control. It is reasonable to expect between 2,500 and 5,000 acres of species conversion for root-rot control during the first decade of the permit. This estimate is based on historical levels and is not expected to change significantly.

Leaf-eating insects, such as hemlock looper, have historically been controlled by aerial spraying of insecticide. Because there have been no major insect infestations on DNR-managed lands in the five west-side planning units for several decades, it is unlikely this treatment will be required or actually carried out during the first decade of the permit. Should unforeseen attacks by forest defoliators occur, they might require appropriate treatment to be determined at that time. Such appropriate treatment might include site-specific application of insecticides. At some of these sites the application of insecticides could result in the incidental take of federally listed invertebrate species. Such activities shall be covered under the Incidental Take Permit except for aerial application of pesticides, which shall be covered upon the U.S. Fish and Wildlife Service's approval of a site-specific plan presented by DNR. If the U.S. Fish and Wildlife Service disapproves such a plan, or if approval of such a plan is not forthcoming within 30 days of the U.S. Fish and Wildlife Service's receipt of the plan, a multi-agency science team may be convened to resolve questions regarding the biological basis of the U.S. Fish and Wildlife Service's decision.

TIMBER HARVESTING

Timber harvesting is perhaps the most common silvicultural practice carried out in forest stands on DNR-managed lands in the five west-side planning units. Timber harvests are designed to produce commercial products and to prepare the forest site for regeneration. Various harvest methods are used to facilitate various regeneration prescriptions. (See the previous discussion titled Timber Harvesting, in the subsection on the east-side planning units, for a description of clearcut and shelterwood harvesting.)

It is reasonable to expect between 140,000 and 165,000 acres of clearcut harvesting to occur on DNR-managed lands in the five west-side planning units during the first decade of the permit based on DNR's harvest level projections. Acreages were decreased slightly to reflect anticipated increases in other harvest techniques.

It is reasonable to expect between 1,000 and 5,000 acres of shelterwood harvest in the five west-side planning units during the first decade of the permit. The lower end of this estimate reflects historical levels for shelterwood harvests. DNR expects to increase the use of this harvest method as more emphasis is placed on maintaining structural diversity in forest stands.

Seed tree harvest is used less frequently in the five west-side planning units as a method of naturally regenerating a forest stand. Trees to be left to provide seed for regeneration are selected for their superior form and quality and are left scattered throughout the harvest unit. It is reasonable to expect between 500 and 1,000 acres of seed tree harvest to occur in the five west-side planning units during the first decade of the permit. This represents the historical level for this activity, which is not expected to change during the next decade.

Green trees, snags, and down logs are commonly left in harvest units. These structures add diversity to regenerated forest stands, enriching younger stands for wildlife benefits. These structures also help maintain long-term forest productivity. State Forest Practices Rules, DNR's Forest Resource Plan (1992), and the terms of the HCP provide the basis for retaining such structures.

Selective harvest and single tree harvesting can occur where special management objectives make these harvest methods appropriate. Partial cuts can be prescribed in order to develop and maintain a multi-aged, multi-storied stand. Single tree selection may be used to create diversity in an even-aged stand or to remove valuable products from a stand without changing its basic characteristics. During the first decade of this HCP, it is reasonable to expect between 20,000 and 30,000 acres of partial cuts in the five west-side planning units. This range reflects historical levels for selective harvests with some allowance for an increase in the use of this harvest method in managing NRF areas.

COMMERCIAL THINNING

Commercial thinning removes some trees from forest stands that are spaced too close together, provided a net financial return can be achieved. Creating more space between trees allows them to grow faster, increasing diameter and thus volume per tree. This practice often generates income before final harvest and increases value of the final harvest by improving the quality of the logs produced.

Conifer stands in the five west-side planning units are commonly overstocked, offering candidates for commercial thinning. Many planted stands are invaded by natural seedlings, which produces a species mix and an overstocked condition. Commercial thinning provides an opportunity to select desired species or produce a desired species mix and to initiate a multi-layered stand condition. Commercial thinning also provides an opportunity to manage the stand toward a prescribed condition, such as spotted owl dispersal habitat. It is reasonable to expect between 30,000 and 45,000 acres of commercial thinning to occur in the five west-side planning units during the first decade of the permit.

Commercial thinning had essentially been abandoned by DNR as a silvicultural tool in the mid-1970s. Region interest in the program caused a resurgence several years ago. Since that time, there has been a significant increase in the level of thinning. This activity is included in the regimes modeled for the HCP harvest projections. The larger acreage of the estimate reflects the level from the harvest model; the lower end is a projection of the current level through the next decade.

PRECOMMERCIAL THINNING

Precommercial thinning is prescribed to space young, overstocked stands in order to allow the remaining trees to grow into commercially valuable products sooner than would otherwise occur. Because this operation does not produce products that are valuable enough to cover the cost of the thinning operation, it is not a commercial operation, but rather an investment designed to increase the value of the stand. Additionally, precommercial thinning can accelerate the development of young stands toward certain habitat conditions desirable for wildlife by opening up crowded, dense stands and allowing other types of vegetation to grow, and by accelerating the growth of the remaining trees. Forest stands that are precommercially thinned are likely to become dispersal habitat sooner than those stands not precommercially thinned.

Because precommercial thinning is an investment, it will be accomplished as budget is available, and candidate stands will be prioritized according to the rate of return expected and the landscape needs to develop habitat as described in the HCP conservation strategies. It is reasonable to expect between 100,000 and 200,000 acres of precommercial thinning to be accomplished during the first decade of the permit on DNR-managed lands in the five west-side planning units. The wide range in this estimate reflects the uncertainty in funding. The lower end of the estimate is based on historic levels, whereas the upper end is about two-thirds of the acreage DNR Regions have identified as needing thinning to maintain growth and increase value. The regimes modeled for the HCP harvest projections indicate a probable precommercial thinning level about mid-way in this range. However, the harvest projections did not account for the backlog that exists from previous fluctuations in funding.

SITE PREPARATION

Site preparation is prescribed if an area scheduled for reforestation requires some treatment to ensure success or increase the efficiency of the reforestation effort. Typical preparations include burning forest debris remaining after harvest, applying herbicides in order to reduce vegetation that might compete with seedlings, or mechanically scarifying the ground to expose mineral soil that will aid the establishment of seedlings.

Site preparation on DNR-managed lands will be guided by state Forest Practices Rules and DNR policies such as the Forest Resource Plan (DNR 1992). Burning forest debris, a traditional site preparation practice, has become less common as concerns for air quality have increased and as the need to provide leave trees and snags has been understood. Further, a greater reliance on natural regeneration and various kinds of partial harvest render burning less appropriate as a site preparation tool. Use of herbicides for site preparation is rare for much the same reasons as the decline in burning. During the first decade of the HCP in the five west-side planning units, it is reasonable to expect between 500 and 1,000 acres of debris burning, between 5,000 and 10,000 acres of herbicide treatment as site preparation, and between 1,000 and 3,000 acres of scarification. Site-preparation acreage ranges are a combination of levels from recent history (last five years) and estimates by DNR Regions.

REGENERATION

Regenerating the forest stand after harvest or after natural disturbances is an important part of silviculture on DNR-managed lands in the five west-side planning units. The harvest method (clearcut, shelterwood, or seed tree) generally determines the regeneration method. The most common method in the five west-side planning units is planting with bare root stock of conifer species appropriate for the particular site. Natural seeding often occurs in these plantations as well, creating a young multispecies stand. Regeneration from natural seeding is prescribed where it is reasonable to expect a plentiful seed source from the desired species and other favorable factors. Some naturally seeded areas are supplemented with planted stock to meet reforestation objectives of number of trees per acre within a certain time. It is reasonable to expect between 120,000 and 160,000 acres of reforestation by planting and between 5,000 and 30,000 acres of strictly natural seeding to be accomplished in the five west-side planning units during the first decade of the HCP. Regeneration levels are directly proportional to harvest levels and depend on harvest method. The estimated level of activity is based on restocking all areas that are harvested for regeneration. There will likely be an increase in the use of natural seeding because of shifts in harvest methods and better recognition of natural seed sources.

VEGETATION MANAGEMENT

Vegetation management is prescribed to control competing vegetation in order to increase the survival, growth, and health of conifers. However, the objective of vegetation control is not to rid the plantation of all vegetation except conifer crop trees. The presence of alder or other hardwoods in a conifer plantation is desirable as long as they do not replace the conifers or significantly reduce the growth rate and yield of the intended crop trees.

Various methods can be used to control competing vegetation. Site-specific conditions and management objectives are considered when choosing a control method. Forest Resource Plan Policy No. 33 tacitly directs DNR to minimize the use of herbicides. The policy directs DNR to weigh the effectiveness of herbicide use against likely adverse effects on public water supplies, public health, fish health, and fish and wildlife habitat. The strategy for minimizing herbicide use presented in Policy No. 33 (DNR 1992) is a conservation measure which is part of DNR's HCP.

Hand slashing or cutting of unwanted vegetation , ground or aerial application of herbicide, and combinations of these methods may be used. The most common type of vegetation control is hand slashing of alder in young forest stands to encourage conifer saplings. DNR expects between 60,000 and 100,000 acres of hand slashing to occur during the first decade in the five west-side planning units. Ground application of herbicides is used to control big leaf maple and other vegetation. It is reasonable to expect between 40,000 and 50,000 acres of ground application of herbicide during the first decade of this HCP. Aerial application of herbicides can be used to control alder and herbaceous plants. It is reasonable to expect between 20,000 and 30,000 acres of aerial applications of herbicides during the first decade of the HCP.

Region input indicates an increased need for vegetation management beyond historic levels. The range for hand slashing reflects historic levels in the lower estimate, whereas the higher value includes an increase based on input from DNR Regions. Aerial application estimates are based on the historic range with no anticipated increases. Ground herbicide use reflects a historic trend of moderately increasing use and is consistent with estimates from DNR Regions.

FERTILIZATION

Application of nitrogen and other mineral nutrients to forest stands can increase growth and be a cost-effective investment for stands growing in certain nutrient-poor soils. This activity is usually done when management funds are available and other investment opportunities in forest productivity are less cost-effective. Large tracts of forest are typically treated once or twice during the harvest rotation. Benefits can be optimized if the applications are done after commercial thinning and about 10 years before final harvest. It is reasonable to expect fertilizer to be applied aerially on 30,000 to 115,000 acres of DNR-managed lands in the five west-side planning units during the first decade of the HCP. The large range in estimated acres of aerial fertilization is due to budget uncertainty. Biosolids are scheduled to be applied in limited areas during the first decade of the HCP. Research on biosolid applications may lead to increased use of this technique in the future.

STAND CONVERSION

Many stands now managed by DNR developed naturally after the original harvest decades ago. Without prescribed silvicultural activities, these stands developed in a variety of ways; for example, some stands developed into brush and hardwood species. When markets support such practices, these stands are harvested and replanted with conifer species. This conversion of stands from low commercial value species to more valuable conifer species is sometimes called stand conversion or stand rehabilitation. Stand conversion is done only on those lands that have supported conifer stands in the past. Lands that are best suited to hardwoods will not be converted. This practice increases the future value of these stands. It is reasonable to expect between 5,000 and 10,000 acres of stand conversion to occur during the first decade in the five west-side planning units.

SPOTTED OWL DISPERSAL AND NESTING, ROOSTING, AND FORAGING HABITAT

An important forest management objective in the five west-side planning units is the creation or maintenance of habitat for northern spotted owls. (See Section A of this chapter for the spotted owl conservation strategy.) On landscapes where these conservation objectives are prescribed, silvicultural practices will be designed to meet the habitat objective as well as the other forest management objectives detailed above. Any or all of the silvicultural practices described for the five west-side planning units may be employed to achieve habitat objectives under the permit. For example, precommercial thinning can accelerate the development of dispersal habitat, whereas commercial thinning can accelerate the development of NRF habitat. Green tree and snag retention can be used to improve the quality of both types of spotted owl habitat to meet conservation objectives. Partial cuts and single tree selection may be applied to existing NRF habitat without degrading the quality of habitat beyond the threshold identified in the HCP. At the end of the first decade of the HCP, it is reasonable to expect approximately 58,000 acres of dispersal habitat and approximately 66,000 acres of NRF habitat in the designated DNR-managed parcels in the five west-side planning units.

MARBLED MURRELET HABITAT

The details of the long-term conservation strategy for marbled murrelets are not known at this time. (See conservation strategy for the marbled murrelet in Section B of this chapter.) However, once the strategy is identified, silvicultural practices described in this section may be applied to meet the conservation objectives for marbled murrelets. Protection of nesting sites may require special silvicultural practices, which will be determined when the long-range conservation strategy is developed.

RIPARIAN MANAGEMENT ZONES

Forest management is allowed in riparian management zones under certain conditions to maintain or restore salmonid freshwater habitat. (See Section D of this chapter titled Riparian Conservation Strategy.) Silvicultural practices that might be appropriate for riparian management zones may include precommercial thinning, commercial thinning, partial cuts, single tree selection harvesting, and stand conversion.

Precommercial thinning and commercial thinning can be used to accelerate the development of riparian forest stands in order to provide essential elements of salmon habitat as well as contribute to upland species habitat needs. Shade and large woody debris can be provided from larger diameter trees that are grown using these practices. Spotted owl habitat and marbled murrelet habitat can be developed faster with the application of these practices in riparian management zones. The complex forest structures resulting from these practices can provide habitat for multiple species. See Table IV.16 at the end of this section for an estimate of the acres of riparian habitat to be developed during the first decade.

Stand conversion can be employed to restore riparian management zones to more natural conditions. Restoration is an activity allowed in the riparian conservation strategy. The most common restoration prescription might be the conversion of streamside hardwood or brush stands, typically created after original logging over the past decades, to conifer stands that can provide a source of large woody debris to the streams. Because a complete inventory of stream miles that could benefit from stand conversion is not available at this time, estimates of acreage to be converted cannot be made.

A program to identify opportunities and accomplish stand conversion along streams may be developed during the first decade of the permit.

Partial cuts and single tree harvest may be appropriate in riparian management zones to increase wind-firmness of the riparian buffers or for other reasons.

Activities in the Olympic Experimental State Forest Planning Unit

This subsection will describe typical silvicultural activities that may occur on DNR-managed forest lands covered by the HCP in the OESF Planning Unit. All silvicultural practices described for the five west-side planning units can be prescribed for the OESF; therefore, they will not be described again in this subsection. Basic silvicultural practices may be modified or emphasized in the OESF, but only the significant differences in silvicultural practices from those described in the subsection on the five west-side planning units will be described here. The forest management activities described in this section will be guided by state Forest Practices Rules, DNR policies such as the Forest Resource Plan (DNR 1992), and the conditions of the permit.

COMMODITY PRODUCTION AND ECOSYSTEM MAINTENANCE

Forest management on DNR-managed lands in the OESF will focus on both commodity production and ecosystem maintenance. Managing the forest ecosystem implies a process by which stand-level decisions regarding silvicultural practices and activities are influenced by larger scale landscape-level ecological goals and objectives to achieve an appropriate balance between using the forest for commodity production and sustaining natural ecological functions. In the OESF, DNR will seek to understand the complexity of forest ecosystems within a commercial forest. This emphasis is what is unique about this planning unit. Where appropriate, knowledge gained will be carried over to DNR-managed lands in other planning units.

SILVICULTURAL PRACTICES

Understanding ecological principles and natural tendencies in the context of tree growth and forest communities should provide better guidance to forest managers as they prescribe silvicultural applications. This is not to imply that management should passively allow nature to take its course. Rather, the OESF will be a place to learn how to manage actively in harmony with natural forest growth and reap the benefits of its inherent ecological and commercial outputs.

Forest growth can be described as having four basic stages or structures. These are stand initiation (an open condition and new regeneration), stem-exclusion (tree competition and mortality), understory reinitiation (undergrowth development and some tree regeneration) and old growth. The primary hypothesis of the OESF is that it is possible to provide and protect ecological values in a managed forest by maintaining an arrangement of forest structures and stand densities.

Silviculture in the OESF should be viewed as a means of manipulating and producing a variety of possible stand structures at the landscape level. The various silvicultural practices described in the previous subsection on the five west-side planning units constitute an array of forest management choices to develop stands and landscapes that will have desirable conditions for both timber production and wildlife habitat. For example, spotted owls have shown a strong habitat preference for forest that has multi-layered canopies containing trees ranging from young saplings to those with large diameters. Old-growth forests contain large-diameter trees, which have considerable economic value. Where old-growth attributes are desired in the future for both ecological and economic values, management strategies (silvicultural practices) must be initiated to recreate these attributes, because protecting existing old growth is not sufficient to ensure the presence of old growth in the future. It is intended that OESF silvicultural practices will endeavor to enhance stand structure diversity by including plans for maintaining or developing large-diameter trees.

Silvicultural prescriptions that emphasize both commodity production and ecological function begin with stand-level silvicultural operations. These actions will focus increasingly on what is retained as well as what is removed from stands and will prescribe arrangement of structure within and across multiple stands to meet desired patterns that benefit both stand-level and ultimately landscape-level ecological objectives. For example, some of the components of old-growth ecosystems have been described as large, standing trees, both live and dead, large-diameter down wood, and large woody debris in streams. Silvicultural prescriptions promoting these components will satisfy forest-stand diversity objectives and landscape-level diversity of habitat.

Other silvicultural activities (e.g., selective harvest) can develop multiple age-class stand conditions that, over time, can enhance stand-level diversity and provide both small- and large-tree age classes that support favorable economic returns and ecosystem values. Variations of in-stand silvicultural prescriptions for mid-aged stands in the OESF will provide opportunities for immediate commodity production and set a course for future in-stand habitat benefits. The application of various silvicultural prescriptions to test the general hypothesis of the OESF will provide much of the experimentation direction for the forest.

QUANTIFYING SILVICULTURAL PRACTICES

Due to the experimental nature of the OESF, it is difficult to quantify potential management activities. However, based on current inventory, the conservation strategies, and potential harvest opportunities, one can reasonably expect approximate ranges described in Table IV.15 at the end of this section. Potential experimental harvest within some riparian, murrelet, and spotted owl habitat is not included in these estimates but is expected to occur during the first 10 years. These ranges reflect an attempt to capture what could occur as a result of experimenting with many variables, including rotation length, silvicultural treatment options, and experimentation in habitat maintenance and creation in managed stands. The quantity and distribution of harvest among commercial thinning, selective and shelterwood harvesting, and clearcutting may shift as activities are designed to meet site-specific conditions and specific production and conservation objectives. Furthermore, activities estimated for the first decade of the HCP are not necessarily representative of what will occur in subsequent decades.

Learning how to sustain natural ecological functions within the context of a managed forest will lead forest managers to employ silvicultural prescriptions that are most harmonious with natural forest development. Harvesting will focus on retaining structural elements of the original stand, while site preparation and reforestation will be prescribed to minimize disruptions of the natural forest renewal process. For this reason, natural regeneration will be more important in the OESF Planning Unit than in the five west-side planning units. Tree spacing, through both precommercial and commercial thinning, will be carried out to increase the rate of development of forest stands towards desired target conditions. Selective harvesting may be prescribed more frequently here to develop multi-layered stand structures more quickly. Clearcutting will occur but with more emphasis on structure retention in order to provide structural diversity to future stands. All of the silvicultural prescriptions will be designed to meet landscape goals consistent with the overall objectives of the OESF and the conditions of the permit.

Table IV.15: Estimated amount of forest land management activities on DNR-managed lands in the area covered by the HCP during the first decade of the HCP

Activity	East-side planning units (acres)	West-side planning units (acres)	OESF Planning Unit (acres)
Harvest: clearcut	3,000-6,000	140,000-165,000	3,000-15,000
seed tree	0	500-1,000	0-300
shelterwood	1,000-5,000	1,000-5,000	300-1,000
selective	25,000-35,000	20,000-30,000	8,000-11,300
salvage	5,000-10,000	0	1,500-2,500
commercial thinning	4,000-10,000	30,000-45,000	25,000-35,000
Site preparation: broadcast burn	0-1,000	500-1,000	0-1,000
herbicide	500-5,000	5,000-10,000	0
scarification	2,000-8,000	1,000-3,000	0-1,000
Regeneration: planting	6,000-20,000	120,000-160,000	3,000-15,000
natural seeding	30,000-50,000	5,000-30,000	800-1,200
Vegetation management: hand slashing	0	60,000-100,000	5,000-10,000
ground herbicide	0	40,000-50,000	0-1,000
aerial herbicide	5,000-15,000	20,000-30,000	0-500
Forest health: under-burning	3,000-10,000	0	0-500
root-rot control	1,000-5,000	2,500-5,000	0-500
insect damage control	2,000-15,000	0	0-500
Precommercial thinning	3,000-10,000	100,000-200,000	10,000-25,000
Fertilization	4,000-10,000	30,000-115,000	0-1,000

Table IV.16: Estimated amount of habitat on DNR-managed lands in the area covered by the HCP at the end of the first decade of the HCP

Type of habitat	East-side planning units	West-side planning units	OESF Planning Unit
Dispersal	34,000	58,000	N/A
Nesting, roosting, foraging	25,000	66,000	56,000
Riparian	N/A	23,000	10,000

V. Plan Implementation

V. Plan Implementation

Implementation of the HCP is governed by an agreement among DNR, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. (See the Implementation Agreement.) The Implementation Agreement defines the roles and responsibilities of these parties regarding implementation of the HCP. The HCP and the Implementation Agreement are supplementary to each other. Together, they fulfill the requirements as outlined in the Endangered Species Act for issuance of an incidental take permit. (See the section in Chapter II on the Endangered Species Act for a discussion of these requirements.) The processes for addressing unforeseen or extraordinary circumstances, amending the HCP, review, and funding are among the issues discussed in the Implementation Agreement.

Funding

DNR shall submit to the Washington State Legislature, on at least a biennial basis, an agency operating and capital budget for asset management that will be adequate to fulfill DNR's obligations under the HCP, Incidental Take Permit, and Implementation Agreement. Failure by DNR to ensure that adequate funding is provided to implement the HCP shall be grounds for suspension or partial suspension of the Incidental Take Permit.

Transition Activities

Timber sales prepared by DNR normally require approximately 24 months of preparation between the planning of the sale and its eventual auction. The HCP conservation strategies require certain actions to occur (i.e., the designation of the 300-acre spotted owl nest patches) and certain materials be prepared (e.g., implementation procedures for riparian areas) in the first year after approval of the HCP and issuance of the Incidental Take Permit. Additionally, once implementation procedures are completed, training will be required for DNR staff. For these reasons, following approval of the HCP and issuance of the Incidental Take Permit, a transition period will be required. Timber sales in the DNR "pipeline" at the time of approval of the HCP will continue to be brought forward by DNR through the end of calendar year 1998, provided such sales are consistent with spotted owl survey agreements in effect between DNR and the U.S. Fish and Wildlife Service. Such sales will not include known occupied marbled murrelet sites or unsurveyed, suitable marbled murrelet habitat. Because of current DNR actions such as spotted owl survey efforts and the deferral of sale of marbled murrelet habitat, it is believed that take of any listed species will be limited to non-existent. Mitigation for any such take has been included in the conservation strategies contained within the HCP.

Monitoring

OBJECTIVES

DNR shall monitor this HCP on DNR-managed lands according to the following objectives for all planning units:

(1) to determine whether the HCP conservation strategies are implemented as written; and

(2) to determine whether implementation of the conservation strategies results in anticipated habitat conditions.

These two monitoring objectives can be referred to as implementation and effectiveness monitoring, respectively (U.S. Forest Service et al. 1994).

There is a third monitoring objective, referred to as validation monitoring (U.S. Forest Service et al. 1994), for DNR-managed lands in the Olympic Experimental State Forest (OESF) Planning Unit:

(3) to evaluate cause-and-effect relationships between habitat conditions resulting from implementation of the conservation strategies and the animal populations these strategies are intended to benefit.

Implementation monitoring will document the types, amounts, and locations of forest management activities carried out on DNR-managed lands in each HCP planning unit, both inside and outside areas addressed by the conservation strategies. Activities in areas addressed by the HCP will be described in sufficient detail to document compliance with the requirements of the conservation strategies. Activities outside of these areas will be described in summary detail. Implementation monitoring will also periodically describe changes in landscape-level habitat conditions in areas managed to provide spotted owl and murrelet habitat. Such monitoring will be primarily accomplished through DNR's planning and tracking, and geographic information systems. Statistically valid sampling of management activities will be conducted to evaluate the reliability of information stored in these databases.

Effectiveness monitoring will document changes in habitat conditions, including general forest structure, specialized habitat features (e.g., in-stream large woody debris, marbled murrelet nesting platforms), and spotted owl prey populations, that result from timber harvest and other forest management activities carried out pursuant to the HCP. Only habitat areas addressed by the conservation strategies, i.e., riparian, spotted owl nesting, roosting, and foraging (NRF), spotted owl dispersal, and marbled murrelet habitat areas, will be monitored for effectiveness. Within these habitat areas, representative samplings will be monitored, which means not all managed acres or management activities will be monitored. Effectiveness monitoring will rely upon field-based before-and-after comparisons. Changes in habitat conditions will be evaluated both in the short term (one to three years after harvest) and over the life of the HCP.

Validation monitoring, which will occur only within the OESF Planning Unit, will document spotted owl and marbled murrelet use of areas managed to provide nesting habitat, and salmonid use of streams crossing DNR-managed lands. For spotted owls and marbled murrelets, validation monitoring will rely upon surveys to detect changes in site occupancy, numbers and locations of breeding pairs, and reproduction, as appropriate for each species. For salmonids, validation monitoring will employ surveys to detect changes in the productivity of spawning adults and salmon-habitat relationships. As an additional objective for the OESF, validation monitoring reflects the emphasis on experimentation that defines the OESF. (See Section E in Chapter IV titled Olympic Experimental State Forest Planning Unit.) In this sense, the OESF will be an open-air laboratory in which the assumptions that underlie the conservation strategies will be tested.

MONITORING PROGRAM

Table V.1 outlines the monitoring program that results from applying the first two monitoring objectives to the major conservation strategies. (See the sections in Chapter IV on conservation strategies for the northern spotted owl, marbled murrelet, and riparian areas, and the unique spotted owl and riparian conservation strategies for the OESF.) Implementation and effectiveness monitoring will be carried out for all of these major strategies. The spotted owl conservation strategy, current spotted owl and marbled murrelet habitat, and current riparian ecosystem conditions are not uniform across planning units. Effectiveness monitoring will necessarily be tailored to the conservation strategy and habitat or ecosystem conditions in each planning unit.

Validation monitoring will be carried out for spotted owl nesting habitat, marbled murrelet nesting habitat, and salmonid habitat in the OESF. Validation monitoring will not be undertaken for the other conservation strategies or in other planning units. Validation monitoring will not be undertaken for spotted owl dispersal habitat. The OESF spotted owl conservation strategy does not draw the management distinction between NRF habitat and dispersal habitat that prevails in other HCP planning units. In the other planning units, an evaluation of the cause-and-effect relationship between conditions on DNR-managed lands and the ability of juvenile spotted owls to disperse successfully across the landscape would be difficult to design, expensive to implement, and impractical to undertake, given the distribution of DNR-managed lands. Resources for monitoring the HCP's success in providing dispersal habitat will be better directed at evaluating forest structure and prey responses (i.e., effectiveness monitoring) in areas that are specifically managed for spotted owl dispersal habitat.

Validation monitoring for salmonid habitat will be focused to detect changes in the productivity of spawning adults and salmon-habitat relationships, parameters that are not affected by marine conditions and downstream fisheries. This will involve estimating numbers of spawning adults and numbers of recruits (i.e., out migrating smolts or rearing juveniles), and surveying different stream habitat types and conditions to determine fish numbers, species composition, and densities. Validation monitoring for salmonid habitat will be conducted in an appropriate watershed unit comprised primarily of DNR-managed lands, to minimize the potential influences of management activities not under DNR's control. Validation monitoring will not be conducted for any other, non-salmonid fish species, or for wildlife species (other than spotted owls and marbled murrelets) influenced by the riparian/salmonid conservation strategy.

Effectiveness and validation monitoring need not be undertaken while the interim murrelet conservation strategy is in effect. Although lower quality habitat types that support up to 5 percent of the total murrelet use of DNR-managed lands within each of the five west-side and the OESF planning units may be harvested under the interim strategy, DNR will not alter or manage the higher quality murrelet nesting habitat, which supports 95 percent of potentially occupied sites, during this period. Neither will there be any attempt to alter or manage any habitat known to be occupied by murrelets, regardless of habitat quality. DNR expects to initiate effectiveness monitoring in all planning units where murrelet nesting habitat is a management goal once the long-term murrelet conservation strategy has been designed and implemented. DNR also expects to initiate validation monitoring in the OESF once the long-term murrelet conservation strategy is in place.

DNR recognizes the substantial financial commitment that the HCP monitoring program entails. DNR will provide adequate funding for monitoring to the extent that DNR is given the flexibility to make such budget decisions. DNR shall request funds from the legislature to cover the costs of the monitoring program. The exact funding level may vary from year to year, depending on actions of the legislature.

MONITORING PROCEDURES

Detailed procedures will be prepared to implement the monitoring approaches for each element of the HCP monitoring program outlined in Table V.1. These procedures will identify specific assumptions or hypotheses to be tested, data to be collected, sampling intensity and frequency, field and analysis methods, budgets, and timelines; the procedures will provide the level of detail anticipated in the U.S. Fish and Wildlife Service's Endangered Species Habitat Conservation Planning Handbook (USFWS and NMFS 1996). Monitoring procedures will be prepared by a team of scientists from DNR, the U.S. Fish and Wildlife Service, and the National Marine Fisheries Service. Implementation, effectiveness, and validation monitoring procedures will be completed and reviewed before forest management activities consistent with a conservation strategy are first undertaken. Tables V.2 and V.3 outline some of the environmental variables that will be measured as part of effectiveness monitoring for the spotted owl and riparian conservation strategies, respectively.

MONITORING REPORTS

DNR will prepare an annual report that describes the results of all monitoring activities carried out during the preceding calendar year. Monitoring reports will be completed and submitted to the U.S. Fish and Wildlife Service by March 30 of each year.

Table V.1: Outline of the HCP monitoring program

	HCP habitat goals			
Monitoring objective	**Spotted owl nesting, roosting, foraging habitat**	**Spotted owl dispersal habitat**	**Marbled murrelet nesting habitat[1]**	**Riparian/salmonid habitat**
Implementation	All planning units	All planning units	Five west-side planning units and the OESF	Five west-side planning units and the OESF
Effectiveness	All planning units	All planning units	Five west-side planning units and the OESF	Five west-side planning units and the OESF
Validation	OESF Planning Unit only		OESF Planning Unit only	OESF Planning Unit only (salmonid habitat only)

[1]Only implementation monitoring will be done during the interim conservation strategy for the marbled murrelet. See text.

Table V.2: Environmental variables to be measured in effectiveness monitoring for the spotted owl conservation strategy

<table>
<tr><th colspan="2">Environmental Variables</th></tr>
<tr><th>Spotted owl nesting, roosting, and foraging habitat</th><th>Spotted owl dispersal habitat</th></tr>
<tr><td>density of nesting structures
snag density
snag diameter
distribution</td><td></td></tr>
<tr><td colspan="2">tree density
tree species composition
tree diameter distribution canopy closure
canopy height
woody debris ground cover
prey density</td></tr>
</table>

Table V.3: Environmental variables to be measured in effectiveness monitoring for the riparian conservation strategy

Salmonid Habitat Element	Environmental Variables
large woody debris	linear density size category tree species shape of form decay category poolforming function
channel characteristics	bankfull width bankfull depth stream gradient total water surface area pool maximum depth pool residual depth pool location pool frequency
sediments	percent of fine sediment in spawning gravel

MANAGEMENT ACTIVITIES IN PROGRESS OR UNDER WAY WHEN THE HCP IS ADOPTED

Management activities in progress or under way when the HCP is adopted that are exempt from compliance with the conservation strategies (see the Implementation Agreement) will be reported as part of implementation monitoring. Otherwise, such activities will not be monitored.

Research

OBJECTIVES

The conservation strategies in this HCP require that research be carried out to answer certain specific questions. These questions can be grouped under three broad research objectives:

- To obtain information needed to move from short- to long-term conservation strategies.
- To obtain information needed to assess and improve the effective-ness of the conservation strategies.
- To obtain information needed to increase management options and commodity production opportunities for lands managed pursuant to the HCP.

RESEARCH PRIORITIES AND TOPICS

These objectives give rise to three research priorities:

(1) Research that is a necessary part of a conservation strategy. DNR recognizes the interim nature of a short-term approach and has delayed management actions until new information is obtained.

(2a) Research needed to assess or improve conservation strategies that are in place. Information gaps that restrict DNR's ability to provide conservation benefits are evident, but DNR has not delayed management actions.

(2b) Research needed to increase management options and commodity production opportunities for lands managed pursuant to the HCP, including testing of new technologies and experimental application of silvicultural techniques.

(3) Research needed to improve general understanding of the animals, habitats, and ecosystems addressed by the HCP.

Research topics identified in the HCP can be prioritized accordingly.

Priority 1

Riparian

- Determine how to design and manage riparian buffers that main-tain wind-firm streamside forests.
- Evaluate the local and downstream effects of forest management activities along Type 5 waters not associated with unstable slopes. Determine whether conditions necessitate buffers along Type 5 streams, and if so, determine how to design and manage such buffers.

Spotted Owl

- Determine the amounts of down woody debris necessary for nesting, roosting/foraging, and dispersal habitats.
- Develop better stand-level definitions for nesting habitat.
- Determine the amount and distribution of nesting habitat needed to support nesting spotted owls within managed forest landscapes.
- Develop better stand- and landscape-level definitions for dispersal habitat.
- Determine how to manage and harvest timber within nesting and roosting/foraging habitats.

Marbled Murrelet

- Evaluate the habitat relationships of murrelets occupying DNR-managed lands. Determine which areas and habitat conditions support nesting murrelets.
- Determine whether certain breeding sites are more important to the population than others and, if so, identify the conditions that influence these differences.
- Develop the ability to delineate the boundaries of breeding sites.
- Determine how to protect and manage breeding sites.
- Determine whether nesting murrelets can colonize unoccupied suitable habitat.

Priority 2

Riparian

- Determine how to harvest timber and meet conservation objectives within riparian areas.
- Determine how to harvest timber and meet conservation objectives on hillslopes with high mass-wasting potential without triggering land slides and causing adverse effects to fish habitat.
- Determine the best approach to growing healthy riparian buffers while managing the buffer for economic return.

Spotted Owl

- Determine the types, amounts, and configurations of habitat required to support spotted owls in managed forest landscapes.
- Develop the ability to accelerate development of functional spotted owl nesting and roosting/foraging habitats in conjunction with commercial silvicultural activities and timber harvest.
- Determine how to reduce the risk of catastrophic habitat loss due to fire, insects, or disease, while maintaining existing nesting and roosting/foraging habitats.

Marbled Murrelet

- Determine whether it is possible to harvest timber at or near breeding sites and meet conservation objectives.

Multispecies

- Determine how to design, create, and manage landscape-level habitat patterns to benefit a variety of native animals that use the various forest ages and structures in a geographic area.

- Determine how to best move these patterns across the landscape through time in order to allow maximum flexibility for timber harvest.

Priority 3

Riparian

- Develop basic information on the relationships between forest management activities and riparian ecosystems in managed forests.

- Develop basic information on the relationships between forest management activities and hydrology in managed forests, particularly the relationships among forest management activities, basin soils, and stream-channel/stream-bed changes during rain-on-snow floods.

Spotted Owl

- Determine whether snags are a necessary part of northern flying squirrel habitat in eastern Washington.

Marbled Murrelet

- Develop basic information on murrelet ecology.

Other research topics may arise as the HCP is implemented and new knowledge is obtained.

RESEARCH PROGRAM

DNR will actively manage the HCP research program to ensure that information is obtained in a timely and cost-effective manner and that research is accomplished with high standards of quality and credibility. DNR does not intend to create a large research infrastructure to conduct the necessary investigations. Most HCP research will be done for DNR by qualified research institutions through cooperative agreements and contracts. Certain applied research that requires close coordination with DNR operations may be carried out by DNR scientists. Some enhancement of current DNR infrastructure will be required to direct the research program, manage the information obtained, and ensure that new information is successfully incorporated into operational programs.

To the maximum extent possible, HCP research will be carried out on DNR-managed lands in the OESF Planning Unit, where management emphasizes research and experimentation. (See the section in Chapter I titled Why the OESF is Unique and Section E of Chapter IV on the OESF conservation strategies.) The special research relationship between DNR and the Olympic Natural Resources Center will enhance DNR's ability to meet HCP information needs. Research that cannot be carried out on the western Olympic Peninsula, or cannot be extrapolated from this planning unit, will take place on other appropriate DNR-managed lands.

There is considerable overlap between the HCP research priorities described previously and those envisioned for the OESF. (See the section in Chapter I titled Why the OESF is Unique.) However, it is important to note that the OESF has broader research objectives and different overall research priorities than those that are part of this HCP. In other words, both priorities for the HCP and other, non-HCP priorities will shape the overall OESF research program. Research on watershed processes and aquatic habitats, the habitat needs of late seral species, ecosystem productivity and health, timber harvesting systems, landscape management, and other topics will be featured in the OESF, in addition to the HCP research topics described previously.

DNR recognizes the substantial financial commitment that the HCP research program entails. DNR will provide research funding commensurate with the importance of the HCP and the scope of the research questions to the extent DNR is given flexibility to make that decision. The exact funding level may vary from year to year, depending on actions of the Legislature, but DNR shall request at least $1 million per year for HCP research until the Priority 1 research topics listed above have been adequately addressed. In some cases, however, it may not be necessary for DNR to fund research on a particular topic. Other organizations may sponsor work that will generate the knowledge needed. An important part of the HCP research program will be to stay in touch with other Pacific Northwest research programs and assimilate information that can be used to meet HCP information needs.

RESEARCH PROCEDURES AND REPORTS

A research procedure will be prepared for each investigation that is part of the HCP research program. Research procedures will describe background and rationale, specific objectives, research approach, hypotheses to be tested, data to be collected, field and analysis methods, budgets, and timelines. A study's principal investigator(s) will prepare procedures for research in consultation with DNR. Investigators will also prepare annual reports that describe the results of work carried out during the preceding year, summarize data collected, and present preliminary data analyses. A comprehensive final report that includes detailed results, conclusions, and management recommendations will be prepared at the conclusion of each research project. DNR will emphasize rapid dissemination of research results to DNR managers, planners, and technical specialists, and rapid assimilation of new information into conservation and management approaches. DNR will also require investigators to seek publication of research results in refereed professional journals.

Reporting

The Implementation Agreement describes how reviews and inspections will occur.

DNR will provide the U.S. Fish and Wildlife Service and the National Marine Fisheries Service with standard year-end reports compiled through DNR's geographic information system or other methods, such as summaries of timber sales and other management activities. As discussed in the earlier section in this chapter titled Monitoring, DNR will also prepare an annual report that describes the results of all monitoring activities carried out during the preceding calendar year. Monitoring reports will be completed and submitted to the U.S. Fish and Wildlife Service by March 30 of each year.

VI. Alternatives to the HCP that Would Avoid Take

1 **No Action/No Change (Current Practices)**

2 **No Harvest/No Take**

VI. Alternatives to the HCP that Would Avoid Take

A discussion of the range of alternatives can be found in the Draft Environmental Impact Statement. However, to meet the requirements for an HCP, a brief discussion is included here of alternatives that would avoid take and why they are not as suitable for DNR-managed lands as operating under an HCP with incidental take permits. (A copy of the Draft Environmental Impact Statement can be obtained from DNR.)

No Action/No Change (Current Practices)

This alternative is considered in detail in the Draft Environmental Impact Statement. Like this HCP, the No Action/No Change alternative adheres to trust duties, state Forest Practices Rules, policies of the Board of Natural Resources, and laws of general applicability such as the Endangered Species Act.

Briefly, under the No Action/No Change alternative, DNR would not seek incidental take permits or an agreement on unlisted species from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service. DNR would not implement a habitat conservation plan. To comply with the Endangered Species Act, DNR's trust land management would be regulated by the federal government and guided by the policies of the Board of Natural Resources as stated in the 1992 Forest Resource Plan.

DNR would continue management policies and practices designed to reduce the risk of violating the Endangered Species Act. Specific policies and practices with regard to compliance with federal law are not necessarily associated with state Forest Practices Rules. Risk-management practices or policies include:

(1) conducting two-year surveys on proposed timber sales in suitable spotted owl habitat;

(2) deferring from sale some suitable spotted owl habitat within the boundary of the Olympic Experimental State Forest;

(3) deferring timber sales involving potential marbled murrelet habitat within 40 miles of marine waters and conducting a case by case review of sales between 40 and 52.25 miles;

(4) conducting marbled murrelet habitat relationship studies to assist the Board of Natural Resources in determining an acceptable level of risk; and

(5) screening certain other sales for potential taking of a federally listed species.

Under the No Action/No Change alternative, the focus of DNR's conservation efforts related to compliance with the Endangered Species Act is on current habitat conditions. Existing suitable habitat for murrelets would be essentially off limits for harvest; and in areas now occupied by spotted owls, sales would be offered only where there is more than 40 percent habitat within a circle. Where survey information shows a spotted owl activity center (or circle) has been abandoned, additional acres would be available for sale upon the completion of a series of decertification surveys. Conversely, where surveys show new spotted owl activity and habitat below the 40 percent threshold, these areas would be off limits. The No Action alternative assumes DNR will continue to survey in an attempt to clear for harvest as much mature timber as possible, but also that the Board would continue its current risk-management approach regarding sales in suitable habitat. The costs of complying with the Endangered Species Act would include the costs of continuing the current survey program.

Uncertainty regarding compliance with the Endangered Species Act is the dominant feature of this alternative and would continue through time. Requirements could stiffen, more species could be listed, or requirements could relax with changes in federal policy. DNR would respond to changing the Endangered Species Act requirements and take precautions when guidance is lacking to ensure compliance with the Endangered Species Act.

The No Action/No Change alternative does not allow DNR to provide the same level of certainty, stability, and flexibility as the HCP would in carrying out DNR's duties as trust manager. (See the section of Chapter II titled Trust Duties.) Because of the continuing changes in regulations to avoid take of a listed species and the possible listings of additional species with more resulting regulations, there is a degree of uncertainty that inhibits DNR's management. Such uncertainty causes lack of stability in DNR's timber sales program, which is the primary source of revenue for the trusts. Uncertainty also limits flexibility in operations. In contrast, it is expected that the HCP will allow DNR to better meet its duty to the trust of striving to produce the most substantial support possible over the long term consistent with all trust duties conveyed on DNR by the state of Washington.

No Harvest/No Take

Briefly, under the No Harvest alternative, DNR would achieve compliance with the Endangered Species Act by not conducting harvest activities, building roads, or conducting other land management activities within or near existing and potential habitat for listed and candidate species. Forested trust lands would be unmanaged in an effort to grow new habitat for listed and candidate species. This alternative is not feasible because it would not allow DNR to meet its legal obligations to the trusts. (See the section of Chapter II titled Trust Duties.) To eliminate the state's responsibilities as trustee, the State Enabling Act and the State Constitution would have to be amended.

A. Appendix - Geographic Analysis

Appendix A. Geographic Analysis

Much of the underlying analysis for the conservation strategies in the HCP was supported by DNR's geographic information system.

A geographic information system (GIS) is a system of integrated processes for the entry, analysis, and query of any data that can be referenced to a specific location. Comprised of computer hardware and software, geographic data, support staff, and applications, the purpose of a GIS is to provide meaningful geographic information in either map or report form.

A GIS query can take either of two general forms. In one form, the user begins with a specific known location (e.g., a timber stand, ownership parcel, or stream segment) and queries the GIS for all characteristics of that location (e.g., age of timber, owner of parcel, or name of stream). For the other form of query, the user enters a list of desired characteristics, without knowledge of where they exist, and queries the GIS for the locations having those characteristics (e.g., stands with timber more than 60 years old, owned by the county, or within 1 mile of the Rushing River).

DNR has been developing its GIS since 1982 and now has a well established, state-of-the-art system. Its client-server architecture consists of a central corporate database, more than 40 workstations, ARC/INFO software, and nearly 400 trained DNR staff. The GIS has become integrated into almost every facet of DNR's daily operations.

For the HCP, DNR's GIS has been used in two general phases: (1) initially providing information to evaluate the current situation, and (2) modeling potential conservation strategies and analyzing results. For the first phase, a large amount of statewide geographic data was required to help lay the foundation of the HCP and define conservation objectives. To avoid producing endless numbers of maps with all possible combinations of geographic data, DNR staff developed a computer menu that allowed any combination of data to be selected and mapped on the computer screen. During Science Team meetings, the maps were displayed through an overhead projector so that the scientists could query the GIS and see the results. Aided by map analyses, the Science Team and DNR determined the wildlife species on which to focus efforts, the resulting geographic extent of the HCP, and the appropriate geographic subunits to use for more detailed analysis.

The second phase — modeling and analysis — used the GIS to its full potential. The breadth and variety of GIS use in this context can best be shown by the following examples. For modeling the conservation strategies for the northern spotted owl and marbled murrelet, the GIS was used to map and evaluate:

- elevation breaks and observed sightings defining the Washington range of both species;

- spatial relationships between DNR-managed forest lands and federal reserves;

- distribution of potential habitat across lands managed by various state and federal agencies; and
- timber age distributions on DNR-managed forest lands.

For developing riparian ecosystem conservation strategies, the GIS was used to map and evaluate:

- stream densities (miles of stream per square mile) by stream type;
- miles of stream, summarized by stream type;
- stream gradients, summarized by stream type;
- hillslopes and slope shapes (for predicting areas of slope instability);
- elevation, rainfall, vegetation, and latitude (to predict rain-on-snow zones, which in turn may predict runoff problems);
- areas where soils may be susceptible to erosion when disturbed;
- various stream buffering scenarios, along with their contribution to habitat and effect on timber harvest activities;
- road densities (miles of road per square mile);
- road/stream intersections (bridges, culverts, fords) as potential trigger points for storm runoff; and
- stream stocking status for anadromous fish.

Approximately 85 percent of the geographic data utilized were already resident in DNR's GIS. The remainder was acquired primarily from the U.S. Forest Service and the Washington Department of Fish and Wildlife.

Any GIS data is, by definition, only a *model* of reality — a snapshot of conditions that are highly complex and dynamic. Although computer automation can give a very high level of precision, it does not in itself assure accuracy. Accuracy is achieved and maintained only at significant cost and is relative to the specific need. Therefore, while all the data used in GIS analysis are of a reasonably high quality, great diligence was exercised throughout the process to assure that the data were not used beyond their inherent limitations.

The GIS has been an important tool for communicating among the scientists, DNR staff, other government agencies, the beneficiaries, and the general public. It was a fundamental aid in establishing confidence in the conservation strategies. The GIS will continue to play a large part in implementing and monitoring the HCP.

B. Appendix - Implementation Agreement

Appendix B. Implementation Agreement

IMPLEMENTATION AGREEMENT FOR THE
WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES
HABITAT CONSERVATION PLAN

THIS AGREEMENT is made and entered into as of the 30th day of January, 1997, by and between the Secretary of the Interior acting through the United States Department of the Interior, as represented by the UNITED STATES FISH AND WILDLIFE SERVICE ("USFWS"), an agency of the federal government, the Secretary of Commerce acting through the NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION as represented by the NATIONAL MARINE FISHERIES SERVICE ("NMFS"), an agency of the federal government, and the WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES, ("DNR"), an agency of the State of Washington, which includes the WASHINGTON STATE BOARD OF NATURAL RESOURCES ("BOARD").

BACKGROUND

1.0 DNR manages approximately 2.1 million acres of forest lands within the State of Washington.

2.0 Approximately 1.6 million acres of DNR-managed forest lands are within the range of the Northern Spotted Owl (*Strix occidentalis caurina), ("the Owl").*

3.0 The Marbled Murrelet *(Brachyramphus marmoratus)*, Bald Eagle *(Haliaeetus leucocephalus)*, Grizzly Bear *(Ursus arctos)*, Gray Wolf *(Canis lupus)*, Peregrine Falcon (Falco peregrinus), Columbian White-tailed Deer *(Odocoileus virginianus leucurus)*, Aleutian Canada Goose *(Branta canadenis leucopareia)*, and Oregon Silverspot Butterfly *(Speyeria zerene hippolyta) (hereafter known collectively as "other federally listed species"*) occur or may occur on the PERMIT LANDS.

4.0 The aforementioned species are listed as threatened or endangered under the Federal Endangered Species Act, 16 U.S.C. § 1531, *et seq.*, ("ESA"), and any taking, as that term is used in the ESA, of these species is prohibited, except as permitted by the ESA.

5.0 Incidental takings in accordance with an Incidental Take Permit ("ITP") issued by the SERVICES in conjunction with approval of a Habitat Conservation Plan ("HCP") are authorized by the ESA.

6.0 DNR, with technical assistance from the SERVICES and others, has prepared an HCP for the Owl and other species that may use the types of habitat that occur on the PERMIT LANDS.

7.0 DNR has applied to have the ITP include the Owl and other federally listed species that may currently use the types of habitats that occur on PERMIT LANDS; and to have the ITP, as amended from time to time, include every species that becomes listed after the effective date of this Implementation Agreement ("Agreement") and that may now or hereafter use the types of habitats that occur within the five Westside Planning Units of the PERMIT LANDS and the Olympic Experimental State Forest (OESF).

8.0 The SERVICES require an Implementation Agreement to be signed by all PARTIES associated with issuance of an ITP for a long-term HCP.

9.0 The purposes of this Agreement are to obtain an approved HCP and ITP covering DNR-management activities on the PERMIT LANDS; to implement the HCP; to commit the PARTIES to fulfill and faithfully perform their respective obligations, responsibilities, and tasks to the extent consistent with their respective authorities; to identify remedies and recourse should any of the PARTIES fail to perform such obligations, responsibilities, and tasks; and to provide for regulatory relief, stability, and species conservation.

10.0 The SERVICES have given full consideration to the HCP and this Agreement and found them to meet the requirements for issuance of an ITP under the ESA.

11.0 DNR has given full consideration to the HCP, its alternatives, the ITP, and this Agreement and found the HCP, the ITP, and this Agreement to be in the best interest of each of the trusts.

NOW, THEREFORE, in consideration of the mutual covenants and conditions contained below, the PARTIES agree as follows:

AGREEMENT

12.0 **Definitions.** The terms of the HCP, and this Agreement shall be interpreted as supplementary to each other, but in the event of any direct contradiction between the terms of the HCP and this Agreement, the terms of this Agreement shall control. Terms capitalized in this document shall have the meanings set forth in this section.

12.1 The terms "PARTY" and "PARTIES" shall mean one or all of the following: the Secretary of the Interior acting through the United States Department of the Interior, as represented by the USFWS, the Secretary of Commerce acting through the National Oceanic and Atmospheric Administration, as represented by NMFS, and DNR, including the BOARD.

12.2 The terms "SERVICE" and "SERVICES" shall mean the USFWS and/or the NMFS acting on behalf of their respective Secretaries.

12.3 The terms "ITP" and "PERMIT" shall mean an incidental take permit issued to DNR pursuant to Section 10(a) of the ESA to authorize any incidental take of listed species which may result from otherwise lawful DNR-management activities on PERMIT LANDS, which are conducted in accordance with the HCP and this Agreement.

12.4 The term "PERMIT LANDS" shall mean the lands covered by the ITP and HCP, as referred to in section 15.1 of this Agreement.

12.5 The term "HCP" shall mean the Habitat Conservation Plan prepared by DNR, and as amended.

12.6 The term "SPECIES ADDRESSED IN THE HCP" includes all species currently listed as threatened or endangered that may use the types of habitat found on the PERMIT LANDS, and all species hereafter listed as threatened or endangered that may use the types of habitat found within the five Westside Planning Units and the OESF. These species include species listed under the ESA or afforded similar status or protection by federal law or regulation applicable to or affecting the PERMIT LANDS during the term of the HCP.

12.7 The term "DAYS" shall mean calendar days.

12.8 The term "COMPLIANCE" shall mean substantial compliance with the commitments of the HCP, ITP, and this Agreement.

12.9 The terms "DEMONSTRATES" and "DEMONSTRATING" shall mean to establish the existence of a condition or development by use of the best scientific and/or commercial data available.

12.10 The term "PEER REVIEWED" shall mean that consistent with section B(1) of the Interagency Cooperative Policy for Peer Review in Endangered Species Activities (59 Fed. Reg. 34,270), the SERVICES will provide for peer review of the scientific data on which the agencies base any finding requiring peer review in this Agreement to ensure that any such findings are based on the best scientific and commercial data available. The SERVICES will request peer review so that the reviews will be completed within seventy-five (75) DAYS of DNR's request. In the event peer review of such data is not available in time to enable the SERVICES to meet their obligations established by statute, regulation, or this Agreement, the required finding or decision based on such data will be effective, but will be reconsidered by the SERVICES as soon as that information becomes available.

13.0 Incorporation by Reference. The HCP is intended to be, and by this reference is, incorporated herein.

14.0 Responsibilities of the PARTIES. The PARTIES agree to be bound by and to the commitments of the HCP, the ITP, and this Agreement, subject to amendment, renewal, or termination as provided herein.

15.0 PERMIT LANDS.

15.1 <u>PERMIT LANDS Description.</u> Contained in Map I.1 of the HCP, and incorporated herein by reference, are Geographic Information Systems (GIS) data describing the PERMIT LANDS subject to the HCP, the ITP, and this Agreement. Said lands are referred to in the HCP, the ITP, and this Agreement variously as the "DNR-managed lands in the area covered by the HCP," "PERMIT LANDS," the "DNR forest lands," the "DNR-managed lands," the "lands within the planning units," and other similar terms. All such terms, unless otherwise indicated, used in the HCP, the ITP, or this Agreement refer to those lands identified in Map I.1 of the HCP as "DNR-managed HCP lands."

15.2 Natural Area Preserves and Natural Resource Conservation Areas. DNR manages approximately 45,000 acres of Natural Area Preserves ("NAPs") and Natural Resource Conservation Areas ("NRCAs") that lie within the range of the Owl. Approximately 14,765 acres of these lands have been designated as important for achieving the commitments of the HCP. It is expected that the designated lands will continue to provide this habitat in the future and this habitat will count as mitigation so long as such habitat remains present. DNR will notify the SERVICES if the designated lands, or a portion thereof, will no longer be managed consistent with the commitments of the HCP. While not subject to the commitments of the HCP or this Agreement, so long as they are managed consistent with the commitments of the HCP, the SERVICES will give DNR credit for the habitat provided by the designated lands in terms of meeting the commitments assigned to DNR in the HCP, the ITP, and this Agreement. Whether the designated lands continue to provide this habitat, and the mitigation if they do not, will be considered by the SERVICES at the time the SERVICES are notified by DNR that the designated lands will no longer be managed consistent with the commitments of the HCP. Take incidental to DNR-management activities on the designated lands is authorized by the ITP so long as such take is in COMPLIANCE with the HCP, the ITP, and this Agreement.

16.0 Forest Product Sales and Other Management Activities Other Than Land Sales, Purchases, and Exchanges.

16.1 Management Activities Subject to this Agreement. DNR has an active management program for its PERMIT LANDS, including but not limited to forest practices, forest product sales, other valuable material sales, licenses, permits, leases, rights-of-way, and public uses. So long as the SERVICES have not suspended or revoked the ITP under section 26.0 of this Agreement or DNR has not terminated the ITP under section 27.0, the ITP will authorize any incidental take otherwise prohibited by the ESA which may result from otherwise lawful DNR-management activities that are conducted in accordance with the HCP and this Agreement.

16.2 Management Activities in Progress or Under Way.

a. Timber Sales. DNR will incorporate the relevant commitments of the HCP into all timber sales sold on or after January 1, 1999. DNR may, but is not required to, incorporate the commitments of the HCP into timber sales sold prior to January 1, 1999.

b. Nontimber Resource Activities. Excepting designations and leases under subsection 25.3.a(2) of this Agreement, DNR will incorporate the relevant commitments of the HCP into all nontimber resource transactional documents pertaining to PERMIT LANDS including, but not limited to, leases, licenses, permits, contracts, and sales, executed on or after January 1, 1999. DNR may, but is not required to, incorporate the commitments of the HCP into nontimber resource transactional documents pertaining to PERMIT LANDS including, but not limited to, leases, licenses, permits, contracts, and sales, executed prior to January 1, 1999. As leases, licenses, contracts, and permits of PERMIT LANDS are renewed, DNR shall alter such leases, licenses, contracts, and permits, to the extent permitted by law, to ensure compatibility with the commitments of the HCP. The level of nontimber resource activity and associated take, if any, of SPECIES ADDRESSED IN THE HCP will be reviewed annually in conjunction with the annual meeting under subsection 17.2 of this Agreement. The annual review meetings will be used by the PARTIES to ensure that any expansion in the level of DNR's nontimber resource activities, as described in

Chapter IV of the HCP, that occur on PERMIT LANDS do not result in increased incidental take of SPECIES ADDRESSED IN THE HCP. If increased incidental take will result, DNR will initiate the amendment process under subsection 25.3(b)-(c) of this Agreement. At the annual meeting, DNR will provide the SERVICES with the results of the nontimber resource monitoring efforts as described in the HCP.

16.3 Severability. Management activities on DNR lands are often accomplished through an agent, lessee, licensee, contractor, permittee, right-of-way grantee, or purchaser. Take incidental to otherwise lawful activities of these entities is authorized by the ITP so long as such take is authorized by DNR and is in COMPLIANCE with the HCP, the ITP, and this Agreement. A violation of the ITP by an agent, lessee, licensee, contractor, permittee, right-of-way grantee, or purchaser, which was not authorized by DNR, shall not result in the suspension, revocation, or termination of the ITP, nor shall it affect other benefits, rights, or privileges under the ITP, except as to that agent, lessee, licensee, contractor, permittee, right-of-way grantee, or purchaser.

17.0 Land Transfers, Purchases, Sales, and Exchanges. DNR has an active program of land acquisition and disposition, including but not limited to land transfers, sales, purchases, and exchanges. This program includes intergrant transactions. The HCP provides for continuation of this program.

17.1 Conservation Objectives of the HCP. The HCP and this Agreement recognize that it is necessary for DNR to continue to pursue an active land disposition program. In carrying out such an active land disposition program, DNR commits to maintaining the conservation objectives described in Chapter IV of the HCP in the course of its land disposition program. DNR may dispose of PERMIT LANDS, including PERMIT LANDS within any Watershed Administrative Unit ("WAU"), or any quarter-township in eastern Washington, even though such a disposition is not in accord with the habitat goals for a particular WAU, or quarter-township, so long as the conservation objectives described in Chapter IV of the HCP are maintained. Annual and other meetings held under section 17.2 will address whether disposition of PERMIT LANDS would have a significant adverse effect on the conservation objectives described in Chapter IV of the HCP.

17.2 Notification and Annual Review of Land Transactions. The PARTIES will hold annual meetings in December of each year, unless otherwise mutually agreed upon by the PARTIES, to review proposed and completed land transactions involving PERMIT LANDS. At such meetings, DNR will notify the SERVICES in writing of any known proposed land transfers, purchases, sales, or exchanges expected to occur within the upcoming year involving PERMIT LANDS. A follow up meeting will be held within sixty (60) DAYS after the annual meeting, if needed. Additional meetings may be convened on a more frequent basis or incorporated into the scheduled comprehensive reviews contemplated under section 21.0 with the mutual consent of the PARTIES. DNR will mail to the SERVICES preliminary transactional documents at the time such documents are mailed to the BOARD for all land transactions involving PERMIT LANDS that were not discussed during the annual meetings. DNR will also mail the closing documents to the SERVICES within thirty (30) DAYS of closing for all transactions involving PERMIT LANDS. Neither SERVICE, however, shall have the power to veto any land transaction. DNR will amend annually, or more frequently if it desires, the HCP pursuant to section 25.3 of this Agreement to reflect lands added to or removed from the PERMIT LANDS. In no event will DNR conduct management activities that will result in take on lands that will be added to the ITP prior to amendment of the HCP.

17.3 Land Acquisition by Transfer, Purchase, or Exchange. The PARTIES shall, upon request by DNR, add lands acquired by transfer, purchase, or exchange within the range of the Owl to the HCP, ITP, and this Agreement. DNR will incorporate the relevant commitments of the HCP into the management of these new PERMIT LANDS. No additional mitigation will be required unless the management of these new PERMIT LANDS increases take beyond the level authorized in the ITP. If the management of these new PERMIT LANDS increases take beyond the level authorized in the ITP, then any additional mitigation will be determined through amendment of the HCP based on mutual agreement among the PARTIES. DNR, at its sole discretion, may at any time add acquired lands to the WAU or quarter-township base referred to in Chapter IV of the HCP, but is not required to do so. So long as land DNR seeks to add to the HCP in accordance with this paragraph does not increase the level of take, it shall be the subject of a minor amendment to the HCP pursuant to section 25.3 and shall thereafter be PERMIT LANDS.

17.4 Land Disposition by Transfer, Sale, or Exchange. DNR, at its sole discretion, may voluntarily dispose of PERMIT LANDS by transfer, sale, or exchange. DNR, at its sole discretion, may require that the recipient of the disposed land commit to managing the disposed land in accordance with the HCP and this Agreement. DNR is not required by the HCP, the ITP, or this Agreement to require continuation of the commitments of the HCP or this Agreement on the disposed land. If DNR sells or exchanges DNR-managed lands, NAPs, or NRCAs, and the acquiring entity commits in writing to the SERVICES that the lands disposed by DNR will be managed in a manner which maintains the commitments of the HCP, DNR will continue to be given credit for such lands for the purpose of determining whether DNR is in COMPLIANCE with the HCP, the ITP, and this Agreement. If land disposed of by DNR does not remain subject to the provisions of the HCP, and the cumulative impact of the land disposition would have a significant adverse effect on the affected species, the PARTIES, based on the best scientific and commercial data available at the time, shall amend the HCP, this Agreement, and the ITP to provide replacement mitigation for the affected species pursuant to the standards and processes outlined in the extraordinary circumstances provisions of section 24 herein.

17.5 Federal Condemnation. In the event of condemnation of DNR-managed lands, NAPs, or NRCAs by the federal government, the PARTIES shall not be required to replace mitigation lost due to condemnation. The PARTIES' obligations relating to the condemned lands under the HCP and this Agreement shall be terminated.

17.6 Rights and Authorities Preserved. Except as otherwise specifically provided in this Agreement, nothing herein contained shall be deemed to restrict the rights, privileges, and powers of the State of Washington or DNR to manage the use of, or exercise all of the rights incident to, land ownership associated with the PERMIT LANDS. Nothing herein contained shall be interpreted to restrict the authority of the SERVICES to administer the ITP with respect to the PERMIT LANDS in accordance with this Agreement and the ESA.

18.0 **Funding.** DNR shall submit to the Washington State Legislature, on at least a biennial basis, an agency operating and capital budget for asset management that will be adequate to fulfill DNR's obligations under the HCP, ITP, and this Agreement. Failure by DNR to ensure adequate funding is provided to implement the HCP shall be grounds for suspension or partial suspension of the ITP.

The SERVICES shall include in their annual budget requests sufficient funds to fulfill their respective obligations under the HCP, ITP, and this Agreement.

19.0 Duration.

19.1 Term of PERMIT. The HCP, ITP, and this Agreement shall remain in full force and effect for a period of seventy (70) years from the effective date, or until revocation under section 26.0 or termination under section 27.0 of this Agreement, whichever occurs sooner. Amendments to the HCP, the ITP, or this Agreement shall be in full force and remain in effect for the then remaining term of this Agreement or until revocation under section 26.0 or termination under section 27.0 of this Agreement, whichever occurs sooner.

19.2 PERMIT Renewal. Unless revoked under section 26.0 or terminated under section 27.0 of this Agreement, DNR may renew the PERMIT, HCP, and this Agreement on the existing terms or other mutually agreeable terms three (3) times for a period of up to ten (10) years per renewal, provided:

(a) DNR is in COMPLIANCE with the HCP and this Agreement;

(b) the PARTIES have met approximately three (3) years prior to the scheduled PERMIT or renewal period expiration date to discuss the renewal of the PERMIT, HCP, and this Agreement, and DNR provides the SERVICES with at least eighteen (18) months notice of its intent to renew the PERMIT;

(c) DNR finds that renewal of the PERMIT, HCP, and this Agreement would be in the best interest of each of the trusts; and

(d) the sum of the original PERMIT term and any continuation or renewal periods does not exceed one hundred (100) years.

19.3 PERMIT Continuation. Unless revoked under section 26.0 or terminated under section 27.0 of this Agreement, the SERVICES may require DNR to continue implementing the HCP, PERMIT, and this Agreement for up to three (3) periods of up to ten (10) years apiece, provided that:

(a) at the end of the original PERMIT term or the continuation periods under this subsection, the SERVICES DEMONSTRATE that DNR has failed to achieve its commitments under the HCP as described in Chapter IV of the HCP;

(b) the PARTIES have met approximately three (3) years prior to the scheduled expiration date to discuss the potential for continuation or renewal of the HCP, PERMIT, and this Agreement, and the SERVICES provide DNR with at least eighteen (18) months notice of their intent to require continuation of the HCP, PERMIT, and this Agreement; and

(c) the sum of the original PERMIT term and any continuation or renewal periods does not exceed one hundred (100) years.

20.0 Reporting and Inspections. DNR will provide the SERVICES with two (2) copies of each report described in Chapter V of the HCP, at the addresses designated by the SERVICES, and any readily available existing information requested by either SERVICE to verify the information contained in such reports. Either SERVICE may inspect PERMIT LANDS in accordance with its then applicable regulations. Except as provided in its regulations, the inspecting SERVICE will notify DNR thirty (30) DAYS prior to the date they intend to make such inspections and allow DNR representatives to accompany SERVICE personnel when making inspections. To assist DNR in meeting its obligations under this Agreement, the SERVICE will brief DNR in writing on the factual information learned during any inspection within thirty (30) DAYS of such inspection, except as provided in its regulations.

21.0 Comprehensive Reviews. The PARTIES to this Agreement will conduct periodic reviews of the HCP, the ITP, and this Agreement, consulting with one another in good faith to identify any amendments that might more effectively and economically mitigate any incidental take. The PARTIES shall conduct comprehensive reviews within one month of the first, fifth, and tenth, anniversaries of the effective date and every tenth anniversary thereafter for the full term that this Agreement is in effect. Upon mutual agreement of all the PARTIES, additional reviews may be scheduled at any time.

22.0 Adequacy and Certainty.

22.1 Assurances. The HCP provides habitat conservation for all SPECIES ADDRESSED IN THE HCP, while providing regulatory relief, certainty, flexibility, and stability for DNR. Specifically, the conservation strategies afforded all habitat types, and the species specific measures of the HCP and this Agreement, adequately provide for all SPECIES ADDRESSED IN THE HCP and contain measurable criteria for the biological success of the HCP. Unless the SERVICES have suspended or revoked the ITP under section 26.0 of this Agreement or have not added a newly listed species to the PERMIT under subsection 25.1(b) of this Agreement, DNR is assured by this Agreement that any incidental taking of a SPECIES ADDRESSED IN THE HCP in the course of its otherwise lawful management activities will be authorized under the ESA. The SERVICES are assured by this Agreement that the incidental taking authorized by the ITP is consistent with the conservation of the species under the ESA.

22.2 Findings by the SERVICES. Based upon the best scientific and commercial data available and after careful consideration of all comments received, the SERVICES have found that with respect to all SPECIES ADDRESSED IN THE HCP:

(a) that any take on PERMIT LANDS under the HCP will be incidental;

(b) the impacts of any incidental take under the HCP will, to the maximum extent practicable, be minimized and mitigated;

(c) that DNR will ensure that adequate funding for the HCP will be provided in accordance with this Agreement and the HCP;

(d) that any taking of a SPECIES ADDRESSED IN THE HCP will not appreciably reduce the likelihood of the survival and recovery of such species in the wild; and

(e) that other measures and assurances required by the SERVICES as being necessary or appropriate for the purposes of the HCP are met.

23.0 Unforeseen Circumstances.

23.1 Unforeseen Circumstances Consultation. In the event of unforeseen circumstances arising in connection with the HCP, the ITP, or this Agreement, the appropriate SERVICE may request consultation with DNR regarding those circumstances and may suggest modifications to the commitments of the HCP, the ITP, or this Agreement. DNR shall consult with the SERVICE to explore whether there is a mutually acceptable means for adjusting the commitments of the HCP, the ITP, and this Agreement that maintains the interests of all PARTIES. If the cost of a mutually acceptable adjustment would be significant to DNR, then the PARTIES must strive to find further or different voluntary adjustments that would avoid or minimize the cost to DNR. The SERVICES shall not seek from DNR without its consent a commitment of additional land or financial undertaking beyond the level of mitigation which is provided under the commitments of the HCP, the ITP, and this Agreement.

23.2 Findings of Unforeseen Circumstances. The SERVICES shall have the burden of DEMONSTRATING that unforeseen circumstances have arisen. If DNR, after consultation and in its sole discretion, does not agree voluntarily to implement the requested changes, then the SERVICE must look to section 24.0 regarding extraordinary circumstances if it wishes to continue to pursue changes, and must satisfy the provisions of section 24.0 regarding such desired changes. The SERVICES agree that so long as DNR is in COMPLIANCE with its commitments under the HCP, ITP, and this Agreement, they will not impose on DNR any nonconsensual additional land-use restrictions, financial obligations, or any other form of additional mitigation for any SPECIES ADDRESSED IN THE HCP except under extraordinary circumstances as addressed in section 24.0.

24.0 Extraordinary Circumstances.

24.1 Extraordinary Circumstances Defined. Additional mitigation requirements shall not be imposed upon DNR without its consent provided DNR is in COMPLIANCE with the HCP, the ITP, and this Agreement, and the HCP is properly functioning, except under extraordinary circumstances. Extraordinary circumstances shall mean that continued DNR-management activities in accordance with the HCP, the ITP, and this Agreement would result in a substantial and material adverse change in the status of a species that was not foreseen on the effective date of this Agreement which can be remedied by additional or different mitigation measures on the PERMIT LANDS. The SERVICES shall have the burden of DEMONSTRATING that extraordinary circumstances exist.

24.2 Findings of Extraordinary Circumstances. Findings of extraordinary circumstances must be clearly documented in writing and based upon reliable, PEER REVIEWED technical information regarding the status and habitat requirements of the affected species. Furthermore, in deciding whether any extraordinary circumstances exist with respect to a particular SPECIES ADDRESSED IN THE HCP, which might warrant additional mitigation, the SERVICES shall consider, but not be limited to the following factors:

(a) the size of the current range of the affected species;

(b) the percentage of range adversely affected by the HCP;

(c) the percentage of range conserved by the HCP;

(d) the ecological significance of that portion of the range affected by the HCP;

(e) the level of knowledge about the affected species and the degree of specificity of the species conservation program under the HCP;

(f) whether the HCP was originally designed to provide an overall net benefit to the affected species and contained measurable criteria for assessing the biological success of the HCP; and

(g) whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the particular species in the wild.

Upon a finding of extraordinary circumstances, the SERVICES will have ninety (90) days to determine any additional mitigation necessary, during which time DNR will use its best efforts to avoid a substantial and material adverse change in the status of the affected species. If the SERVICES are unable to achieve appropriate additional mitigation, the SERVICES shall work with DNR to find the least disruptive method of continuing DNR-management activities.

24.3 Effect of Additional Mitigation Measures on the HCP. Any additional mitigation measures approved under this section shall change the original terms of the HCP only to the minimum extent necessary and shall be limited to modifications on the PERMIT LANDS, and any additional mitigation requirements under this Agreement shall not involve additional financial commitments by DNR or land use restrictions on DNR without its express written consent. The SERVICES may seek additional funding for mitigation from other sources.

24.4 SERVICES Free to Take Independent Action. Nothing in this Agreement shall be construed to limit or constrain either SERVICE from carrying out lawful additional mitigation actions at their own cost with respect to the protection of any listed species, or endeavoring to provide mitigation by means of other resources or financial assistance to DNR to the fullest extent possible in accordance with law and available appropriations.

24.5 **Adaptive Management.** Adaptive management provides for ongoing modifications of management practices to respond to new information and scientific developments. The monitoring and research provisions of the HCP are in part designed to identify modifications to existing management practices. The following adaptive management practices shall be implemented by DNR as reasonably necessary to respond to the following changes of circumstances and are not subject to subsections 23.1, 23.2, 24.1, 24.2, and 24.3:

(a) the best available scientific and commercial data indicate that an increase in the percentage of ground cover of dead and down wood is required for the support of the Owl in the definition of sub-mature habitat in Chapter IV section A of the HCP, provided DNR's responsibility shall be limited to 15 percent ground cover averaged over a stand;

(b) the best available scientific and commercial data indicate that the model used to delineate mass wasting on a site-specific basis under Chapter IV section D of the HCP can be reasonably improved to increase its accuracy;

(c) the best available scientific and commercial data indicate that the landscape-based road network management process described in Chapter IV section D of the HCP can be reasonably and practically improved, considering both the costs and benefits of implementing the improvement;

(d) the necessity for continued provision of nest patches has changed as a result of conducting research to determine the biological feasibility of using silvicultural techniques to create spotted owl nesting habitat;

(e) with specific reference to the marbled murrelet, the habitat definitions will be refined for each planning unit as a result of DNR's habitat relationships study;

(f) with specific reference to the marbled murrelet, the interim conservation strategy will be replaced with a long-term management plan upon completion of the inventory survey phase;

(g) management activities allowed within the riparian management zones will be refined within the first decade of the HCP;

(h) wind buffer management is refined as this priority research item is addressed;

(i) a long-term conservation strategy for forest management along Type 5 Waters is developed and incorporated into the HCP at the end of the first ten years of the HCP; and

(j) prescriptions resulting from a completed watershed analysis call for additional measures than those specified in the HCP.

All other adaptive management strategies are subject to subsections 23.1, 23.2, 24.1, 24.2, 24.3, and 24.4.

25.0 Amendments and Modifications.

25.1 PERMIT Amendments and Modifications. The ITP may be amended or modified as follows:

a. General Amendments to the ITP. The ITP can be amended or modified in accordance with SERVICE regulations as provided in this Agreement. If the federal regulations that govern PERMIT amendment have been modified from those codified at 50 C.F.R §§ 13.23, 220.11, 222.25, and 222.26, as of the effective date of this Agreement, the modified regulations will apply only to the extent the modifications are required by subsequent enactment of the Congress or court order, or upon a determination by DNR that application of the modifications is in the best interests of the relevant trusts.

b. New Listings. The ITP for the Owl and other federally listed species that may currently use the types of habitats that occur on the PERMIT LANDS will be issued contemporaneously with the signing of this Agreement. In the future, the SERVICES shall add to the ITP, within sixty (60) DAYS of receipt by the appropriate SERVICE of a written request by DNR, each species that may use the types of habitats that occur within the five West Side Planning Units and the OESF that is listed as a threatened or endangered species during the term of this Agreement at the level of take requested by DNR and supported by the HCP without requiring additional mitigation, unless, within the specified sixty-day period, the SERVICE DEMONSTRATES that extraordinary circumstances under section 24.0 exist. If such extraordinary circumstances are found to exist, the SERVICE shall provide the appropriate additional mitigation or other amendments in a timely manner and amend the ITP to include the affected species if appropriated funds are available. If appropriated funds are not available, the SERVICES shall use all lawful means, including soliciting nongovernmental sources of funds and other alternative methods of mitigation or amendment, to endeavor to achieve the appropriate additional mitigation and amend the ITP to cover the particular species.

25.2 Amendments to the Agreement. This Agreement may be amended only with the written consent of each of the PARTIES.

25.3 HCP Amendments. The HCP may be amended as follows:

a. Minor HCP Amendments.

(1) The following types of minor amendments may be made to the HCP without notification, provided that the conservation objectives of the HCP are being maintained, there is no increase in the level of incidental take, and appropriate mitigation is provided. Amendments allowable under this subsection include the following:

(a) land acquisition and disposition as described in section 17.0, which provides for periodic notice and review of DNR land transactions involving PERMIT LANDS;

(b) corrections of typographic and grammatical errors and similar editing errors, which do not change the intended meaning of the HCP; and

(c) corrections to any maps, GIS data, or exhibits to reflect previously approved changes in the HCP or other new information.

(2) So long as appropriate mitigation is provided, the alteration of an HCP commitment or commitments, the formal designation of urban lands pursuant to state law, and the leasing of PERMIT LANDS for commercial, residential, or industrial purposes, or the implementation of one or more of the adaptive management strategies described in Chapter IV of the HCP or subsection 24.5 of this Agreement, that does not increase the level of take authorized by the ITP is a minor amendment effective sixty (60) DAYS after the SERVICES receive written notice

from DNR, unless the appropriate SERVICE responds in writing with specific concerns during the sixty-day notification period.

b. Major HCP Amendments. For other amendments of the HCP, including those amendments that would increase the level of take, proposed by DNR, DNR shall provide a written description of the proposed amendment, the effects of the proposal on the HCP, and any alternative ways in which the objectives of the proposal might be achieved. The proposed amendments shall become effective upon written approval by the appropriate SERVICE. The SERVICE shall approve or disapprove the proposed amendment within 180 DAYS after receipt of the DNR proposal.

c. HCP Amendments and the ITP. HCP amendments that will result in an increased level of incidental take will require amendment to the ITP under subsection 25.1.a of this Agreement. HCP amendments that do not increase the level of incidental take will not require amendment to the ITP under subsection 25.1.a of this Agreement so long as appropriate mitigation is provided.

26.0 ITP Suspension or Revocation. The SERVICES maintain the right to suspend or revoke the ITP in accordance with federal law and this Agreement. The SERVICES agree, however, that so long as DNR is in COMPLIANCE with the HCP, the ITP, and this Agreement, they will not suspend or revoke the ITP, or otherwise sanction DNR except to the extent that the sanction, suspension, or revocation of the ITP is required by applicable federal law or the terms of this Agreement. Any revocation of the ITP, in whole or in part, automatically terminates the relevant commitments of the HCP and this Agreement, and subjects activities no longer covered by the ITP to all applicable provisions of the ESA and SERVICE regulations relating to the taking of a listed species. If federal regulations should be modified from those codified at 50 C.F.R. §§ 13.26-13.29, and/or § 222.27, as of the effective date of this Agreement, the modified regulations will apply only to the extent the modifications are required by subsequent enactment of the Congress or court order, or upon a determination by DNR that application of the modifications is in the best interests of the relevant trusts.

27.0 Termination and Mitigation after Termination.

27.1 Generally. DNR reserves the right to terminate for any reason the HCP and this Agreement with thirty (30) DAYS written notice to the SERVICES. For listed species, the written termination notice shall contain a statement describing the species taken, the level of take, and the species mitigation provided prior to termination. DNR management activities not resulting in incidental take may continue after termination. Unlisted species are treated in subsection 27.5. The PARTIES agree that DNR may terminate the HCP and this Agreement in whole, or in part.

27.2 Effect of Termination. Subject to the provisions of this section and subsection 29.1 of this Agreement, any termination of the HCP and this Agreement, in whole or in part by DNR under section 27, automatically terminates the relevant commitments of the HCP, the ITP and this Agreement, except as otherwise provided in this section 27, and subjects activities no longer covered by the ITP to all applicable provisions of the ESA and SERVICE regulations relating to the taking of a listed species.

27.3 Mitigation After Termination for listed species. Subject to the provisions of subsection 29.1, if the HCP and this Agreement are terminated by DNR, in whole or in part, the appropriate SERVICE may require DNR to mitigate any incidental take of a listed species affected by the termination that occurred during the term of the HCP and this Agreement to the effective date of the termination. Such mitigation may require DNR to continue relevant mitigation measures of the HCP as to some or all of the PERMIT LANDS for some or all of the period which would have been covered by the HCP and this Agreement. The SERVICES shall not extend mitigation requirements to non-PERMIT LANDS, nor shall mitigation requirements be extended beyond the term of this Agreement. Mitigation requirements, if any, shall not exceed the difference between mitigation already provided under the HCP and that required by the HCP for listed species at the time of termination. Unlisted species are treated in subsection 27.5.

27.4 Delisting of a Species. In the event that a species is delisted under the ESA, the commitments of the HCP and this Agreement regarding such species shall be terminated. Mitigation measures designed primarily to benefit the delisted species need not be continued after delisting due to another species unless the appropriate SERVICE DEMONSTRATES that failure to continue those measures would not maintain the conservation objectives of the HCP for the other species, or DNR determines that continuation of such measures is in the best interest of the relevant trusts. The SERVICES shall have the burden of DEMONSTRATING that failure to continue the measures in question would not maintain the conservation objectives of the HCP for another species.

27.5 Unlisted Species. The PARTIES agree that DNR may terminate, in whole or in part, the commitments of the HCP and this Agreement regarding unlisted species upon seventy-five (75) DAYS written notice to the SERVICES. Termination of the commitments of the HCP with regard to an unlisted species relieves the SERVICES from their obligations under subsection 25.1.b to add the species to the ITP if it becomes listed.

Within said seventy-five (75) DAYS the SERVICES shall notify DNR in writing if they will require any mitigation as a result of such termination and, if so, the mitigation to be required. In order to require any mitigation after termination, the SERVICES shall DEMONSTRATE that termination would result in a substantial and material adverse change in the biological status of the affected species. Said DEMONSTRATION shall be based upon reliable, PEER REVIEWED technical information as to the species affected by the proposed termination.

To DEMONSTRATE whether the termination might warrant mitigation after termination and what mitigation might be required, the SERVICES shall consider, but not be limited to, the following factors:

(a) the size of the current range of the affected species;

(b) the percentage of range adversely affected by the termination of the HCP;

(c) the percentage of range conserved by the HCP;

(d) the ecological significance of that portion of the range affected and conserved by the HCP;

(e) the level of knowledge about the affected species and the mitigation provided to the species under the HCP; and

(f) whether the HCP was originally designed to provide an overall net benefit to the affected species.

During the said seventy-five (75) DAYS, DNR will use its best efforts to avoid a substantial and material adverse change in the status of the affected unlisted species. If the PARTIES are unable to agree on the necessity for or the amount of such mitigation, the SERVICES and DNR shall work to resolve any such dispute by using the interagency science team and non-binding mediation provisions under subsection 29.4 prior to final determination. The SERVICES shall not extend mitigation requirements to non-PERMIT LANDS, nor shall mitigation requirements be extended beyond the term of this Agreement. Requirements for such mitigation, if any, shall not exceed the difference between mitigation already provided under the HCP and that required by the HCP for unlisted species at the time of termination.

After the PARTIES mutually agree on a final determination of the potential mitigation to be provided after termination, if any, as to an unlisted species, DNR shall send final notice of such termination, or withdraw the notice of termination. Final notice of termination for an unlisted species shall be effective thirty (30) DAYS after written notice to the SERVICES.

28.0 Authority, Remedies and Enforcement. Each of the PARTIES to this Agreement shall have all remedies available in equity or at law to enforce the commitments of the HCP, the ITP, and this Agreement including specific performance. No PARTY shall be liable for damages to any other PARTY or person for any breach of this Agreement, any performance or failure to perform a mandatory or discretionary obligation imposed by this Agreement, or any other cause of action arising from this Agreement. The HCP, this Agreement, and the ITP shall be interpreted and administered in accordance with the ESA. Nothing contained in this Agreement is intended to unlawfully limit the authority or responsibility of the United States government or DNR to invoke penalties or otherwise fulfill their respective responsibilities as public agencies in accordance with law.

29.0 Informal Dispute Resolution Procedures.

29.1 Termination of the PERMIT. A SERVICE receiving a termination notice under section 27.0 of this Agreement shall notify DNR within sixty (60) DAYS after receipt of the notice if it disagrees with the statement of take or mitigation contained therein. Failure by a SERVICE to disagree with the statement of take or mitigation within sixty (60) DAYS shall constitute agreement with and approval of the statement. If the PARTIES cannot agree on the statement of take, or on necessary mitigation, if any, within sixty (60) DAYS after receiving the notice of disagreement, the PARTIES shall endeavor in good faith to resolve their disagreement through nonbinding mediation.

29.2 In the Event of a Possible Violation. If either SERVICE has reason to believe that DNR may have violated the commitments of the HCP, the ITP, or this Agreement, written notice must be provided to DNR regarding the specific provisions which may have been violated and the mitigation that the responsible federal agency proposes to correct the alleged violation. DNR will have sixty (60) DAYS from the date of receipt of notice, or such longer period of time as may be mutually agreed upon, to respond. If the PARTIES cannot agree on the violation or necessary mitigation within thirty (30) DAYS after receiving DNR's response, the PARTIES shall endeavor in good faith to resolve their disagreement through nonbinding mediation.

29.3 Minor HCP Amendments Under Subsection 25.3.a(2). In the event that DNR receives timely notice from the appropriate SERVICE regarding a proposed minor HCP amendment under subsection 25.3.a(2), the proposed minor amendment shall not be effective and the PARTIES shall have thirty (30) DAYS from DNR's receipt of the notice within which to reach mutual agreement through discussion. DNR may convene an interagency science team to provide technical assistance on the disputed issue. If the issue is not resolved within the thirty (30) DAY time period, the PARTIES shall endeavor in good faith to resolve their disagreement through nonbinding mediation, unless an extension is mutually agreed upon by all PARTIES.

29.4 Scheduled Reviews. In the event that a dispute arises at one of the scheduled reviews under section 17.0 of this Agreement, the PARTIES shall have thirty (30) DAYS from receipt of the notice of disagreement to reach mutual agreement through discussion. DNR may convene an interagency science team to provide technical assistance on the disputed issue. If the issue is not resolved within the thirty (30) DAY time period, the PARTIES shall endeavor in good faith to resolve their disagreement through nonbinding mediation, unless an extension is mutually agreed upon by all PARTIES. For land transactions not discussed at the scheduled reviews referenced above, the PARTIES shall endeavor to reach mutual agreement through discussion; the convening of an interagency science team by DNR or other dispute resolution procedures described above will not occur until a scheduled review, absent mutual consent of the PARTIES.

29.5 Other Disputes. In the event of other significant disputes involving the HCP, the ITP, or this Agreement, any PARTY shall provide the other PARTIES with a written notice of disagreement. Within thirty (30) DAYS of receiving the notice of disagreement, the PARTIES shall endeavor in good faith to resolve the dispute through nonbinding mediation.

29.6 Termination of Mediation. Nothing in this Agreement shall prevent any PARTY from terminating nonbinding mediation at any time and seeking any remedy or enforcement procedure available by law or regulation.

30.0 General Provisions.

30.1 No Partnership. Except as otherwise expressly set forth herein, neither the commitments of the HCP, the ITP, nor this Agreement shall make or be deemed to make any PARTY to this Agreement the agent for or the partner of any other PARTY.

30.2 Not a Covenant Running With the Land. Neither the HCP, ITP, or this Agreement shall be construed to establish a covenant that runs with the land.

30.3 Severability. If any of the commitments of the HCP, the ITP, or this Agreement are found to be invalid or unenforceable, or this Agreement is terminated in part, all other commitments shall remain in effect to the extent they can be reasonably applied in the absence of such invalid, unenforceable, or terminated commitment or commitments.

30.4 Congressional Officials Not to Benefit. No member of or delegate to Congress shall be entitled to any share or part of this Agreement, or to any benefit that may arise from it.

30.5 Availability of Funds. Implementation and ongoing adherence to the HCP and this Agreement by all PARTIES shall be subject to the availability of appropriated funds. Failure by DNR to ensure adequate funding to implement the HCP shall be grounds for suspension or partial suspension of the ITP.

30.6 No Third Party Contract Beneficiaries. The commitments of the HCP, the ITP, and this Agreement are not intended to create, and do not create, any third-party beneficiary interest herein in the public or in any member thereof, nor shall it authorize anyone not a PARTY to this Agreement to maintain a suit based in whole or in part on any provision of this Agreement, the HCP, or ITP. The rights of the public under the ESA are set forth in 16 U.S.C. §1540(g) and nothing in this Agreement expands or otherwise alters the rights of citizens thereunder.

30.7 Counterparts. This Agreement may be executed in counterparts with each copy constituting an original. A complete original of this Agreement shall be maintained in the official records of each of the PARTIES hereto.

30.8 Entire Agreement. This Agreement supersedes any and all other agreements, either oral or in writing, among the PARTIES hereto with respect to the subject matter hereof, and contains all of the covenants and agreements among them with respect to said matters except for The 1979 Cooperative Agreement for Endangered Plants and The Agreement for Establishment and Operation of the Washington Cooperative Fish and Wildlife Research Unit. Further, each PARTY to this Agreement acknowledges that no representation, inducement, promise, or agreement has been made by another PARTY or anyone acting on behalf of another PARTY that is not embodied herein.

30.9 Contents Not Binding in Other Litigation. The contents of the HCP, ITP, and this Agreement shall not be construed as statements against interest or admissions and are not binding in litigation except in matters related to enforcement by the PARTIES of the HCP, ITP, and this Agreement. In addition, DNR reserves the right to assert that its activities do not require an ITP.

31.0 Notices. The names, addresses, and telephone and facsimile numbers of the designated representatives may be changed at any time by written notice to the other PARTIES. Notices under this Agreement will be deemed received when delivered personally, on electronic confirmation that a facsimile message has been received at the "FAX" number most recently provided by the recipient representative, or five (5) DAYS after deposit in the United States mail, certified and postage prepaid, return receipt requested and addressed as above.

32.0 Designated Representatives. Each PARTY to this Agreement will designate a representative through whom notices under this Agreement shall originate and to whom notices under this Agreement shall be directed. The initial designated representatives are:

for DNR: Department of Natural Resources Administrator
Washington State Department of Natural Resources
1111 Washington Street S.E.
P.O. Box 47000
Olympia, Washington 98504-7000
Telephone: (360) 902-1000
FAX: (360) 902-1796

for USFWS: Assistant Regional Director
United States Fish and Wildlife Service
911 N.E. 11th Avenue
Portland, Oregon 97232-4181
Telephone: (503) 231-6159
FAX: (503) 872-2771

for NMFS: Regional Administrator
National Marine Fisheries Service
7600 Sand Point Way N.E.
Seattle, Washington 98115-0070
Telephone: (206) 526-6150
FAX: (206) 526-6426

IN WITNESS WHEREOF, THE PARTIES HERETO have executed this Implementation Agreement to be in effect as of the date last signed below.

WASHINGTON DEPARTMENT OF NATURAL RESOURCES
including THE BOARD OF NATURAL RESOURCES

Date 1/30/97

JENNIFER M. BELCHER
Commissioner of Public Lands

Approved as to form this 30th day of January, 1997,

Paul A. Silver, Senior Assistant Attorney General

UNITED STATES DEPARTMENT OF THE INTERIOR
through the U.S. FISH AND WILDLIFE SERVICE

Date 1/30/97

MICHAEL J. SPEAR
Regional Director

UNITED STATES DEPARTMENT OF COMMERCE
through the NATIONAL MARINE FISHERIES SERVICE

Date 1/30/97

WILLIAM W. STELLE, Jr.
Regional Administrator

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Glossary

Glossary

Active channel - Defined by DNR as the stream area occupied by typical flood events (i.e., comparable to the two-year recurring flood). The active channel generally coincides with the ordinary high-water mark.

Age class - An interval, commonly 10 years, into which the age range of forest stands is divided for classification.

Anadromous fish - Those species of fish that mature in the ocean and migrate to freshwater rivers and streams to spawn; an example is salmon.

Aquatic zone - The location of aquatic ecosystems within the riparian ecosystem, as defined in the HCP.

Blowdown - Trees felled by high wind.

Board of Natural Resources - A Washington State board that establishes policies for the Department of Natural Resources to ensure that the acquisition, management, and disposition of lands and resources within DNR's jurisdiction are based on sound principles. The board is composed of six members: The Commissioner of Public Lands, the Governor, the Superintendent of Public Instruction, the dean of the College of Agriculture at Washington State University, the dean of the College of Forest Resources at the University of Washington, and an elected representative from a county that contains Forest Board land.

Bog - A hydrologically isolated, low nutrient wetland that receives its water from precipitation only. Bogs typically have no inflow and rarely have outflows. Bogs have peat soils 16 or more inches in depth (except where over bedrock), and 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.

Buffer - A forested strip left during timber harvest to conserve sensitive ecosystems or wildlife habitat. Management activities may be allowed as long as they are consistent with the conservation objectives for the buffer.

Candidate species - A federal and state designation for species that are being considered for listing. Federal candidate species, category 1, are species for which there is substantial information to support listing the species as threatened or endangered; listing proposals are either being prepared or are delayed. Federal candidate species, category 2, are species for which information indicates that listing may be appropriate, but conclusive data are not available; additional information is being collected. State candidate species are those that the Washington Department of Fish and Wildlife will review for possible listing as endangered, threatened, or sensitive. Federal candidate species are examined individually to determine their status in Washington and whether inclusion as a listed species is appropriate or warranted.

Canopy - The continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth. See also "Understory canopy" and "Overstory canopy."

Canopy closure - The degree to which the canopy (forest layers above one's head) blocks sunlight or obscures the sky. See also "Relative density."

Clearcut - A harvest method in which all or almost all of the trees are removed in one cutting; an even-aged silvicultural system. Clearcutting establishes a stand without protection from an overstory canopy.

Climax - The culminating, highly stable stage in plant succession for a given environment; an ecosystem will stay at the climax stage until disturbance affects the ecosystem and the stages of ecological succession begin again.

Cluster - An area that contains habitat capable of supporting three or more breeding pairs of spotted owls with overlapping or nearly overlapping home ranges.

Coarse woody debris - See "Large woody debris."

Code of Federal Regulations (CFR) - A codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the federal government.

Commercial thinning - The removal of generally merchantable trees from an even-aged stand, so that the remaining trees can develop faster and with less competition.

Critical habitat, federal - Areas designated under the federal Endangered Species Act that have the physical and biological features necessary for the conservation of a listed species and that require special management.

Critical habitat, state - Habitats of threatened or endangered species as designated by the Washington Forest Practices Board.

Debris avalanches - The very rapid and usually sudden sliding and flowage of loose, unsorted mixtures of soil and weathered bedrock.

Debris flow - A moving mass of rock fragments, soil, and mud, more than half the particles being larger than sand size; can travel many miles down steep confined mountain channels; a form of debris torrent.

Debris torrent - Debris flow or dam-break flood. Rapid movement of a large quantity of materials, including wood and sediment, down a stream channel. Usually occurs in smaller streams during storms or floods, and scours the stream bed.

Demographic support - The reproductive contributions of individuals which enhance population viability.

Diameter at breast height (dbh) - The diameter of a tree, measured 4.5 feet above the ground on the uphill side of the tree.

Direct influence zone - The area in uplands, bordering the riparian zone, that has a direct influence on aquatic ecosystems. Direct influences include shading, sedimentation, input of organic nutrients, and recruitment of large woody debris.

Dispersal - The movement of juvenile, subadult, and adult animals from one sub-population to another. For juvenile spotted owls, dispersal is the process of leaving the natal territory to establish a new territory.

Dispersal habitat, spotted owls (east-side planning units) - In DNR's HCP, dispersal habitat has the following characteristics: (1) canopy closure of at least 50 percent; (2) overstory tree density of at least 40 trees per acre that are at least 11 inches dbh; (3) top height of at least 60 feet; (4) retention of four green trees per acre from the largest size class present for recruitment of snags and cavity trees; and, (5) at least 50 percent of DNR-managed lands designated for dispersal function on a quarter township basis will be maintained in these stand conditions.

Dispersal habitat, spotted owls (west-side planning units) - Habitat used by juvenile owls or by owls of any age to disperse or move from one area of nesting-roosting-foraging habitat to another. In DNR's HCP, dispersal habitat will be maintained on 50 percent of lands selected for a dispersal habitat role. The 50 percent will be measured on a WAU basis. In the HCP, dispersal habitat has the following minimum characteristics: (1) canopy cover of at least 70 percent; (2) the largest trees in a stand should have a quadratic mean dbh of 11 inches; (3) a top canopy height of at least 85 feet (top height is the average height of the 40 largest diameter trees per acre); and, (4) green tree retention of at least four trees from the largest size class per acre. Type A, Type B, and sub-mature habitat can be counted as dispersal habitat.

Down woody debris - See "Large woody debris."

Draft Environmental Impact Statement (DEIS) - A public document prepared pursuant to the State or National Environmental Policy Acts (SEPA or NEPA).

Earthflow - A mass-movement landform and process characterized by downslope translation of soil and weathered rock over a discrete basal shear surface (landslide) within well defined lateral boundaries.

Edge - Where plant communities meet or where successional stages or vegetative conditions with plant communities come together.

Edge effects - The drastically modified environmental conditions along the margins, or "edges," of forest patches surrounded by partially or entirely harvested lands.

Effectiveness monitoring - Monitoring done to determine whether the HCP conservation strategies result in the anticipated habitat conditions.

Enabling Act - The Congressional Enabling Act of 1889, which authorized statehood for Washington. The act provided the state with Federal Grant lands to be held in trust for the support of the state's public institutions and placed limits on the sale, lease and management of these lands.

Endangered species - A federal and state designation. A species determined to be in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act - The federal Endangered Species Act of 1973, as amended, sets up processes by which plant or animal species can be designated as threatened or endangered. Two federal agencies, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, administer the act. Once species are listed, the act also provides that these agencies develop recovery plans for these species, including conserving the ecosystems on which listed species depend.

Environmental impact statement (EIS) - A document prepared under the National and/or State Environmental Policy Acts to assess the effects that a particular action will have on the environment.

Evapotranspiration - The conversion of water, whether open or as soil moisture (both by evaporation) or within plants (by transpiration), into water vapor that is released to the atmosphere.

Even-aged - A system of forest management in which stands are produced or maintained with relatively minor differences in age; generally, less than a 10-year difference in age.

Evolutionarily Significant Units - A population that is substantially reproductively isolated from other population units of the same species, and represents an important component in the evolutionary legacy of the species.

Exterior riparian buffer - A buffer whose purpose is to protect the integrity of the interior-core buffer; part of the OESF riparian strategy. See also "Buffer."

Extirpation - The elimination of a species from a particular area.

Federally listed - Species formally listed as a threatened or endangered species under the federal Endangered Species Act; designations are made by the U.S. Fish and Wildlife Service or National Marine Fisheries Service.

Federal Reanalysis Team - A group of six federal scientists assembled to review existing data and develop a population model to estimate the importance of contributions of varying amounts of habitat from nonfederal lands to the long-term existence of a spotted owl population on the Olympic Peninsula.

Federal reserves - Federal lands that have been, or are proposed to be, withdrawn from acreage used for timber yields. These include Congressional Reserves such as national parks, wild and scenic rivers, national recreation areas, national monuments, and wilderness; Late-Successional Reserves, Riparian Reserves, Administratively Withdrawn Areas, Research Natural Areas, Special Recreation Management Areas, etc.

50-11-40 guideline- The Interagency Scientific Committee's recommendation that forested federal lands between designated Habitat Conservation Areas be managed such that 50 percent of every quarter township have forest stands in which trees have an average dbh of 11 inches and at least a 40 percent canopy closure.

Forest ecosystem - The interrelationships between the various trees and other organisms (both plants and animals) that form a community; and the interrelationships between these organisms and the physical environment in which they exist.

Forest Ecosystem Management Assessment Team (FEMAT) - A team organized by the federal government in 1993 to develop a management plan for federal lands within the range of the northern spotted owl.

Forest Practices Act - A Washington State statute establishing minimum standards for forest practices and providing for necessary administrative procedures and rules applicable to activities conducted on or pertaining to forests on both state-managed and private lands.

Forest Practices Board - A Washington State board created to write forest practices rules which are administered and enforced by the Washington Department of Natural Resources.

Forest Resource Plan - DNR's Forest Land Management Division's 1992 final policy plan, containing the current policies of the Board of Natural Resources.

Forest stand - See "Stand."

Fragmentation - The spatial arrangement of successional stages across the landscape as the result of disturbance; often used to refer specifically to the process of reducing the size and connectivity of late successional or old-growth forests. Fragmentation of existing habitat increases the accessibility of nest sites to predators and isolates portions of the population.

Geographic information system (GIS) - A computer system that stores and manipulates spatial data, and can produce a variety of maps and analyses. DNR's GIS is able to (1) assign information and attributes to polygons and lines, which represent relationships on the ground; and, (2) update and retrieve inventory, mapping, and statistical information. DNR uses its GIS as one of several tools for setting landscape-level planning objectives.

Geomorphic processes - Landscape-modifying processes such as erosion, mass wasting, and stream flow.

Green tree retention - A stand management practice in which live trees are left within harvest units to provide habitat components.

Habitat complexity - As defined in the HCP OESF riparian conservation strategy, habitat complexity includes (1) variations in stream flow velocity and depth by structural obstructions to channel flow; (2) physical and biological interactions between a channel and its floodplain; (3) aquatic and riparian structures that provide cover from predators; (4) a variety of stream substrates that include gravel for fish spawning and macroinvertebrate habitat; (5) sufficient storage area within channels and floodplains for sediment and organic matter; and, (6) diversity of riparian vegetation that provides adequate sources of woody debris and nutrients to channels, and that moderates water and air temperatures within the riparian corridor.

Habitat conservation plan (HCP) - An implementable program for the long-term protection and benefit of a species in a defined area; required as part of a Section 10 incidental take permit application under the federal Endangered Species Act.

Habitat preference - The choice of habitat(s) that the animal would make if all habitat types were available to it.

Habitat selection - The choice of a habitat(s) directly available to the animal.

Harm - A form of take under the federal ESA; defined in federal regulations as an act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation where it actually kills wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3).

High quality nesting habitat, spotted owls (five west-side planning units) - An interim definition developed in DNR's HCP, to be applied as an average condition over a 300-acre nesting habitat patch. High quality nesting habitat consists of (1) at least 31 trees per acre greater than or equal to 21 inches dbh per acre; (2) at least three trees from the above group of 31 trees have broken tops; (3) at least 12 snags per acre greater than 21 inches dbh; (4) a minimum of 70 percent canopy closure; and, (5) a minimum of 5 percent ground cover of large down woody debris.

Home range - The area used by a species and to which it exhibits fidelity. There is much geographic variation in spotted owl home range size. The median home range (determined by USFWS radio telemetry data) is a circle 1.8 miles in radius east of the I-5 corridor, or a circle 2.7 miles in radius west of the I-5 corridor. Hanson et al. (1993) determined that the median range radius for owls in the western Washington Cascades is 2.0 miles. Researchers have observed median home ranges of 14,232 acres on the Olympic Peninsula and 6,609 acres in the eastern Cascades. (See Chapter III of the HCP for more discussion.)

Hydrologic analysis unit (HAU) - Subdivisions of the Watershed administrative unit (WAU) used in the Washington Forest Practices Board's watershed analysis manual 'Hydrology Module.'

Hydrologic maturity - The degree to which hydrologic processes (e.g., interception, evapotranspiration, snow accumulation, snowmelt, infiltration, runoff) and outputs (e.g., water yield and peak disharge) in a particular forest stand approach those expected in a late seral stand under the same climatic and site conditions. In DNR's HCP, a "hydrologically mature forest," with respect to rain-on-snow runoff, is a well-stocked conifer stand at age 25 years or older.

Identifiable channel - A river or stream channel with well-defined and measurable channel banks where vegetative ground cover has been disturbed and sediment is exposed.

Implementation Agreement (IA) - A part of the application for an incidental take permit, which specifies the terms and conditions, resources, schedule of activities, and expectations for the parties to the agreement.

Implementation monitoring - Monitoring done to determine whether the HCP conservation strategies are implemented as written.

Incidental take - The taking of a federally listed wildlife (animal) species, if the taking is incidental to, and not the purpose of, carrying out otherwise lawful activities. See also "Take."

Incidental take permit - Permit issued by the U.S. Fish and Wildlife Service to either a private entity or a state, that allows incidental take of a threatened or endangered species; permit also requires permitee to carry out specified actions that minimize and mitigate the incidental take, and may contribute to the recovery of the species.

Interior-core riparian buffer - Streamside buffer in the HCP OESF riparian strategy; minimizes disturbance of unstable channel banks and adjacent hillslopes, and protects and aids natural restoration of riparian processes and functions. See "Buffer."

Landscape - Large regional units of lands that are viewed as a mosaic of communities, or a unit of land with separate plant communities or ecosystems forming ecological units with distinguishable structure, function, geomorphology, and disturbance regimes. In DNR's HCP, a landscape is defined as a large area comprised of various interacting patterns of stand structure and function going through alterations over time.

Landscape assessment - In DNR's HCP, any method to field verify the amount of habitat in WAUs on DNR-managed lands.

Landscape-level planning - The process of planning across a larger area than stand by stand.

Landscape planning - The process of planning for a specified landscape by setting specific objectives for a given area, such as protection of wildlife and timber production.

Landscape planning unit - Landscape-level planning units used by DNR's Olympic Region to identify 11 watershed-based units within the Olympic Experimental State Forest.

Landslide - Any mass movement process characterized by downslope transport of soil and rock, under gravitational stress, by sliding over a discrete failure surface; or the resultant land form. In forested watersheds, landsliding typically occurs when local changes in the soil pore water pressure increase to a degree that the friction between soil particles is inadequate to bind them together.

Large saw - Large sawtimber. DNR's GIS forest classification for large saw is: dominant dbh 20-30 inches; more than 10 dominant trees/acre of this size; co-dominant trees are 14 inches dbh or greater; two or three canopy layers more closed than old growth; small snags present with sparse or no large snags; few large down logs.

Large woody debris - Large pieces of wood in stream channels or on the ground - includes logs, pieces of logs, and large chunks of wood; provides streambed stability and/or habitat complexity. Also called coarse woody debris or down woody debris. Large organic debris is large woody debris, but may contain additional non-woody debris, such as animal carcasses.

Late successional forest - A mature and/or old-growth forest stand. Also called late seral stage forest. Typical characteristics are moderate to high canopy closure, a multi-layered, multispecies canopy dominated by large overstory trees, numerous large snags, and abundant large woody debris (such as fallen trees) on the ground. Typically, stands 80-120 years old are entering this stage.

Layered - A transitional forest structure, when second-growth is being manipulated to create old growth features; there is greater structural diversity than understory and somewhat less than with classic old growth.

Leeward - In this document, the side of a stream opposite that from which the wind blows.

Listed wildlife species - Species formally listed as endangered, threatened, or sensitive by a federal (USFWS or NMFS) or state (WDFW) agency.

Low-harvest area - As defined for the HCP's west-side planning units, the outermost portion of the riparian buffer, more than 100 feet from the active channel margin.

Low order streams - Small streams with very few tributaries; often are headwaters. Type 4 and 5 waters are low order streams.

Maintenance and Enhancement Phase - In the HCP OESF strategy, the remainder of the permit period following the restoration of threshold amounts of total spotted owl habitat (40 percent) in all Landscape planning units. This phase follows the Restoration Phase.

Maintenance of species distribution - Supporting the continued presence of a species in as much of its historic range as possible.

Marbled murrelet - A Pacific seabird that nests in mature or old-growth forests within 50 miles of the marine environments; listed as a threatened species by the U.S. Fish and Wildlife Service and Washington State.

Marbled murrelet habitat - For marbled murrelets, potential habitat is coniferous forests within 50 miles of the coast; old growth regardless of stand size; mature forests (80-200 year old stands) with or without an old growth component; young stands with remnant old growth or mature trees greater than 32 inches in diameter; young (70-80 years) coniferous forests that have deformities that result in structures suitable for nesting. Marbled murrelet habitat requires structural features such as large residual trees, large limbs, and nesting platforms.

Mass wasting - Dislodgment and downslope transport of soil and rock under the direct application of gravitational stress, i.e., without major action of water, wind, or ice.

Matrix - As proposed by FEMAT, the matrix is the area of federal lands where most timber harvest will occur, in the areas outside of the Late-Successional Reserves and Riparian Reserves.

Mature stand - The period of life in a forest stand from culmination of mean annual increment to an old-growth stage or to 200 years. This is a time of gradually increasing stand diversity. Hiding cover, thermal cover, and some forage may be present.

Metapopulation - Several sub-populations linked together by immigration and emigration. Metapopulation dynamics are influenced by the relationships between source and sink habitats and source and sink sub-populations.

Minimal-harvest area - As defined for the HCP's west-side planning units, the part of the riparian buffer outside of the no-harvest area; the next 75 feet from the active channel, and inside the low-harvest area (25-100 feet from the stream).

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 - A state designation. Wildlife 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 appear.

National Environmental Policy Act (NEPA) - NEPA 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) - The federal agency that is the listing authority for marine mammals and anadromous fish under the Endangered Species Act.

Natural Area Preserve (NAP) - In Washington State, a natural area which has been so dedicated under the provisions of state law, or formally committed to protection by a cooperative agreement between a government landholder and the Department of Natural Resources.

Natural Heritage Program - A DNR program that identifies, selects and nominates outstanding natural areas in Washington; also, oversees state listing of plants.

Natural Resources Conservation Area (NRCA) - Washington State lands designated by the legislature to protect special scenic and/or ecological values.

Nest patches - Patches of old forest with a high degree of structural complexity (i.e., forest types known to support nesting spotted owls) that will be retained in an unmanaged state during the research phase of the HCP; part of the west-side NRF management strategy.

Nesting platform, marbled murrelet - Any large limb or other structure at least 50 feet above ground and at least 7 inches in diameter. In DNR's HCP, platforms are counted in conifer trees only, and only if located within the live crown.

Nesting, roosting, and foraging habitat (NRF) - Habitat with the forest structure, sufficient area, and adequate food source to meet the needs of a nesting pair of spotted owls. The forest structure consists of stands at least 70 years old that include a three-layer canopy of very large diameter trees (200+ years old) from the previous stand, large diameter trees (70+ years old), and small understory trees, along with snags and large down woody debris.

No-harvest area - As defined for the HCP's west-side planning units, the 25 feet of the riparian buffer closest to the stream.

Northern spotted owl - A medium-size dark brown owl that has round to elliptical white spots on the head, white mottling on the body and abdomen, and white bars on the tail; native to the Pacific coastal region. Federally listed as a threatened species, and listed as endangered by Washington State.

NRF management areas - Lands identified in DNR's HCP that will be managed to provide demographic support and contribute to maintaining species distribution for the spotted owl. Also called NRF areas.

Old-growth forest - A successional stage after maturity that may or may not include climax old-growth species; the final seral stage. Typically, contains trees older than 200 years. Stands containing Douglas fir older than 160 years, which are past full maturity and starting to deteriorate, may be classified as old growth. DNR's GIS forest classification for old growth is: a dominant dbh of 30 inches or greater; usually more than eight dominant trees/acre; three or more canopy layers with less than complete canopy closure; several snags/acre with a 20 inch dbh or greater; and several down logs per acre with a 24 inch dbh or greater.

Olympic Experimental State Forest (OESF, the Experimental Forest) - A DNR planning unit on the Olympic Peninsula, which has unique potential for research and experiments involving forestry, wildlife, and related disciplines; an integral part of DNR's HCP.

Orographic - Pertaining to mountains, especially in regard to their location, distribution, and accompanying phenomenon; also, said of the precipitation that results when moisture-laden air encounters a high barrier and is forced to rise over it, such as the precipitation on the windward slopes of a mountain range facing a steady wind from a warm ocean.

Overstory canopy - The uppermost forest canopy layer. See also "Canopy" and "Understory canopy."

Owl circle - A radius that approximates the median spotted owl home range size. See also "Home range."

Packing - An increased density of birds nesting in the habitat that is available.

Partial cutting - Removal of selected trees from a forest stand, leaving an uneven-aged stand of well-distributed residual, healthy trees. Also called uneven-aged management.

Patch - See "Nest patches."

Physiographic province - A region of which all parts are similar in geologic structure and climate and which consequently had a unified geomorphic history; a region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

Planning unit - DNR-managed land units, grouped into three blocks for the purpose of implementing the HCP: the Olympic Experimental State Forest, five west-side planning units, and three east-side planning units. The nine planning units in the HCP area are: Olympic Experimental State Forest, South Coast, North Coast, Columbia, Straits, South Puget, Chelan, Yakima, and Klickitat.

Pole - Any considerable length of round timber before saw log size, ready for use without further conversion. DNR's GIS classification for pole is: dominant dbh 10-14 inches; one canopy layer; and, little or no down dead woody debris.

Population dynamics - How populations and the environment interact to cause changes in a population over time.

Population viability analysis - Using population dynamics to analyze how large a population needs to be and how its habitat needs to be distributed across landscapes to persist over time. See also "Viable population."

Precommercial thinning - Cutting trees at an immature age to allow for better growth of the remaining trees; may include removal of excess and/or diseased trees in the 10-35 year class.

Proposed threatened or endangered species - Species proposed by the USFWS or NMFS for listing as threatened or endangered under the Endangered Species Act; not a final designation.

Rain-on-snow zone - Area, generally defined as an elevation zone, where it is common for snowpacks to be partially or completely melted during rainstorms several times during the winter.

Recovery plan - A plan developed by a government agency, that if implemented is expected to result in the recovery of a threatened or endangered species to the extent that the species can be delisted from threatened or endangered status.

Relative density (RD) - The basal area of a stand divided by the square root of the quadratic mean dbh of the stand. In the HCP, when canopy closure is used in a habitat definition, RD will be used as a measurement if and when DNR has established a correlation between RD and canopy closure in spotted owl habitats for its lands.

Reserves - See "Federal reserves."

Restoration Phase - In the HCP OESF strategy, the 40-60 year period during which existing young stands are developing the characteristics of young forest marginal and sub-mature habitat.

Revised Code of Washington (RCW) - A revised, consolidated, and codified form and arrangement of all the laws of the state of a general and permanent nature.

Riparian buffer - As defined for the HCP's west-side planning units, the inner buffer of the riparian management zone that serves to protect salmonid habitat. See "Riparian management zone."

Riparian ecosystem - In DNR's HCP, the area of direct interaction between terrestrial and aquatic environments.

Riparian management zone - Defined in DNR's Forest Resource Plan (1992) Policy No. 20, and refined in DNR's HCP, an area consisting of an inner riparian buffer and an outer wind buffer. The riparian buffer serves to protect salmonid habitat; the wind buffer protects the riparian buffer. This policy expands the level of protection required under the current Forest Practices Act and authorizes DNR to establish riparian protection zones along Type 1 through 4 waters and, when necessary, along Type 5 waters. DNR may remove timber from riparian management zones if adequate protection can be provided to fish and other nontimber resources. These riparian management zones apply to the west-side planning units.

Riparian zone - A narrow band of moist soils and distinctive vegetation along the banks of lakes, rivers, and streams; in the HCP, the portion of the riparian ecosystem between the aquatic zone and the direct influence zone (uplands).

River mile - A statute mile as measured along the center line of a river. River miles are measured from the mouth of the river, or are discrete measures of distance (i.e., a distance of 2-4 river miles).

Salmonids - Fish species belonging to the family Salmonidae, including trout, salmon, char, and whitefish species.

Sapling - A young tree no longer a seedling but not yet a pole. DNR's GIS classification for sapling is: approximately 2-5 inches dbh.

Seed tree harvest - A harvest method in which all mature timber from an area is harvested in one entry except for a small number of trees left as a seed source for the harvested area.

Selective harvest - A general term for partial cutting or salvage cutting in which individual trees are removed.

Sensitive species - A state designation. State sensitive species are species native to the state of Washington that are vulnerable or declining and are likely to become endangered or threatened in a significant portion of their ranges within the state without cooperative management or the removal of threats.

Shelterwood cut - A harvest method in which a portion of a mature forest stand is removed in two or more cuttings; a portion of the stand is retained as a source of seed and/or protection during the period of regeneration.

Silviculture - The theory and practice of controlling the establishment, composition, growth, and quality of forest stands in order to achieve management objectives.

Sink area - The area in which local mortality rate exceeds local reproductive rate. Because mortality rates exceed reproduction, these populations would go extinct without immigration from source areas.

Site center - The actual nest tree or the primary roost of territorial owls.

Site index - A measure of forest productivity expressed as the height of the dominant trees in a stand at an index age.

Site index curves - Nonlinear regressions of tree height versus breast height age for different site productivities; used as a means to predict future growth.

Site potential tree height - The height a dominant tree may attain, given site conditions where it occurs.

Slump - A landslide characterized by a shearing and rotary movement of a generally independent mass of rock or earth along a curved slip surface (concave upward) and about an axis parallel to the slope from which it descends, and by backward tilting of the mass with respect to that slope so that the slump surface often exhibits a reversed slope facing uphill.

Small saw - Small sawtimber. DNR's GIS forest classification for small saw is: dominant dbh 14-20 inches; one or two canopy layers; small snags or none present; and, small down dead wood or none present.

Snag - Dead tree that is still standing.

Source area - The area in which local reproductive success is greater than local mortality (lambda is greater than one at the scale of an owl cluster). Populations in source areas produce an excess of individuals that must emigrate from their natal area to establish new territories.

Special Emphasis Areas - Proposed federally designated areas in Washington, as outlined in the draft 4(d) rule under the ESA.

Spotted owl - See "Northern spotted owl."

Spotted owl site status - See "Status 1 through 5, spotted owl site centers."

Stand - A group of trees that possess sufficient uniformity in composition, structure, age, spatial arrangement, or condition to distinguish them from adjacent groups.

Stand conversion - The conversion of stands from low-commercial value species to more valuable conifer species; also called stand rehabilitation.

Stand initiation - The first stage of forest growth; an open condition and new regeneration. The other three stages are stem exclusion, understory reinitiation, and old growth.

State Environmental Policy Act (SEPA) - This law is the basic state charter for protection of the environment. SEPA requires all state 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.

Status 1 through 5, spotted owl site centers - Status assigned to spotted owl site centers by the Washington Department of Fish and Wildlife (WAC 222-16-080). The five categories are: Status 1- Pair or reproductive; Status 2- Two birds, pair status unknown; Status 3- Resident territorial single; Status 4- Status unknown; and, Status 5- Historic status (formerly occupied).

Stem exclusion - The second stage of forest growth, with tree competition and mortality. The other three stages are stand initiation, understory reinitiation, and old growth.

Stream classifications - See "Water typing system."

Subalpine - The area above the upper limit of contiguous closed forest and beneath the upper limit of growth; typically, a mosaic of tree patches and meadows.

Sub-mature forest - DNR defines this as a younger forest category that includes mid-seral forest (non-late successional or old growth) that has the structural characteristics necessary to provide roosting and foraging functions.

Sub-mature habitat (east-side planning units) - In DNR's HCP, sub-mature habitat has the following characteristics: (1) forest community composed of at least 40 percent Douglas-fir or grand fir component; (2) canopy closure of at least 70 percent; (3) tree density of between 110-260 trees per acre; (4) tree height or vertical density with either (a) dominant and co-dominant trees at least 90 feet tall, and/or (b) two or more canopy layers, numerous intermediate trees, numerous low perches; (5) snags/cavity trees or mistletoe infection with either (a) three or more snags or cavity trees per acre that are equal to or greater than 20 inches dbh, and/or (b) a moderate to high infection of mistletoe; and (6) 5 percent ground cover of dead and down wood averaged over a stand.

Sub-mature habitat (west-side planning units) - In DNR's HCP, sub-mature habitat has the following characteristics: (1) forest community dominated by conifers, or in mixed conifer/hardwood forest, the community is composed of at least 30 percent conifers (measured as stems per acre dominant, co-dominant, and intermediate trees); (2) at least 70 percent canopy closure; (3) tree density of between 115-280 trees per acre (all greater than 4 inches dbh); (4) height of dominant and co-dominant trees at least 85 feet tall; (5) at least three snags or cavity trees per acre that are at least 20 inches dbh; and, (6) a minimum of 5 percent ground cover of large down woody debris.

Sub-population - A well-defined set of interacting individuals that comprise a proportion of a larger, interbreeding population.

Suitable habitat block, marbled murrelets - In DNR's HCP, a suitable habitat block is a contiguous forested area that is at least 5 acres in size, contains an average of at least two potential nesting platforms per acre, and is within 50 miles of marine waters.

Take - A prohibited action under federal law, except where authorized. 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[19]). 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 - A homogeneous area of rock rubble, ranging in average size from 1 inch to 6.5 feet, derived from and lying at the base of a cliff or very steep, rocky slope.

Target conditions - Achieving ecological recovery and population restoration of a listed species; target conditions are often defined in federally-mandated recovery plans for a given species.

Taxon - A category in the biological system of arranging plants and animals in related groups, such as class, family, or phylum.

Threatened species - A federal and state designation as defined in the Endangered Species Act for species likely to become an endangered species throughout all or a significant portion of their range within the foreseeable future.

Threatened and endangered species - Formal classifications of species. Federal designations are made by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service. State of Washington designations are made by the Washington Fish and Wildlife Commission (RCW 77.08.010). See also "Candidate species," "Endangered species," "Proposed threatened or endangered species," "Sensitive species," and "Threatened species."

Trust - In law, a fiduciary relationship in which one person (the trustee) holds the title to property or manages it for the benefit of another (the beneficiary).

Trust lands - Those lands held in trust and managed by the Washington Department of Natural Resources for the benefit of the trust beneficiaries.

Turbidity - The relative clarity of water, which may be affected by material in suspension in the water.

Types 1 through 5 streams or waters - See "Water typing system."

Underburning - Prescribed burning of the forest floor or understory for botanical or wildlife habitat objectives, hazard reduction, or silvicultural objectives.

Understory canopy - Forest undergrowth; the lowest canopy layer of trees and woody species. See also "Canopy" and "Overstory canopy."

Understory reinitiation - The third stage of forest growth, with undergrowth development and some tree regeneration. The other three stages are stand initiation, stem exclusion, and old growth.

Uneven-aged - Forests composed of trees that differ markedly in age. This results from partial cutting practices.

U.S. Fish and Wildlife Service (USFWS) - The federal agency that is the listing authority for species other than marine mammals and anadromous fish under the Endangered Species Act.

Unzoned forest - In DNR's HCP, a forest without areas deferred from timber management.

Validation monitoring - Monitoring done to evaluate the cause-and-effect relationships between habitat conditions resulting from the HCP conservation strategies and the animal populations these strategies are intended to benefit.

Vegetative zones - Broad areas that have similar types of vegetation. Zones within the HCP area include the Sitka spruce zone, the western hemlock zone, the Pacific silver fir zone, the subalpine fir/mountain hemlock zone, the alpine zone, the grand fir zone, the Douglas-fir zone, and the ponderosa pine zone (based on Franklin and Dyrness 1973).

Viability analysis - See "Population viability analysis."

Viable population - A population that is of sufficient size and distribution to be able to persist for a long period of time in the face of demographic variations, random events that influence the genetic structure of the population, and fluctuations in environmental conditions, including catastrophic events.

Washington Administrative Code (WAC) - All current, permanent rules of each state agency, adopted pursuant to chapter 34.05 RCW.

Washington Board of Natural Resources - See "Board of Natural Resources."

Washington Forest Practices Act - See "Forest Practices Act."

Washington Forest Practices Board - See "Forest Practices Board."

Washington Fish and Wildlife Commission - The state commission with statutory authority to list threatened, endangered, and sensitive species.

Water resource inventory area (WRIA) - Watershed-based planning unit, defined by the Washington State Department of Ecology. WRIAs are determined by drainages to common water bodies.

Water typing system - A simplified explanation of Washington's classifications of water types appears here. For the complete classification system, see WAC 222-16-030.

Type 1: All waters, within their ordinary high-water mark, as inventoried as "shorelines of the state."

Type 2: Segments of natural waters which are not Type 1 and have a high fish, wildlife, or human use. These are segments of natural waters and periodically inundated areas of their associated wetlands.

Type 3: Segments of natural waters which are not Type 1 or 2 and have a moderate to slight fish, wildlife, and human use. These are segments of natural waters and periodically inundated areas of their associated wetlands

Type 4: Segments of natural waters which are not Type 1, 2, or 3, and for the purpose of protecting water quality downstream are classified as Type 4 water upstream until the channel width becomes less than 2 feet in width between the ordinary high-water marks. These may be perennial or intermittent.

Type 5: Natural waters which are not Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks and drainage ways having short periods of spring or storm runoff.

Watershed - The drainage basin contributing water, organic matter, dissolved nutrients, and sediments to a stream or lake.

Watershed administrative unit (WAU) - In Washington, the basic hydrologic unit used for watershed analysis. See WAC 222-22-020 for more information.

Watershed analysis - A systematic procedure for characterizing watershed and ecological processes to meet specific management objectives; provides a basis for resource management planning. In Washington, the assessment of a watershed administrative unit completed under state law.

Wetland - Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, such as swamps, bogs, fens, and similar areas.

Wetland typing system - A simplified explanation of Washington's classifications of wetland types appears here. For the complete classification system, see WAC 222-16-035.

Nonforested Wetland - Any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of less than 30 percent. There are two types of nonforested wetlands: Type A and Type B. A Type A Wetland is (1) greater than 0.5 acre in size; (2) associated with at least 0.5 acre of ponded or standing open water; or, (3) are bogs and fens greater than 0.25 acre. A Type B Wetland classification is all other nonforested wetlands greater than 0.25 acre.

Forested Wetland - Any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of 30 percent or more.

Wildlife Code of Washington - Title 77 RCW (Revised Code of Washington).

Wind buffer - As defined for the HCP's west-side planning units, the outer buffer of the riparian management zone that maintains the ecological integrity of the riparian buffer by reducing windthrow.

Windthrow - Trees blown down by wind; also called blowdown.

Yarding - Transporting logs from the point of felling to a collecting point or landing.

Young forest - A forest that is 50-80 years old.

Young forest marginal habitat - As defined by the Washington Forest Practices Board Spotted Owl Advisory Group, younger forest that provides some of the characteristics spotted owls need for roosting, foraging, and dispersal. This habitat type corresponds to the low to mid-range of the former Type C designation.

The following references were used in developing the glossary:

Bates, R. L., and J. A. Jackson, eds. 1987. Glossary of geology, 3rd ed. American Geological Institute, Alexandria, VA. 788 p.

Ford-Robertson, F. C., ed. 1971. Terminology of forest science, technology practice and products; English-language version. Society of American Foresters, Washington, D.C. 349 p.

Statute Law Committee. 1992. Revised Code of Washington. State of Washington, Olympia. 9 v.

U.S. Fish and Wildlife Service, and Oregon Department of Forestry. 1995. Elliott State Forest—Environmental assessment for the habitat conservation plan, Coos and Douglas Counties, Oregon. U.S. Fish and Wildlife Service, Olympia. 1 v.

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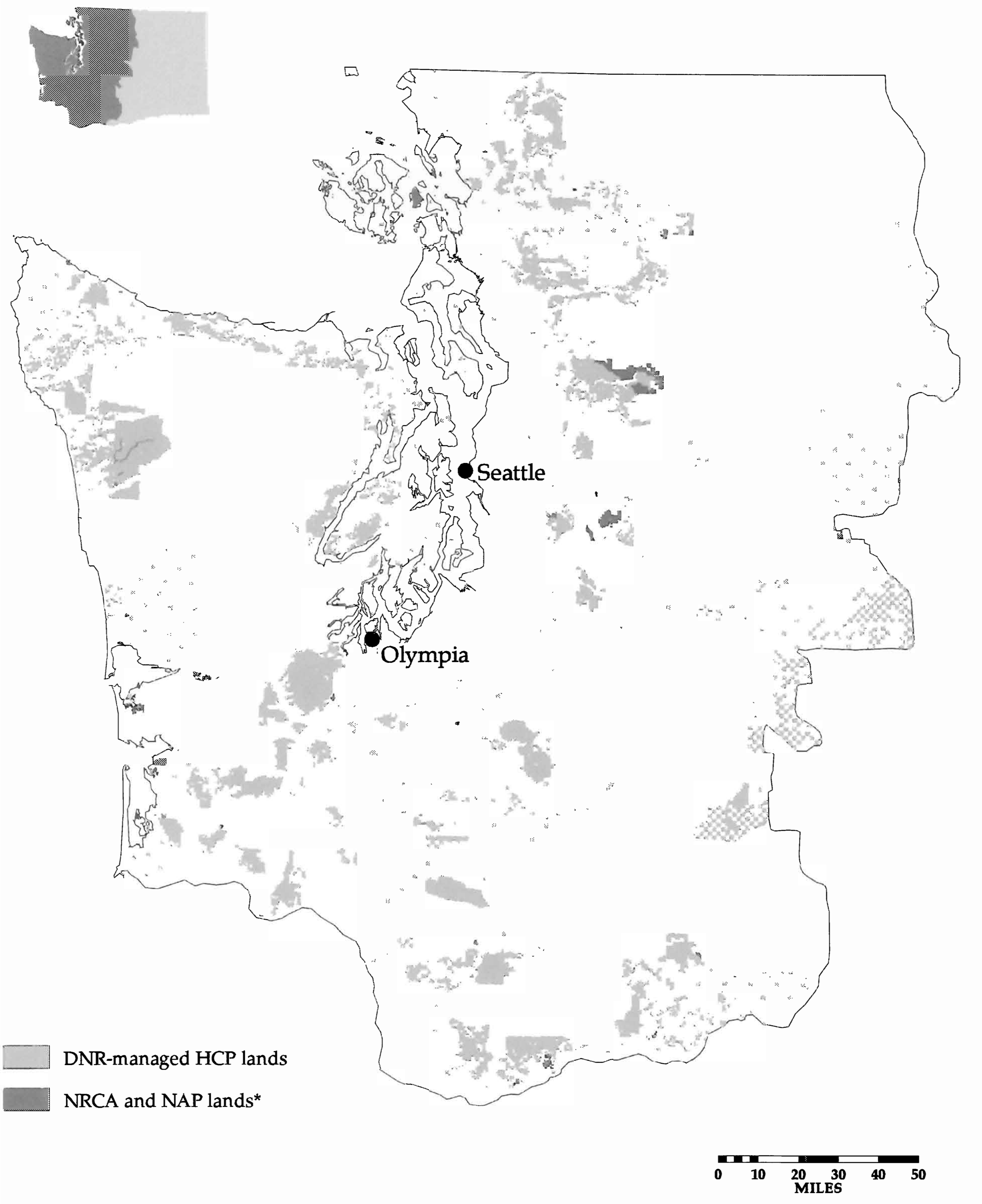
Washington Forest Practices Board. 1994. Washington Forest Practices: Board manual, Standard methodology for conducting watershed analysis under chapter 222-22 WAC, version 2.1. Washington Department of Natural Resources, Forest Practices Division, Olympia. 1 v.

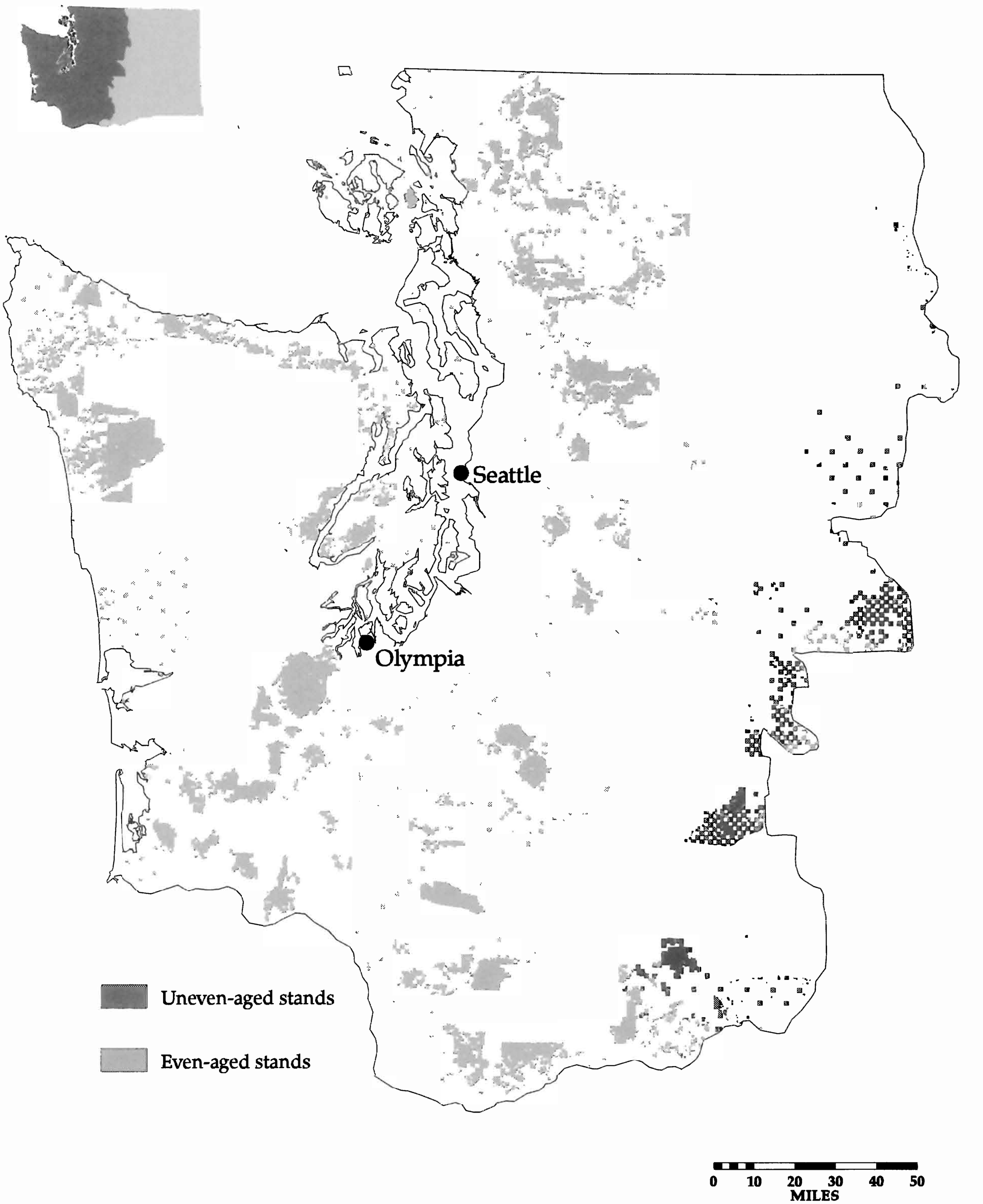
Maps

Map I.1: DNR-managed lands covered by the Habitat Conservation Plan



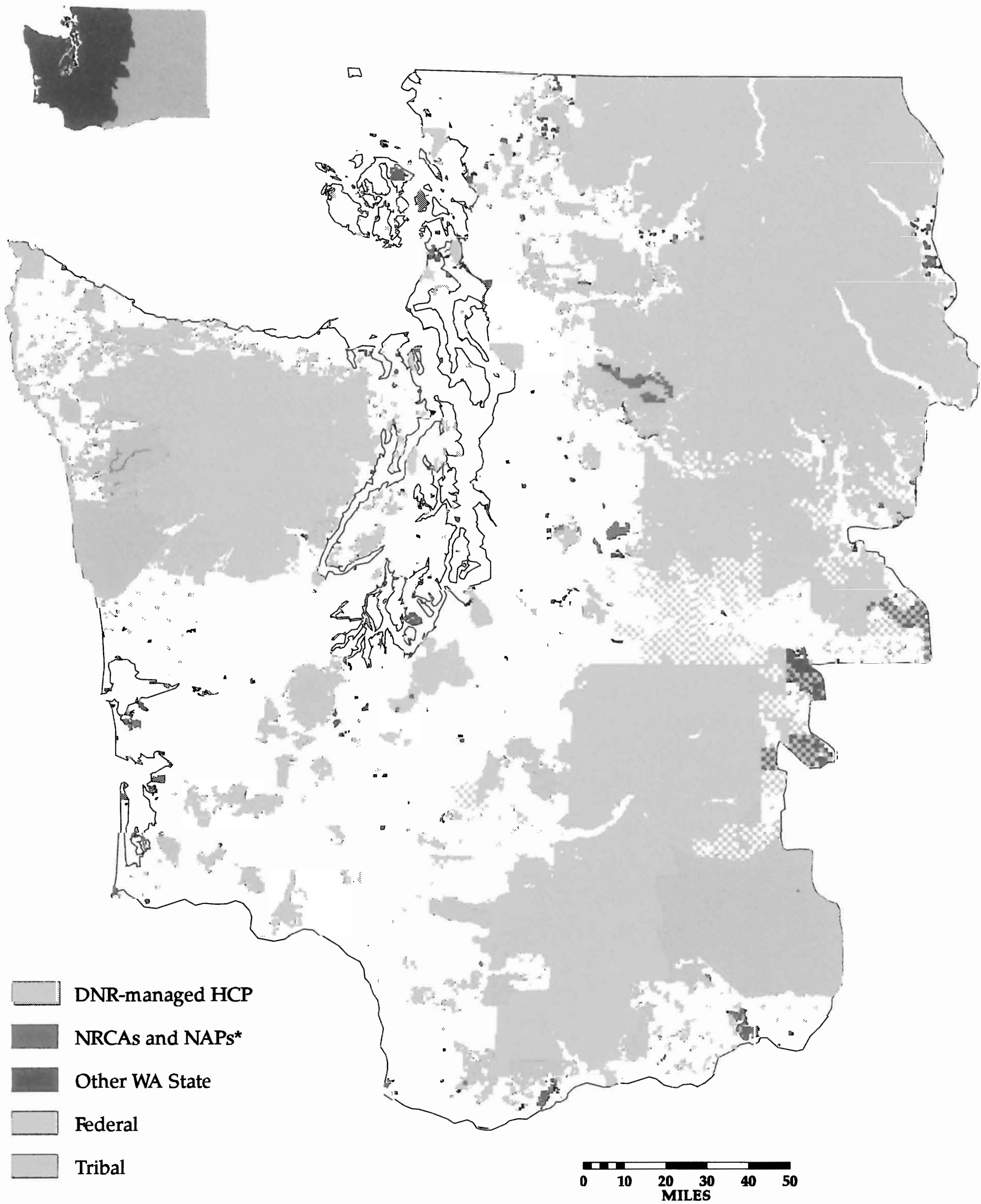
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.2: Location of uneven-aged and even-aged stands on DNR-managed lands covered by the HCP



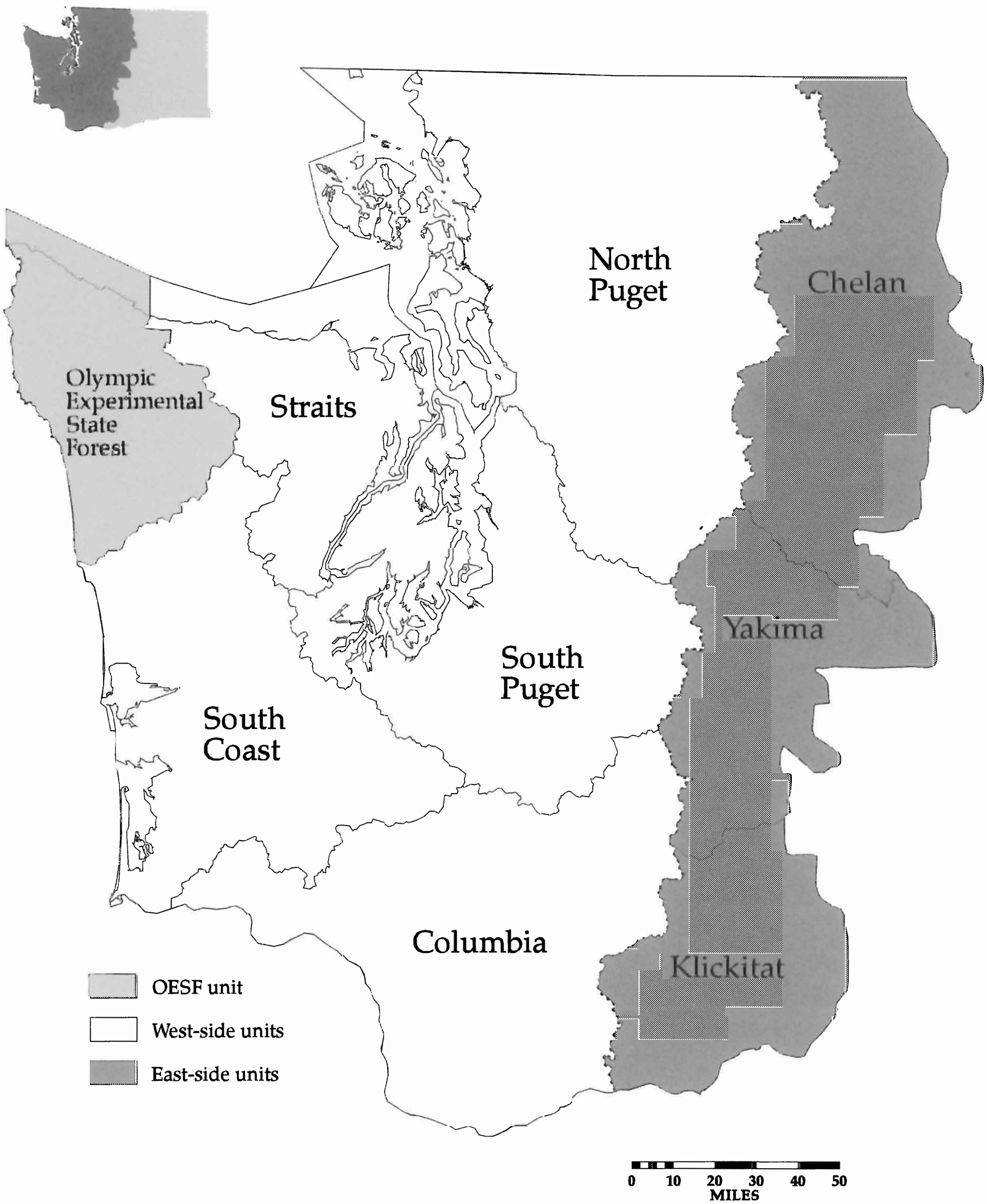
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.

Map I.3: DNR-managed lands and adjacent ownerships in the area covered by the HCP



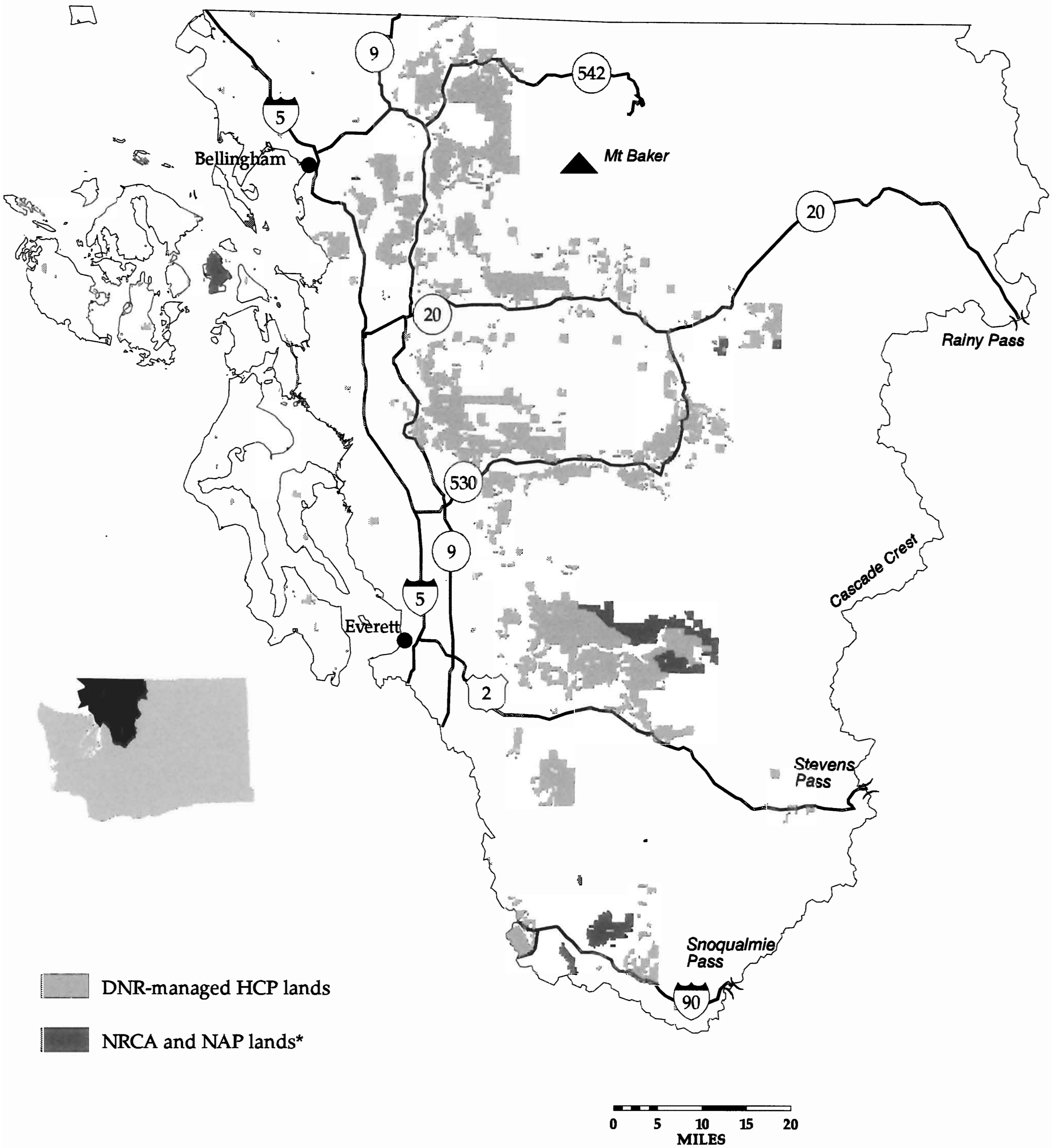
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.4: HCP planning units



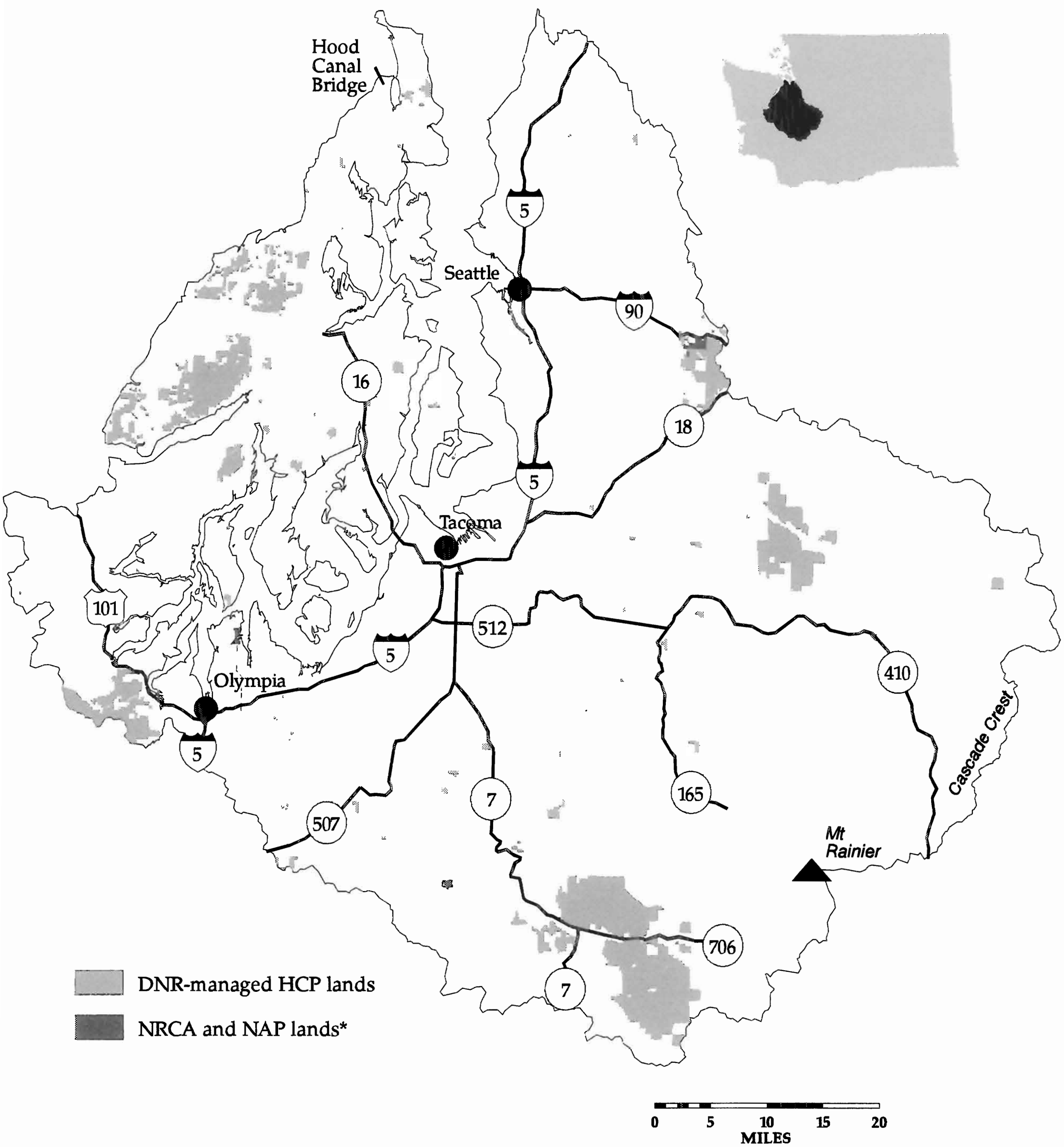
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.

Map I.5: North Puget Planning Unit



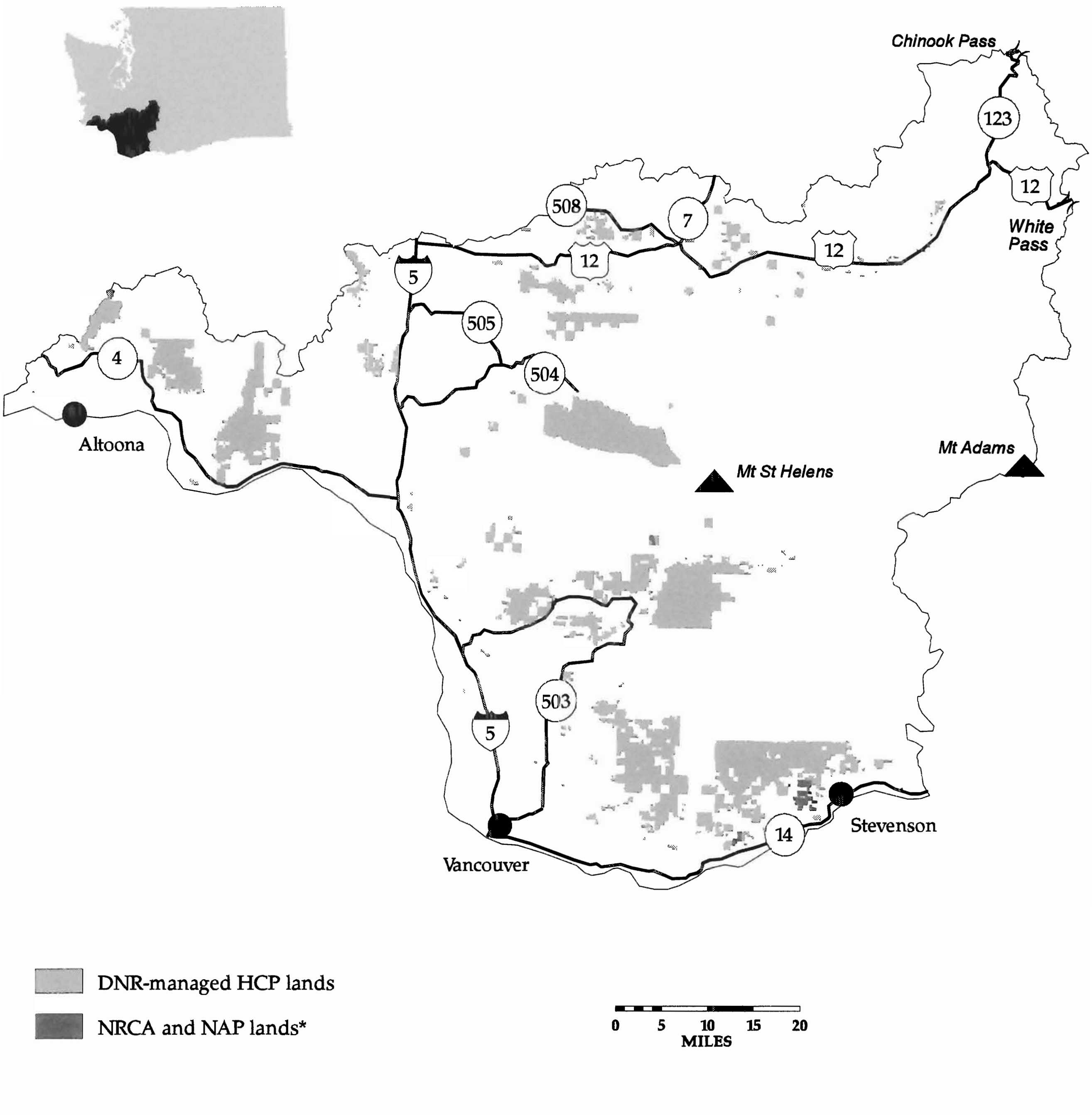
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.6: South Puget Planning Unit



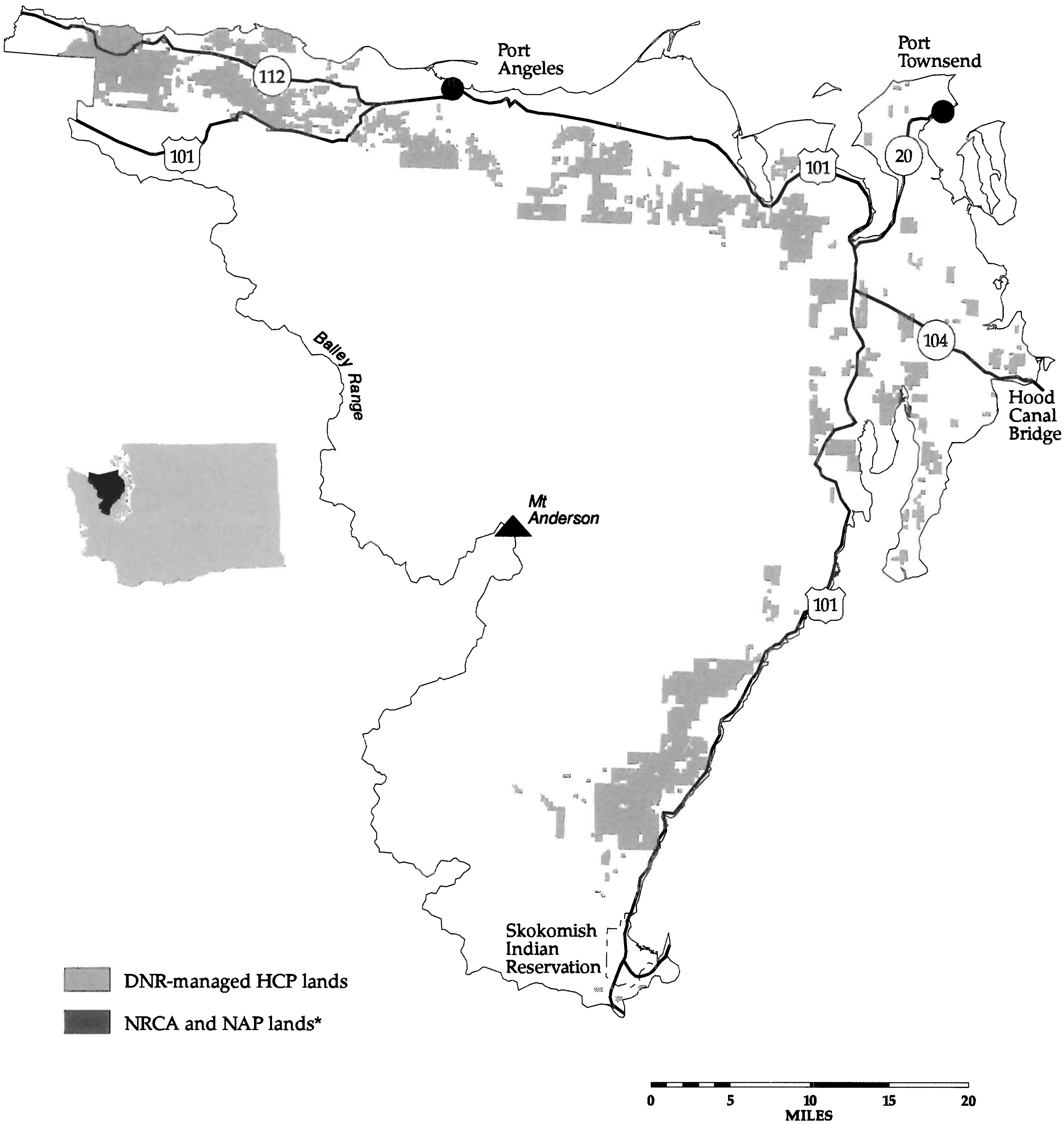
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.7: Columbia Planning Unit



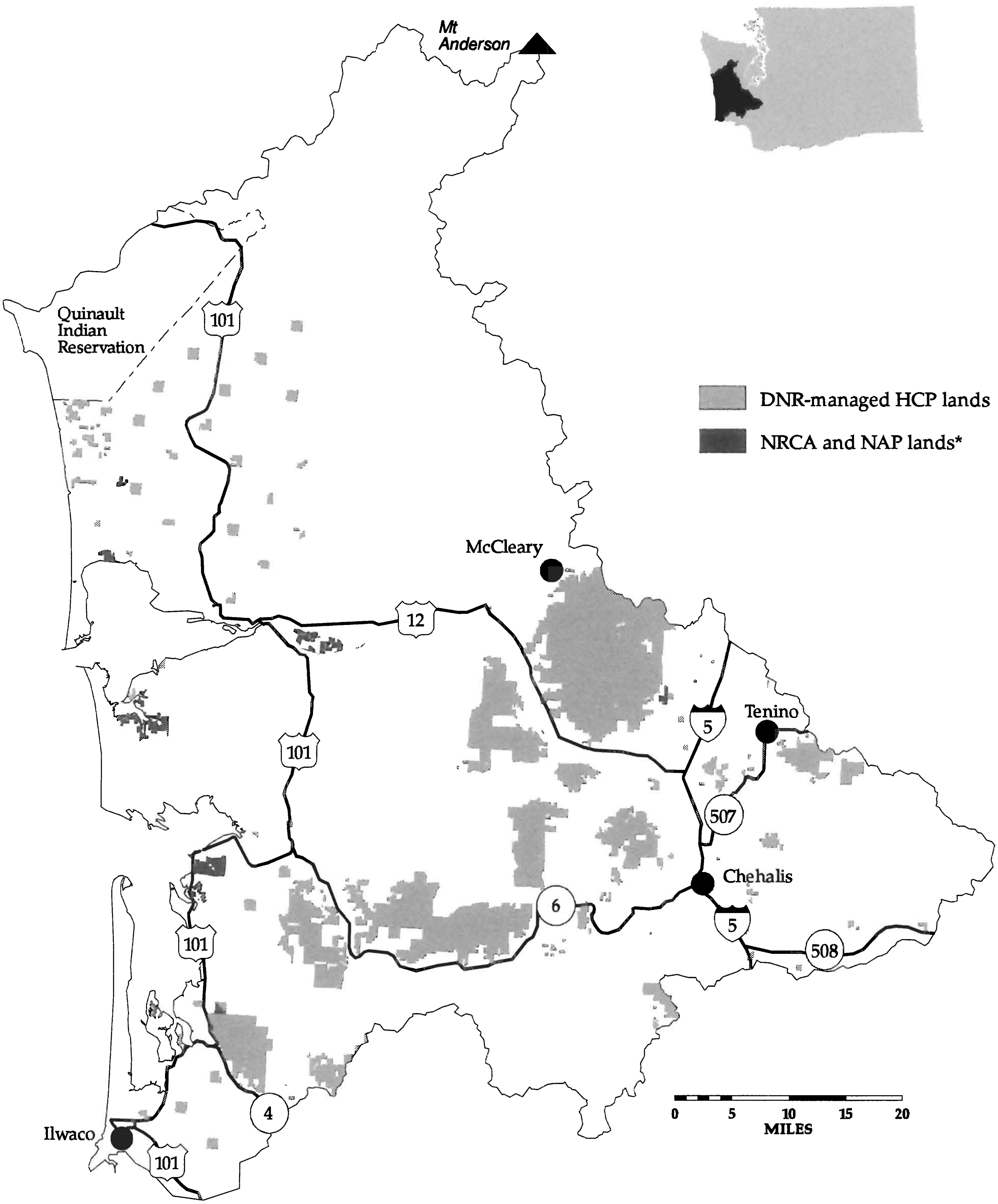
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.8: Straits Planning Unit



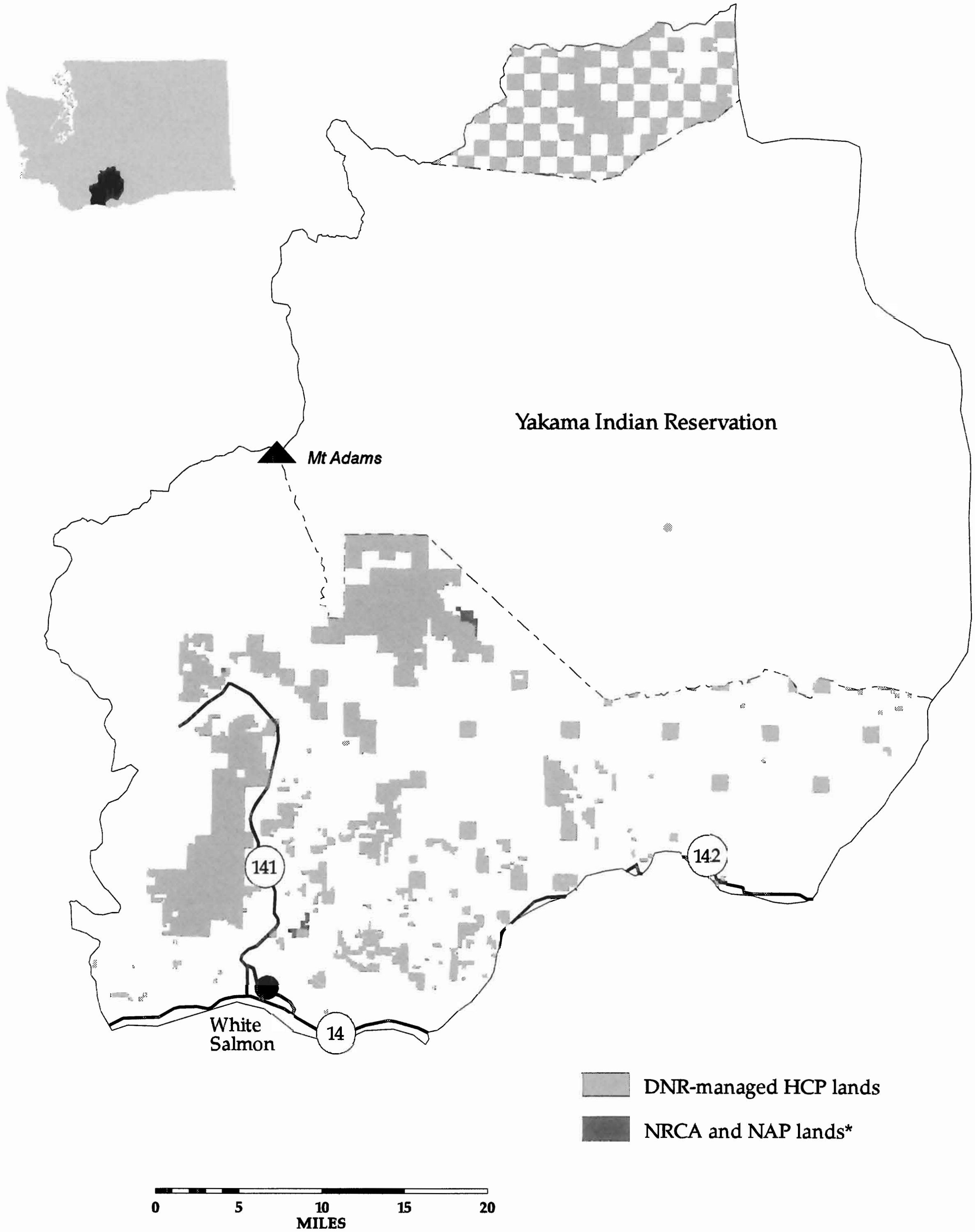
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.9: South Coast Planning Unit



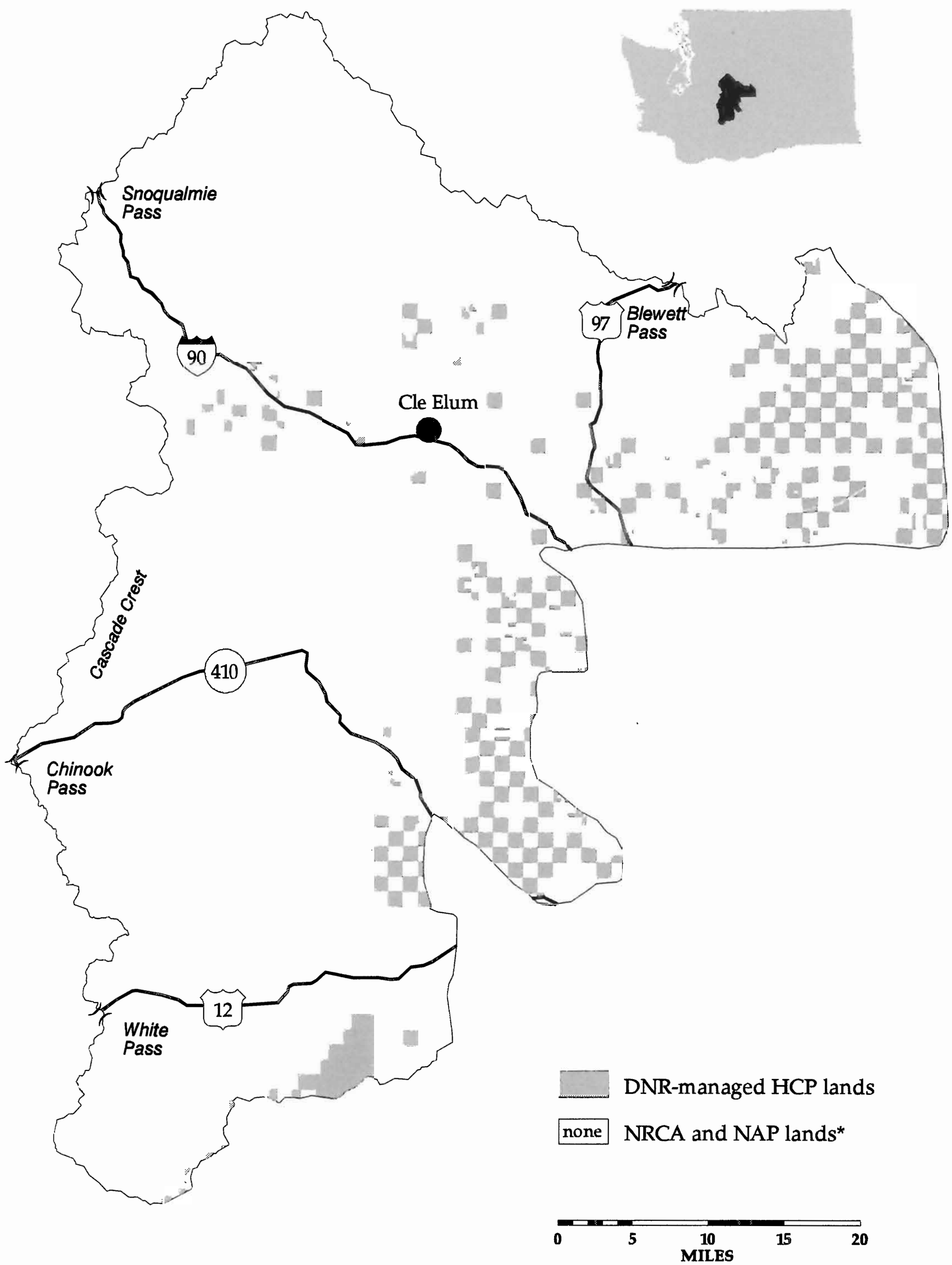
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.10: Klickitat Planning Unit



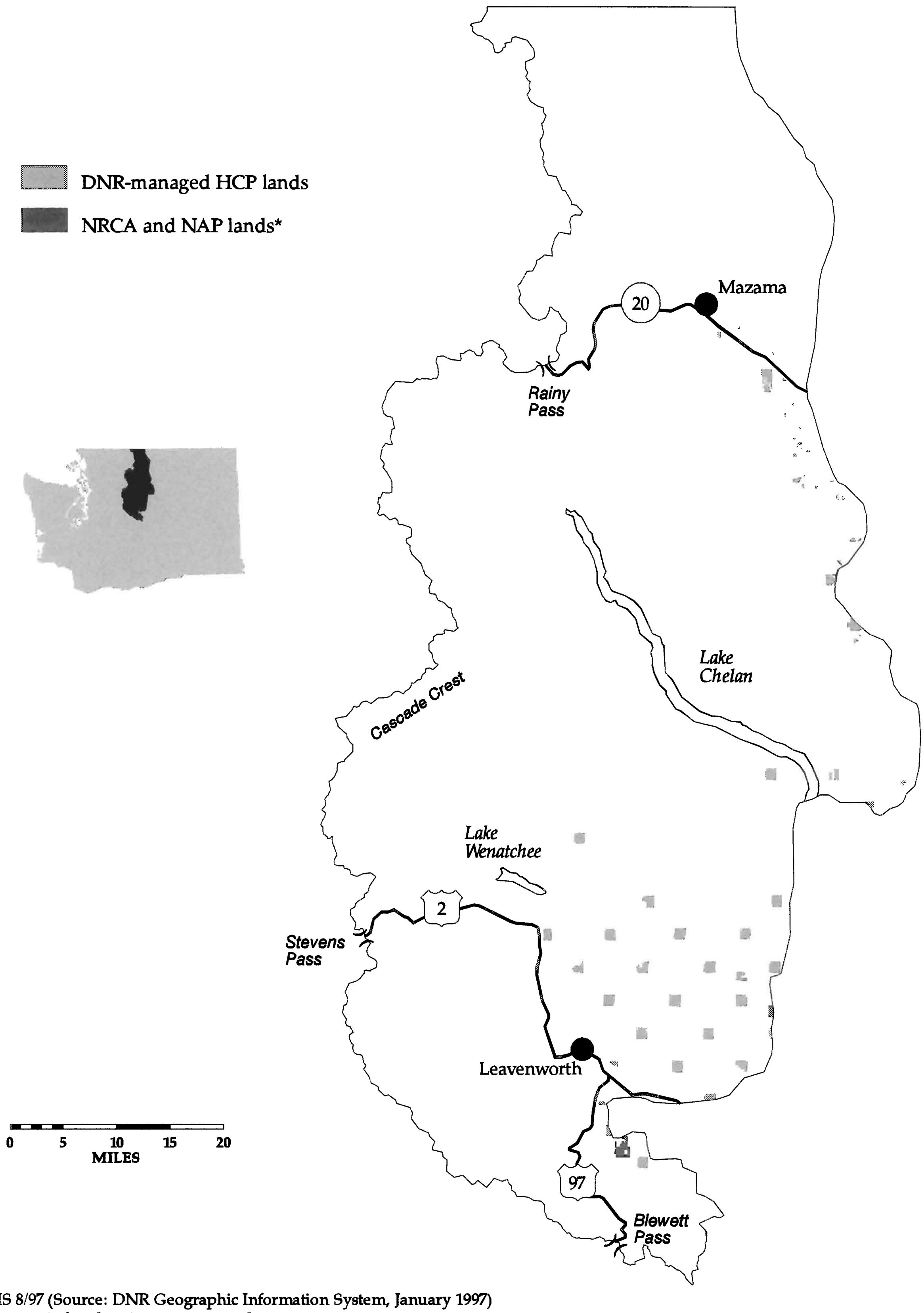
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.11: Yakima Planning Unit



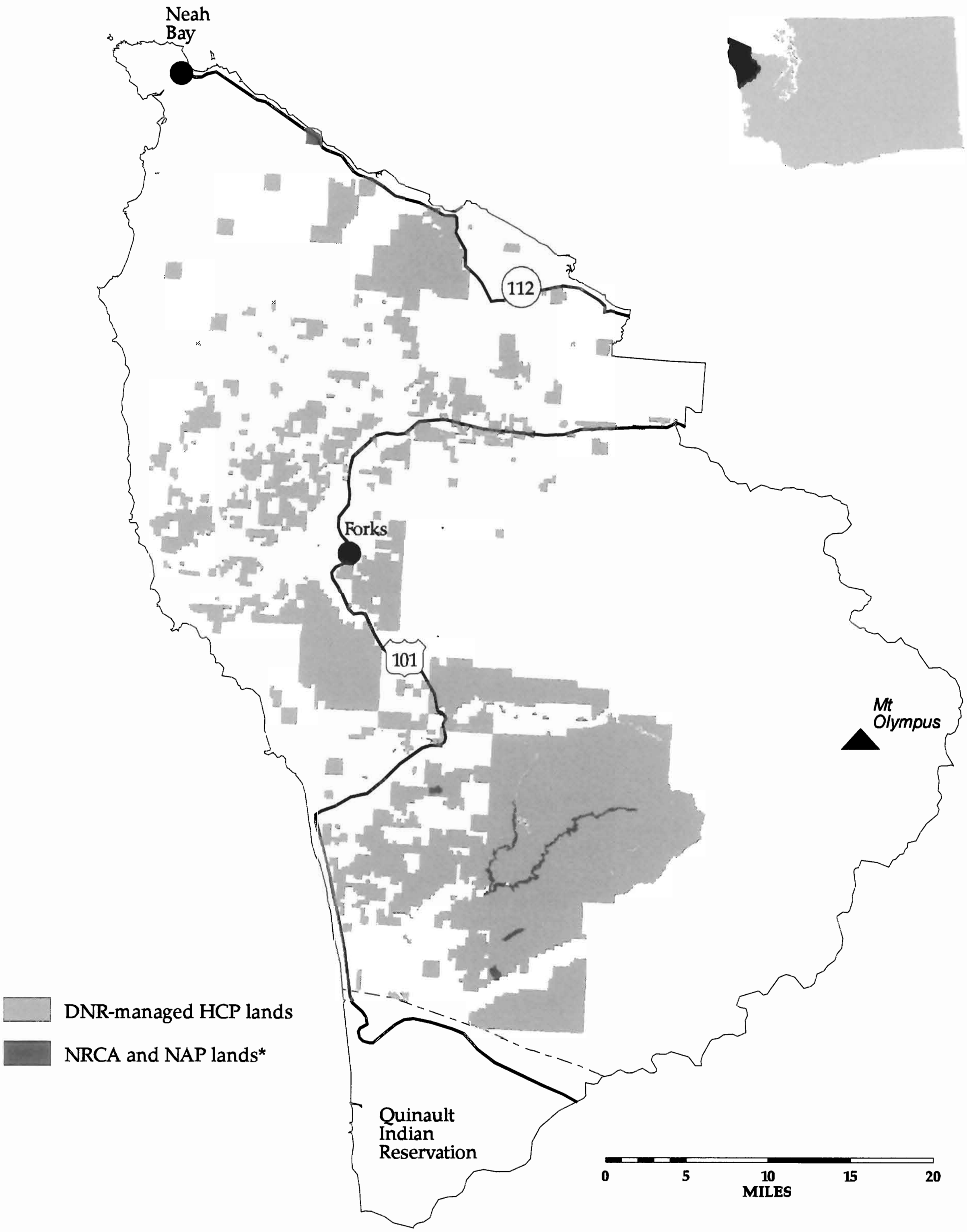
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.12: Chelan Planning Unit



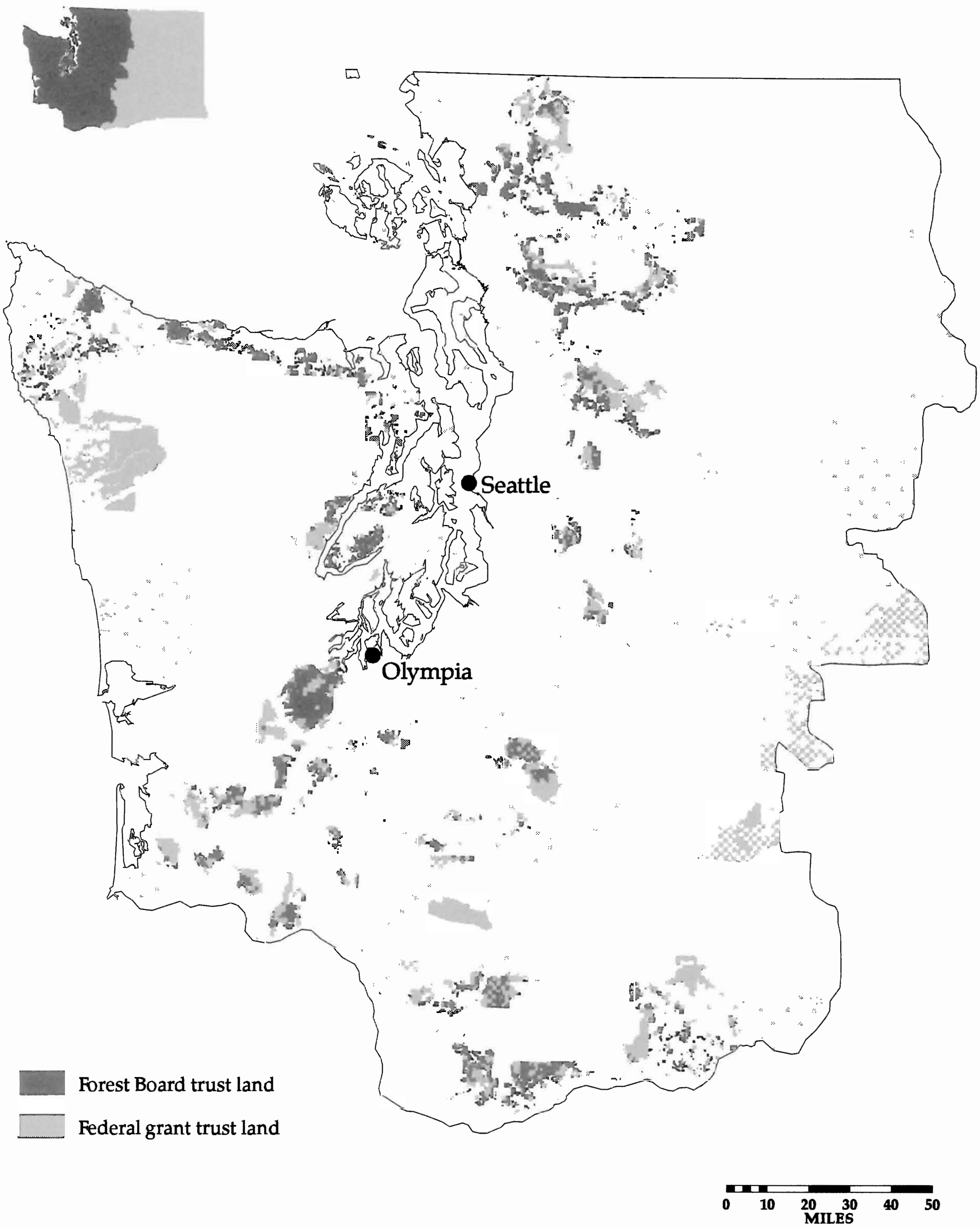
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map I.13: The Olympic Experimental State Forest Planning Unit



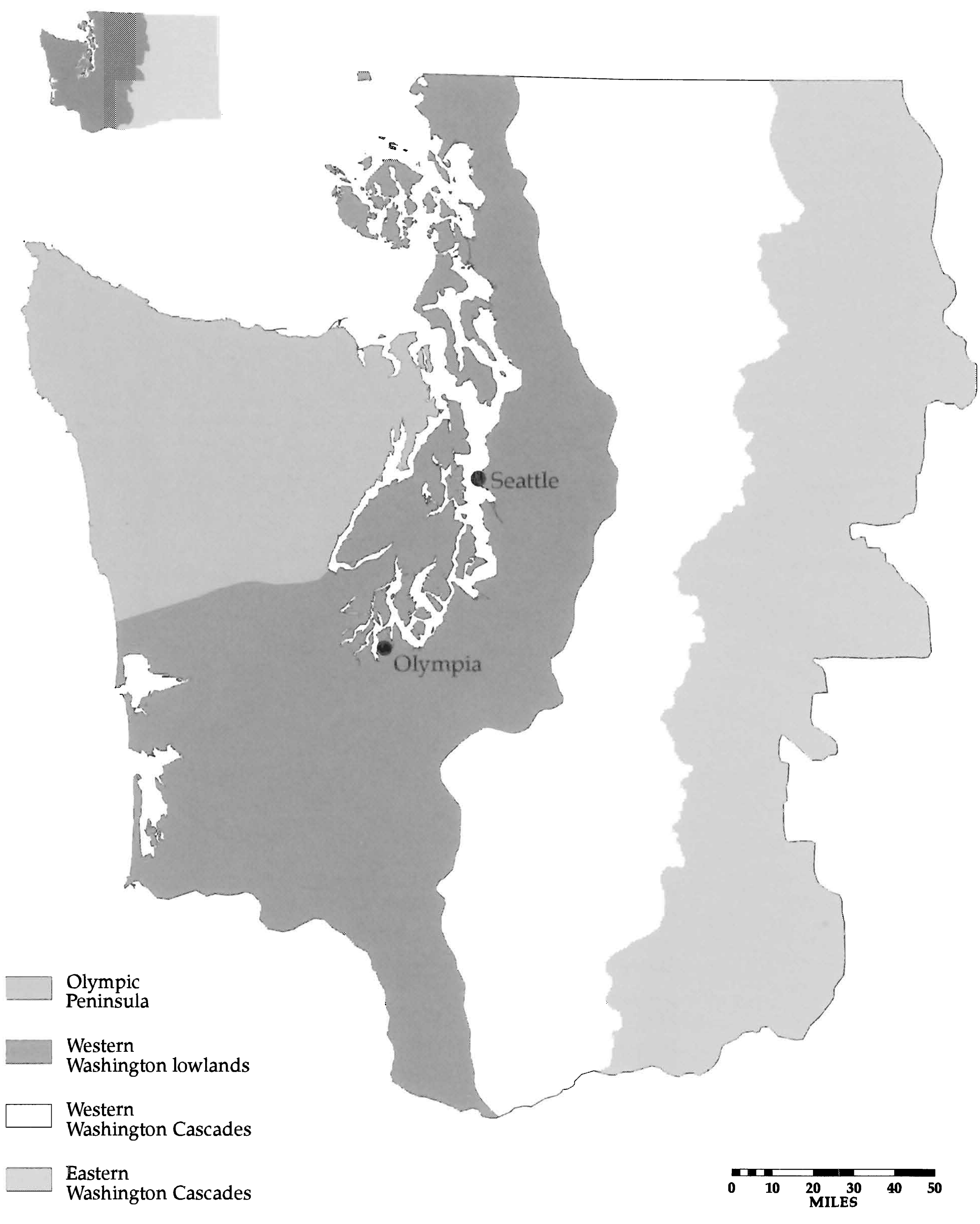
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map II.1: DNR-managed trust lands in the area covered by the HCP



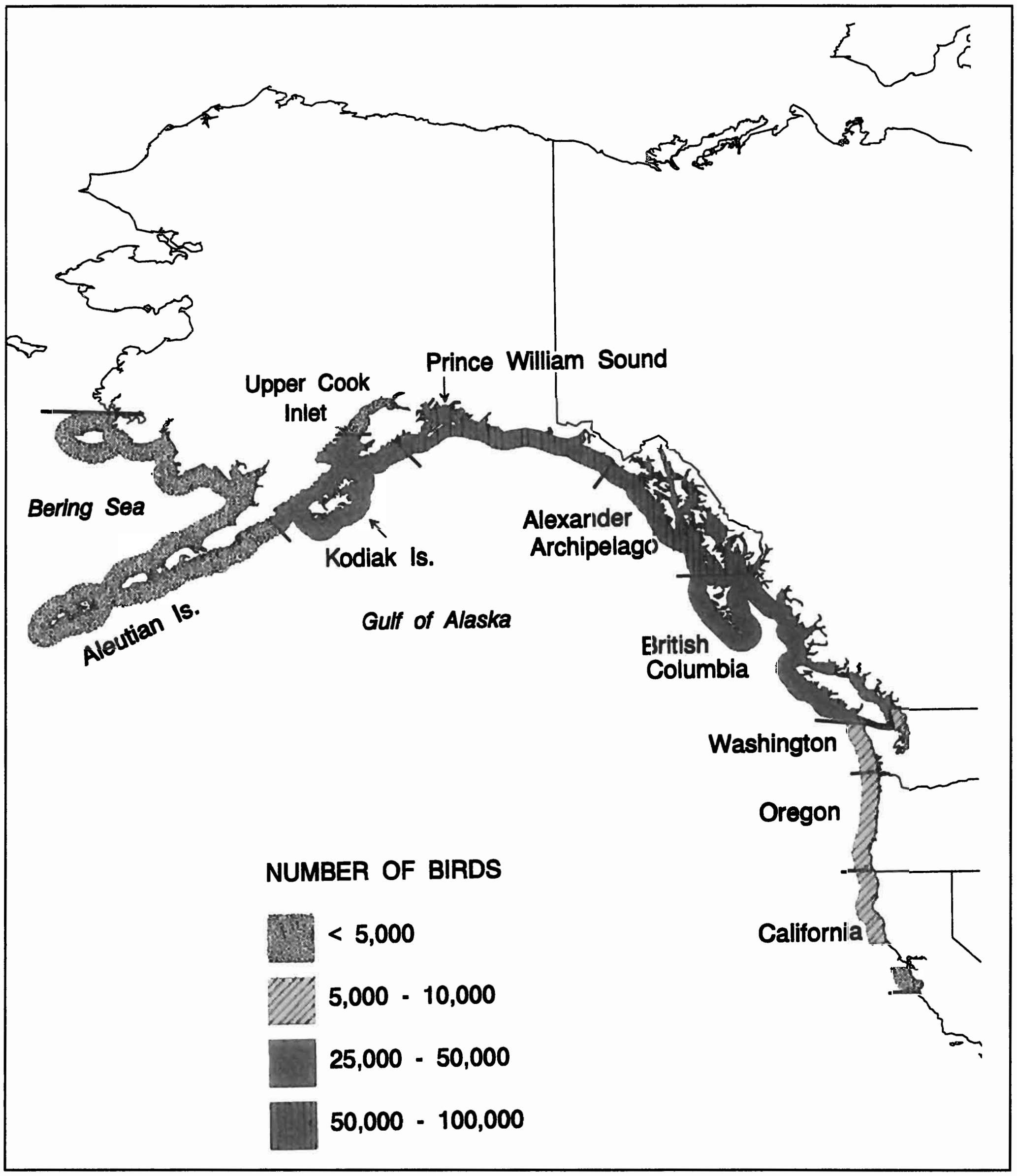
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.

Map III.1: Physiographic provinces of the northern spotted owl



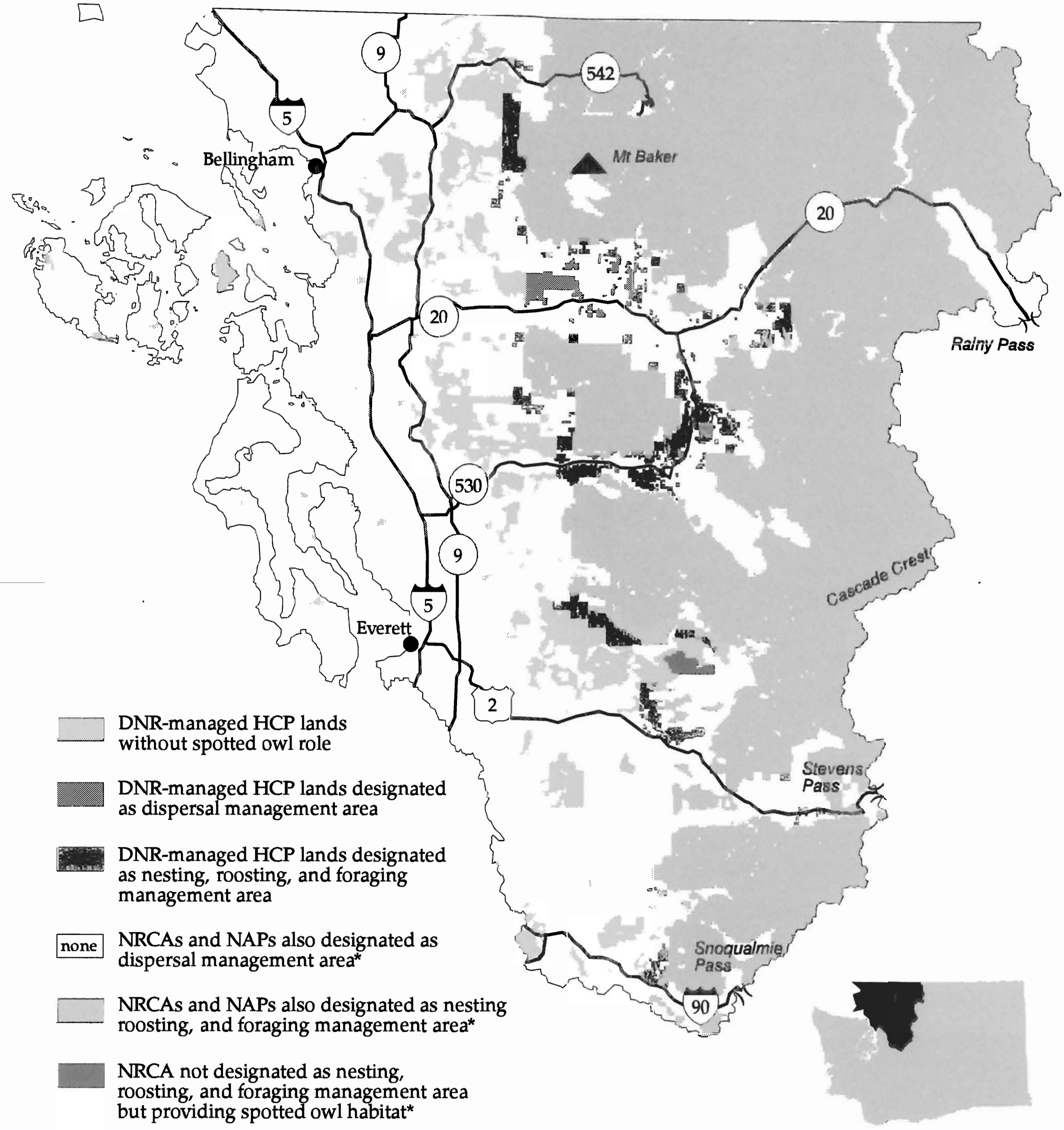
RMS 8/97 (Source: USDI 1992a p. 32)
This map is for planning purposes only.

Map III.2: Range of the marbled murrelet and population sizes along the Pacific coast



RMS 8/97 (Source: Reproduced from Ralph et al. 1995 p. 52)
This map is for planning purposes only.

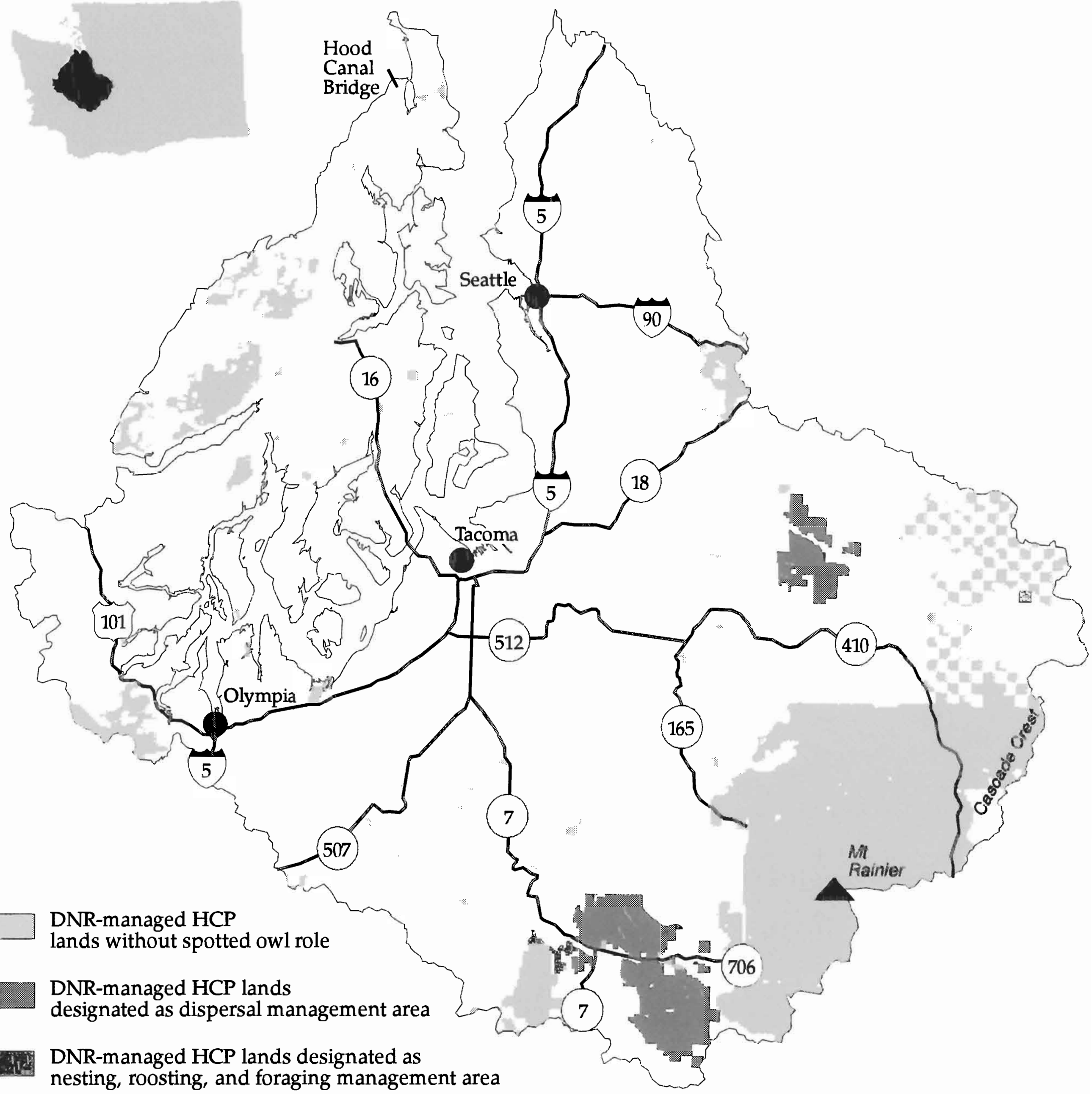
Map IV.1: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the North Puget Planning Unit



- DNR-managed HCP lands without spotted owl role
- DNR-managed HCP lands designated as dispersal management area
- DNR-managed HCP lands designated as nesting, roosting, and foraging management area
- none — NRCAs and NAPs also designated as dispersal management area*
- NRCAs and NAPs also designated as nesting roosting, and foraging management area*
- NRCA not designated as nesting, roosting, and foraging management area but providing spotted owl habitat*
- Federal reserves (including Late Successional Reserves, Managed Late Successional Reserves, Adaptive Management Areas, Wilderness Areas, & National Parks)

RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves: See section in Chapter I titled Land Covered by the HCP.

Map IV.2: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the South Puget Planning Unit



DNR-managed HCP lands without spotted owl role

DNR-managed HCP lands designated as dispersal management area

DNR-managed HCP lands designated as nesting, roosting, and foraging management area

none NRCAs and NAPs also designated as dispersal management area*

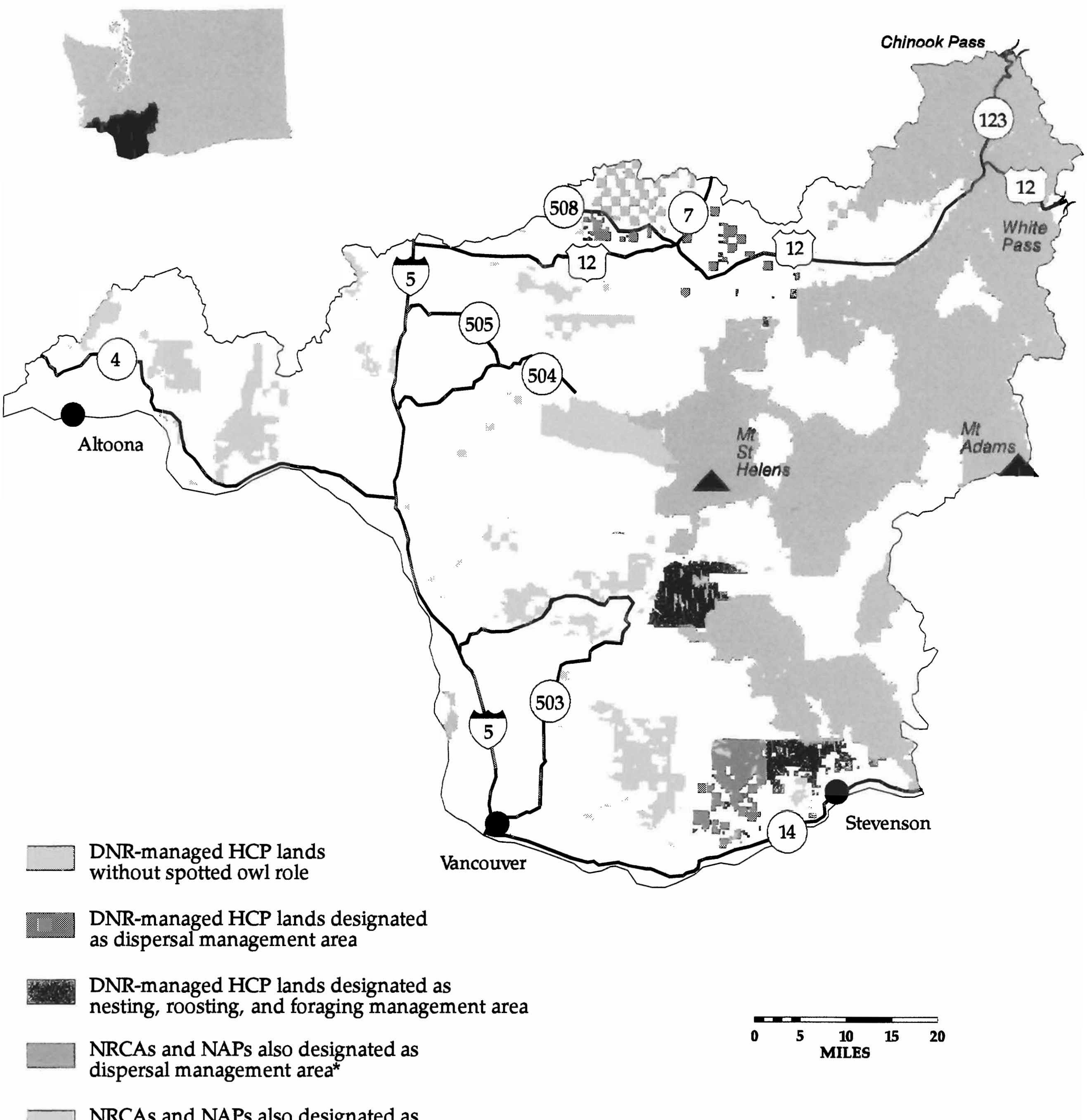
none NRCAs and NAPs also designated as nesting, roosting, and foraging management area*

Federal reserves (including Late Successional Reserves, Managed Late Successional Reserves, Adaptive Management Areas, Wilderness Areas, & National Parks)

0 5 10 15 20
MILES

RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves: See section in Chapter I titled Land Covered by the HCP.

Map IV.3: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the Columbia Planning Unit



DNR-managed HCP lands without spotted owl role

DNR-managed HCP lands designated as dispersal management area

DNR-managed HCP lands designated as nesting, roosting, and foraging management area

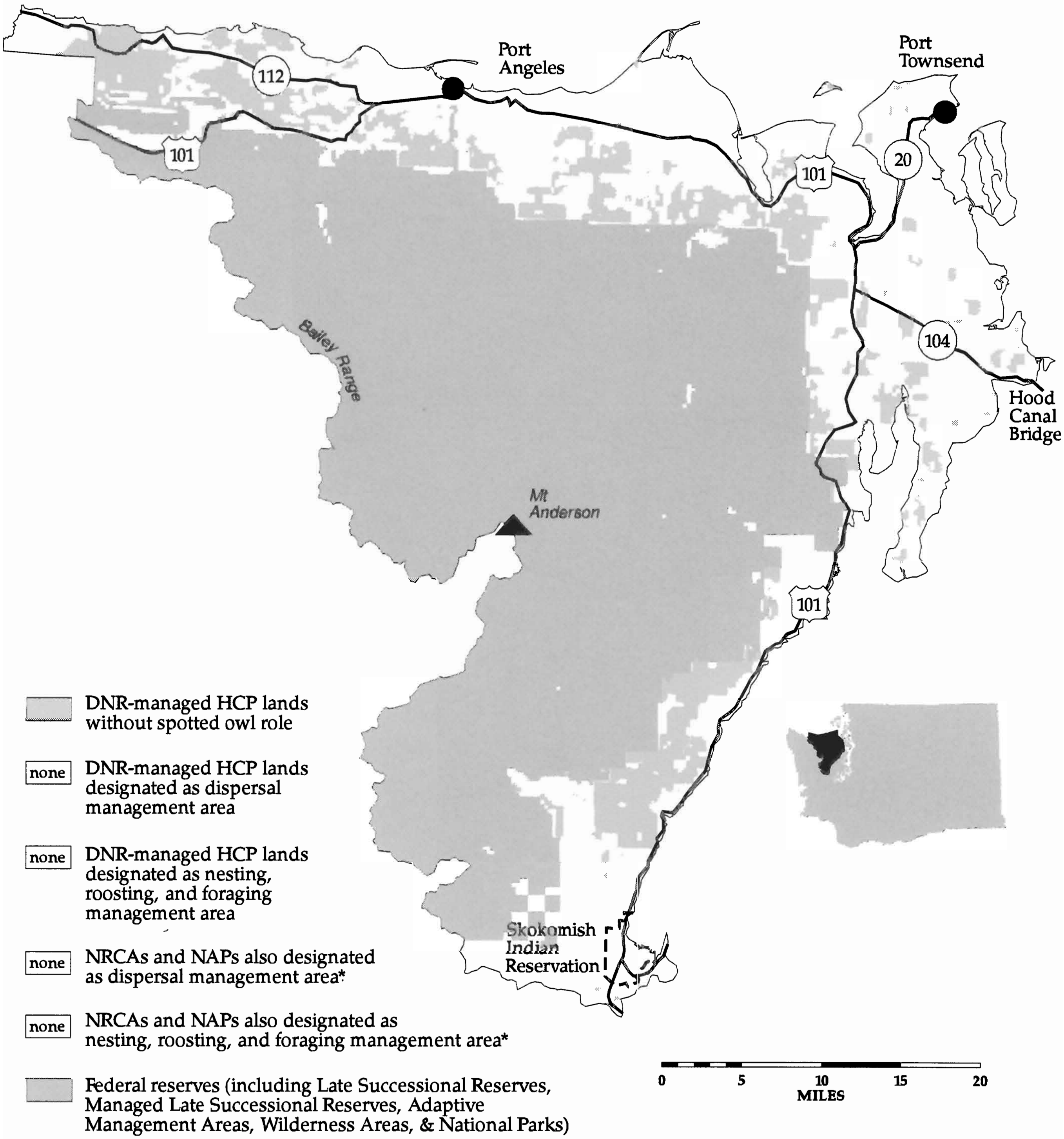
NRCAs and NAPs also designated as dispersal management area*

NRCAs and NAPs also designated as nesting, roosting, and foraging management area*

Federal reserves (including Late Successional Reserves, Managed Late Successional Reserves, Adaptive Management Areas, Wilderness Areas, & National Parks)

RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map IV.4: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the Straits Planning Unit



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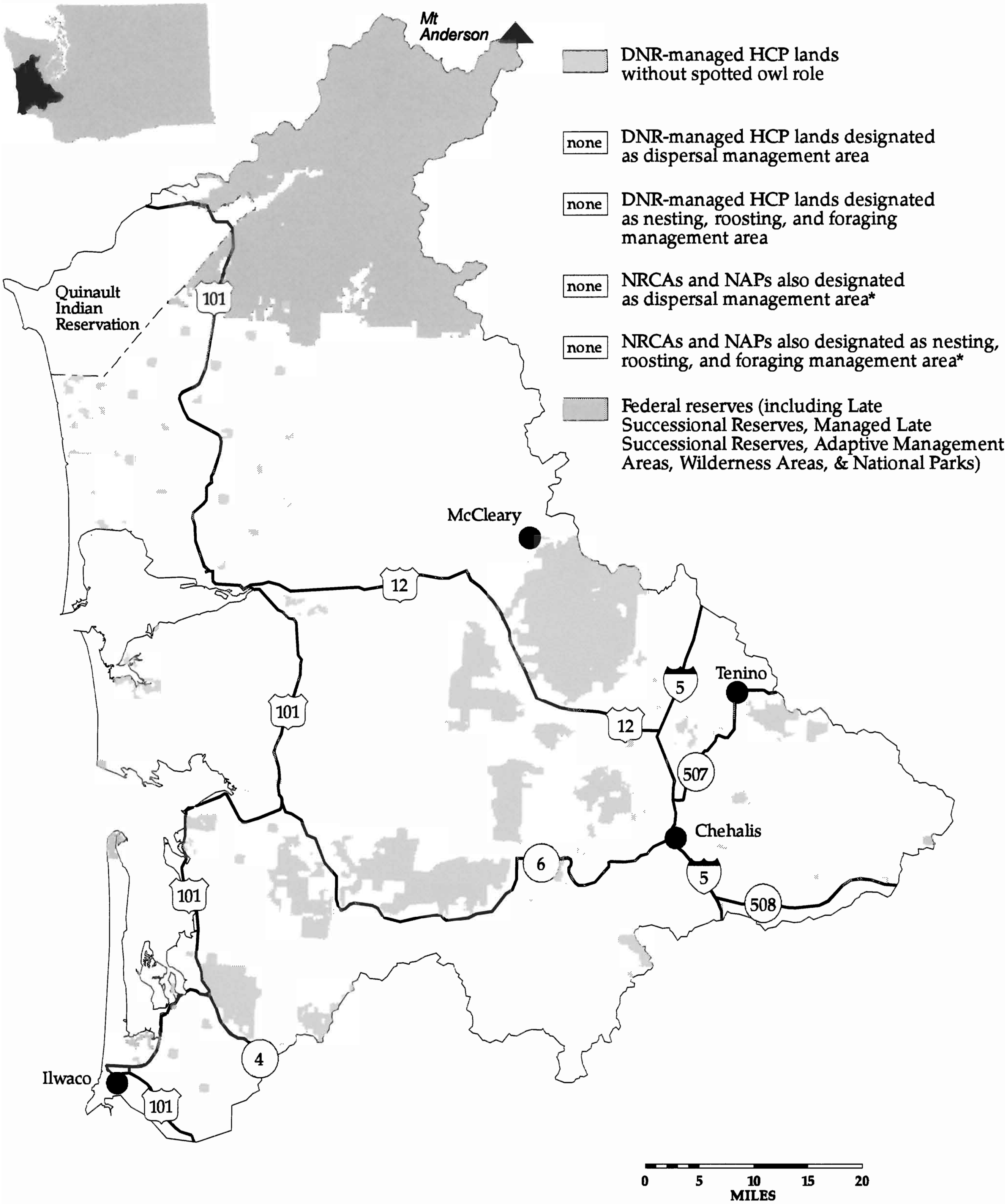
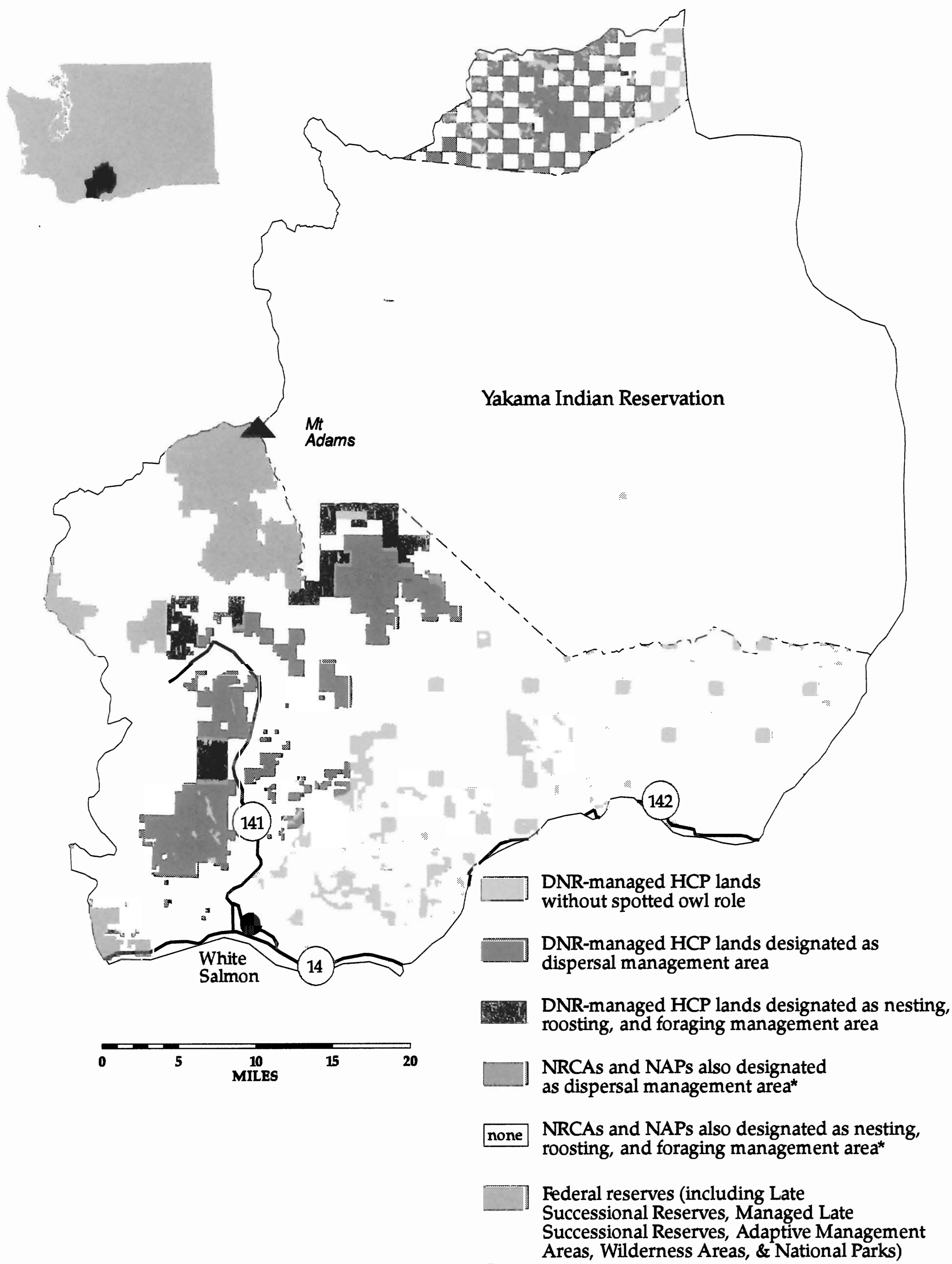
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves: See section in Chapter I titled Land Covered by the HCP.

Map IV.5: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the South Coast Planning Unit



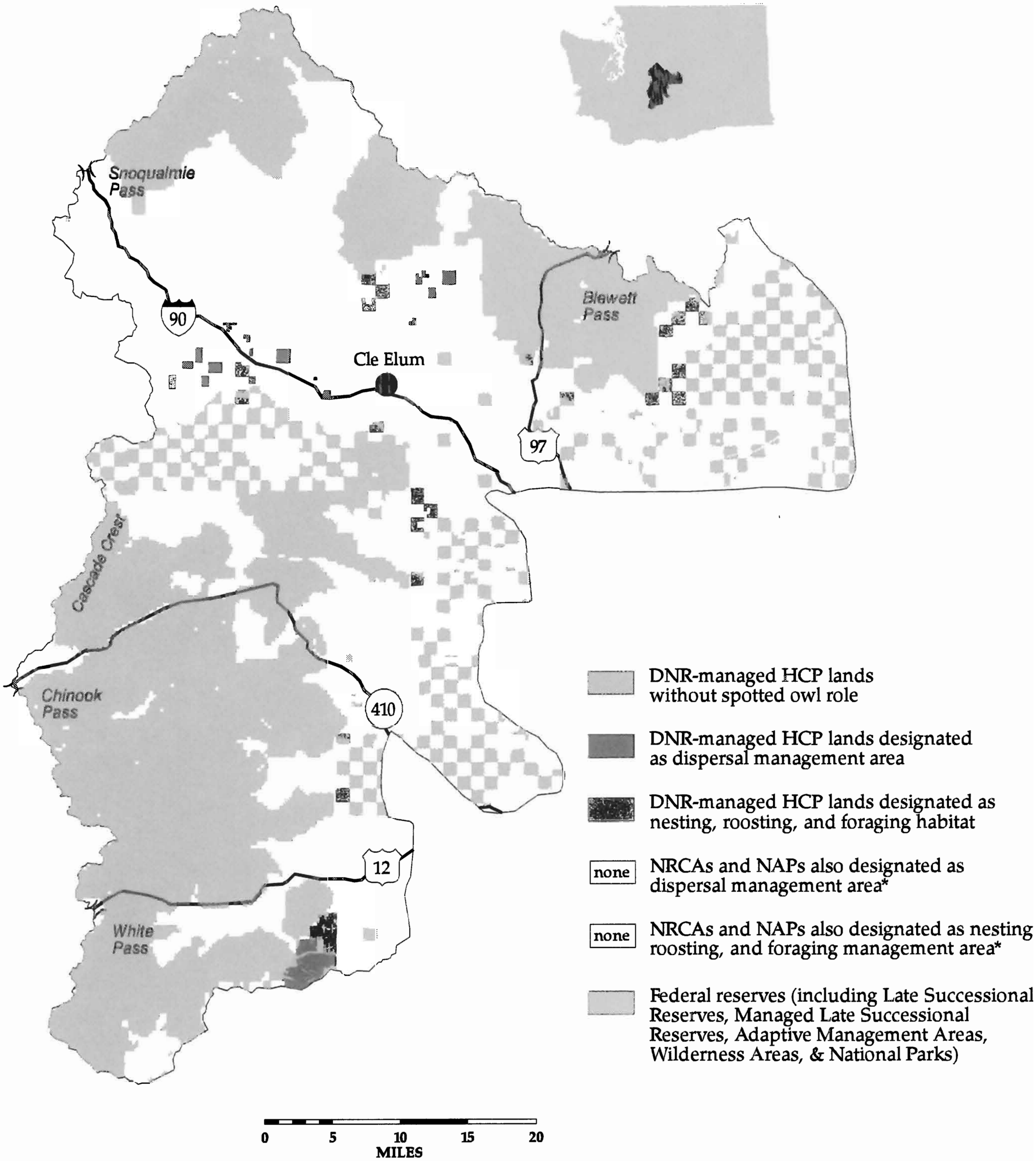
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves: See section in Chapter I titled Land Covered by the HCP.

Map IV.6: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the Klickitat Planning Unit



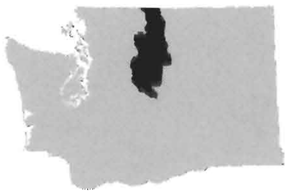
RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves:
See section in Chapter I titled Land Covered by the HCP.

Map IV.7: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the Yakima Planning Unit



RMS 8/97 (Source: DNR Geographic Information System, January 1997)
This map is for planning purposes only.
*Natural Resources Conservation Areas and Natural Area Preserves: See section in Chapter I titled Land Covered by the HCP.

Map IV.8: Role of DNR-managed lands in providing mitigation for the northern spotted owl in the Chelan Planning Unit



DNR-managed HCP lands without spotted owl role

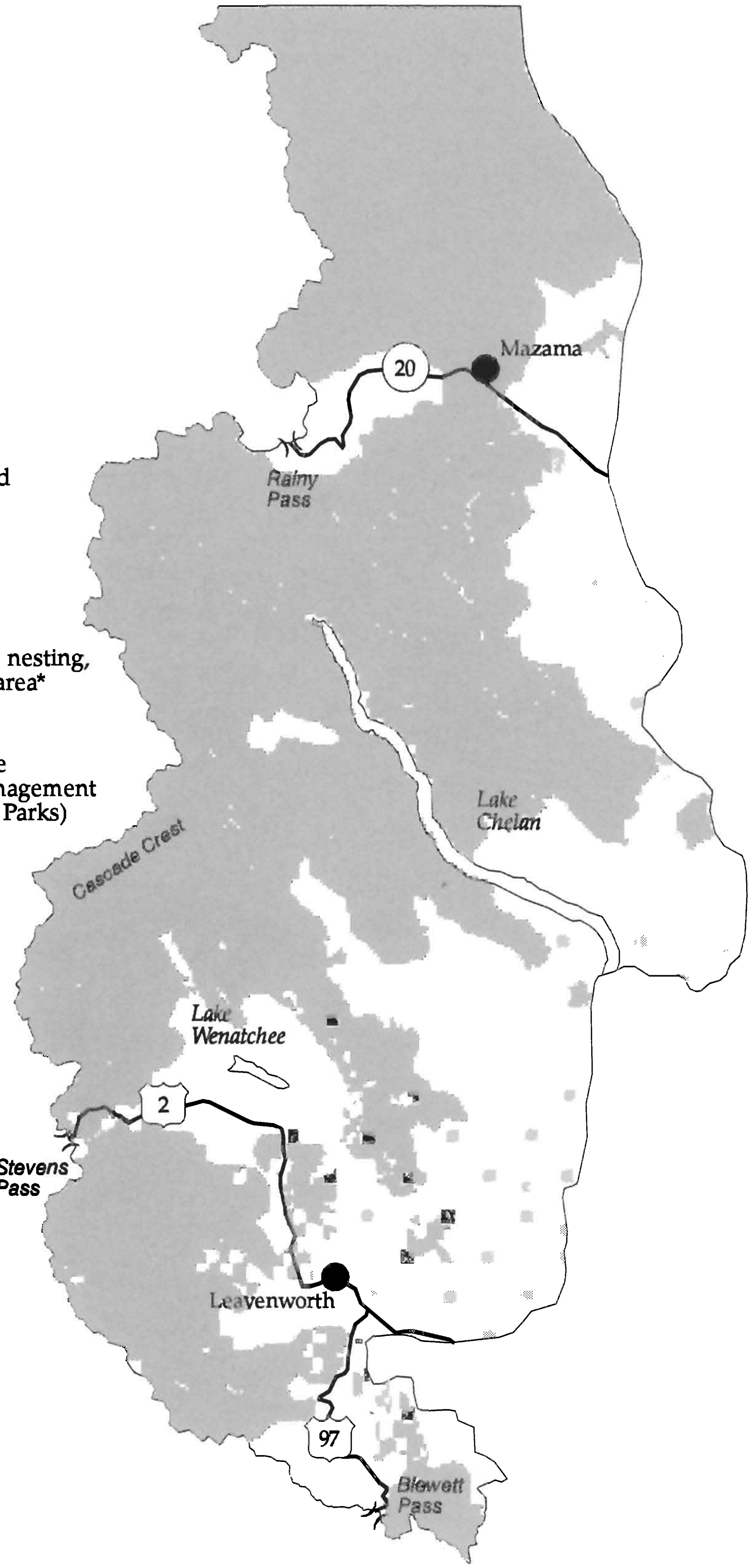
none — DNR-managed HCP lands designated as dispersal management area

DNR-managed HCP lands designated as nesting, roosting, and foraging management area

none — NRCAs and NAPs also designated as dispersal management area*

NRCAs and NAPs also designated as nesting, roosting, and foraging management area*

Federal reserves (including Late Successional Reserves, Managed Late Successional Reserves, Adaptive Management Areas, Wilderness Areas, & National Parks)



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RMS 8/97 (Source: DNR Geographic Information System, January 1997)
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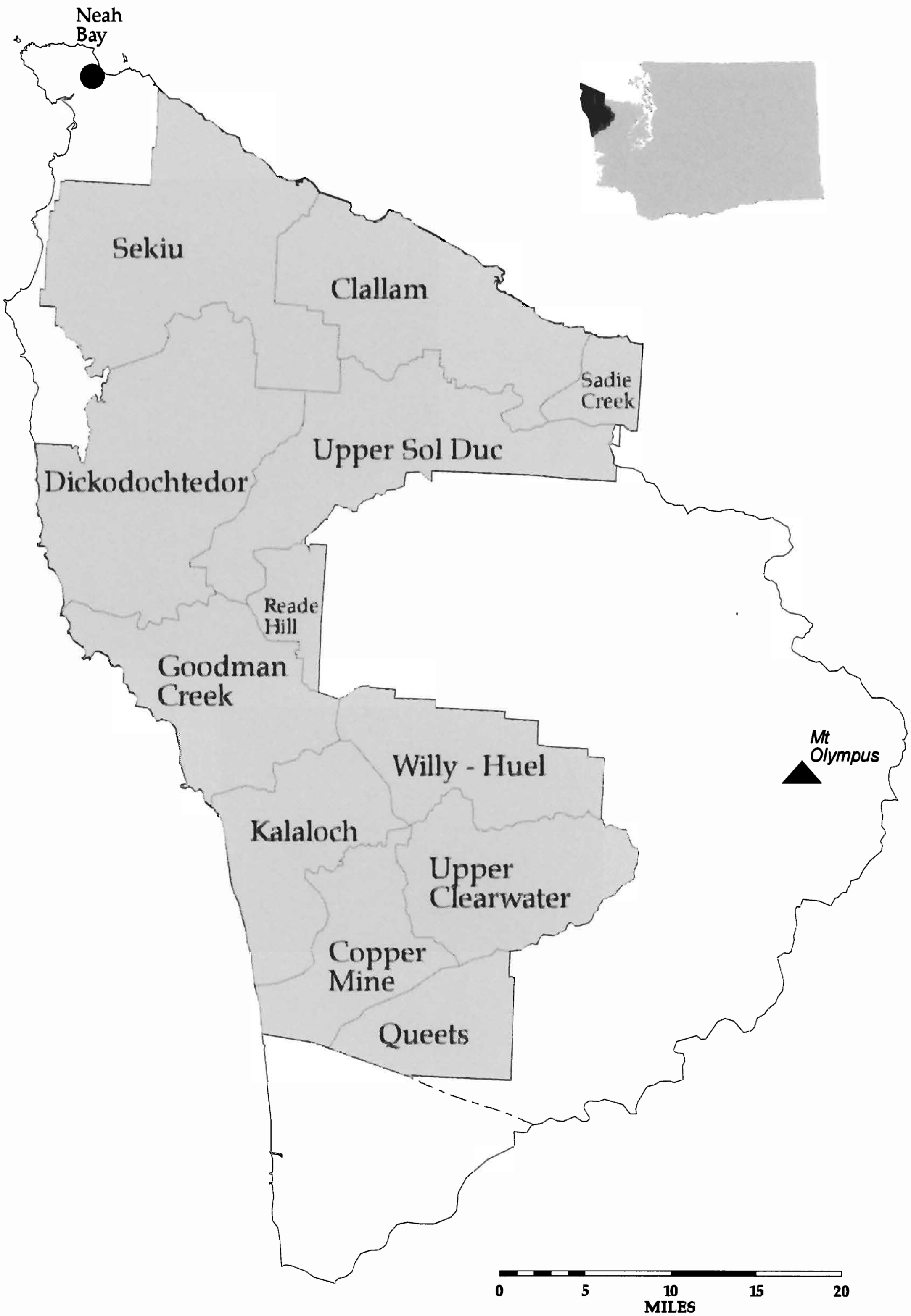
*Natural Resources Conservation Areas and Natural Area Preserves: See section in Chapter I titled Land Covered by the HCP.

Map IV.9: Landscape planning units in the Olympic Experimental State Forest



RMS 8/97 (Source: DNR Geographic Information System, January 1997)
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Natural Resources
Jennifer M. Belcher - Commissioner of Public Lands

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