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4.6 Fisheries and Aquatic Resources

4.6.1 Introduction

This section addresses the potential for impacting fisheries and aquatic resources by implementing management regimes associated with the proposed NFHCP, other action alternatives, and No Action Alternative. The analysis focuses on Permit species and their habitat, but also addresses other endangered, threatened, or special status aquatic species as well as other aquatic resources occurring in the Project and Planning Areas. Eight of the Permit species have federal protected status under the ESA, all as threatened:

- Columbia River Basin (CRB) bull trout Distinct Population Segment (DPS)
- Snake River steelhead Evolutionarily Significant Unit (ESU)
- Snake River spring/summer chinook salmon ESU
- Snake River fall chinook salmon ESU
- Lower Columbia River steelhead ESU
- Lower Columbia River chinook salmon ESU
- Columbia River chum salmon ESU
- Mid-Columbia River steelhead ESU

The status and scientific names for the Permit species are provided in Table 4.6-1. Throughout this document, the CRB bull trout DPS is referred to as **bull trout**.

Which Alternative is Best for Native Salmonids?

The effects of the alternatives are described in terms of the NFHCP Biological Goals, or the Four C's: cold, clean, complex, and connected water. Under the No Action Alternative, the Four C's would improve somewhat through time. Habitat conditions could potentially improve faster (or be maintained better) under both the Internal Bull Trout Conservation Plan and the Simplified Prescriptions Alternatives than under the No Action Alternative. The NFHCP would have the greatest potential for improvement to the Four C's, and would therefore have the greatest potential benefit for native salmonids. Improvements in habitat quality are likely to be greatest under the proposed 30-year Permit, and would diminish under the optional 10- and 20-year Permits.

4.6.2 Issues Eliminated from Further Analysis

Most fisheries and aquatic resources issues identified during public scoping were analyzed. The following were eliminated by FWS and NMFS (1998) from further analysis for the reasons given:

- Reasons are not clear or compelling for listing bull trout and should be assessed—The EIS will describe the basis for listing but it is beyond the scope of this EIS to defend or refute that basis.
- The NFHCP must not prevent the listing of bull trout or other aquatic species—The decision to list species is addressed by Section 4 of the ESA and is beyond the scope of this EIS, which addresses issuing a Permit under Section 10 of the ESA.

TABLE 4.6-1
State and Federal Protective Status of Native Salmonids in the Planning Area

Species	Montana	Idaho	Washington	Federal
Resident Freshwater Species				
Bull trout (*Salvelinus confluentus*)	SC	SC	SC	T
Redband trout (*Oncorhynchus mykiss*)	SC	SC	--	SC
Coastal rainbow trout (*Oncorhynchus mykiss*)	--	--	--	--
Southwestern Washington/Columbia River coastal cutthroat trout DPS (*Oncorhynchus clarki clarki*)	--	--	--	P
Westslope cutthroat trout (*Oncorhynchus clarki lewisi*)	SC	SC	SC	SC
Mountain whitefish (*Prosopium williamsoni*)	--	--	--	--
Pygmy whitefish (*Prosopium coulteri*)	--	--	SC	--
Anadromous Species				
Snake River steelhead ESU (*Oncorhynchus mykiss*)	--	SC	SC	T
Mid-Columbia River steelhead ESU (*Oncorhynchus mykiss*)	--	--	SC	T
Lower Columbia River steelhead ESU (*Oncorhynchus mykiss*)	--	--	SC	T
Snake River spring/summer chinook salmon ESU (*Oncorhynchus tshawytscha*)	--	T	SC	T
Upper Columbia River summer/fall chinook salmon ESU (*Oncorhynchus tshawytscha*)	--	--	--	--
Snake River fall chinook salmon ESU (*Oncorhynchus tshawytscha*)		E	SC	T
Mid-Columbia River spring chinook salmon ESU (*Oncorhynchus tshawytscha*)	--	--	--	--
Lower Columbia River chinook salmon ESU (*Oncorhynchus tshawytscha*)	--	--	SC	T
Lower Columbia River/Southwest Washington coho salmon ESU (*Oncorhynchus kisutch*)	--	--	--	C
Columbia River chum salmon ESU (*Oncorhynchus keta*)	--	--	SC	T

Key for state and federal status categories:

ESU = Evolutionarily significant unit
SC = Species of concern or special concern
E = Endangered
T = Threatened
P = Proposed for listing as threatened
C = Candidate for listing as threatened
-- = No listed status

- FWS has a duty to designate critical habitat—This is done under Section 4 of the ESA, not Section 10, and is beyond the scope of this EIS.

- Include copies of Federal Register (FR) announcements of species-specific recovery plans—FR announcements will be referenced if plans are available.

- The NFHCP should contain fisheries population objectives and fish habitat requirements—The Services' decision on Permit issuance will focus on the NFHCP achieving fisheries habitat objectives, which are within Plum Creek's control, but will not contain population objectives because fish populations could be influenced by a variety of factors unrelated to Plum Creek's actions, such as effects of downstream dams on steelhead migration and the effects of land management activities conducted by entities other than Plum Creek.

- Why is there a bounty on squawfish but not bull trout since both are salmonid predators—Beyond the scope of this EIS, which is intended to address the effects of issuing a Permit, covering forestry-related actions, on native salmonids.

- Assess translocation as the best method for achieving bull trout recovery—Beyond the scope of this EIS, which is intended to address the effects of issuing a Permit, covering forestry-related actions on native salmonids.

- Assess increasing bull trout by using hatcheries and closing the fishing season—Beyond the scope of this EIS, which is intended to address the effects of issuing a Permit, covering forestry-related actions on native salmonids.

- Address concerns of excess harvest of salmonids—Defining what constitutes excess harvest is beyond the scope of this EIS, which is intended to address the effects of issuing a Permit, covering forestry-related actions on native salmonids.

4.6.3 Issues Addressed in the Impact Analysis

A number of specific issues directly or indirectly related to fisheries and aquatic resources were identified during public scoping and are described in detail in the Scoping Report (FWS and NMFS 1998). Those issues are addressed in the impact analyses contained in this EIS/NFHCP and are generally represented by the following broad concerns:

- Address the many limiting factors external to streams and within fish-bearing and non-fish-bearing perennial and intermittent streams that have impacted bull trout, steelhead, and other Permit species.

- Address the need to provide and protect the Four C's of clean, cold, complex, and connected water for resource viability, harvest, and recovery.

- Assess the basis and validity of the aquatic ecosystem management approach for benefiting native salmonids given the tiered categorization of watersheds.

- NFHCP conservation measures should maintain, protect, and restore cold waters and spawning and rearing habitats throughout watersheds.

- Assess life history requirements, distribution, and threats to bull trout subpopulations, steelhead, and other Permit species.

- Assess how NFHCP conservation measures and any impacts from covered activities would affect Permit species on Plum Creek lands and adjacent lands.

- Compare the effects of implementing the NFHCP, a range of action alternatives, and the No Action Alternative.

Detailed public comments in the Scoping Report can be reviewed on the Internet at the FWS's site (http://www.fws.gov/r1srbo/srbo/plumck.htm) or at Plum Creek's site (http://www.plumcreek.com).

Many of the issues addressed in the impact analysis, including those listed above, are related to aquatic habitat. These issues can be assessed by focusing primarily on concerns associated with the Four C's, which are described later in this section under the heading, *Ecological Implications of Land Management Activities on Aquatic Habitat and Fish,* and by determining whether the NFHCP's 4 biological goals and 15 specific habitat objectives established by Plum Creek for each of the Four C's can be achieved. Issues associated with the following biological goals listed in Table 4.6-2 are addressed in the impact analysis.

4.6.4 Description of Area of Influence

The area of influence for fisheries and aquatic resources includes surface waters within the Project Area (Plum Creek lands) and Planning Area (Plum Creek and adjacent lands) in western Montana, northern Idaho, and Washington. Project and Planning Area boundaries are shown on Map 1.3-1 in Chapter 1. At a broad scale, these surface waters include those that could potentially be affected by implementing the proposed NFHCP, other action alternatives, or No Action Alternative in such a manner that habitat for the Permit species and any threatened or endangered species would be directly or indirectly affected. These are the same surface waters as described for the area of influence in Section 4.3, *Water Resources and Hydrology*. These waters may be fish-bearing or non-fish-bearing, and consist of perennial rivers and streams, intermittent drainages, and lakes, ponds, and wetlands. Additional areas of influence include those waters and adjacent riparian corridors and upland areas that provide habitat for, or contribute to the well-being of, the Permit species assessed in this document. These waters are depicted on maps in this section for bull trout, steelhead, and most of the other Permit species.

The Project Area contains more than 5,000 miles of perennial and intermittent streams. Of this total, there are approximately 190 miles of rivers or large streams likely to be fish-bearing, 1,400 miles of fish-bearing intermittent streams and perennial streams (this category includes an unknown amount of non-fish-bearing perennials), 260 miles of streams known to be non-fish-bearing perennials, and 3,200 miles of intermittent streams that are non-fish-bearing. The Project Area contains 312 miles of streams that support bull trout. Of this total, 175 miles (56 percent) are in Tier 1 watersheds and 137 miles (44 percent) are on Tier 2 lands and are primarily Key Migratory Rivers (Plum Creek 1999a).

TABLE 4.6-2
Biological Goals and Objectives of Plum Creek's NFHCP

Biological Goal	Specific Habitat Objectives
Cold Protect stream temperatures where they are suitable for fish, and contribute to restoration of temperatures where past Project Area management has rendered them unsuitable.	1. Minimize impacts on canopy closure and changes in channel morphology resulting from riparian timber harvest and grazing. 2. Improve the ability of riparian vegetative communities to provide canopy closure over streams through passive and active restoration. 3. Create a net increase in canopy closure over streams.
Clean Protect instream sediment levels where they are suitable for fish and contribute to restoration of instream sediment levels where they have been impacted by past Project Area management.	4. Minimize sediment delivery to streams resulting from the construction of new roads and timber harvesting. 5. Reduce sediment delivery to streams from existing roads. 6. Create a net reduction in sediment delivery to streams. 7. Contribute to restoration of the function of riparian vegetative communities for sediment filtration and streambank stability.
Complex Protect in-stream habitat diversity where it is suitable for fish and contribute to restoration of instream habitat diversity where it has been impacted by past Project Area management.	8. Minimize impacts on large woody debris recruitment and bank stability in harvested streamside stands. 9. Minimize impacts on overhanging stream banks because of grazing or riparian harvest. 10. Improve the ability of riparian forests to provide a broad range of riparian functions to streams. 11. Improve the ability of riparian vegetative communities to develop overhanging banks and other habitat diversity through passive or active restoration. 12. Create a net increase in large woody debris recruitment potential and other riparian functions in the Project Area.
Connected Protect and contribute to restoration of connectivity among sub-populations of native fish in the Project Area.	13. Avoid creating fish passage barriers when constructing stream crossings. 14. Restore fish passage where existing road stream crossings restrict passage. 15. Cooperate to restore fish migration where restricted by other factors, such as irrigation diversions or thermal barriers.

A helpful scale for summarizing potential influences on fisheries and aquatic resources is by Planning Area basin (see Section 2.2, *Land Ownership and Planning Area Basins*). Table 4.6-3 provides a broad overview of various attributes by Planning Area basin, including the distribution of Plum Creek versus federal ownership by Tier, lengths of Key Migratory Rivers, stream miles affected by grazing, and estimated new road construction. This information can be used to qualitatively identify those Planning Area basins that would benefit

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most from various categories of conservation measures, such as road management, grazing management, riparian management, and land use. For example, grazing management actions would mostly affect those basins that have significant lengths of streams in Plum Creek grazing leases. As shown in Table 4.6-3, the Blackfoot River Planning Area basin has 405 miles of Project Area streams in grazing leases, whereas the Lower Tieton River Planning Area basin has only 21 miles. The Lochsa basin has no grazing leases on Project Area lands. Similarly, road upgrading would most greatly benefit Planning Area basins with more roads (for example, Middle Clark Fork River and Middle Kootenai River Planning Area basins). This table is referred to frequently later in this document to compare alternatives.

4.6.5 Affected Environment

Permit Species

Table 4.6-1 lists the common and scientific names of the 17 Permit species of native salmonids covered in the proposed NFHCP, as well as federal and state protective status afforded these species. Seven of the species are residents, spending most or all of their lives in freshwater, while 10 of the species are anadromous, spending most of their lives at sea. Of the 17 species identified in Table 4.6-1, eight are classified under the ESA as threatened with varying distributions in the Project Area, and the remainder are protected by various state laws.

The NFHCP was developed to maintain, improve, or provide habitat on Plum Creek lands for those native salmonids occurring in the Project and Planning Areas that are listed in Table 4.6-1. The NFHCP is part of Plum Creek's application to the Services for the incidental take (under Section 10 of the ESA) of the eight salmonid species federally listed as threatened. FWS and NMFS policy allows the inclusion of unlisted species in HCPs, even though they are not technically protected under Section 9 of the ESA against take and no federal Permit is needed for their incidental take (FWS 1996). The Permit authorizing incidental take for the nine unlisted species of native salmonids identified in Table 4.6-1 would take effect on the date of any future listing of these species with no further action required by Plum Creek, except as described in the Implementing Agreement (IA) in Appendix A. Plum Creek intends to implement all prescriptions described under the NFHCP in Chapter 3 and referred to in the IA regarding unlisted species on final approval of the NFHCP by the Services.

All species listed in Table 4.6-1 are considered game fish by management agencies and provide recreational value. Chinook salmon are also commercially valuable, primarily because of the ocean fishery. Whitefish, while not generally considered a sport fish, do provide some recreational and food value. Other salmonids present in the Project and Planning Areas were not included in the NFHCP because they are non-native and are considered by most biologists to be detrimental to native populations because of competition, predation, and hybridization. Non-native salmonids include brook trout (*Salvelinus fontinalis*), lake trout (*Salvelinus namaycush*), brown trout (*Salmo trutta*), introduced rainbow trout (*Oncorhynchus mykiss*) and introduced Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*).

What Species and Habitat Characteristics are Important?

The EIS alternatives will be evaluated, in part, based on the requirements of Permit species included in the NFHCP. The following subsections describe the distribution, status, life history characteristics, habitat requirements, and factors affecting populations for the native salmonid species. General background information common to all the species is presented first, followed by individual discussions of each species.

General Information

Distribution. All salmonids covered in the NFHCP are native to at least portions of the Planning Area. Geographically, the resident trout species are the most widespread group. Resident trout occur in large and small streams in at least some portion of most watersheds in the Planning Area. They also occur in most of the lakes and reservoirs that support fish. The distribution of resident trout species varies considerably. Westslope cutthroat trout are the most widespread of these trout, occurring in most of the major watersheds of the Planning Area in Montana, Idaho, and Washington. Redband trout occur in the Kootenai River drainage in western Montana, and they occur in Idaho and Washington.

The anadromous species covered in the NFHCP (chinook salmon, coho salmon, steelhead, chum salmon, and coastal cutthroat trout) have wide-ranging distributions along the west coast of the United States and Canada and inland along the major waterways. The NFHCP focuses on those species, subspecies, or other biological entities (all defined as species under the ESA) that have been federally listed, or are under consideration, for protection. Five chinook salmon ESUs, three steelhead ESUs, one coho salmon ESU, and one chum salmon ESU are covered in the NFHCP and listed in Table 4.6-1.

Of the two whitefish species covered in the NFHCP, mountain whitefish are far more widely distributed than pygmy whitefish and almost as widely distributed as the resident trout species group. Pygmy whitefish are only found in a few specific locations of the Planning Area in northwestern Montana and northern Idaho.

Status of Populations. Nine of the 17 native salmonid Permit species have, or are proposed to have, special protective status at the federal level, as indicated in Table 4.6-1. At the federal level, species are listed under the ESA as either threatened or endangered. This listing determination is made by FWS for freshwater species and NMFS for anadromous species. The ESA listing process is explained in Chapter 1, Section 1.5.1, *Federal Regulations*. Some species may be classified as species of concern by states. This means that species' populations may be low in numbers, have a limited distribution, or have experienced significant habitat losses. Montana, Idaho, and Washington all have guidelines for classifying a species' status. Designation by a state focuses only on the status of the population within the state and not throughout the species' entire range.

Life History and Habitat Requirements. Salmonids may exhibit one or more general life history characteristics among species. The Services believe habitat needs of the Four C's of cold, clean, complex, and connected water are similar. Specific differences are described for each species in the following text.

The most fundamental characteristic is whether a species is anadromous or a freshwater resident. **Anadromous species** generally rear in freshwater, reach sexually maturity in the ocean or shortly after entering freshwater as an adult, then migrate to freshwater rivers and streams to spawn (although anadromous forms of coastal cutthroat trout may not enter the ocean until they are 2 to 6 years of age [NMFS 1996]). **Resident freshwater** species spend their entire lives in freshwater rivers, streams, or lakes. However, freshwater species can have several fundamental variations in their life history strategies:

- **Adfluvial**—stocks that migrate between lakes and streams
- **Fluvial**—stocks that migrate between small streams and larger rivers
- **Non-migratory resident**—stocks that remain in the streams where born
- **Lacustrine**—stocks that spend their entire lives in lakes

In general, salmon and steelhead are anadromous salmonids while trout and whitefish are resident freshwater fish. However, there are several exceptions to this generalization (for example, some forms of coastal cutthroat trout).

Salmonid habitat use and needs can be discussed and analyzed by the following life stages:

- Spawning and incubation habitat
- Juvenile rearing habitat
- Adult habitat, including migratory habitat
- Overwintering habitat

Descriptions and analysis of spawning and incubation habitat generally focus on the quality and type of substrate for egg-laying and the temperature and quality of water for incubation. Discussions of juvenile and adult habitat usually focus on cover (which includes items such as substrate, debris in streams, overhanging banks, and water depth), water quality and temperature, water flow (velocity), and the quality of food producing areas (typically riffle areas where most aquatic insect production occurs). Discussions of overwintering habitat typically focus on cover and water velocity. Key Migratory Rivers are shown on Map 4.6-1.

Factors Affecting Populations. All salmonids require cool, clean water for rearing and spawning; therefore, one of the most important components of their habitat is water quality. The more important aspects of water quality for salmonids are temperature, sediment, and pollutants (Groot and Margolis 1991; Rieman and McIntyre 1993). Temperature affects the growth of fish, as well as their food, and the duration of egg incubation. Each species has a preferred range of water temperature by life stage, and there is often much overlap in these ranges among species. Activities that affect water temperature include those that reduce stream shading.

The amount of sediment in a stream is also important. Excessive sediment can become embedded in the stream bottom. This potentially limits the amount of open, interstitial spaces and the flow of well-oxygenated water among the gravels and cobbles of the stream bottom. This, in turn, affects egg incubation and benthic invertebrate (insect) production and survival (Groot and Margolis 1991; Rieman and McIntyre 1993).

Bull Trout. Bull trout are trout-like in appearance and have a long broad head that is flat above and sharply tapered through the snout. However, bull trout are taxonomically classified as a char, which differ from trout by having light spots on a darker background on their sides, more than 190 scales in the lateral line, and few teeth in the roof of the mouth. Bull trout are similar in appearance to Dolly Varden (*Salvelinus malma*) and were only recently recognized as separate species based in part on chromosomal differences (Platts et al. 1993; FWS 1994). Bull trout feed on other fish. They were not historically an important game or commercial species and the taking of bull trout for purposes of reducing population levels was encouraged. Now, this species is recognized as an important part of the Pacific Northwest ecosystem and is listed as a threatened species under the ESA.

Bull Trout Distribution. Historically, bull trout occurred in major river drainages throughout the Pacific Northwest within the range of bull trout, but now only occupy about 45 percent of their historic range (FR 1998a). Their native range extends from the McCloud River Basin in northern California and Jarbidge River Basin in Nevada northward to headwaters in the Yukon River drainage in the Northwest Territories of Canada. West of the continental divide, their range includes the Puget Sound drainage, various coastal rivers of British Columbia, and south-eastern Alaska. Bull trout also occur in the Klamath River Basin in Central Oregon. Bull trout occur throughout the Columbia River Basin, including its headwaters in Montana and Canada. East of the divide, bull trout are found in the headwaters of the Saskatchewan and MacKenzie River Basins in Alberta and British Columbia.

Within the Columbia River Basin, FWS has analyzed bull trout population status in four geographic areas:

- Lower Columbia River (downstream of the Snake River confluence)
- Mid-Columbia River (Snake River confluence to Chief Joseph Dam)
- Upper Columbia River (upstream of Chief Joseph Dam)
- Snake River and its tributaries

Lands in the Planning Area occur in areas of the Lower Columbia River area (Lewis River drainage), Mid-Columbia River area (Ahtanum and Tieton River drainages), Upper Columbia River area (Kootenai, Flathead, Clark Fork, Blackfoot, and Swan drainages), and the Snake River area (Lochsa River drainage). Within the Planning Area, bull trout are most widely distributed in the Swan, Blackfoot, Kootenai, and Clark Fork River Basins. Bull trout populations are present in the other major drainages of the Planning Area, but they are generally limited to a few headwater streams. Map 4.6-2 shows bull trout distribution in Planning Area basins in Montana, Idaho, and Washington.

Status of Bull Trout Populations. FWS recently listed the Klamath River and Columbia River population segments of bull trout as threatened under the ESA with a special 4(d) rule (FR 1998a). The special rule allows for take of bull trout if the take is in accordance with applicable state and Native American tribal fish and wildlife conservation laws regulating harvest of fish by anglers. In Idaho, Montana, and Washington, bull trout are considered a species of concern (see Table 4.6-1).

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Insert Map 4.6-2
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Table 4.6-4 lists the status and trend for each subpopulation of bull trout present in Planning Area basin drainages as assessed by FWS (1998a). The status of most stream and river subpopulations is depressed or, in some cases, unknown. The trend for most subpopulations is unknown. Strong subpopulations have only been identified in portions of the Yakima, South Fork Flathead, and Swan River drainages (Table 4.6-4).

Bull Trout Life History and Habitat Requirements. Bull trout exhibit three different life history strategies over their range in the Project Area: resident, fluvial, and adfluvial. Resident populations usually occupy headwater streams, are often isolated from other populations by a physical barrier (FS 1989), and complete their entire life cycle in the home tributary or nearby streams in which they spawn and rear. Fluvial and adfluvial stocks are migratory. Fluvial stocks migrate between stream systems and larger rivers, and adfluvial stocks migrate between stream systems and lakes. These migratory stocks spawn in tributaries and rear as juveniles for 1 to 4 years before migrating to other streams or lakes. Although not present in the Project Area, bull trout can also exhibit an anadromous life history strategy, rearing in tributaries where spawned and then migrating to sea where they mature (FR 1998a).

Bull trout spawn during the fall, usually September and October; however, spawning may occur earlier or later depending on specific geographic location. Migratory stocks of bull trout may begin spawning migrations as early as April, and travel up to about 150 miles to reach spawning streams (FR 1998a). Bull trout require clean gravels for spawning, and appear to select groundwater upwelling zones in which to build their redds (Watson and Hillman 1997 [Technical Report #2]). These spawning areas often occur in low-gradient sections of moderate-sized streams. Various studies documenting bull trout spawning activities show that spawning can occur in water temperatures from 39 to 55°F (Rieman and McIntyre 1993).

Depending on water temperature, eggs incubate during the winter and early spring months for about 100 to 145 days, with fry emerging from early April through May. Few studies have been conducted on egg incubation; however, available data suggest preferable temperatures for bull trout egg incubation range from 39 to 43°F (Rieman and McIntyre 1993).

Upon hatching, bull trout fry may spend several weeks in the gravels before emerging into the water column of streams (FS 1989). Once emerged from the gravel, small bull trout (less than 4 inches long) primarily inhabit areas in or near the stream bottom among the gravels and cobbles (FS 1989). As juveniles grow, they tend to move to backwater and sidewater channels, eddies, or pools that provide suitable cover and substrate (FS 1989; FR 1998a). The Oregon Department of Environmental Quality (ODEQ 1995) and EPA (1997) at 40 CFR 131.E.1 indicate the optimum water temperature range for bull trout juvenile rearing is 39 to 50°F, although some studies have found that juvenile rearing can occur at substantially higher temperatures (Plum Creek 1998f).

Adult bull trout are primarily bottom dwellers, preferring deep pools or areas with sufficient cover in river habitat (FS 1989). Bull trout in headwater streams often use woody debris and overhanging banks along the stream margins for cover, while fish in lower river reaches often use

TABLE 4.6-4
Summary of Bull Trout Subpopulation Characteristics, Status, and Trends for Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Single Spawning Area	Refounding Unlikely	Life-History Forms[a]	Number	Data Type, Descriptor, Years[b]	Status[c]	Trend[d]	Risk of Stochastic Extirpation
Lower Columbia River area	Lewis River	Yale Reservoir	Y	N	M	22	S,A,3	D	U	N
		Swift Reservoir	N	Y	M	224	S,A,3	D	S	N
Mid-Columbia River area	Yakima River	Ahtanum Creek	Y	Y	R	8.5	R,A,4	D	D	Y
		Naches River	N	N	M,R	64	R,T,1	D	U	N
		Rimrock Lake	N	Y	M	311	R,A,4	S	I	N
Upper Columbia River area	Kootenai River	Upper Kootenai River	N	Y	M	500	R,A,2	U	U	N
		Sophie Lake	Y	Y	M	U	NA	U	U	Y
		Middle Kootenai River	Y	N	M,R	<75	R,A,2	U	U	N
		Lower Kootenai River	N	N	M	<40	R,A,4	U	U	N
		Bull Lake	N	Y	M	<75	R,A,2	U	U	N
	Flathead River	Flathead Lake	N	N	M	<200	R,A,18	D	D	N
		Whitefish Lake	N	N	M	LOW	MBTSG	D	D	N
		Upper Whitefish Lake	Y	Y	M	LOW	MBTSG	U	U	Y
		Tally Lake	Y	Y	M	LOW	R,A,4	D,E	D,E	Y
		Upper Stillwater Lake	N	Y	M	<20	R,A,2	D	D	N
		Lower Stillwater Lake	Y	N	M	E	MBTSG	D,E	E	N
		Cyclone Lake	Y	Y	M	<10	R,A,2	U	U	Y

TABLE 4.6-4
Summary of Bull Trout Subpopulation Characteristics, Status, and Trends for Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Single Spawning Area	Refounding Unlikely	Life-History Forms[a]	Number	Data Type, Descriptor, Years[b]	Status[c]	Trend[d]	Risk of Stochastic Extirpation
		Frozen Lake	Y	Y	M	U	MBTSG	U	U	Y
		Kintla Lake	Y	Y	M	LOW	MBTSG	D	D	Y
		Upper Kintla Lake	Y	Y	M	U	MBTSG	U	U	Y
		Cerulean Lake	Y	Y	M	U	MBTSG	U	U	Y
		Upper Quartz Lake	N	Y	M	U	MBTSG	U	U	N
		Middle Quartz Lake	N	Y	M	U	MBTSG	U	U	N
		Lower Quartz Lake	Y	Y	M	U	MBTSG	U	U	Y
		Akokala Lake	Y	Y	M	U	MBTSG	U	U	Y
		Logging Lake	Y	Y	M	U	MBTSG	U	U	Y
		Bowman Lake	Y	Y	M	LOW	MBTSG	D	D	Y
		Arrow Lake	Y	Y	M	E	MBTSG	E	E	Y
		Trout Lake	Y	Y	M	U	MBTSG	U	U	Y
		Lower Isabel Lake	Y	Y	R	U	MBTSG	U	U	Y
		Upper Isabel Lake	Y	Y	R	U	MBTSG	U	U	Y
		Harrison Lake	Y	Y	M	U	MBTSG	U	U	Y
		Lake McDonald	Y	Y	M	LOW	MBTSG	D	D	Y
		Lincoln Lake	Y	Y	M	LOW	MBTSG	D	D	Y
	Swan River	Swan Lake	N	N	M,R	>500	R	S	I	N
		Lindbergh Lake	Y	Y	M	<50	R	D	U	Y
		Holland Lake	Y	Y	M	<20	R	D	U	Y
	Clark Fork River	Cabinet Gorge Reservoir	N	N	M,R	<50	R,T,1	D	U	N

TABLE 4.6-4
Summary of Bull Trout Subpopulation Characteristics, Status, and Trends for Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Single Spawning Area	Refounding Unlikely	Life-History Forms[a]	Number	Data Type, Descriptor, Years[b]	Status[c]	Trend[d]	Risk of Stochastic Extirpation
		Noxon Reservoir	N	N	M,R	<50	R,T,1	D	U	N
		Middle Clark Fork	N	N	M,R	U	NONE	U	U	N
		Upper Clark Fork	N	N	M,R	250+	R,T,I	U	U	N
	Bitteroot River	Bass Creek	Y	Y	R	<50	A,D	D	U	Y
		Bear Creek	Y	Y	R	<50	A,D	D	U	Y
		Big Creek	Y	Y	R	<50	A,D	D	U	Y
		Burnt Fork Bitterroot River	Y	Y	R	<50	A,D	D	U	Y
		Fred Burr Creek	Y	Y	R	<50	A,D	D	U	Y
		Gold Creek	Y	Y	R	<50	A,D	D	U	Y
		Kootenai Creek	Y	Y	R	<50	A,D	D	U	Y
		Lost Horse Creek	Y	Y	R	<50	A,D	D	U	Y
		Mill Creek	Y	Y	R	<50	A,D	D	U	Y
		One Horse Creek	Y	Y	R	<50	A,D	D	U	Y
		Railroad Creek	Y	Y	R	<50	A,D	D	U	Y
		Reimel Creek	Y	Y	R	<50	A,D	D	U	Y
		Roaring Lion Creek	Y	Y	R	<50	A,D	D	U	Y
		Sawtooth Creek	Y	Y	R	<50	A,D	D	U	Y
		Sleeping Child Creek	Y	Y	R	U	A,D	D	U	Y
		South Fork Lolo Creek	Y	Y	R	<50	A,D	D	U	Y
		Sweathouse Creek	Y	Y	R	<50	A,D	D	U	Y

TABLE 4.6-4
Summary of Bull Trout Subpopulation Characteristics, Status, and Trends for Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Single Spawning Area	Refounding Unlikely	Life-History Forms[a]	Number	Data Type, Descriptor, Years[b]	Status[c]	Trend[d]	Risk of Stochastic Extirpation
		Sweeney Creek	Y	Y	R	<50	A,D	D	U	Y
		Tincup Creek	Y	Y	R	<50	A,D	D	U	Y
		Tolan Creek	Y	Y	R	<50	A,D	D	U	Y
		Warm Springs Creek	Y	Y	R	<50	A,D	D	U	Y
		Watchtower Creek	Y	Y	R	<50	A,D	D	U	Y
		West Fork Lolo Greek	Y	Y	R	<50	A,D	D	U	Y
		Willow Creek	Y	Y	R	<50	A,D	D	U	Y
		Skalkaho Creek	N	Y	M	<100	A,D	D	U	N
		East Fork Bitterroot River	N	Y	M	<150	A,D	D	U	N
		West Fork Bitterroot River	N	Y	M	<100	A,D	D	U	N
	Blackfoot River	Blackfoot River	N	N	M	<100	R	D	U	N
Snake River geographic area	Clearwater River	Upper Clearwater River	N	N	M,R	U	U	U	U	N
		Shotgun Creek	Y	Y	R	U	U	U	U	Y

[a]M—migratory, R—resident
[b]Data type: A—adults, J—juveniles, R—redds, S—spawners, T—total; descriptor: A—average, D—density, T—total count; years—number of years of record
[c]D—depressed, S—strong, U—unknown; modified after Rieman et al. (in press) (that is, strong subpopulations have all life history forms that once occurred, abundance that is stable or increasing, and at least 5,000 total fish or 500 adult fish are present; depressed subpopulations have either a major life history form eliminated, abundance that is declining or half of historic, or less than 5,000 total fish or 500 adults are present)
[d]D—decreasing, I—increasing, S—stable, U—unknown

water depths of large pools and boulder substrate for cover. In lakes, bull trout may have the most diverse habitat usage of all native salmonids, having been observed throughout the water column. Bull trout will travel along shorelines, occupy areas near the thermocline (cold water-warm water interface in lakes) during warm summer months, and may even occur at depths over 300 feet (FS 1989).

Few data are available indicating the temperature ranges preferred by adult bull trout. ODEQ (1995) states that adults prefer temperatures of 48 to 55°F; Rieman and McIntyre (1993) cite information that suggests bull trout distribution can be limited by water temperatures in excess of about 59°F; however, Plum Creek research has shown bull trout can occur in water temperatures up to 68°F (Plum Creek 1998f).

Resident adult and juvenile bull trout are opportunistic feeders, preying on terrestrial and aquatic insects, macro-zooplankton, and small fish. Migratory bull trout, however, are primarily piscivorous, feeding on a variety of fish species (FR 1998a).

Little information is available regarding winter habitat requirements of juvenile and adult bull trout. Some researchers have observed juvenile bull trout hiding in dense mats of debris or in areas of groundwater seepage during the winter (FS 1989). Adults have been observed wintering in deep pools or migrating downstream to deeper water near tributary mouths (FS 1989).

Factors Affecting Bull Trout Populations. FWS has listed generic and specific factors or threats they consider to be affecting bull trout. These threats are summarized in Table 4.6-5 for each subpopulation of bull trout present in Planning Area basin drainages. Threats can include dams, forest management practices, livestock grazing, agriculture and agricultural diversions, roads, mining, residential development, harvest predation, poor water quality, and introduced non-native fishes. The magnitude of most threats to stream and river subpopulations is medium or high. The effects of forestry, grazing, agriculture, non-native fish, or residential development have been identified as among the more common threats to bull trout (FR 1998a).

FWS and other sources (such as MBTSG 1998) report dams affect bull trout by changing various biological and physical processes. Dams can alter habitats; flow, sediment, and temperature regimes; migration corridors; and interspecies interactions, especially between bull trout and introduced species. Impassable dams have caused declines of bull trout primarily by preventing access of migratory fish to spawning and rearing areas in headwaters and by precluding recolonization of areas where bull trout have been extirpated. Within the Columbia River population segment, 66 percent of bull trout subpopulations are isolated by dams or indirectly by dam or water diversion operations that alter habitat conditions.

TABLE 4.6-5
Summary of Threats to Bull Trout Subpopulations in Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Dams	Forestry	Grazing	Ag[a]	Roads	Mining	Resdev[b]	Fish Harvest	PD[c]	Water Quality[d]	Non-natives[e]	Magnitude[f]	Imminence[g]	Priority[h]
Lower Columbia River area	Lewis River	Yale Reservoir	X	X						X			BK	H	I	3
		Swift Reservoir	X							X			BK	M	NI	12
Mid-Columbia River area	Yakima River	Ahtanum Creek	X	X	X	X		X		X		X		H	I	3
		Naches River	X	X		X		X		X		WA,X	BK	H	I	3
		Rimrock Lake	X	X	X	X				X			BK	H	I	3
Upper Columbia River area	Kootenai River	Upper Kootenai River	X	X		X					BK	X	BK	M	I	9
		Sophie Lake		X										M	I	9
		Middle Kootenai River	X	X				X		X	BK	X		M	I	9
		Lower Kootenai River	X	X				X			BK	X		H	I	3
		Bull Lake	X	X							O			M	I	9
	Flathead River	Flathead Lake	X	X				X	X		LT		BK,LT	H	I	3
		Whitefish Lake		X					X		LT,O	X	BK,LT,O	H	I	3
		Upper Whitefish Lake		X								X		H	I	3
		Tally Lake		X							LT,O		BK,LT,O	H	I	3
		Upper Stillwater Lake	X	X			X				LT,O		BK,LT,O	H	I	3
		Lower Stillwater Lake	X	X			X				LT,O			H	I	3
		Cyclone Lake		X										L	NI	12
		Frozen Lake		X										L	NI	12
		Kintla Lake									LT		LT	H	I	3
		Upper Kintla Lake												L	NI	12

TABLE 4.6-5
Summary of Threats to Bull Trout Subpopulations in Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Dams	Forestry	Grazing	Ag[a]	Roads	Mining	Resdev[b]	Fish Harvest	PD[c]	Water Quality[d]	Non-natives[e]	Magnitude[f]	Imminence[g]	Priority[h]
		Cerulean Lake												L	NI	12
		Upper Quartz Lake												L	NI	12
		Middle Quartz Lake												L	NI	12
		Lower Quartz Lake									LT			H	I	3
		Akokala Lake												L	NI	12
		Logging Lake									LT		LT	H	I	3
		Bowman Lake									LT		LT	H	I	3
		Arrow Lake												H	NI	6
		Trout Lake												L	NI	12
		Lower Isabel Lake												L	NI	12
		Upper Isabel Lake												L	NI	12
		Harrison Lake											BK	H	I	3
		Lake McDonald									LT		BK,LT	H	I	3
		Lincoln Lake											BK	H	I	3
	Swan River	Swan Lake	X	X					X				BK,O	M	I	9
		Lindbergh Lake		X									BK	H	NI	6
		Holland Lake		X					X				BK	H	I	3
	Clark Fork River	Cabinet Gorge Reservoir	X	X				X		X	O,BR	X	BK,O	H	I	3
		Noxon Reservoir	X	X						X	O,BR	MT	BK,O	H	I	3
		Middle Clark Fork	X	X		X	X	X		X	O,BR	MT	BK,O	M	I	9
		Upper Clark Fork	X	X	X	X	X	X		X	O,BR	MT,X	BK,O	M	I	9

TABLE 4.6-5
Summary of Threats to Bull Trout Subpopulations in Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Dams	Forestry	Grazing	Ag[a]	Roads	Mining	Resdev[b]	Fish Harvest	PD[c]	Water Quality[d]	Non-natives[e]	Magnitude[f]	Imminence[g]	Priority[h]
	Bitteroot River	Bass Creek		X	X	X			X			MT	BK,O	H	I	3
		Bear Creek		X	X	X			X			MT	BK,O	H	I	3
		Big Creek		X	X	X			X				BK,O	H	I	3
		Burnt Fork Bitterroot River		X	X	X			X				BK,O	H	I	3
		Fred Burr Creek		X	X	X			X			MT	BK,O	H	I	3
		Gold Creek		X	X	X			X			MT	BK,O	H	I	3
		Kootenai Creek		X	X	X			X			MT	BK,O	H	I	3
		Lost Horse Creek		X	X	X			X			MT	BK,O	H	I	3
		Mill Creek		X	X	X			X			MT	BK,O	H	I	3
		One Horse Creek		X	X	X			X				BK,O	H	I	3
		Railroad Creek		X	X	X			X				BK,O	H	I	3
		Reimel Creek		X	X	X			X			MT	BK,O	H	I	3
		Roaring Lion Creek		X	X	X			X			MT	BK,O	H	I	3
		Sawtooth Creek		X	X	X			X				BK,O	H	I	3
		Sleeping Child Creek		X	X	X			X			MT	BK,O	H	I	3
		South Fork Lolo Creek		X	X	X			X			MT	BK,O	H	I	3
		Sweathouse Creek		X	X	X			X				BK,O	H	I	3
		Sweeney Creek		X	X	X			X				BK,O	H	I	3
		Tincup Creek		X	X	X			X			MT	BK,O	H	I	3
		Tolan Creek		X	X	X			X				BK,O	H	I	3
		Warm Springs Creek		X	X	X			X			MT	BK,O	H	I	3

TABLE 4.6-5
Summary of Threats to Bull Trout Subpopulations in Portions of the Columbia River Distinct Population Segment Occurring in Planning Area Basin Drainages (after FWS 1998a)

Area of Distinct Population Segment	Planning Area Basin	Subpopulation	Dams	Forestry	Grazing	Ag[a]	Roads	Mining	Resdev[b]	Fish Harvest	PD[c]	Water Quality[d]	Non-natives[e]	Magnitude[f]	Imminence[g]	Priority[h]
		Watchtower Creek		X	X	X			X				BK,O	H	I	3
		West Fork Lolo Creek		X	X	X			X			MT	BK,O	H	I	3
		Willow Creek		X	X	X			X			MT	BK,O	H	I	3
		Skalkaho Creek		X	X	X			X			MT	BK,O	H	I	3
		East Fork Bitterroot River		X	X	X			X			MT	BK,O	M	I	9
		West Fork Bitterroot River	X	X	X	X			X			MT	BK,O	H	I	3
	Blackfoot River	Blackfoot River	X	X		X	X	X		X	BR	X	BK	M	I	9
Snake River geographic area	Clearwater River	Upper Clearwater River		X	X		X	X					BK	L	NI	12
		Shotgun Creek			X							ID		L	I	9

[a]Ag—agricultural practices
[b]Resdev—residential development
[c]PD—predation (BK—brook trout, BR—brown trout, LT—lake trout, O—other introduced non-native)
[d]States for which stream reaches appear on 303(d) lists (ID—Idaho, MT—Montana, OR—Oregon, WA—Washington); X—water quality threat to bull trout for streams not on 303(d) lists
[e]Non-native fish species (BK—brook trout, BR—brown trout, LT—lake trout, O—other introduced non-native)
[f]H—High; M—Medium; L—Low
[g]I—Imminent; NI—Not Imminent
[h]3—Highest Priority; 12—Lowest Priority

Forest management activities, including timber harvest and road building, can affect stream habitat by altering recruitment of large woody debris, erosion and sedimentation rates, runoff patterns, the magnitude of peak and low flows, and annual water yield. Logging and road building in riparian zones can reduce stream shading and widen stream channels, allowing greater sunlight penetration, surface water warming, and winter anchor ice formation. Timber harvest in riparian areas that results in increased water temperatures in spawning and rearing areas may cause bull trout populations to decline (MBTSG 1998). Although bull trout occur in watersheds affected by past timber harvest, bull trout strongholds persist in a greater percentage of watersheds experiencing little or no past timber harvest, such as the wilderness areas of central Idaho and the South Fork Flathead River drainage in Montana (Quigley and Arbelbide 1997). These strongholds could also reflect the beneficial effects of other factors, possibly including favorable geomorphic or climatic conditions, lack of introduced and exotic species, and minimal fishing or poaching pressure. One bull trout stronghold subject to significant logging and road construction is in the Swan River Basin. However, the Swan River tributaries also drain large areas of contiguous roadless lands that provide important protected bull trout habitat. The effects of forestry practices vary throughout the Planning Area among different geomorphologies.

Another factor influencing bull trout populations is livestock grazing, which can degrade aquatic habitat by removing riparian vegetation, destabilizing streambanks, widening stream channels, promoting incised channels and lowering water tables, reducing pool frequency, increasing soil erosion, and altering water quality. These effects increase summer water temperatures, promote formation of anchor ice in winter, and increase sediment delivery to spawning and rearing habitats (MBTSG 1998; Elmore and Beschta 1987).

Steelhead. Steelhead are the anadromous form of rainbow trout. Two genetically distinct subspecies of steelhead are found in the Northwest: coastal steelhead and inland steelhead. The coastal subspecies is generally limited to streams west of the Cascades. The inland subspecies is generally east of the Cascades, and migrates farther up the major river systems and uses inland tributaries. The precise boundary between the two forms in the Columbia River basin is not known. Both types are represented by the steelhead ESUs covered in the NFHCP. The Lower Columbia River steelhead ESU consists of the coastal subspecies, while the Mid-Columbia River steelhead ESU and the Snake River steelhead ESU consist of the inland subspecies. Steelhead are a popular game fish, with essentially all sport fishing occurring during their residence (juveniles) and spawning migrations in freshwater. Mid-Columbia River, Lower Columbia River, and Snake River steelhead are currently listed as threatened under the ESA.

Steelhead Distribution. Steelhead are the most widely distributed anadromous salmonid in the Columbia River drainage. However, over 23 indigenous steelhead stocks are believed to have been extirpated during this century and 43 stocks have been identified as being at high or moderate risk of extinction (FR 1997). Steelhead are extinct in a large portion of their historical range, including the

Owyhee Uplands, Lower Clark Fork, and Upper Klamath regions. The current known distribution of steelhead includes about 41 percent of their historical range. Access to an estimated 7,739 miles of steelhead habitat has been blocked by dams in the Columbia River and Snake River Basins. Production of wild steelhead in the Columbia River Basin has declined about 95 percent from presumed historic levels. The historic extensive distribution of steelhead is reflected in historically large runs, which were estimated as 423,000 summer-run fish passing Bonneville Dam in 1940 (Quigley and Arbelbide 1997).

Steelhead in the Lower Columbia River ESU are defined as those occupying the tributaries to the Columbia River between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon. Map 4.6-3 depicts steelhead distribution and boundaries of the two Columbia River steelhead ESUs in Planning Area basins in Washington. Excluded from this general geographic range are those steelhead found in the upper Willamette River above Willamette Falls and those in the Little and Big White Salmon Rivers. Those in the upper Willamette River are considered a separate ESU, and steelhead of the Little and Big White Salmon Rivers are included in the Mid-Columbia River ESU. There are no historical (pre-1960s) estimates of the abundance of stocks within the Lower Columbia River ESU. Twenty-three stocks have currently been identified, 19 of which are considered to be of native origin and predominantly maintained through natural reproduction (NMFS 1996a). Of these 19 native stocks, only 2 are considered healthy, 10 are depressed, and 7 are classified as unknown. Status of the four non-native stocks is considered depressed.

Steelhead in the Mid-Columbia River ESU are defined as those occupying the Columbia River Basin from above the Wind River in Washington and the Hood River in Oregon upstream to, and including, the Yakima River in Washington (see Map 4.6-3). The portions of the Mid-Columbia River steelhead ESU of concern for this EIS/NFHCP are those individuals occurring or potentially occurring in Ahtanum Creek, the Tieton River, and other Yakima River drainages. The ESU boundary includes all areas historically accessible to steelhead in the Yakima River and its tributaries. The western boundary of this ESU is indicated by a red, dotted line on Map 4.6-3. No attempt is made here or on the map to distinguish areas presently occupied by steelhead from those historically occupied by steelhead. Six stocks have been identified in this ESU, four of which are considered to be of native origin and predominantly maintained through natural reproduction. The status of one of these stocks is considered depressed, while the other three are classified as unknown. The two non-native stocks are considered depressed.

Steelhead occurring in the Snake River Basin are found in that portion of the Snake River downstream of Hells Canyon Dam (impassable barrier) and in the Salmon River and Clearwater River drainages in the Central Idaho Mountains region. Map 4.6-3 shows their distribution and ESU boundary in Planning Area basins. Steelhead are currently present in 566 of the 1,051 subwatersheds this species historically occupied in the Central Idaho Mountains region. Wild indigenous steelhead occur in an estimated 150 of the 566 watersheds, primarily in reaches of the Salmon and Selway Rivers. However, only three of these sub-watersheds are judged to have “strong” rather than “depressed”

Map 4.6-3 (page 1 of 2)
Color 11 x 17

Map 4.6-3 (page 2 of 2)
Color 11 x 17

spawning and rearing areas (Quigley and Arbelbide 1997).

Status of Steelhead Populations. NMFS listed several populations of steelhead as threatened on August 18, 1997 (FR 1997a), and February 5, 1999 (FR 1999b). The listed steelhead ESUs covered in this NFHCP are the Lower Columbia River steelhead ESU, the Mid-Columbia River steelhead ESU, and the Snake River steelhead ESU (Table 4.6-1).

Steelhead Life History and Habitat Requirements. Steelhead exhibit a wide variety of life history strategies. In general, steelhead spend 2 years in freshwater before migrating to the ocean, then spend 2 years in the ocean before returning to spawn. There are many variations on this strategy, since they may spend 1 to 4 years in saltwater before becoming sexually mature. Although steelhead are anadromous and are often perceived by the public to be similar to salmon, there are differences. The most significant difference is that some steelhead survive spawning and return to the ocean for one or more years before returning to spawn again. Salmon spawn only once in their life, dying soon after their eggs are deposited and fertilized.

Biologically, steelhead are divided into two basic reproductive types, based on 1) the state of sexual maturity at the time they enter rivers for spawning, and 2) the duration of their spawning migration (NMFS 1996a). The stream-maturing type enters freshwater rivers in a sexually immature condition and require several months to mature and spawn. These fish are commonly known as **summer steelhead** in the Planning Area. The other type are ocean-maturing fish, which enter rivers sexually mature and spawn shortly after entering freshwater. These steelhead are known as **winter steelhead**.

Summer steelhead enter freshwater between May and October and are divided into two groups: A-run steelhead, and B-run steelhead. The A-run group enters freshwater first, between May and August, and the B-run group enters between August and October. This distinction between the two summer groups is based on bimodal migration past Bonneville Dam on the Columbia River (NMFS 1996a). Winter steelhead enter freshwater between November and April. The Lower Columbia River steelhead ESU is comprised of both winter and summer-run fish. The Mid-Columbia River steelhead ESU and the Snake River steelhead ESU are comprised of summer steelhead.

Discussion of steelhead migration requirements usually focuses on dams and other physical barriers to upstream and downstream movement. Warm water temperatures, particularly in impounded reaches, can also halt upstream migration. Adult steelhead upstream migration ceases in the Columbia River when water temperatures reach 70°F (Lanz 1971, in Beschta et al. 1987).

In addition, warm water temperatures can potentially interfere with the process of smolting before outmigration, which is generally in the spring. Smolting ceases when water temperatures increase to about 57 to 64°F (Stoltz and Schnell 1991). This can result in residualization, turning anadromous individuals into resident individuals.

Steelhead spawn from late March to early July, peaking in April and May (Busby et al. 1996). Redds are constructed in areas with gravel 1/2 to 4 inches in diameter. Water temperatures during spawning of 36 to 46°F have been observed in Idaho (Orcutt et al. 1968). Bell (1990) gives the preferred spawning temperatures for steelhead as 39 to 49°F. Egg incubation takes place between February and June, with fry emergence between March and June (Bell 1990).

Steelhead juveniles can remain in their natal streams for a year or more. Rearing steelhead tend to inhabit riffles and higher gradient habitats. Densities of juvenile steelhead in streams are greatest where there are good amounts of instream cover (Stoltz and Schnell 1991). Preferred water temperatures for summer rearing range from 45 to 58°F (Stoltz and Schnell 1991).

During winter, juvenile steelhead take cover in and around stream substrates and in interstitial spaces among streambank boulders (Hillman et al. 1989). This behavior occurs at water temperatures below 50°F.

Factors Affecting Steelhead Populations. During their investigation for potentially listing steelhead, NMFS concluded that all of the factors identified in Section 4(a)(1) of the ESA have played a role in the decline of the species. Their report identifies destruction and modification of habitat, overutilization for recreational purposes, and natural and human-caused factors as the primary reasons for the decline of west coast steelhead. The following discussion, taken from the listing (FR 1997a), briefly summarizes factors causing decline across the range of west coast steelhead.

Steelhead on the west coast of the United States have experienced declines in abundance in the past several decades because of natural and human factors. Forestry, agriculture, mining, and urbanization have degraded, simplified, and fragmented habitat. Water diversions for agriculture, flood control, domestic, and hydropower purposes have greatly reduced or eliminated historically accessible habitat. Loss of habitat complexity has also contributed to the decline of steelhead. Sedimentation from land use activities is recognized as a primary cause of habitat degradation in the range of west coast steelhead.

Steelhead support an important recreational fishery throughout their range. During periods of decreased habitat availability (for example, drought conditions or summer low flow when fish are concentrated), the impacts of recreational fishing on native anadromous stocks may be heightened. Incidental harvest mortality in mixed-stock sport and commercial fisheries may exceed 30 percent of listed populations. Finally, introductions of non-native species and habitat modifications have resulted in increased predator populations in numerous river systems, thereby increasing the level of predation on steelhead.

Westslope Cutthroat Trout. Westslope cutthroat trout is one of two subspecies of cutthroat trout found in the middle and upper Columbia River Basins, the South Saskatchewan drainage, and the upper Missouri and Yellowstone systems (Behnke 1992). The other subspecies is the Yellowstone cutthroat trout. These large-scale basins encompass the Planning Area where cutthroat trout occur. Westslope cutthroat trout are a Permit species throughout the Project Area in Montana, Idaho, and Washington, and provide much of the recreational fishery in the Planning Area.

Westslope Cutthroat Trout Distribution. The native distribution of westslope cutthroat trout is primarily in western Montana, eastern and northern Idaho, and southern Alberta (Behnke 1992). A few adjunct populations are located in central Oregon in the John Day drainage, in central Washington around Lake Chelan, and in southern British Columbia. These adjunct populations are principally the result of isolation in headwater streams because of natural barriers. Within their primary range, westslope cutthroat occur in the Missouri River Basin (in the mainstem river and tributaries) downstream to Fort Benton, as well as the headwaters of the Judith, Milk, and Marias Rivers; and in the Kootenai River, Clark Fork River, and Pend Oreille River drainages (Behnke 1992). Westslope cutthroat also occur in the Salmon and Clearwater drainages of the Snake River system (Behnke 1992). Within the Planning Area, westslope cutthroat are widely distributed throughout many of the river drainages (mainstems and tributaries), as indicated in Map 4.6-4. However, contiguity of their distribution is unclear, and is likely over-represented by the map. Cutthroat trout have the potential of occurring in any of the streams shown in the map, but whether westslope cutthroat trout that were considered for protection under the ESA occur in all stream segments identified on Map 4.6-4 currently is unclear.

Status of Westslope Cutthroat Trout Populations. Westslope cutthroat trout are classified as a species of concern at the federal level and in all three states of the NFHCP planning area, Montana, Idaho, and Washington. On June 6, 1997, the Service received a formal petition to list westslope cutthroat trout as threatened throughout their range under the Endangered Species Act and to designate critical habitat. At that time, the Service concluded it could not process the petition because of a backlog of listing actions and personnel and budget restrictions and that processing the petition took a lower priority. On January 25, 1998, the petitioners provided an amended petition which contained substantial additional information. On June 10, 1998, the Service published a notice in the Federal Register (FR 1998e) of a 90-day finding that the amended westslope cutthroat trout petition contained substantial information that indicated the listing of the subspecies may be warranted. The Service immediately began a 12-month fact-finding period. On April 14, 2000, the Service published in the Federal Register (FR 2000b) that after review of all the available scientific and commercial information, the listing of westslope cutthroat trout was not warranted at that time.

Westslope Cutthroat Trout Life History and Habitat Requirements. Westslope cutthroat trout vary widely in habitat use and life histories. For example, westslope cutthroat, like bull trout, have three life history variations: fluvial, adfluvial, and resident (Liknes and Graham 1988). Unlike bull trout and most other salmonids, however, westslope cutthroat trout can occupy a greater range of habitats (Rieman and Apperson 1989). Historically, cutthroat trout occurred throughout the drainages of their native range. Today, most cutthroat trout persist in cold, high-elevation, nutrient-poor headwater reaches, where they appear to have a competitive advantage over introduced salmonids (Liknes and Graham 1988; Rieman and Apperson 1989; Behnke 1992; Bozek and Hubert 1992; Mullan et al. 1992).

Westslope cutthroat trout can be found throughout large river basins, although their preferred habitats have not been well described and limiting factors associated with physical habitat cannot be readily defined. However, some characteristics of cutthroat habitat use have been described. Most of this information was derived by relating distribution, or densities, to habitat characteristics and by measuring microhabitats associated with individual fish. In general, the distribution of westslope cutthroat trout tends toward higher-elevation, lower-order streams (Platts 1974; Fraley and Graham 1982). Platts (1974) found westslope cutthroat in both fluvial and depositional land types at elevations that ranged from 4,000 to 8,000 feet in the South Fork Salmon River drainage. He also reported that both bull trout and westslope cutthroat trout increased as stream order decreased and that cutthroat occurred at gradients that ranged from 4 percent to 14 percent (Platts 1974).

Westslope cutthroat trout are spring to early summer spawners, with spawning generally occurring from March to July at water temperatures near 50°F (McIntyre and Rieman 1995). Spawning occurs primarily in small tributaries, in pools with overhead cover, and in gravel smaller than 3 inches diameter (Shepard et al. 1984; McIntyre and Rieman 1995). In steeper-gradient streams, gravels can be limited because of removal by scour. In lower-gradient streams, gravel quality can be reduced by deposition of fine sediment, which limits the survival of incubating eggs (Behnke 1992). Some migratory populations may remain in the streams where they spawned, but most will move to lakes or larger rivers during summer (Behnke 1992). Habitat used in lakes and streams during summer is generally associated with fish size. Smaller fish use shallower water as refuge from predation and because larger fish are likely already established in deeper waters.

Westslope cutthroat trout will use all available types of habitat (for example, pools, riffles, glides, rapids, and pocket water) (Irving 1987; Rieman and Apperson 1989). However, juvenile cutthroat trout often use pools and runs, while adults are strongly associated with pools (Rieman and Apperson 1989; Ireland 1993). In general, stream reaches with several pools generally support the highest densities of fish (Hoelscher and Bjornn 1989; Ireland 1993). Platts (1974) found westslope cutthroat in stream reaches with 20 percent to 80 percent of the channel as pools. He also noted that cutthroat often occurred in pools of fair to very poor quality. Pools also provide important winter habitat for westslope cutthroat trout (Jakober 1995), as do side channels and areas with woody debris (Chapman and Bjornn 1969; Bustard and Narver 1975; Griswold 1991; McIntyre and Rieman 1995).

Westslope cutthroat trout occur over a wide range of substrate types; however, high levels of fines can negatively influence embryo survival, emergence success, and winter rearing of juvenile trout (Weaver and Fraley 1991; Bjornn et al. 1977). Accurately predicting the effects of fine sediment on wild populations remains difficult (Chapman 1988) and some populations persist despite abundant sediment (Magee 1993). Platts (1974) found cutthroat in sites with 0 to 60 percent fine sediments.

Westslope cutthroat trout use a wide variety of cover types. Pratt (1984) found that juvenile cutthroat trout were often associated with some form of cover, such as cobble or woody debris, while larger trout (longer than about 4 inches) ranged freely in the water column. Shepard et al. (1984) found that overhead turbulence also provided cover for cutthroat trout. Platts

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(1974) observed westslope cutthroat trout in channels with grass, brush, or forest streamside cover and streambanks in fair (unstable) to excellent condition.

Adult cutthroat trout form dominance hierarchies in pools and runs, with small (juvenile) fish at the stream margins and larger fish in pools. Trout will also establish territories in water at least 1 foot deep, where slow water for holding is near faster water for feeding. Cover provided by instream boulders and logs, and by overhanging vegetation and undercut banks, is an essential component of both adult and juvenile habitat (Behnke 1992). Cutthroat trout tend to be found in cooler stream reaches, with preferred temperatures in the 50 to 55°F range (Bell 1990).

Data collected from study sites within the NFHCP Project Area reflect the plastic nature of westslope cutthroat trout in response to environmental variants. The frequencies of westslope cutthroat occurrences, sampled at sites throughout the Project Area, were plotted against the distribution of percent surface fines within habitat units and against the density of LWD per 100 meters (328 feet) of stream length (Plum Creek 1999f). The relative distributions show that westslope cutthroat occurrence is roughly equal to the frequency of occurrence of the habitat variables. If westslope cutthroat exhibited a preference for certain habitat types (for example, large amounts of LWD), the distribution of cutthroat would be skewed in the direction of preference, which is not the case corresponding to Plum Creek's research. Hence, these data suggest westslope cutthroat tend to use habitats in proportion to their availability, irrespective of the concentration of fine sediment or the density of LWD. However, other researchers (for example, Pratt 1984 and Behnke 1992) observed that cutthroat trout are associated with LWD. The degree to which cutthroat trout need LWD is uncertain.

Factors Affecting Westslope Cutthroat Trout Populations. Generally, environmental factors that can potentially affect populations of westslope cutthroat trout are the same as those listed for bull trout because many of the very basic needs, such as cool, clean water, are the same. FWS, in their notice of the Petition Findings and Initiation of Status Review of cutthroat trout (FR 1998e), concluded that the decline of westslope cutthroat populations mainly results from the destruction and adverse modification of habitat and negative effects of stocked non-native fish species.

Coastal Cutthroat Trout. Coastal cutthroat trout are a subspecies of cutthroat trout related to the more commonly known inland varieties, such as westslope and Yellowstone cutthroat trout. Coastal cutthroat trout are the only subspecies of cutthroat that exhibit an anadromous form. However, there are also resident freshwater populations of this subspecies that never migrate to the ocean. A significant physical characteristic separating the coastal subspecies from the interior subspecies is that coastal cutthroat have small to medium-sized, irregular spots (Behnke 1992). All other cutthroat trout have round spots. Coastal cutthroat are a sport fish, although they are less popular with anglers than steelhead, the only other anadromous trout species in the western United States (Behnke 1992).

Coastal Cutthroat Trout Distribution. The Southwestern Washington/Columbia River ESU of coastal cutthroat trout was proposed for listing as a threatened species on April 5, 1999 (Federal Register 1999a). Within this proposed ESU, the Planning

Area includes the Cowlitz and Lewis River watersheds and their associated coastal cutthroat trout populations.

The Services identified several factors affecting the species that contributed to the rationale supporting the proposed listing, including the following:

1. Habitat degradation associated with logging and other land management activities, such as dredging, diking and filling of estuarine areas and alteration of riparian areas
2. Overutilization relative to directed recreational fishing and incidental to recreational fishing for other species
3. Disease factors related to the presence of the parasite Ceratomyxa shasta in the Lower Willamette and Lower Columbia Rivers
4. The inadequacy of existing regulatory mechanisms, including the State of Washington's forest practice rules and Federal Clean Water Act (CWA) standards
5. Hatchery practices that result in competition and/or hybridization between naturally spawning coastal cutthroat trout populations and introduced hatchery spawned fish

Freshwater habitat within the Lewis River watershed has declined in quality as a result of several factors, including the construction of hydropower facilities that have destroyed spawning habitat and isolated fish populations by restricting migratory behavior, housing development, water withdrawal, gravel mining, logging, road construction, and the 1980 eruption of Mt. St. Helens (WDFW 1999). Limiting factors (that is, conditions that limit the ability of habitat to fully sustain populations of salmonids) in the Lewis River watershed include a scarcity of LWD, reduced riparian function (for example, high erosion rates and streambank instability), reduced water quality (especially high water temperatures), both low water flows and increased peak flows resulting from habitat alteration, and loss of off-channel habitats related to diking and hardening of stream channels (Washington State Conservation Commission [WSCC] 2000). Watershed analyses conducted by the FS (1996) confirm the WSCC limiting factors conclusions. In addressing key habitat attributes for salmonids, the FS identified fire, timber harvest/management activities, road construction, and dams as key factors in the degradation of the watershed. Resultant effects of the factors identified (applicable to some but not necessarily all portions of the watershed) include the following:

1. Levels of LWD are reduced in quantity
2. Pool frequency is reduced
3. Stream temperatures are elevated
4. Aquatic habitat is fragmented
5. Sediment levels are elevated

Freshwater habitat within the Cowlitz River watershed has been affected by many of the same human-induced factors, including hydropower, timber harvest, road building, agriculture, and rural development (WDFW 1999).

Because it addresses at least two of the factors that contributed to the proposed listing of the Southwestern Washington/ Columbia River ESU of coastal cutthroat trout (inadequacy of existing regulatory mechanisms and habitat degradation associated with logging and related land management activities), the proposed NFHCP is likely to have positive effects on coastal cutthroat trout populations in the planning area. The NFHCP proposes to improve habitat conditions relative to several of the factors identified by the WSCC (2000) (for example, bank and channel stability, erosion rates, and water quality) and the FS (1996) (for example, LWD, stream temperatures, and stream sediment levels) through forest road and upland management, riparian management, and legacy and restoration commitments. Additionally, although the NFHCP is primarily designed to respond to ESA and landowner needs, aspects of the CWA will also be incidentally addressed (for example, NFHCP cold water temperature maintenance/reduction commitments, and sediment reduction commitments). Although results of NFHCP implementation within the proposed Southwestern Washington/ Columbia River ESU will be relatively minor on a landscape scale relative to watershed conditions on the whole (that is, the vast majority of both watersheds are either under Federal ownership or owned by other non-Federal entities), NFHCP efforts will complement enhanced habitat conditions anticipated in the future through continued implementation of the Northwest Forest Plan on FS lands and the implementation of the Washington Forests and Fish process (developed with the intention of meeting Federal ESA requirements for listed salmonids) on non-Federal lands.

The northern (and western) extent of coastal cutthroat distribution is the Prince William Sound area of southern Alaska. The southern limit is the Eel River in California. Coastal cutthroat are rarely found in, or use, rivers and tributaries farther than 100 miles from the coast. NMFS has identified six ESUs or DPSs within the range of west coast coastal cutthroat trout in the Pacific Northwest. The Project and Planning Areas contain only one of these, the Southwestern Washington/Columbia River coastal cutthroat trout DPS. The proposed boundaries of this DPS include all tributaries to the Columbia River downstream of the Klickitat River in Washington and the Deschutes River in Oregon, as well as the coastal drainages in southwestern Washington between the Columbia River and Point Grenville. Within the Planning Area, populations belonging to this DPS occur primarily in the Lewis River Basin and the Cowlitz River Basin (North Riffe Lake Planning Area basin) in western Washington, shown in Map 4.6-4.

Status of Coastal Cutthroat Trout Populations. The Services have proposed that the Southwestern Washington/ Columbia River coastal cutthroat trout ESU be listed as threatened under the ESA (FR 1999a). Restoration of native runs of this DPS is being considered for the Lewis River and Cowlitz River portions of the Planning Area above fish migration barriers. Habitat above such barriers may be considered necessary for species recovery.

Coastal Cutthroat Trout Life History and Habitat Requirements. The life history of the resident form of coastal cutthroat closely resembles that of inland sub-species, such as westslope cutthroat. Spawning occurs in the spring, typically in April through early May, with young fish emerging from the gravels in late spring. Adults and juveniles use riffle and pool habitat in streams for feeding and cover, respectively, and primarily pool and deep water habitat in the winter. The resident form feeds primarily on aquatic insects, as opposed to the piscivorous (fish eating) anadromous form (Wydoski and Whitney 1979).

Anadromous coastal cutthroat exhibit a much different life history pattern than residents, since activities throughout their life are tied closely to migrations between freshwater and saltwater systems. Anadromous coastal cutthroat trout spawn in the smaller headwater streams and tributaries of coastal rivers to which they have access (Wydoski and Whitney 1979). Adults return to the estuaries of the coastal streams as early as July and migrate upstream. Spawning takes place primarily from late December to February (Wydoski and Whitney 1979). Young fish emerge from the gravels around mid-May. They remain in their natal streams for about a year before moving downstream to larger streams where they can live for 2 to 9 years. In Washington, most migrate to the ocean when they are 3 years old. As stated above, the anadromous form is much more piscivorous than the resident forms while rearing in freshwater (Behnke 1992). Outmigration to the ocean occurs from January through June, with most migrating from April through June (Wydoski and Whitney 1979).

Little is known about the life history and habitat requirements of coastal cutthroat while in saltwater (Wydoski and Whitney 1979). They do not appear to migrate to the open ocean, but instead tend to concentrate in bays, estuaries, and along the coast where they feed on crustaceans and fish (Behnke 1992).

Factors Affecting Coastal Cutthroat Trout Populations. Behnke (1992) states that numbers of coastal cutthroat trout have drastically declined in many areas because of environmental alterations (mainly logging practices that result in increased sedimentation, reduced cover, and increased stream temperatures) and hybridization with non-native trout species. NMFS' comprehensive status review (FR 1999a) indicates reasons for declining numbers of coastal cutthroat trout ESUs include a reduction in life history diversity, habitat degradation, and, to a lesser extent, the introduction of hatchery coastal cutthroat trout.

NMFS' present information on the Southwestern Washington/Columbia River coastal cutthroat trout DPS suggests that the freshwater forms are well distributed and relatively abundant compared to the anadromous form. Even though freshwater forms can, on occasion, produce smolts (anadromous outmigrants), this production has not bolstered or re-established the anadromous form. Likely reasons for the decline of the anadromous form include habitat degradation in streams, recreational fishing, and poor ocean and estuarine conditions.

Redband Trout. Redband trout are a subspecies of rainbow trout and a highly sought game fish in streams, lakes, and reservoirs. Those found in the Planning Area are Columbia River Basin inland redband trout and are predominantly residents of freshwater streams. However, a few lacustrine (lake dwelling) populations of Columbia River Basin redband trout are present in the upper Columbia River and Fraser River Basins, and are commonly referred to as Kamloops trout (Behnke 1992). The following discussion focuses on the stream-dwelling variety.

Redband Trout Distribution. Inland, or resident, freshwater redband trout consist of three major groups (Behnke 1992):

- Redband trout of the Columbia River Basin east of the Cascade Mountains and the upper Fraser River Basin (a subspecies present within the Planning Area)

- Redband trout of the Sacramento River Basin
- Coastal rainbow trout

Other subspecies of redband trout have been described, but they have not been consistently distinguished from these three groups (Behnke 1992). Within the Planning Area, most redband trout are found in tributaries to the Kootenai River, which is a major tributary to the upper Columbia River.

Map 4.6-5 depicts the occurrence or potential occurrence of redband trout in Planning Area Basins. This distribution map is based on work by Behnke (1992), who comments that he “somewhat arbitrarily” defines the distribution of Columbia River redband trout to include the Columbia River basin east of the Cascades to barrier falls on the Kootenai, Pend Oreille, Spokane, and Snake Rivers; the upper Fraser River basin above Hell's Gate; and Athabasca headwaters of the Mackenzie River basin. Behnke (1992) notes that “in the Columbia basin the original genetic diversity of resident and anadromous stocks of redband trout has been impoverished by land and water use practices and the stocking of nonnative forms of rainbow trout.” All strains of naturally occurring redband trout are designated a Permit species throughout the Project Area in Montana, Idaho, and Washington.

Status of Redband Trout Populations. Columbia River Basin redband trout are undergoing a status review at the federal level, and are identified as a species of concern in the states of Montana and Idaho (Table 4.6-1).

Redband Trout Life History and Habitat Requirements. The life history and habitat requirements of the different subspecies of rainbow trout are essentially the same. Their main differences are in geographic location/isolation and morphological characteristics (physical appearance) (Behnke 1992).

Redband trout are generally spring spawners, depending on geographic location. Spawning occurs between February and June when water temperatures exceed about 35 to 39°F (Stolz and Schnell 1991).

During the rearing season, resident redband trout are found in cool, clear, fast-flowing permanent streams where riffles tend to predominate over pools (Moyle 1976). Adults are typically drift feeders. They prefer habitat with sufficient depth and velocity to allow holding near an area with swifter water where drifting invertebrates can be intercepted. These sites may include near-bank instream cover, an undercut bank, instream wood, or boulders and cobbles in riffles (Stoltz and Schnell 1991). Redband trout inhabit a variety of stream types and have been observed at stream gradients of 0.1 to 24 percent. Fry and small juveniles tend to school in slow, shallow inshore waters or eddies. Preferred water temperatures for rearing redband trout are 54 to 66°F (Bell 1990).

Winter habitat preferences are similar to most salmonid species. Preferences include areas with low water velocities and access to refuge cover, such as deep pools, areas with woody debris, side channels, and backwaters (Baltz et al. 1991; Behnke 1992). Patterns of feeding and hiding behavior tend to shift as water temperatures decrease, with daytime hiding behavior starting as water temperatures decrease from 46 to 37°F. Rainbow trout have been observed seeking refuge in stream substrates during winter days and feeding at night (Campbell and Neuner 1985; Riehle and Griffith 1993).

Factors Affecting Redband Trout Populations. Environmental factors potentially affecting redband trout are essentially the same as those listed for bull trout and westslope cutthroat trout. However, factors that strictly affect water temperature would be less severe for redband trout since they have a wider range of preferred temperatures and are more tolerant of higher temperatures than bull trout or cutthroat trout.

Coastal Rainbow Trout. Coastal rainbow trout, like redband trout, are a popular game fish and a subspecies of the *Oncorhynchus mykiss* species group (Behnke 1992). They are one of five NFHCP Permit species, together with redband trout and three steelhead ESUs, that belong to this species group. As a Permit species, coastal rainbow trout are defined as those resident *O. mykiss* occurring entirely in freshwater habitats west of the Cascade Mountains, specifically in the Cowlitz and Lewis River drainages. By comparison, steelhead are migratory (anadromous), using ocean and freshwater habitats, while redband trout are freshwater residents occurring east of the Cascades.

Coastal Rainbow Trout Distribution. Coastal rainbow trout are distributed from the Kuskokwim River drainage in west-central Alaska south to northern Baja California, Mexico (Behnke 1992). In the Planning Area, coastal rainbow trout occur in the Lewis River and Cowlitz River drainages in southwestern Washington, as shown on Map 4.6-5.

Status of Coastal Rainbow Trout Populations. Coastal rainbow trout have no special status with federal agencies, and they are managed as a game fish species by the state of Washington.

Coastal Rainbow Trout Life History and Habitat Requirements. Coastal rainbow trout life history and habitat requirements are similar to those described previously for redband trout. Basic life history and habitat requirements of the different sub-species of rainbow trout are generally similar, with the main differences among subspecies being their geographic location/isolation, morphological characteristics, and possibly any population-specific resident or migratory life history strategies displayed.

Factors Affecting Coastal Rainbow Trout Populations. Environmental factors that can potentially affect coastal rainbow trout are essentially the same as those listed for bull trout and coastal cutthroat trout. All salmonids benefit from cold, clear, complex, and connected habitat, although coastal rainbow trout may be less tolerant of elevated water temperatures than the closely related redband trout. Behnke (1992) reports that, as a whole, coastal rainbow trout populations are stronger than other native salmonid species populations, and they have probably reached record abundance because of their establishment around the world as an introduced sport fish and propagation in hatcheries. Behnke (1992) acknowledges the management concern of maintaining the genetic diversity of the unique life history forms of resident coastal rainbow trout populations.

Chinook Salmon. Chinook salmon are one of the most important commercial and recreational fishes in the Pacific Northwest. However, because of the various factors affecting their habitat and harvest, many chinook stocks have been so

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depleted that they have been listed under the ESA. As previously mentioned, there are five chinook salmon ESUs within the Planning Area: the Lower Columbia River chinook salmon ESU, the Mid-Columbia River chinook salmon ESU, the Upper Columbia River summer/fall chinook salmon ESU, the Snake River spring/summer chinook salmon ESU, and the Snake River fall chinook salmon ESU. All of these ESUs are listed as threatened, except for the Mid- and Upper-Columbia River ESUs. Within each of these ESUs are one or more specific runs of chinook salmon, which are based on when adults enter freshwater on their spawning migration runs. The Lower Columbia River ESU contains both fall-run and spring-run chinook, and the Mid-Columbia River ESU contains spring-run chinook. The Snake River chinook salmon spring/summer and fall ESUs are defined by the spring/summer run and the fall run, respectively.

Chinook Salmon Distribution. Chinook salmon are widely distributed along the Pacific coast, with their native range extending from the Ventura River in Southern California to Point Hope, Alaska. This species is also found in northeast Asia from the Anadyr River south to Hokkaido, Japan. In the lower 48 states, chinook salmon are found in most of the larger streams along the coast, in the Columbia and Snake River drainages, and in the Puget Sound drainage (Wydoski and Whitney 1979).

The Lower Columbia River spring-run chinook salmon ESU includes all native populations from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. The Mid-Columbia River spring-run chinook salmon ESU includes those fish spawning in the Klickitat, Deschutes, John Day, and Yakima Rivers. The Upper Columbia River summer/fall run chinook salmon ESU includes all naturally spawned populations in the Columbia River and tributaries upstream from the confluence of the Snake and Columbia Rivers to Chief Joseph Dam (with the exception of chinook salmon that spawn in the Marion Drain). The Snake River fall-run chinook salmon ESU includes all populations spawning in the Snake River basin, below Hell's Canyon Dam, and the Deschutes River was recently proposed to be included with this ESU (FR 1998f). The Snake River spring/summer chinook salmon ESU includes all populations spawning in the Snake River Basin, excluding the Clearwater River Basin for reasons described below. Map 4.6-6 depicts chinook salmon distribution and boundaries of the five chinook salmon ESUs in Planning Area basins.

Because of the exclusion of the Clearwater River Basin, the Snake River spring/summer chinook salmon ESU **does not** overlap with lands in the Planning Area. The Clearwater River is a major tributary to the Snake River. The Planning Area covers a substantial amount of land within the Clearwater Basin, primarily in the Lochsa River Basin, which is a major tributary to the Clearwater. Exclusion of the Clearwater Basin was based on the fact that native fish runs in the Clearwater River Basin were probably eliminated following the construction of Lewiston Dam in 1927 (NMFS 1998b). However, modifications were made to the dam in the 1940s and 1950s and the river basin was, and continues to be, seeded with hatchery stock. This "stock" of fish has been included as a Permit species in the proposed NFHCP because NMFS may someday include Clearwater Basin salmon in the Snake River spring/summer chinook salmon ESU if demographic changes occur, where spring/summer chinook salmon spawning in the Clearwater Basin would become genetically indistinguishable from the Snake River ESU. For consistent nomenclature in describing the anadromous salmonids by ESU, the stock of chinook salmon in the Lochsa River will be referred to as part of the Snake River spring/summer chinook salmon ESU, even though this is not technically correct.

Some individuals of the Snake River fall chinook salmon ESU spawn in the Clearwater River Basin, which is included in the area designated by NMFS as critical habitat. Virtually all spawning by this species in the Clearwater River is reported to occur in the lower river reach downstream of its confluence with the North Fork Clearwater River (Rondorf and Tiffan 1997). Even though this reach is well below Project Area and Planning Area boundaries, the Snake River fall chinook salmon ESU is included as a Permit species because of the entire Clearwater River Basin's designation as critical habitat, and the potential for Plum Creeks activities to have downstream effects.

Status of Chinook Salmon Populations. Among the five Permit species of chinook salmon, only the Lower Columbia River chinook salmon ESU, the Snake River spring/summer chinook salmon ESU, and the Snake River fall chinook salmon ESU are listed under the ESA (NMFS 1998b). The Snake River Basin below Hell's Canyon dam and the entire Clearwater River Basin (except for waters above Dworshak Dam) is designated as critical habitat for at least one of the Snake River chinook salmon ESUs (FR 1993). The Mid-Columbia River chinook salmon ESU and the Upper Columbia River chinook salmon ESU were recently considered for listing but NMFS determined that protection for these ESUs was not warranted at the time.

Chinook Salmon Life History and Habitat Requirements. Chinook salmon, like other salmon species, have some of the most complex life history characteristics and habitat needs among the salmonids because they are anadromous and often migrate extreme distances to spawn. Spring-run chinook of the Snake River Basin, for example, may travel up to 900 miles to spawn. This is the longest migration journey of any salmon species in the lower 48 states (Simpson and Wallace 1978). The Planning Area only contains portions of rivers that are used for spawning and juvenile rearing; therefore, the following discussion of spring chinook life history only focuses on those life history aspects.

Adult spring-run chinook enter the Columbia River from March through May, and those migrating the farthest (to the Snake River Basin) may continue to migrate upstream until July (Simpson and Wallace 1978). Spawning occurs in areas with clean large gravels, small cobbles, and sufficient flow to oxygenate eggs within the substrate. Spawning typically occurs in the fall, usually within 2 to 3 weeks after the fish reach their natal spawning grounds. However, because spring chinook enter river systems relatively early compared to other chinook salmon stocks, their spawning may be delayed for some time until water temperatures cool. Preferred spawning temperatures for spring-run chinook range from 42 to 57°F (Bjorn and Reiser 1991). Eggs incubate through the winter and early spring months, then hatch in April and May. Fry remain in the gravel for about 1 month before emerging.

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Juvenile chinook usually rear for 1 year in freshwater before outmigrating to the ocean. Most smolt outmigration is completed by June. While in fresh water, juveniles prefer deeper pools and run habitat (Everest and Chapman 1972;). Preferred water temperatures during the growing season for juvenile chinook range from 53 to 57°F (Bjornn and Reiser 1991), with optimum temperatures ranging from 50 to 64°F (Pennell and Barton 1996). During the winter, juvenile chinook reside in and around the interstitial spaces among large substrates, such as boulders and cobble, to conserve energy during periods of colder water temperatures. Movement into winter habitat occurs when water temperatures reach about 50°F.

Many habitat requirements of fall-run chinook salmon are similar to those described for spring-run chinook, except that fall-run chinook tend to use the more downstream reaches of tributaries. Snake River fall chinook salmon ESU adults migrate upstream during fall and generally spawn in November, soon after arriving at their spawning grounds. Historically, prior to dam construction, most spawning by fall chinook in the Snake River occurred near Marsing, Idaho, about 150 miles upstream of the present Hells Canyon Dam location (Rondorf and Tiffan 1997). Adults reached spawning grounds in late September and October, and began spawning 2 to 3 weeks later (Simpson and Wallace 1978). Today, fall chinook spawn in accessible reaches of the Snake River where suitable habitat is available and in downstream reaches of larger tributaries such as the Clearwater and Salmon Rivers in Idaho, and the Grande Ronde and Imnaha Rivers in northeastern Oregon. Unlike the Snake River spring/summer chinook ESU, the Snake River fall chinook ESU exhibits an "ocean type" life history strategy, with most migrating toward sea as subyearlings within about 3 months following their emergence from spawning redds (Rondorf and Tiffan 1997). Adults return from the ocean at ages 4 or 5 to spawn in their natal streams.

Factors Affecting Chinook Salmon Populations. Because salmon are anadromous and often migrate extensively, they can be subjected to a wide variety of environmental conditions (both natural and influenced by man) that affect their populations. These include conditions in the ocean, along their migration routes in freshwater rivers, and on their spawning grounds. Factors commonly associated with impacted salmon populations in the Northwest, particularly in the Columbia River/Snake River Basin, include the following:

- Upstream fish passage past hydroelectric dams on the Columbia and Snake Rivers
- Genetic introgression from hatchery fish
- Ocean habitat conditions
- Suitability of spawning substrate (clean gravels and cobbles)
- Water temperature
- Predation by non-native fish on downstream migrating juveniles, particularly in mainstem reservoirs on the Columbia and Snake Rivers
- Mortality of downstream migrating juveniles through power-generating dams
- Instream flows
- Over-harvest

Specific issues identified by NMFS for the Snake River spring-run chinook salmon ESU and the Snake River fall-run chinook salmon ESU are degradation of spawning and rearing habitat and blockage of much of the remaining spawning and rearing habitat.

Chum Salmon. Chum salmon are one of eight species of Pacific salmonids in the genus *Oncorhynchus*. Chum salmon are best known by the enormous canine-like fangs of spawning males. Their body color is a calico pattern with a bold, jagged, reddish line. Near the tail, the line changes from reddish to black. Females have smaller teeth and are less vibrantly colored (FR 1998c). During the first half of the century, chum salmon spawned in Columbia River drainages supported a substantial commercial fishery. Now, there are no recreational or directed commercial fisheries for chum salmon from this drainage (FR 1998c).

Chum Salmon Distribution. Chum salmon have the widest geographic and spawning distribution area of any of the Pacific salmonids. Historically, chum salmon were found throughout the west coast of Canada and the United States, as far south as Monterey, California. Currently, the four main groups from the United States are found only as far south as Tillamook Bay on the northern Oregon coast (FR 1998c):

- Puget Sound/Strait of Georgia ESU
- Hood Canal Summer-Run ESU
- Pacific Coast ESU
- Columbia River ESU (the subspecies present in the Project Area)

The Columbia River chum salmon ESU (hereafter referred to as chum salmon) spawn in tributaries to the lower Columbia River in Washington and Oregon. These populations are few in number and low in abundance (FR 1998c). On the Washington side of the lower Columbia River, native chum salmon are recognized as occurring in only three drainages. These are Hamilton and Hardy Creeks near Bonneville Dam at river mile 147 and Grays River at river mile 21 in the lower Columbia (FR 1998c). These drainages are not on Project Area lands and are outside of Planning Area boundaries. Map 4.6-7 depicts the boundary of the chum salmon ESU in Planning Area basins.

Status of Chum Salmon Populations. The chum salmon was listed by NMFS as threatened on March 25, 1999 (FR 1999b). Only naturally spawned chum salmon residing below impassable barriers were listed.

Chum Salmon Life History and Habitat Requirements. Chum salmon spawn primarily in fresh water; spawning only once, then dying. Adults usually spawn in coastal areas, then the juvenile fish migrate to the ocean almost immediately after emerging from their redds. This means that chum salmon are less dependent on freshwater habitats than most other salmonid species, which spend more of their life cycle in streams (FR 1998c).

Chum salmon spawn in the lower reaches of rivers and have little ability to pass river blockages. Spawning occurs in the fall, and they typically dig their redds at groundwater upwellings in the stream (FR 1998c). The water temperature preference for spawning is between 53.6 and 57.2^{o}F (Scott and Crossman 1973).

Factors Affecting Chum Salmon Populations. Chum salmon depend more on the ecological integrity of estuaries and nearshore environments for most of their

Map 4.6-7
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11 x 17 Color

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life cycle. However, the environmental stability of freshwater spawning areas can impact the success of this species. Among habitat losses in estuarine and freshwater environments documented by NMFS (FR 1998c), the following have the most impact on chum salmon:

1. Water withdrawal, conveyance, storage, and flood control—resulting in insufficient flows, stranding, juvenile entrainment, and instream temperature increases

2. Logging and agriculture—loss of LWD, sedimentation, loss of riparian vegetation, and habitat simplification

3. Mining—especially instream gravel removal, dredging, and pollution

4. Urbanization—stream channelization, increased runoff, pollution, and habitat simplification

Coho Salmon. This anadromous species historically occurred throughout the North Pacific Ocean and probably inhabited most coastal streams in Washington, Oregon, and central and northern California. Some populations that are now considered extinct likely migrated inland hundreds of miles to spawn in tributaries to the upper Columbia River in Washington and the Snake River in Idaho (FR 1995). Annual coho salmon spawning surveys in the lower Columbia River Basin indicate that natural spawning by coho salmon in this region declined markedly in the early 1970s and has remained at extremely low levels (NMFS 1999a).

Coho Salmon Distribution. The coho salmon Permit species present in or near the Project Area is the Lower Columbia River/Southwest Washington coho salmon ESU (hereafter referred to as coho salmon). This coho salmon ESU historically included nearly all naturally spawned populations of coho salmon from Columbia River tributaries downstream of the Klickitat River in Washington and the Deschutes River in Oregon, as well as coastal streams in southwest Washington between the Columbia River and Point Grenville (FR 1995). Today, there are no coho salmon populations above Bonneville Dam eligible for ESA consideration (FR 1995). Map 4.6-7 depicts the boundary of the coho salmon ESU in Planning Area basins.

Status of Coho Salmon Populations. On July 25, 1995, NMFS determined that listing was not warranted for the coho salmon ESU Permit species. However, NMFS designated this coho salmon ESU as a candidate for listing until the distribution and status of native populations can be resolved (FR 1995).

Coho Salmon Life History and Habitat Requirements. The coho salmon ESU generally exhibits a relatively simple, 3-year life history pattern (FR 1995). Adults commence freshwater spawning migrations in late summer and fall, spawn by mid-winter, then die. Depending on water temperature, eggs incubate in gravels of spawning redds for about 1.5 to 4 months before hatching as alevins (FR 1995). Alevins soon emerge from the gravel as young juveniles and begin active feeding. Juveniles feed and grow in fresh water for up to 15 months before migrating to the ocean the following spring as smolts. Coho salmon typically rear for 2 years in the ocean before returning to their natal stream to spawn as 3-year old fish (FR 1995).

Factors Affecting Coho Salmon Populations. NMFS has identified a number of human-related and natural factors they believe have contributed to declines of coho salmon (FR 1995). These factors include extensive habitat degradation, overfishing, inadequate regulatory mechanisms, negative effects of hatchery programs, drought, and adverse ocean conditions.

Mountain Whitefish. Mountain whitefish is the most common whitefish species in the Northwest. It is generally considered a game fish by most states and is taken by hook and line.

Mountain Whitefish Distribution. Mountain whitefish are the most widely distributed whitefish in the Northwest, residing in lakes, reservoirs, and streams. They are widely distributed on both sides of the Continental Divide, occurring in the Great Basin, throughout much of the Columbia River drainage, in the upper Missouri River Drainage, and in the Saskatchewan River drainage in Alberta, Canada (Brown 1971; Wydoski and Whitney 1979). Mountain whitefish are widely distributed in the Planning Area.

Status of Mountain Whitefish Populations. Mountain whitefish populations have no special status at the federal level or in any of the three states within the Planning Area. They are protected by state law as game fish, with generally large allowable levels of harvest.

Mountain Whitefish Life History and Habitat Requirements. Mountain whitefish migrate within stream systems over the course of a year. Fish migrate from feeding areas in smaller streams during summer to congregating and spawning areas in medium and larger streams during fall. Fish often move from larger streams and rivers to smaller tributaries to avoid high flows, then return to larger streams to avoid periods of low or no flow in smaller streams. Fish also migrate to overwintering areas that consist of deeper-water habitat in larger streams (Davies and Thompson 1976; Shepard et al. 1984; Northcote and Ennis 1994).

Mountain whitefish spawn during the fall (October through early December) when water temperature is less than 48°F. Spawning occurs almost exclusively in streams, where the eggs are broadcast over the stream bottom, and almost always at night (Brown 1971). Some instances of mountain whitefish spawning have been observed in lakes (Brown 1971; Northcote and Ennis 1994), although spawning success is less likely than in streams. Spawning can occur in any size of stream if there is sufficient flow to keep the gravels free of sediment.

Mountain whitefish eggs hatch during March and April, depending on water temperature (Brown 1971; Northcote and Ennis 1994). During the rearing season (late spring through early fall), young fry use shallow pocket water and side channels until they grow to sufficient size to enter the main stream channel. Larger juveniles and adults use the bottom habitat of pools and runs in areas with suitable water temperatures. Whitefish generally feed on aquatic insect larvae, usually on the stream bottom.

Factors Affecting Mountain Whitefish Populations. Like the other native salmonids, mountain whitefish prefer cool, clean water for spawning and rearing, and clean gravels for spawning. Therefore, those factors discussed above for other salmonids can also affect mountain whitefish populations. However, habitat needs for whitefish are generally considered to be less conservative than for other native fish described in this document, which may account in part for its abundance where it occurs even in streams that have been impacted by past land management actions.

Pygmy Whitefish. Pygmy whitefish are a small species of game fish, usually less than 6 inches long. Because of their small size they are mainly a forage fish preyed on by trout and other predatory fish (Wydoski and Whitney 1979). They are found in lakes and cold streams in the Northwest, although their distribution is the most limited of all the native salmonid Permit species.

Pygmy Whitefish Distribution. Pygmy whitefish have a discontinuous distribution in North America (Scott and Crossman 1973), and are found primarily in Lake Superior, western Montana, northern Idaho, Washington, southwest Alaska, and western Canada. Pygmy whitefish are only found in a few locations in Montana, Idaho, and Washington. In Montana, they occur in the following lakes: Bull (and tributaries), McDonald (and tributaries), Little Bitterroot, Ashely, Flathead, Swan, and Seely (Brown 1971). In Idaho, this species is found in Priest and Pend Oreille Lakes (Simpson and Wallace 1978). In Washington, pygmy whitefish are found in only nine lakes, most of which are near Cle Elum, Chelan, and the northern Idaho border (Hallock and Mongillo 1998).

Status of Pygmy Whitefish Populations. Pygmy whitefish have no federal status. In Idaho, they are considered a species of concern. The State of Washington is currently reviewing the status of pygmy whitefish to determine whether they should be moved from a species of concern to a higher classification of a sensitive species. In Washington, a sensitive species is one whose population is native to the state, is vulnerable or declining, and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of threats (Washington Administrative Code [WAC] 232-12-297, Section 2.6).

Pygmy Whitefish Life History and Habitat Requirements. The life history and habitat requirements of pygmy whitefish are poorly documented. Their habitat is typically deep, cold-water lakes. This species is also found in streams that have moderate to swift currents and may be silty or clear (Hallock and Mongillo 1998).

Pygmy whitefish spawn in streams and lakes from late summer to early winter, depending on geographic location and elevation. In the Northwest, spawning occurs from November through January. Pygmy whitefish probably scatter their eggs over coarse gravel, primarily at night, like other whitefish (Brown 1971; Hallock and Mongillo 1998).

Pygmy whitefish become sexually mature as early as 1 year and often only live 3 to 4 years (Brown 1971). Food includes plankton, zooplankton, and small aquatic insect larvae.

Factors Affecting Pygmy Whitefish Populations. Like the other native salmonid Permit species, pygmy whitefish prefer cool, clean water for spawning and rearing, and clean gravels for spawning, in both lakes and streams. Therefore, those factors discussed above for other salmonids can also affect pygmy whitefish populations.

Endangered, Threatened, and Special Status Species

Appendix D lists other, non-Permit species designated by FWS or NMFS as endangered, threatened, proposed, candidate, or of concern that the Services determined may occur on or near Project Area lands. FWS (1998) identified this information to Plum Creek in a letter dated November 20, 1998, in part to fulfill requirements for a species list under Section 7(c) of the ESA. The Services added information to improve the accuracy of the list as it became available, when they subsequently identified Snake River fall chinook salmon, and Columbia River chum salmon as potentially occurring in the Project Area. Threatened, endangered, and special status species include those that have been listed by FWS or NMFS as endangered or threatened, proposed for listing as endangered or threatened, or are candidates that may subsequently be proposed for listing as endangered or threatened. Species of concern identified in Appendix D have no status under the ESA, but are of concern to FWS because of threats to these species' population status and long-term viability. Species, as defined by the ESA, includes species, subspecies, and distinct population segments (DPSs) or evolutionarily significant units (ESUs).

Five taxa of fish and the aquatic invertebrate not previously discussed and listed in Appendix D are briefly described below.

Sockeye salmon* (Oncorhynchus nerka*)—Endangered. A remnant population of this anadromous species, which occurs in Redfish Lake in the Upper Salmon River Basin, Idaho, is federally listed as endangered (FWS 1998b). This population historically migrated up the Columbia, Snake, and Salmon Rivers, spawned in the main tributary to Redfish Lake, reared for 2 years in the lake, then migrated to sea where it spent 2 years growing and maturing sexually before returning to spawn (Simpson and Wallace 1978). However, since 1990, from zero to only eight adult sockeye have returned annually to Redfish Lake to spawn (Quigley and Arbelbide 1997). Much of the overall decline in sockeye populations has generally been attributed to mainstem dams on the Columbia and Snake Rivers that have blocked access to spawning and rearing areas and otherwise caused mortalities to migrants. An intensive captive brood stock program has been initiated on the Upper Salmon River in an attempt to prevent extinction of the remaining Redfish Lake population (Quigley and Arbelbide 1997).

The Redfish Lake population of sockeye salmon is outside Project Area and Planning Area boundaries. This remnant population has not been identified by NMFS (the jurisdictional agency) or FWS as being potentially affected by the proposed project, has not been recommended by either agency for coverage in Plum Creek's NFHCP, and therefore is not addressed further in this document.

White sturgeon* (Acipenser transmontanus)*: Kootenai River Population—Endangered. This population of white sturgeon is federally listed as endangered and was identified by FWS as potentially occurring in the area of the proposed project (FWS 1998). The Kootenai River population occurs in the Kootenai River from Kootenai Falls, Montana, downstream through northern Idaho to Kootenay Lake, British Columbia. The primary limiting factor for this population has been decreased spring river flows below Libby Dam, Montana, that have contributed to spawning failures in recent years (Quigley and Arbelbide 1997). Plum Creek has very few land holdings within the Middle Kootenai River and Lower Kootenai River Planning Area basins of the Planning Area and none immediately adjacent to the Kootenai River. The Kootenai River population of white sturgeon has not been identified by FWS (the jurisdictional agency) as being potentially affected by the proposed project, has not been recommended by FWS for coverage in Plum Creek's NFHCP, and therefore is not addressed further in this document.

White sturgeon* (Acipenser transmontanus*): Snake River Population—Species of Concern. This population of white sturgeon has been identified by FWS as a species of concern (FWS 1998b). It has been adversely affected by hydropower projects (for example, migration barriers, population fragmentation) (Quigley and Arbelbide 1997). The Snake River population occurs in the Snake and Salmon Rivers, but it does not occur within the Project or Planning Areas. This population of white sturgeon has not been identified by FWS as being potentially affected by the proposed project, has not been recommended by FWS for coverage in Plum Creek's NFHCP, and therefore is not addressed further in this document.

Pacific lamprey (*Lampetra tridentata*)—Species of Concern. This anadromous, parasitic lamprey was identified as a species of concern by FWS (1998b). It is reported from all major drainages accessible to salmon and steelhead. Threats include dams on the Columbia and Snake Rivers that block or constrain upstream passage of adults, harvest of young lamprey (ammocoetes) by bait fisheries, and sedimentation of stream substrate and freshwater spawning/nursery areas because of land disturbances (Quigley and Arbelbide 1997). Pacific lamprey migrate from the ocean into freshwater streams where they spawn in sandy gravel at the upstream edge of riffles. Young rear in natal streams for 5 or 6 years before migrating to sea, where they remain 1 to 2 years before returning to freshwater tributaries to spawn (Scott and Crossman 1973).

Pacific lamprey potentially occur in those habitats accessible to the anadromous salmonids (steelhead and salmon) being addressed in this document and could therefore be affected by the proposed NFHCP and alternatives. These potential effects are discussed in Section 4.6.6, *Environmental Consequences*.

River lamprey (*Lampetra ayresi*)—Species of Concern. This species is also an anadromous, parasitic lamprey that is regarded as a species of concern by FWS (1998). River lamprey apparently only migrate short distances inland and are rare. In the Columbia River, this species does not occur upstream of Bonneville Dam (Quigley and Arbelbide 1997). River lamprey spawn in small, clear streams, probably in gravel (Scott and Crossman 1973). The ammocoetes (young) rear in silty backwater areas for an unknown period, then emigrate to the ocean where individuals feed and grow for several years before returning to freshwater streams to spawn. River lamprey do not occur in the Project Area, have not been identified by FWS as being potentially affected by the proposed project, and therefore are not discussed further in this document.

Columbia pebblesnail (*Fluminicola columbiana*)—Species of Concern. This freshwater snail has been identified as a species of concern by FWS and as potentially occurring in the area of the proposed project (FWS 1998). Frest and Johannes (1995) report that the species *Fluminicola fuscus,* which they described in *Interior Columbia Basin Mollusk Species of Special Concern*, most commonly is cited as *Fluminicola columbiana. Fluminicola columbiana (fuscus)* is restricted to small to large rivers with swift current, a stable gravel to boulder substrate, and cold, unpolluted, and highly oxygenated water (Frest and Johannes 1995). Today, this species is found only in the Hanford Reach of the Columbia River, Washington; the Okanogan and Methow Rivers, Washington; and a limited portion of the Snake River (Hells Canyon National Recreation Area) and possibly a few of its tributaries (Frest and Johannes 1995). Threats to *Fluminicola columbiana* include impoundment and damming of original habitat, sedimentation of river substrate, nutrient enrichment from agricultural practices, effluents from pulp mills, and residues and discharges from metal smelting. This species does not appear to occur within Project Area or Planning Area boundaries, has not been identified by FWS as potentially being affected by the proposed project, and therefore is not addressed further in this document.

Other Aquatic Resources

Other groups of representative aquatic resources besides native salmonids are present in the Project and Planning Areas. Groups include the following:

- Non-native (introduced) salmonids such as brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), hatchery-reared rainbow trout (*Oncorhynchus mykiss*), lake trout (*Salvelinus namaycush*), and kokanee (*Oncorhynchus nerka*)
- Other native fish species such as species of sculpin (*Cottidae*), and dace, minnow, and shiner (*Cyprinidae)*
- Other non-native fish species such as northern pike (*Esox lucius*), sunfishes and bass (*Centrarchidae*), yellow perch (*Perca flavescens*), and walleye (*Stizostedion vitreum*)
- A diversity of aquatic invertebrates including insects, crustaceans, annelids, snails, and clams

A number of interactions occur among these representative groups under existing conditions. Introduced salmonids can compete with and adversely affect some species of native salmonids. For example, brook trout can compete for food and space, and negatively impact bull trout and westslope cutthroat trout (Rieman and McIntyre 1993). Other non-native fish species (like walleye) prey upon smaller native fish. Other native fish, such as sculpin, often serve as prey for native salmonids (like bull trout) and introduced salmonids (like brown trout). Other native fish species are also likely to benefit from the occurrence of one or more of the Four C's: clean, cold, complex, and connected water. Aquatic invertebrates are typically a major food source for most fish species during some or all of their life, and generally benefit in terms of numbers and diversity from the presence of one or more of the Four C's.

Ecological Implications of Land Management Activities on Aquatic Habitat and Fish

Background. One of the foundations for analyzing potential impacts of the proposed NFHCP and alternatives is a full understanding of the ecological implications (that is, cause-effect relationships) associated with planned land use activities and management commitments, particularly as they relate to aquatic ecosystems. All land use practices within the Project and Planning Areas could affect aquatic ecosystems to varying degrees. Depending on how land use practices are implemented, their effects can be either adverse or beneficial. Cause-effect relationships associated with past and current land use practices provide a basis for predicting habitat conditions under future management strategies.

The following listed land management activities are commonly associated with timberlands in Montana, Idaho, and Washington. The list contains activities recognized to have potential impacts on fish habitat, and are derived from the bull trout Programmatic Biological Opinion on federal land management actions, the Federal Register announcing the listing of bull trout, and the ICBEMP. Because this EIS/NFHCP covers native salmonids and not just bull trout, and because all native salmonids have broadly similar habitat requirements, the ecological implications of the following land management activities for salmonids are described in general:

- Roads
- Forest Management
- Grazing
- Agriculture
- Water Diversion/Storage
- Fire Management
- Mining
- Recreation/Fishing
- Land Development

What are "Ecological Implications?"

Ecological implications are the cause-and-effect relationships between management choices and habitat quality. Bull trout and the other native salmonid Permit species need clean, cold, complex, and connected water (the Four C's). Activities such as road building, timber harvest, and grazing have affected water quality, and would continue to do so, to varying degrees under each of the alternatives. These relationships between activity and habitat are important because they are the basis for evaluation of management alternatives in this EIS.

The discussion of ecological implications for each land use activity listed above addresses basic ecology. The purpose of this discussion is twofold:

1. Provide a basic understanding of potential cause-effect relationships within the Project and Planning Areas, especially as related to aquatic resources.

2. Provide the background science that will be used to evaluate the potential effects of the conservation commitments, programmatic prescriptions, and other covered activities associated with the proposed NFHCP and alternatives. This scientific rationale is used in Section 4.6.6, *Environmental Consequences* of this discussion of *Fisheries and Aquatic Resources* to determine the potential direction and magnitude of trend (the size of the impact or benefit) for effects associated with the proposed NFHCP and the other alternatives.

Management of Aquatic Habitat

Historical Management. Prior to 1950, forest harvesting, grazing, recreation, and other land uses along streams and rivers differed little from upslope harvesting: forests were used from the ridge to the stream's edge (Gregory 1997). Logging operations dragged logs down stream channels to landings at the bottom of harvesting units. From the late 1800s until World War II, lower reaches of Pacific Northwest watersheds were subject to log drives—artificial floods created by splash dams to run logs down the rivers to mills. These practices delivered large amounts of sediments to streams, lakes, and estuaries; removed forest canopies and warmed water temperatures; altered habitats associated with wood and greatly decreased future sources of wood inputs; and simplified and narrowed floodplains. Previous to implementation of such logging practices, Native Americans used fire to maintain and enhance their hunting and berry producing areas, which likely affected aquatic habitat (McIntosh et al. 1994).

On federal land, production of timber commodities was the primary goal prior to the Multiple Use-Sustained Yield Act of 1960, the National Wilderness Act, and the Wild and Scenic Rivers Act. Prior to 1960, no attempt was made to practice riparian management consistently across federal lands.

Mining for gold and coal significantly altered rivers and floodplains in watersheds where it occurred (Oliver et al. 1994). There was little or no attempt to restrict grazing in the open range or the effects of water-based recreation. Prior to the 1930s, grazing and harvesting became regulated where public concern for preventing siltation into irrigation reservoirs was raised. Stream channels were straightened to prevent stream bank erosion and control floods (Oliver et al. 1994). For years, standard forest practice was to remove structures from stream channels to improve conveyance. Increasingly, roads encroached on channels and floodplains, often greatly constricting the channel's ability to interact with the floodplains (McIntosh et al. 1994). After 1950, the public and resource managers in the Pacific Northwest increasingly expressed concerns over effects of land uses on streams and anadromous salmonids.

Agreement is widespread that historical land use practices negatively altered the structure of aquatic ecosystems and decreased their productivity (Elmore and Beschta 1987; MBTSG 1998). The legacy of historical management is expressed in the state of forested landscapes, the influence of riparian practices, and the absence of streamside protection prior to 1970. The existing landscape reflects more than a century of land uses on all forest lands with little or no protection of riparian resources and aquatic ecosystems.

State regulations that apply to private land are crafted primarily to address the water quality standards of the federal Clean Water Act. They vary by state, and are intended to provide site-specific management flexibility. They identify distinct riparian management zones in which ecological functions are targeted. They are evolving from an emphasis primarily on stream shading and erosion control to one addressing a range of functions, including shade, food resources, woody debris, channel dynamics, sedimentation, mass failure, hydrologic regimes, and invertebrate, fish, and wildlife populations (Gregory 1997). The diversity of riparian practices on private and federal lands in the Pacific Northwest may be one of the strongest assets for managing aquatic resources—to account for scientific uncertainty and balance risk tradeoffs—without perfect knowledge of the potential consequences of individual actions (Gregory 1997).

Forested Landscapes: Functions and Disturbances

Natural Variation of Ecological Functions. Forested landscapes in the Project Area reflect climate, topography, and past ecological disturbances of varying frequency and severity. Ecological functions and processes of forest stands vary as species composition and stand structure change during successional development. Disturbance resets or redirects the trends of ecological functions. The primary natural disturbance processes affecting plant communities are fire, grazing and browsing by ungulates, insect outbreaks and disease epidemics, windthrow, flooding, and erosion (mass wasting and surface erosion). Most of these processes in the Planning Area are altered by human activities. Disturbance, interacting with climate and topography, produces landscape heterogeneity—a dynamic mosaic of matrices, patches, and corridors.

Disturbances range from very frequent to very infrequent, depending on the disposition of the stands and conditions surrounding the disturbance agent. The stand's development pattern can sometimes set up another disturbance, thus influencing the disturbance frequency and type. The frequency of disturbances can also interact within a stand, with one disturbance either increasing the probability of another disturbance, or compensating for its absence (Johnson et al. 1994).

Natural and human disturbances have long-term influences on the appearance and composition of forests and the ecological services they provide (Waring and Schlesinger 1985). Natural disturbance regimes generally provide beneficial ranges of ecological responses, and are required to create and maintain sustainable ecosystems and associated habitats and ecological processes (Everett et al. 1994; Johnson et al. 1994). The historical or natural range of variability is useful for establishing the limits of acceptable change for ecosystem components and processes (Morgan et al. 1994).

Landscape Disturbances. Ecological functions in riparian and aquatic areas may become unsustainable when disturbance regimes are altered. Disturbances that do not emulate historical events and disturbance scales, or replace elements required by the ecosystem, can be destructive (Everett et al. 1994). Fire suppression has greatly disrupted natural disturbance regimes in the northwest (ICBEMP 1997b).

For example, artificial management boundaries for riparian and aquatic areas, such as inflexible reserves or riparian buffers that do not reflect natural disturbance patterns, may alter riparian functions by the following (Everett et al.1994):

1. Isolating species or habitat from the larger system in which it evolved or interacts

2. Preventing disturbances required for species viability and landscape sustainability

3. Reducing forest health such that adjacent lands are less readily managed to reduce ecological risks

Such administrative fragmentation may result when conservation strategies focused on individual sensitive species and unique habitats are not consistent with forest types, species, and disturbances within the landscape (Oliver and Hinckley 1987; Everett et al. 1994), or when buffers are of insufficient size to maintain natural processes.

Disturbances caused by timber harvest can be qualitatively and quantitatively different from natural disturbances (Boot and Gullison 1995), and there is no natural analog to disturbances created from road building. Compared to riparian areas with sustained commercial timber harvest, disturbance patterns in no-touch riparian buffers are more likely to approximate the temporal patterns of natural processes. Repeated harvest activities shift the timing of disturbances from episodic (pulse) events to chronic (press) events, with complex and poorly understood consequences.

How Can "Landscape Disturbances" be Acceptable?

Landscapes are "disturbed" through a variety of natural and human-caused events. Some disturbances enhance fish habitat, while others reduce habitat quality. In general, disturbances similar to natural events are most likely to sustain natural communities. Artificial disturbances are likely to be more acceptable when they are similar to the patterns, intensity, and scales of natural disturbances. For example, management using a variety of clearcut patch sizes, harvest prescriptions, and lengths of timber rotation more closely approximate natural disturbance patterns than application of similar techniques over an entire landscape.

The NFHCP Biological Goals: The Four C's. The aquatic habitat of greatest interest in the Project and Planning Areas is stream habitat capable of supporting native salmonid fishes (the trout, steelhead, salmon, and whitefish Permit species). Habitat conditions or requirements important to the survival of native salmonids are referred to in this document as the Four C's, which represent the NFHCP biological goals. They consist of Clean water, Cold water, Complex water, and Connected water. Clean water with acceptable sediment levels is important to the spawning and rearing success of all native salmonids, while cold water is particularly important to bull trout because of this species' limited tolerance of warmer water temperatures, especially for spawning and rearing. Complex water contains a variety of cover types, which provide spawning, rearing, foraging, and resting habitat for salmonids as well as protection from predators and high flows. All life history stages of bull trout and other native salmonids are strongly associated with cover. Connected water is particularly important to bull trout because of this species' multiple life history and migration strategies whose success depends on river corridor connectivity. Bull trout populations are also influenced by natural landform conditions that favor the Four C's. These conditions include clean, cold water provided by groundwater upwelling in streams; complex water found in moderately steep drainages that have large deep pools, undercut banks, and streamside (riparian) trees and shrubs; and connected waters of free-flowing systems.

Table 4.6-6 summarizes the potential effects of land management activities on aquatic habitat (that is, the Four C's). These effects are described in detail in the following sections.

Land Management Activities and Ecological Implications

Roads. Most forest land management activities in the Project and Planning Areas require roads capable of supporting heavy machinery and trucks. Roads or access systems are also required for agricultural, ranching, and recreational activities.

The primary effects of roads on aquatic habitat are increased soil erosion and sediment delivery to streams (Packer 1967), blockage of fish movements due to impassable culverts at stream crossings (Evans and Johnston 1980; Clancy and Reichmuth 1990; Furniss et al. 1991), and physical changes to floodplains and streams when roads occupy floodplains or former stream channels (MBTSG 1998).

Road Effects on Clean Habitat. Erosion is the detachment and movement of soil or rock by water, wind, ice, or gravity (Brady 1974). Erosion of the landscape is a natural condition that occurs through a variety of processes that vary in frequency and magnitude. Road construction and maintenance, and exposed soils in the road prism, accelerate erosion and increase the potential for sediment delivery to streams.

TABLE 4.6-6
Potential Relationships Among Land Management Activities and the Four C's

	Four C's			
Activity	**Clean Water**	**Cold Water**	**Complex Water**	**Connected Water**
Roads	X	-	X	X
Forest Management	X	X	X	-
Grazing	X	X	X	-
Agriculture	X	X	X	-
Water Diversion/Storage	-	-	X	X
Fire Management	X	X	X	-
Mining	X	X	X	X
Recreation/Fishing	X	-	-	-
Land Development	X	X	X	-

X = Potential likelihood for a cause-effect relationship
\- = No, or indirect effect

Eroded materials delivered to streams and deposited on the streambed affect aquatic habitat. The construction, maintenance, and use of forest roads have been indicated as primary sources of sediment impacts in managed watersheds (FWS 1998a, Packer 1967). Increased levels of fine sediment in streambed gravels have been associated with decreased salmonid embryo survival (Cederholm et al. 1981; Tappel and Bjornn 1983) and the quality of juvenile rearing habitat (Bjornn et al. 1977). Fine sediment fills the interstitial spaces among gravels and, if severe, can suffocate incubating fish eggs by blocking the flow of water and oxygen to the eggs. Juvenile fish, particularly newly hatched individuals, use interstitial spaces as refugia from high water velocities and predators (Rieman and McIntyre 1993). Land management that minimizes erosion and sediment delivery to streams addresses this well-documented sensitivity (Chapman 1988).

Two erosion processes, surface erosion and mass wasting (landslides and debris flows), are of principal importance on forest hillslopes (Swanston 1991; WFPB 1995). Surface erosion in forested watersheds occurs principally through the action of water on the soil surface. Mass wasting occurs when the force of gravity exceeds the resistive forces that hold the soil on the hillslope, causing mass movement of the soil as a unit. Mass wasting usually occurs when water accumulates on steep slopes. The following discussions of erosion processes relate to roads, as well as other land use activities.

Surface Erosion and Mass Wasting Process. Surface erosion occurs when soil on sufficiently steep slopes is exposed to the impacts of rainfall and the overland flow of water. Raindrop splash, freeze/thaw, dry ravel, and processes such as windthrow and animal burrowing are natural causes of soil detachment. Gravity and overland flow of water are natural transport mechanisms for detached soil particles. Surface erosion of hillslopes can be divided into raindrop, rill, and gully erosion (Schwab et al. 1981). Raindrop erosion occurs when rain falls directly on exposed soil particles and splashes them into the air. Rill erosion occurs when particles are detached by water from rivulets in the soil surface; overland flow develops and concentrates flows during intense rainfall. Gully erosion occurs as rills collect and concentrate water into larger flows during heavy runoff, forming pronounced and persistent channels on hillslopes.

Undisturbed forest soils of the Pacific Northwest coastal and interior areas are normally well protected by surface organic materials and a thick, organic surface soil horizon. As a result, raindrop splash, overland flow of water, and associated surface erosion occur in forested environments only when there are large amounts of precipitation, when vegetation, ground cover, or soils are disturbed, or when soils are frozen or snow-covered, (Dunne and Leopold 1978). In arid environments, vegetation and ground cover can be sparse, and surface erosion occurs with even moderate precipitation. Surface erosion occurs on undisturbed arid sites in the Idaho Batholith, but rates are much lower than disturbed sites. Overland flow and accelerated surface erosion can occur where soils are compacted through activities that remove the surface organic materials and expose underlying mineral soil horizons (Swanston 1991). Activities and events that may promote surface erosion include road construction, skidding, yarding, site preparation (for example, high intensity broadcast burns and mechanical scarification), and high intensity wildfire (McNabb and Swanson 1990; WFPB 1995).

Surface erosion occurs on nearly all roads, but the timing and volume of sediment delivery to streams varies with the location and design of the road, ditches, and stream crossings. The delivery rate of road-related sediment to streams is highest where 1) ditches or culverts drain directly to streams, and 2) the distance between the stream and nearby road is insufficient to filter the sediment-laden water (Ketcheson and Megahan 1996; Megahan and Ketcheson 1996; WFPB 1995). Erosion may also occur in association with culvert failures and diversions because of culvert blockages (Piehl et al. 1988; Furniss et al. 1991). Road erosion rates are highest during the first 1 or 2 years following road construction, then normally decrease to less than half as much in successive years (Megahan 1974; WFPB 1995). Irrespective of their age, roads that receive heavy traffic produce substantially more sediment than low-use or closed roads (Reid and Dunne 1984; Bilby et al. 1989; WFPB 1995).

Mass wasting is a dominant erosion process in many forested watersheds of the Northwest, especially west of the Cascade Mountains (Ice 1985; Swanston 1991). Slope gradient and groundwater have the greatest effect on slope stability (Burroughs et al. 1976). Within the Project and Planning Areas, mass wasting is a more dominant process west of the Cascades than it is in the drier areas of eastern Washington, Idaho, and Montana (Plum Creek 1998a). Over most of the Project Area, failures are often confined to specific landforms, such as steep bedrock hollows and inner gorge terrace escarpments.

Additional factors such as soil composition, depth, degree of parent material weathering, and microtopographic features also are important (Swanston 1991). Three types of mass wasting contribute to stream habitat change: deep seated slumps and earthflows, shallow planar failures (debris avalanches), and debris flows along stream channels, sometimes referred to as debris torrents (Swanston 1991).

Slumps and earthflows typically are triggered by the build-up of pore water pressure in mechanically weak, and often clay-rich, parent materials (Burroughs et al. 1976; Swanston 1991). Earthflows are most commonly reported as significant processes in western Oregon, California, and Washington (Swanston 1991). Debris avalanches are more common than slumps and earthflows (Ice 1985; Swanston 1991; Megahan et al. 1978) and are primarily associated with two specific landforms: bedrock hollows (also referred to as swales or zero-order basins), and stream-adjacent inner gorges (Benda et al. 1997). Few debris avalanches occur on slopes of less than 60 percent gradient, with the majority occurring on slopes exceeding 70 percent gradient (Benda et al. 1997). Debris avalanches and debris torrents are the forms most likely to be influenced by forest disturbances, such as wildlife and forest management activities (Ice 1985). Debris torrents can drastically alter stream habitat for many years (Benda et al. 1997; Swanston 1991).

Mass wasting is a naturally occurring watershed process that can be accelerated by human activities. Roads are the predominant cause of increased rates of mass wasting associated with forest management. Forest roads may produce 10 to 100 times greater sediment delivery than ground disturbance by timber harvesting (Swanston and Swanson 1976). Road embankment failures, including fill failures associated with culvert blockages and diversions, are the predominant form of road-associated mass wasting (Ice 1985).

In addition to sediment generation, roads are potential conduits for other effects on aquatic habitats, such as noxious weed introductions, illegal transplants of predatory and non-native fishes, increased fish harvest rates, increased poaching, dispersed recreational impacts, and spills of toxic materials (FWS 1998). Many of these effects are addressed in the following sections.

Plum Creek requires the use of roads to conduct forest management on its lands. Plum Creek has or shares management responsibility for approximately 20,000 miles of roads in the Project Area, many of which were constructed prior to current road construction standards. Road width, cut/fill slopes, surfacing, traffic levels, vegetative cover, and condition are the fundamental characteristics that determine erosion potential. Figure 4.6-1 summarizes how roads within the Project Area, high priority watersheds, and other watersheds are distributed by geologic type. High priority watersheds include Tier 1 watersheds and watersheds with known sediment impacts (see NFHCP, Section 2). Tier 2 lands would be primarily in other watersheds. The majority of roads occur in the Metasedimentary Geologic District with low to moderate erosion potential, and most are in Tier 2 lands.

The miles of road in a given area is the road density, which indicates the relative amount of human activity. Overall, Project Area road density is 6.9 miles/sq. mile. Road density is 7.1 miles/sq. mile within Tier 1 watersheds, and 6.8 miles/sq. mile within Tier 2 lands. The road system contains about one stream crossing per mile of road in Montana and Idaho, and about two stream crossings per mile of road in Washington. In general, the distribution and character of the transportation system in the Project Area are representative of the Planning Area.

Road density has been used as an indicator of potential sediment delivery, but its ability to predict specific causes of erosion within individual watersheds is limited (ICBEMP 1997a, b). To quantify sediment delivery from road-surface erosion within the Project Area, Plum Creek reviewed sediment erosion studies of 11 watersheds (see Technical Report #3, Plum Creek 1998a). Data from six more watershed studies (Plum Creek 1998c, d; Plum Creek 1996a; Murray Pacific 1994, 1996, 1998) were added to the original data set to more completely represent the four major geologic districts within the Project and Planning Area (see Table 4.6-7). Assessment methods relied on Washington state watershed assessment road erosion modeling procedures to predict direct sediment delivery to streams (WFPB 1995).

A summary of the transportation and annual road sediment delivery to streams in the 15 study watersheds is presented by geologic district in Table 4.6-7. Averaging less than 1 ton/mile, existing sediment delivery is lowest in the Metasedimentary District, which represents most of the Project and Planning Areas. Averaging 15.3 tons/mile, existing sediment delivery is highest in the Eastern Washington Volcanics, which represents only 1 percent of the Project Area.

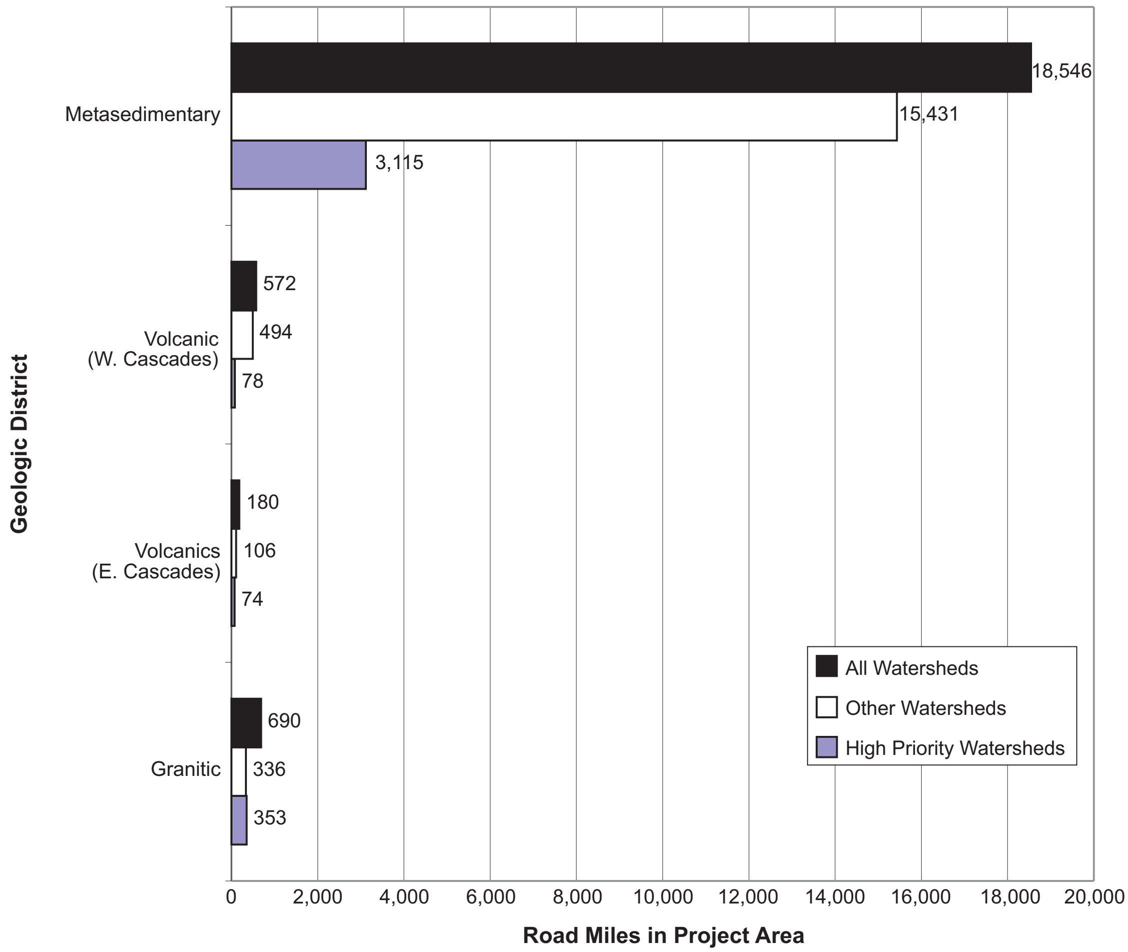

Figure 4.6-1
Summary of Roads in the Project Area by Soil and Watershed Type

TABLE 4.6-7
Summary of Transportation System and Annual Road Sediment Delivery in 17 Study Watersheds

Geologic District and Watershed	State	Area (total acres)	Road Mileage (total miles)	Road Density (average miles/sq.mile)	Existing Annual Sediment Delivery (total tons)	Existing Annual Sediment Delivery (average tons/mile)
Metasedimentary (Belt Supergroup)						
Beatrice Creek	MT	6,566	53	5.2	59	1.1
Belmont Creek	MT	18,630	135	4.6	198	1.5
Boiling Springs Creek	MT	5,490	49	5.8	27	0.5
Boles Creek	MT	13,241	72	3.5	5	0.1
Cedar Creek	MT	16,060	41	1.6	53	1.3

TABLE 4.6-7
Summary of Transportation System and Annual Road Sediment Delivery in 17 Study Watersheds

Geologic District and Watershed	State	Area (total acres)	Road Mileage (total miles)	Road Density (average miles/sq.mile)	Existing Annual Sediment Delivery (total tons)	Existing Annual Sediment Delivery (average tons/mile)
Goat Creek	MT	24,440	87	2.3	45	0.5
Murr Creek	MT	19,900	115	3.7	27	0.2
Piper Creek	MT	7,910	22	1.8	28	1.3
Total/Average		**112,237**	**575**	**3.3**	**442**	**0.8**
Granitics						
LeClerc Creek	WA	66,100	267	2.6	1,787	6.7
Granite Creek	MT	13,295	84	4.0	68	0.8
Spruce Creek	MT	15,810	39	1.6	257	6.6
Rutledge Creek	ID	5,335	50	6.0	40	0.8
Total/Average		**100,540**	**440**	**2.8**	**2,151**	**4.9**
Volcanics (East Slope Cascades)						
Ahtanum Creek	WA	69,850	342	3.1	5,485	16.0
Taneum Creek	WA	29,410	78	1.7	930	11.9
Total/Average		**99,260**	**420**	**2.7**	**6,415**	**15.3**
Volcanics (West Slope Cascades)						
East Fork Tilton River	WA	19,592	104	3.4	1,128	10.8
Tilton River headwaters	WA	8,625	93	6.9	314	3.4
Rainey Creek	WA	18,101	111	3.9	381	3.4
Total/Average		**46,318**	**308**	**4.3**	**1,823**	**5.9**

Road density was lowest in the Eastern Washington Volcanics (2.7 miles/sq. mile) and highest in the Western Washington Volcanics (4.3 miles/sq. mile).

Hot Spots. Road system hot spots are specific locations not meeting current state BMPs that pose relatively high risk for erosion or mass wasting. They pose a much higher potential for water quality impacts. The number and magnitude of road system hot spots is unknown because Plum Creek does not maintain a current inventory.

In many watersheds, hot spots constitute the most severe sources of sediment delivery to streams. A few hot spots can contribute more sediment than the rest of the entire road system. For example, in the Goat Creek watershed in the Swan Valley, five locations contributed 70 percent of road sediment (see Technical Report #5, Plum Creek 1996a). In Boiling Springs Creek, three locations contributed 30 percent of the road sediment delivery (see Technical Report #11, Plum Creek 1998d). It is expected that hot spots will most often be associated with roads constructed prior to BMP standards, and include potential problems such as stream-adjacent roads, roads in unstable areas, and inadequate ditch relief culverts near stream crossings.

Road Effects on Connected Habitat. Culverts designed and built for water passage only can be a barrier to fish passage, depending on the design (Belford and Gould 1989). Four aspects of culvert design have the potential to affect fish passage: opening size, length, slope, and drop. Culverts with an opening larger than necessary may result in water depths too shallow for fish passage, especially during low-flow periods. Depending on the water velocity, extremely long culverts may preclude fish passage since fish cannot sustain high swimming speeds for long periods of time (Bell 1990). One of the greatest influences on water velocity in culverts is the slope of the structure. The greater the slope, the higher the velocity. Therefore, culverts with high slopes may create velocities during certain flows that are impassible, regardless of culvert length. The last aspect of culverts is drop, which is the vertical distance from the discharge of the culvert into the stream. Drop is created either by erosion of the streambed at the culvert outlet or was designed into the feature. Depending on the distance, drop may preclude small fish from passage and even discourage larger fish from attempting passage (Bell 1990).

Culverts can be designed or retrofitted to alleviate most of these fish passage problems. Baffles that concentrate water during low flows can be installed inside the culvert to increase water depths. Baffles can also provide velocity breaks during high flows or in instances where slope has caused increased water velocities. Problems created by drop usually need to be corrected by constructing an outlet to the culvert that acts as a fishway or fish ladder (Bell 1990).

Forest Management. Fiber production is one of the major land use activities in the Planning Area and the primary management objective in the Project Area. A complete silvicultural system includes tree regeneration, tending, and harvest. The components of a silvicultural system may occur discretely or simultaneously. Regeneration involves site preparation, seeding, and planting. Tending involves cultural activities, such as thinning and competition control, at intermediate tree ages to accelerate growth or achieve certain qualities. Timber harvest involves the felling, skidding, yarding, and hauling of trees from the forest. Potential ground-disturbing activities of silviculture, and their definitions, include the following:

- **Felling**—The cutting down of trees.
- **Skidding**—A land-based method of removing trees from the area in which they are cut. This usually involves dragging, or carrying, trees on the ground with a tractor.
- **Yarding**—An above-ground method of collecting cut trees using a cable and pulley system, or helicopter. This method is used on sloped land.
- **Landings**—The areas at which cut trees are gathered (through skidding or yarding) for transport out of the forest.

- **Thinning**—A treatment to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality.

- **Competition Control**—Reduction of weeds and brush through mechanical or chemical methods to promote growth of desired species.

- **Pest and Disease Control**—Use of pesticides or biological controls to reduce the incidence of forest pests and diseases.

Each of these silvicultural activities has potentially different effects on aquatic habitats. Collectively, they can affect three general categories of aquatic habitat important to native salmonids: clean, cold, and complex water. The following sections present more detailed discussions of the cause-effect relationships of forest management on aquatic habitat.

Forest Management Effects on Complex Habitat. The harvest of trees results in changes in forest structure and landscape composition. Tree removal in riparian corridors reduces the potential for input of LWD and organic matter to a stream, and can reduce bank stability if trees are removed near the stream bank (Swanson et al. 1987; MBTSG 1998). These changes have the potential to alter the channel morphology and reduce habitat complexity in streams.

Riparian areas provide a suite of ecological functions that support aquatic ecosystems. These functions include LWD inputs, canopy closure, bank stabilization, sediment trapping, nutrient inputs (leaf litter and dissolved materials), microclimate, and flow regime modifications. Riparian areas can also act as buffers that prevent or attenuate stream inputs of management-related materials like fine sediment or forest chemicals. Where these functions have been studied, research shows that the relative influence of riparian forests on stream ecosystems diminishes with increasing distance from the stream (FEMAT 1993).

The effect of distance is not uniform for each function, with full function being provided close to the stream for some functions (such as bank stability), and much farther away for others (such as microclimate). For example, distances as small as one-half a tree crown diameter may be sufficient to maintain the effectiveness of root strength for bank stability (Wu 1986). On the other hand, based on upland Douglas fir forest, microclimate effects are reported to extend as far away as 800 feet into a forest from its clearcut edge (Chen et al. 1995).

Thinning and harvest of timber in riparian areas reduces the availability of LWD that enters streams. LWD provides complexity by the addition of woody cover or by facilitating the creation of hydrologic features such as pools, gravel bars, and backwater areas. In small streams, gravel bars created by log jams or single pieces of LWD can sometimes be the only source of spawning gravels available for long distances. Pools and backwater areas provide cover by virtue of deep water and provide fish refugia from stream flows. These areas often are critical to the juvenile lifestage of most salmonids. LWD also provides nutrients to a stream system as well as a substrate for aquatic invertebrate (insect) production (Bisson et al. 1987; Montgomery et al. 1996).

The degree to which thinning and harvest can affect LWD recruitment depends on numerous factors, including distance from the stream, stand type, stand structure, and tree size. The degree to which a reduction in LWD recruitment can alter channel morphology and complexity also depends on numerous factors, including stream gradient, streambed geology, and flow regime. Technical Report #7 (Plum Creek 1999a) provides a detailed discussion of impacts and harvesting practices as they relate to LWD recruitment.

LWD can help shape stream channels, form habitat features such as pools, and provide hiding cover for fish. Nearly all LWD supplied to streams is produced from trees growing within a distance of one site-potential tree height from stream channels, subject to chance events and the uncertainties of random and predictable ecological disturbances, as well as slope and soil stability. In this document, it is assumed that site-potential tree height is 100 feet in the ICRB, and 175 feet in western Washington. Several studies conducted within mature ICRB and western Washington forests have demonstrated that 90 percent of LWD input from stream-adjacent sources originates within 0.76 site-potential tree height of stream channels, with 80 percent provided within 0.62 site-potential tree height (Andrus and Lorenzen 1992; Robison and Beschta 1990; McDade et al. 1990; Van Sickel and Gregory 1990). More LWD comes from farther away from the stream channels in western Washington because trees are taller. Occasionally, LWD is delivered from farther distances by floods, debris torrents, and mass wasting events (Benda and Sias 1998).

Several variables affect LWD loading to streams, including the following:

- Stand structure, growth, and mortality
- Natural and human-induced disturbances, including the pattern, frequency, and intensity of tree harvest, fire, insects, or disease
- Channel size

The greatest probability of management effects on LWD loading occurs at the H-9, H-15, T-9, and T-15 riparian stand types in the ICRB and the Class WW5 stand types in western Washington (see Section 4.5, *Vegetation Resources*). These are the denser types with bigger and taller trees; they contain merchantable forest commodities and could be partially harvested. All other stand types in the Project Area are unlikely to be subject to timber management actions within the proposed Permit period. All stand structures in the Project Area could be subjected to natural ecological disturbances that range in frequency and severity. The width of stream channels affects the rate of LWD depletion through decay, high flow, and other processes (Murphy and Koski 1989).

Computer models such as FVS and Riparian Aquatic Interaction Simulator (RAIS) can provide estimates of potential LWD input to streams (Wykoff et al. 1982; Welty 1998; Plum Creek 1999a). Table 4.6-8 shows the potential LWD loading to streams for riparian stand types at the end of a 30-year period, assuming no tree harvesting or other disturbances. (Only LWD that reaches the stream channel, and is at least 4 inches in diameter and at least 6.5 feet long, is tallied.) The stands that are denser and have large-size trees produce the most LWD.

TABLE 4.6-8
Potential LWD Loading[a] and Canopy Cover[b] for Riparian Forest Stand Types[c]

Riparian Stand Classification	Cumulative LWD Loading at the End of 30 Years (pieces per 1,000 feet of stream)	Canopy Cover (percent)
Interior Columbia River Basin		
L3	5	8
L9	8	24
L15	9	24
H3	12	37
H9	63	65
H15	80	53
T3	38	66
T9	198	67
T15	243	71
Non-stocked[d]	0	0
Non-Forest	0	0
Other[e]	78	40
Western Washington		
Class WW1	35	42
Class WW2	78	45
Class WW3	102	42
Class WW4	104	61
Class WW5	104	61

[a]LWD loading is the total remaining after a 30-year period, assuming a stream channel width of 10 feet and a riparian width of 50 feet.
[b]Canopy cover is the amount of open sky blocked by the riparian forest, expressed as a percent, and assumes a riparian width of 50 feet.
[c]Assumption: Streams start with half as much LWD load as an average, unmanaged stream reach in the Project Area.
[d]Non-stocked stands are assumed to be those with fewer and smaller trees than in L3 stands.
[e]LWD and canopy closure estimates are averages for all the stand types.

Several LWD loading patterns are apparent from the Plum Creek model runs. For all riparian conditions, the lower the level of initial disturbance, the greater the potential for LWD loading over time as trees grow and new trees establish. Except after clearcutting, all stand types respond to a disturbance with increasing potential for LWD loading over time. The potential LWD loading at any point in time and the rate of recovery are greatest for merchantable stands that hold higher initial tree densities and larger trees at the time of disturbance; that is, for ICRB T9 and T15 stands. Potential LWD loading for T9 and T15 stands approaches or exceeds average rates within 30 years following all disturbance regimes except clearcutting. On the other hand, H9 and H15 stands generally do not achieve the Planning Area average even for stands without any disturbance (no-cut buffers). However, all merchantable stands provide potential LWD loads within the natural range of variation for Planning Area forests, regardless of the scale of disturbance or the stream width. Class WW4 and WW5 stands in western Washington would respond in a similar way. Potential LWD loading is greater for narrower (10-foot-wide) streams than for wider (30-foot) streams for all regimes. Therefore, disturbance regimes that retain greater proportions of trees near streams deliver the most total LWD, and greater assurances that adequate and desirable amounts of LWD are delivered, all other factors being equal.

The potential LWD loading and the recovery rates for LWD recruitment to streams do not address the amount of LWD that would be needed or desired to conserve or restore aquatic habitat. It is unknown how much LWD currently is in Project Area streams, or precisely how much LWD is adequate for properly functioning aquatic habitats.

Removal of trees near streambanks may result in an increased potential for bank erosion, which can result in the loss of underbank habitat and decreased depth. Many salmonid species, particularly adults, use under-cut banks as holding habitat and feeding stations. Under-cut areas provide fish refugia from main channel velocities, overhead cover from predators, and a place to feed on drifting aquatic invertebrates and smaller fish. Under-cut banks form when soils are scoured out beneath vegetation or roots that keep the surface soils intact. Removal of trees along streambanks can eliminate or reduce the potential for this type of habitat. The root systems of trees near the banks also provide channel stability during periods of high flow, thus reducing the potential for erosion of the floodplain and bank materials (MBTSG 1998).

Thinning and harvest of timber in uplands also has the potential to affect channel complexity by altering streamflow patterns (peak flows). Peak flow increases could lead to increased bank erosion scour of spawning gravels, and loss of LWD. Increases could also reduce the presence of undercut banks, which provide hiding cover for fish. Harvest effects on streamflow were analyzed in Chapter 4, Section 4.3, *Water Resources and Hydrology.* This analysis found that potential risk associated with Project Area management on the peak and low-flow hydrologic regime was low because of the prevalence of partial cutting as a harvest technique, the intermingled ownership patterns, and the historic vegetative conditions. See Section 4.3, *Water Resources and Hydrology*, for additional discussion of this watershed process.

Forest Management Effects on Cold Water Habitat. All species and life stages of native salmonids, especially bull trout, require relatively cold water. Suitable water temperatures in streams are maintained through a variety of mechanisms. In general, surface water temperatures are related to local air temperatures, except where influenced by groundwater. Primary factors affecting air temperature include elevation, aspect, latitude, humidity, wind, and sunlight. Stream temperatures are also affected by stream gradient, stream flow and water source (groundwater, snowmelt, or rain). Of these factors, tree removal generally reduces shade and humidity, and increases wind velocities, and stream flow.

A reduction in tree density and canopy cover in areas adjacent to streams might also affect stream temperature by allowing changes in **microclimate** variables, including increased air temperature, lower humidity, increased wind speed and increased ground temperatures. The principal source of heat for small mountain streams is solar radiation striking the surface of the stream (Brown 1969; Plum Creek 1998f). Flow can be affected if the removal of large areas of vegetation reduces the amount of surface water infiltration into the soil because of compaction (Chatwin et al. 1994). Although reduced infiltration is not directly related to temperature, the amount of groundwater reaching a stream over time can be affected. The temperature of groundwater is usually close to the average annual ambient air temperature of a region, which for the northern United States ranges between 45 and 55°F.

Water temperature increases resulting from timber harvest are greatest during the low-flow periods in summer and early fall. During low flow, groundwater makes up most of the stream flow because input from other sources such as snowmelt is greatly reduced. Also, the travel time for water through a given stream reach is longer (because velocities decrease with decreasing flow), exposing the water to more solar radiation. Reductions in canopy cover because of timber harvest could worsen this condition (Beschta et al. 1987).

Reductions in canopy cover may also increase fish mortality from low temperatures in late fall or early winter. Tree canopies moderate heat loss from streams when the air temperature is cooler than the water. A reduction in canopy cover accelerates heat loss, with the greatest effect in small streams, and little or no effect on wide rivers. Before ice begins to form on streams in late fall and early winter, rapid decreases in stream temperatures can occur during the night.

Average existing canopy cover for riparian stand types in the Project Area was estimated using the FVS or RAIS computer models (Plum Creek 1999a; Welty 1998). In the ICRB, current riparian forest cover typically ranges from 8 to 71 percent depending on the riparian stand type, and is greatest in stand types H9, and T3, T9, and T15. In western Washington, riparian forest cover ranges from 42 to 61 percent, and is greatest in stand Classes WW4 and WW5 (Table 4.6-8). The canopy cover of forest tends to increase over time as trees increase in density and size, until a disturbance occurs.

Canopy cover plays an important role in blocking solar radiation to streams, and reducing the risk of warm air affecting stream temperatures, and air or ground humidity or temperature. The amount of blockage by vegetation depends on the percent cover, width of the vegetated riparian buffer, and width of the stream. Trees at the latitudes of Washington, Idaho, and Montana cast shadows of approximately 0.5 their height at solar noon (McGreer 1995). Between the hours of 10:00 a.m. and 2:00 p.m., approximately 50 percent of total daily solar radiation inputs occur (Brown 1969). At these times of day, solar angle is higher, and trees cast longer shadows approximately equal to 0.7 tree height (McGreer 1995). Trees cast even longer shadows earlier and later in the day, but when solar radiation is relatively low. Therefore, trees beyond a distance of 0.5 to 0.7 tree height contribute little effective cover to shade streams.

Field measurements show that riparian area canopy cover is well correlated with canopy closure over streams, especially for denser H- and T-series stands (Plum Creek 1999a; NCASI 1999). Actual canopy closure over streams is probably greater than that predicted by the FVS model because trees retained in riparian areas are likely to be concentrated closer to the stream, unlike the model which assumes uniform tree retention. The potential effects of canopy cover on stream temperatures are discussed more fully in NFHCP Technical Report #12 (Plum Creek 1998e).

Forest Management Effects on Clean Habitat. Primarily three aspects of clean habitat could be affected by forest management activities:

- Increased sedimentation
- Decreased dissolved oxygen levels
- Introduction of contaminants

This section provides a discussion of these topics as they relate to forest management.

Sedimentation. The amount of sediment deposition in a stream depends on the availability of sediment through erosion, and the rate that this sediment is delivered to the stream. Generally, the amount of sediment created from timber management activities is related to the amount of bare and compacted soils that are exposed to rainfall and runoff. Slope steepness, slope storage capacity, and proximity to stream channels determine the rate of sediment delivery (Quigley and Arbelbide 1997). The potential effects of sedimentation were discussed in the *Road Effects on Clean Habitat* section. Activities such as skidding and yarding can compact soils because of the machinery that is used, especially at landings. Skidding generally causes more ground disturbance than cable or helicopter yarding. However, cable yarding on steep slopes also may result in soil disturbances because the ends of trees may drag on the ground, leaving scars of exposed soil.

Dissolved Oxygen. Dissolved oxygen levels in forest streams in the Planning Area are generally not a significant source of mortality for adult salmonids, but oxygen limitations can cause mortality while eggs and fry are in the gravels. Dissolved oxygen levels decline when water temperatures increase and stream flows drop. As water warms, it loses its capacity to hold or retain dissolved oxygen; at low flows, the surface mixing of water and air is minimal. Therefore, a substantial reduction in canopy cover (shade) has the potential to reduce dissolved oxygen levels in streams if stream temperatures become elevated.

Increased nutrient levels also can reduce dissolved oxygen levels by increasing the biological oxygen demand in the water. Tree removal near streams may result in nutrient loading through soil disturbance and the input of organic material. However, nutrient levels quickly return to normal levels following harvest activities (Chamberlain et al. 1991, in Quigley and Arbelbide 1997).

Contaminants. Most aspects of forest management require the use of mechanized equipment. Where there is machinery used, there is the potential for contamination of stream waters through accidental spills of fuels, oils, and other toxic materials associated with machinery. The relative risk and potential magnitude of pollution is related to the location of the machinery and the duration of the activity. Landings near streams have the greatest potential to deliver pollutants to streams because they are areas of concentrated activity.

The application of pesticides, herbicides, and fire retardant also has the potential to introduce pollutants to streams. These contaminants are most likely to be introduced as aerosols and as chemicals are released through runoff associated with precipitation.

Grazing. The impacts of livestock grazing on aquatic habitat and fish can be either direct or chronic (FWS 1998c). **Direct effects** result in the immediate loss of fish or eggs, or the loss of specific critical microhabitat that displaces an individual fish. **Chronic effects** include those that, over time, result in a widespread reduction in habitat quality or quantity **(**Elmore and Beschta 1987**)**. The severity of either direct or chronic effects depends greatly on the intensity, duration, and timing of grazing activities (Platts 1989), as well as the prior condition and ability of the watershed to assimilate the activity (Odum 1981). Grazing near streams has the potential to affect three general categories of aquatic habitat important to native salmonids: clean, cold, and complex water. Examples of these effects include the following (FWS 1998):

- Compaction of stream substrate by livestock, reducing interstitial spaces in the substrate (clean).
- Collapsing undercut banks, resulting in the elimination of specific microhabitat features and increasing the potential for stream bank erosion (complex).
- Direct mortality of fish eggs and small, immobile fry from trampling by livestock.
- A localized reduction in riparian vegetation along the stream bank, possibly reducing LWD recruitment and canopy cover and increasing erosion (clean, cold, complex).

Chronic effects are similar to direct effects except they occur over a longer period of time. Eventually, they may cause a substantial reduction in fish numbers, large areas of streambank destabilization, and widespread reduction in riparian vegetation. Chronic impacts could cause substantial changes in stream channel integrity and substantial reductions in instream habitat complexity.

At present, Plum Creek has 764,560 acres within grazing leases or allotments (45 percent of the Project Area). About 98 percent of the managed grazing lands are in Montana. While some of these leases are inactive, 106 ranch operations are currently active on nearly 600,000 acres of Plum Creek land. Additionally, most of the Project Area is designated as open range and experiences some level of unauthorized livestock use. Plum Creek estimates that over 10,000 cows grazed on Plum Creek lands in the summer of 1998 (Plum Creek 1998f).

There are about 1,928 miles of streams in the Project Area where riparian grazing occurs (Plum Creek 1998f). Of the total, about 265 miles (14 percent) occur within Tier 1 watersheds and 40 miles (2 percent) are designated as Tier 2 Key Migratory Rivers (Table 4.6-9). Estimated grazing effects on riparian areas range from undisturbed (65 percent) to moderately disturbed (25 percent) to severely disturbed (10 percent) (Plum Creek 1998f).

The Project Area characterization is based on several grazing studies. Within the Thompson River Basin, about 24 percent

TABLE 4.6-9
Estimated Amount of Grazing Effects along Streams within the Project Area

Grazing Effect	Tier 1	Key Migratory Rivers	Tier 2	Project Area
	Miles			
Undisturbed (65%)	172	26	1,055	1,253
Moderately disturbed (25%)	66	10	406	482
Severely disturbed (10%)	27	4	162	193
Total	265	40	1,623	1,928

Undisturbed = generally no recent evidence of grazing. Riparian area is functioning properly and generally considered healthy (BLM 1995; UM RWRP 1998).

Moderately disturbed = some livestock-induced streambank alteration, brush hedging, and soil disturbance evident. Channel is functioning properly, but at risk.

Severely disturbed = stream banks laid back and channel widened as a result of livestock trampling. Bare mineral soil exposed, and extensive loss of native riparian vegetation. Riparian areas are not functioning properly and not in a healthy condition.

of streams show moderate grazing or browsing impacts, and 1 percent show severe grazing or browsing impacts (Plum Creek 1997d). Within Tier 1 watersheds, 3 percent of stream reaches have moderate impacts, and 3 percent have severe impacts; all along Fishtrap Creek. Within Tier 2 lands, 31 percent show moderate grazing impacts, and less than 1 percent show severe impacts. In the Tier 1 Beatrice Creek watershed, little or no grazing impacts on water quality are evident, perhaps because riparian forest adjacent to most of Beatrice Creek is too dense for cattle (Plum Creek 1998d). In the Tier 2 Boiling Springs watershed, moderate grazing impacts are evident at a few locations.

At Belmont Creek, a Tier 1 tributary to the Blackfoot River, about 7 percent of streams have trampled banks, widened channels, and loss of riparian vegetation. Another 22 percent of the streams have reduced riparian vegetation attributed to cattle grazing. Most grazing impacts are concentrated in lower-gradient portions of the channel network (Sugden 1994). At Mount Creek, in Tier 2 lands west of Kalispell, approximately 50 percent of the fish-bearing stream length shows trampled banks, channel widening and downcutting, and loss of riparian vegetation as a result of cattle grazing (Sugden 1993).

Agriculture. Only about 16 percent of the land in the Pacific Northwest, and much less in the Project and Planning Areas, is dedicated to agriculture (Spence et al. 1995, in Quigley and Arbelbide 1997). However, agriculture can have a considerable effect on the aquatic resources of a region because agricultural lands are usually in floodplains and valley bottoms. Agriculture near streams has the potential to affect three general categories of aquatic habitat important to native salmonids: clean, cold, and complex water. Examples of these potential effects include the following (Spence et al. 1995, in Quigley and Arbelbide 1997):

- Loss of native vegetation from planting crops and other land improvements associated with farming, such as buildings, could reduce LWD recruitment, canopy cover and increase erosion (clean, cold, complex).

- Loss of floodplain function could cause increased peak flows, decreased low flows, increased erosion potential and sedimentation, and increased stream temperatures (clean, cold, complex).
- Changes in nutrient supply from fertilizer application and potential sediment delivery (clean).
- Chemical pollution from pesticide and herbicide application (clean).
- Channel modification/reduced habitat complexity and channel instability caused by immediately adjacent agricultural practices (complex).
- Sediment contained in irrigation return flows (clean).
- Temperature elevation caused by irrigation return flows (cold).

Water Diversion and Storage. Dams have played a predominant role in the alteration of some stream and river systems in the Northwestern United States. Dams provide water storage for agriculture, municipal, and industrial uses, and enable hydroelectric facilities to generate electricity. Some dams may be large, such as those on the Columbia, Snake, and Flathead Rivers, while others are small, such as diversion dams on headwater streams that provide seasonal water for small agricultural operations. Numerous dams are scattered throughout watersheds in the Planning and Project Areas, with many smaller dams and diversions in existence that may be undocumented. The U.S. Bureau of Reclamation only inventories and inspects dams that provide greater than about 650,000 cubic feet of water storage, and many states only keep records to comply with federal inventory requirements.

Dams can potentially affect all four general categories of aquatic habitat important to native salmonids: clean, cold, complex and connected water. Examples of these effects include the following:

- Concentrating nutrients and pollutants that would otherwise flush downstream (clean)
- Increasing stream temperatures by slowing water flows and allowing increased heat absorption of water by lengthened exposure to sunlight.
- Delaying or impeding upstream and downstream fish passage (connected).
- Causing direct mortality of fish at hydropower facilities through turbine entrainment, such as fish being killed by turbines (connected).
- Delaying, reducing, or eliminating the downstream recruitment of stream bedload, such as spawning gravel (clean).
- Reducing spawning and rearing habitat through armoring of streambeds downstream of dams (clean).
- Causing physiological stress and increased susceptibility to predators in the tailrace areas of dams, such as disorientation because of swirling and high velocity water (connected).

Fish passage is the most documented and studied of these potential effects. The

National Research Council (NRC 1995) assessed dams listed in the state databases for Oregon, Washington, Idaho, and California and found that most small dams do not have fish passage facilities. However, the extent to which any of these dams impede fish migration was not documented (Quigley and Arbelbide 1997).

Withdrawal of water from storage facilities also potentially affects fish and their habitats. Water withdrawals at diversion structures can cause three primary impacts on fish:

- Reduction in stream flow
- Entrainment of fish into the water supply system
- Water quality impacts resulting from irrigation return flows

Reduced stream flows are particularly important during late summer and early fall because stream flows are naturally low and demand for crop irrigation is usually high during this time. Fish that become entrained in water supply systems are essentially lost to the population, except where diversion systems have bypass facilities that return fish to the streams. Bypass facilities are uncommon and usually only associated with larger diversion structures. Stranding of fish can also occur in the mainstem of streams below diversion structures if the bulk of stream flow is diverted.

Fire Management. Fire is a naturally occurring disturbance event in western forests and rangelands. Terrestrial and aquatic ecosystems have evolved with, and often depend on, the occurrence of fire to perpetuate themselves. Fire management attempts to influence fire effects through fire prevention and control. To reduce fire hazards, fire prevention involves silvicultural practices such as thinning, salvage, and prescribed burning, and the construction of barriers such as roads and fire breaks. Fire control involves mechanical and chemical methods of fire suppression. Decades of fire suppression have created expansive areas that are outside of their historical ranges of variation in plant species composition, density, and structure.

Fire prevention and control, particularly from activities in or near riparian corridors, has the potential to affect three general categories of aquatic habitat important to native salmonids: clean, cold, and complex water. Examples of these effects include the following (FWS 1998c):

- Removal or reduction of LWD, which could reduce habitat complexity and alter stream channel configuration (complex).
- Reduction in stream canopy cover, which could increase stream water temperatures (cold).
- Promotion of mass wasting and surface erosion through the reduction of surface vegetation. This could cause increased surface erosion and sedimentation of streams, which could alter peak and low flows if it occurs over a large area (clean).
- Use of chemical retardant to fight wildfires, which can kill fish if applied on and near streams in sufficient quantities. Potential mortality of aquatic invertebrates and the increased nutrient input to downstream reaches are indirect effects of fire retardant on fish (clean).

- Fire plow lines and soil scarification, which could increase stream sedimentation (clean).

- Catastrophic effects on aquatic habitats from fire after decades of suppression (clean, cold, complex).

Mining. The mining of metal, minerals, stones, and abrasives occurs below ground and at the surface. The greatest impacts on aquatic habitats associated with mining result from surface mining (Quigley and Arbelbide 1997). Surface mining includes open-pit mining, where the surface is slowly scraped away. The ore or rock is either processed onsite or hauled to a processing facility. Surface mining activities have the potential to affect all four general categories of aquatic habitat important to native salmonids: clean, cold, connected, and complex water. Examples of these effects include the following (Quigley and Arbelbide 1997):

- The addition of sediment to streams through the erosion of mine tailings, the direct discharge of mining wastes, and the movement of clay particulate-bearing groundwater originating at mining activities. Impacts on fish from increased sedimentation have been discussed previously (clean).

- The addition of solutions contaminated with toxic metals or acids. This is usually the result of rain or other surface water passing through waste piles from mining operations. In addition, a common practice for extracting gold involves heap leach mining where piles of ore are sprayed with sodium cyanide to extract the gold. This cyanide solution is collected in small ponds, which have the potential to leach or spill to nearby rivers and streams. The Pacific States Fisheries Commission (1994) concluded that 9,000 miles of rivers and streams in the western United States have been polluted through mining activities (clean).

- As surface streams become more acidic, the water dissolves toxic metals that are naturally embedded in soil and streambeds, making metals available for bioaccumulation in fish and their food sources. Bioaccumulation of metals may impair growth and reproductive ability or cause death. Acidic streams and the release of toxic metals into surface waters also can affect fish directly by reducing egg viability and fry survival and by altering behavior and migration patterns (Spence et. al 1995, in Quigley and Arbelbide 1997).

- Increased bank and streambed instability, and subsequent changes in channel formation and stability. Past (and some present) surface mining practices of dredging and placer mining have resulted in the alteration or destruction of riparian vegetation and the realignment of stream channels. The alteration of riparian habitat and stream channel integrity can reduce instream habitat complexity and alter flow and water temperature regimes (cold and complex).

- Creation of chemical barriers from changes in pH or toxic concentrations of metals (connected).

Recreation and Fishing. Two important values of most aquatic ecosystems are the recreational and fishing opportunities. In fact, maintenance of high-quality recreation values is a natural resource management goal for many rivers, streams, and lakes. However, recreation and fishing activities can adversely affect fish populations and aquatic habitats as described below.

Introduction of Non-Native Fish Species. The introduction of non-native fish species by federal or state agencies and private individuals is usually intended to create or expand fishing opportunities. It is unknown how many introduced non-native fish species occur in the Project and Planning Areas. One report estimated that at least 35 non-native species have been introduced in eastern Washington, eastern Oregon, Idaho, and Montana (Quigley and Arbelbide 1997). Many of these introductions occurred in lakes that were historically barren of native fish for a variety of reasons, such as natural barriers or lack of spawning habitat. However, many introductions have been made in rivers and streams with the intent of enhancing recreational fishing.

Three interactions potentially take place when fish or species occur together:

- **Competition** occurs over a wide range of ecological situations when two or more organisms compete for the same limited resource. It includes physical competition between individuals (Chapman 1966), and niche specialization where one species is more efficient at using a habitat than another (Miller 1967).

- **Predation** includes predation on one species by another, and predation by larger (older) fish on smaller ones of the same species.

- **Genetic introgression and hybridization** includes reproductive crosses between species that result in a sterile hybrid (such as most brook trout/bull trout hybrids—some second and third generation hybrids are reported from the West Fork Bitterroot [American Fisheries Society 2000]), as well as crosses between species that result in changes to the gene pool of one species (such as cutthroat/rainbow hybrids or introduction of genetic material from hatchery fish).

All three interactions may affect native fish populations simultaneously where non-native introductions have occurred. The exact effects of some species introductions are unknown; however, the broad implications of species introductions may extend beyond native fish population impacts. Some effects cascade throughout an aquatic ecosystem (Winter and Hughes 1995, in Quigley and Arbelbide 1997) and jeopardize the entire ecological structure and function of that ecosystem (Li and Moyle 1981, in Quigley and Arbelbide 1997). An example of this is the introduction of mysid shrimp (*Mysis relicta*), a relatively large species of zooplankton, into several large lakes in Montana and Idaho. The mysids greatly reduced the population of smaller zooplankton, a preferred food of adult kokanee (landlocked sockeye salmon). The result was a collapse of the recreational kokanee fishery in several of these lakes (Bowles et al. 1991, in Quigley and Arbelbide 1997).

Legal Fishing. Legal fishing has the potential to adversely affect local populations of native salmonids, primarily through incidental catch and habitat alteration. Bull trout populations are a good example of the potential impacts of legal fishing on native salmonids. Even though FWS has listed bull trout as a threatened species, the 4(d) rules of the ESA state that legal fishing for bull trout is to be determined by state fishing regulations. In recognition of the decline of this species, state agencies in Montana, Idaho, and Washington have suspended harvest for most populations of bull trout. State regulations, however, still allow the catch and release of bull trout and the harvest of other salmonids in most bull trout waters. Catch and release fishing regulations are believed to have contributed to increases in some local populations of bull trout. However, mortality from the incidental catch and release of bull trout and from their harvest because of misidentification still continues under existing state fishing regulations. For example, only about half or fewer of anglers surveyed in west-central Montana were able to correctly identify bull trout from other salmonids (FR 1998a). Incidental catch and release mortality and misidentification probably occurs with other species of salmonids as well.

In addition to angling mortality, legal recreational fishing may also affect native salmonids by altering habitat. Wading by anglers can result in the trampling of spawning redds and increased bank erosion (FWS 1998c). Trampling of redds can result in the direct mortality of incubating fish eggs and recently emerged fry, while increased bank erosion can exacerbate habitat degradation.

Illegal Fishing. For some species, one of the most detrimental fishing activities is illegal fishing or poaching. Poaching is the killing of a fish when it is not allowed because of laws or special seasonal regulations. Laws and regulations developed for certain species are put in place to protect sensitive lifestages such as spawners, certain local populations that are depressed, or, in the case of threatened or endangered species such as bull trout, to prevent extinction. Poaching can severely impact fish populations by further reducing populations or sensitive lifestages that are already depressed, and directly killing individuals of a species.

Foot Traffic. Foot traffic can damage vegetation along lakes and streams. Damage of vegetation is direct through trampling or indirect through soil compaction. Vegetation damage can lead to erosion and sedimentation in much the same way as livestock grazing, depending on the amount of activity.

Off-Road Use of Recreational Vehicles. The effects of off-road recreational vehicle use on the environment are well documented for terrestrial systems. However, off-road vehicle use can alter plant community structure and create gaps in vegetation along shorelines and streams (Quigley and Arbelbide 1997). The partial loss of vegetation can increase erosion along waterbodies. Also, use of off-road vehicles in streams may result in the direct destruction of redds, eggs, and possibly young fish.

Land Development. Land use activities discussed in the previous sections all occur within the Project and Planning Areas to some degree and most are related in some way to timber harvest or activities conducted by timber harvest companies such as Plum Creek. In addition to these activities, timber companies also occasionally sell or retire lands that have higher non-timber related values. Often these lands are referred to as those that have a Higher and Better Use (HBU). These include lands that have the potential to provide conservation, recreation, or residential and commercial uses. Obviously, lands that have a high conservation value, and are set aside as such, would have little or no impact on habitat or fish. The others have the potential to affect habitat and fish.

Recreational, residential, and commercial development is rapidly increasing in portions of the ranges of the native salmonid Permit species covered in this EIS/NFHCP. Land development activities such as residential subdivisions, ranchettes, golf courses, or commercial properties could adversely impact water temperature or quality, or degrade corridor connectivity or complexity for native salmonids in key watersheds and along key migratory rivers. Development has the potential to alter stream and riparian habitats through streambank modification and destabilization, and increase nutrient loading (MBTSG 1995, in FR 1998a). Indirectly, urbanization within floodplains also has the potential to alter groundwater recharge by routing water into streams through drains rather than through more gradual subsurface flow (Booth 1991, in FR 1998a). Not only would this possibly reduce areas of groundwater upwelling, which are important to bull trout spawning, but also may exacerbate high flow events that could result in increased streambank erosion, and even direct mortality to fish in extreme instances.

4.6.6 Environmental Consequences

Potential impacts on fisheries and aquatic resources in the Project and Planning Areas include potential changes in habitat conditions, expressed primarily through the Four C's (clean, cold, complex and connected water), that could subsequently benefit or adversely affect the Permit species, other federal special status species, and other aquatic resources. The following discussion focuses on the likelihood of such impacts occurring under the proposed NFHCP and other alternatives and on measures for mitigating or avoiding potential impacts. The impact analysis focuses on the proposed 30-year Permit period, and also includes brief assessments for 10- and 20-year Permit periods following the *Summary of Effects* discussion. Where appropriate, discussions of the proposed NFHCP and other action alternatives refer to discussions under Existing Regulations, the No Action Alternative.

For the purposes of this analysis, clean water is evaluated primarily in terms of sediment delivery. Clean stream gravels are important for salmonid spawning success and in the production of aquatic invertebrates as a food source for fish. Cold water is important to all salmonids, which are relatively sensitive to warm waters. Complex water or habitat refers primarily to instream habitat, which provides cover for fish and helps define and add complexity to the stream channel through undercut banks, pools, and other features. Connected water or habitat refers to stream corridor connectivity, which is important to those salmonids with multiple life history, movement, and migration strategies (Rieman and McIntyre 1993; MBTSG 1998). Table 4.6-6 identifies potential cause-and-effect relationships among land management activities and each of the Four C's.

To conduct the impact analysis in this section, it is helpful to think about threats to bull trout in terms of the NFHCP biological goals: the Four C's. For example, threats such as dams and residential development can affect the connected aspect of the Four C's. By grouping the threats, it is easier to evaluate how those threats might be mitigated or reduced through application of the alternatives. Table 4.6-10 contains a summary of threats to bull trout subpopulations in Planning Area basins (FWS 1998a) and was developed based on

TABLE 4.6-10
Threats to the Four C's for Bull Trout Subpopulations in Columbia River Population Segments Occurring in Planning Area Basin Drainages (after FWS 1998a)

Planning Area Basin[a]	Bull Trout Subpopulation	Threatened Bull Trout Needs				Mortality		Threat to Population		
		Clean Water[b]	Cold Water[c]	Complex Habitat[d]	Connected Water[e]	PD or Harvest[f]	Non-Native[g]	Magnitude[h]	Imminence[i]	Priority[j]
Montana										
Upper Kootenai	Upper Kootenai River	X	X	X	X	BK	BK	M	I	9
	Sophie Lake	X	X	X				M	I	9
Middle Kootenai	Middle Kootenai River	X	X	X	X	BK		M	I	9
Lower Kootenai	Lower Kootenai River	X	X	X	X	BK		H	I	3
	Bull Lake	X	X	X	X	O		M	I	9
Flathead	Flathead Lake	X	X	X	X	LT	BK, LT	H	I	3
	Whitefish Lake	X	X	X	X	LT, O	BK, LT, O	H	I	3
	Upper Whitefish Lake	X	X	X				H	I	3
	Tally Lake	X	X	X		LT, O	BK, LT, O	H	I	3
	Upper Stillwater Lake	X	X	X	X	LT, O	BK, LT, O	H	I	3
	Lower Stillwater Lake	X	X	X	X	LT, O		H	I	3
	Cyclone Lake	X	X	X				L	NI	12
	Frozen Lake	X	X	X				L	NI	12
	Kintla Lake					LT	LT	H	I	3
	Upper Kintla Lake							L	NI	12
	Cerulean Lake							L	NI	12
	Upper Quartz Lake							L	NI	12
	Middle Quartz Lake							L	NI	12
	Lower Quartz Lake					LT		H	I	3
	Akokala Lake					LT	LT	L	NI	12

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		Threatened Bull Trout Needs				Mortality		Threat to Population		
Planning Area Basin[a]	**Bull Trout Subpopulation**	**Clean Water[b]**	**Cold Water[c]**	**Complex Habitat[d]**	**Connected Water[e]**	**PD or Harvest[f]**	**Non-Native[g]**	**Magnitude[h]**	**Imminence[i]**	**Priority[j]**
	Logging Lake					LT	LT	H	I	3
	Bowman Lake							H	I	3
	Arrow Lake							H	NI	6
	Trout Lake							L	NI	12
	Lower Isabel Lake							L	NI	12
	Upper Isabel Lake							L	NI	12
	Harrison Lake						BK	H	I	3
	Lake McDonald					LT	BK, LT	H	I	3
	Lincoln Lake						BK	H	I	3
	Doctor Lake					H		L	NI	12
Swan	Swan Lake	X	X	X	X		BK, O	M	I	9
	Lindbergh Lake	X	X	X			BK	H	NI	6
	Holland Lake	X	X	X			BK	H	I	3
Lower Clark Fork	Cabinet Gorge Reservoir	X	X	X	X	H, O, BR	BK, O	H	I	3
	Noxon Reservoir	X	X	X	X	H, O, BR	BK, O	H	I	3
Middle Clark Fork	Middle Clark Fork River	X	X	X	X	H, O, BR	BK, O	M	I	9
Upper Clark Fork	Upper Clark Fork River	X	X	X	X	H, O, BR	BK, O	M	I	9
Bitteroot River	Bass Creek	X	X	X	X		BK, O	H	I	3
	Bear Creek	X	X	X	X		BK, O	H	I	3
	Big Creek	X	X	X	X		BK, O	H	I	3

TABLE 4.6-10
Threats to the Four C's for Bull Trout Subpopulations in Columbia River Population Segments Occurring in Planning Area Basin Drainages (after FWS 1998a)

Planning Area Basin[a]	Bull Trout Subpopulation	Threatened Bull Trout Needs: Clean Water[b]	Cold Water[c]	Complex Habitat[d]	Connected Water[e]	Mortality: PD or Harvest[f]	Non-Native[g]	Threat to Population: Magnitude[h]	Imminence[i]	Priority[j]
	Burnt Fork Bitterroot River	X	X	X	X		BK, O	H	I	3
	Fred Burr Creek	X	X	X	X		BK, O	H	I	3
	Gold Creek	X	X	X	X		BK, O	H	I	3
	Kootenai Creek	X	X	X	X			H	I	3
	Lost Horse Creek	X	X	X	X		BK, O	H	I	3
	Mill Creek	X	X	X	X		BK, O	H	I	3
	One Horse Creek	X	X	X	X		BK, O	H	I	3
	Railroad Creek	X	X	X	X		BK, O	H	I	3
	Reimel Creek	X	X	X	X		BK, O	H	I	3
	Roaring Lion Creek	X	X	X	X		BK, O	H	I	3
	Sawtooth Creek	X	X	X	X		BK, O	H	I	3
	Sleeping Child Creek	X	X	X	X		BK, O	H	I	3
	South Fork Lolo Creek	X	X	X	X		BK, O	H	I	3
	Sweathouse Creek	X	X	X	X		BK, O	H	I	3
	Sweeney Creek	X	X	X	X		BK, O	H	I	3
	Tincup Creek	X	X	X	X		BK, O	H	I	3
	Tolan Creek	X	X	X	X		BK, O	H	I	3
	Warm Springs Creek	X	X	X	X		BK, O	H	I	3
	Watchtower Creek	X	X	X	X		BK, O	H	I	3
	West Fork Lolo Creek	X	X	X	X		BK, O	H	I	3
	Willow Creek	X	X	X	X		BK, O	H	I	3

TABLE 4.6-10
Threats to the Four C's for Bull Trout Subpopulations in Columbia River Population Segments Occurring in Planning Area Basin Drainages (after FWS 1998a)

		Threatened Bull Trout Needs				Mortality		Threat to Population		
Planning Area Basin[a]	**Bull Trout Subpopulation**	**Clean Water[b]**	**Cold Water[c]**	**Complex Habitat[d]**	**Connected Water[e]**	**PD or Harvest[f]**	**Non-Native[g]**	**Magnitude[h]**	**Imminence[i]**	**Priority[j]**
	Skalkaho Creek	X	X	X	X		BK, O	H	I	3
	East Fork Bitterroot River	X	X	X	X		BK, O	M	I	9
	West Fork Bitterroot River	X	X	X	X		BK, O	H	I	3
Blackfoot	Blackfoot River	X	X	X	X	H, BR	BK	M	I	9
Idaho										
Clearwater	Upper Clearwater River	X	X	X			BK	L	NI	12
	Shotgun Creek	X	X					L	I	9
Washington										
Lewis River	Yale Reservoir	X	X	X	X	H	BK	H	I	3
	Swift Reservoir	X	X	X	X	H	BK	M	NI	12
Ahtanum Creek	Ahtanum Creek	X	X	X	X	H		H	I	3
Lower Tieton	Naches River	X	X	X	X	H	BK	H	I	3
	Rimrock Lake	X	X	X	X	H	BK	H	I	3

TABLE 4.6-10
Threats to the Four C's for Bull Trout Subpopulations in Columbia River Population Segments Occurring in Planning Area Basin Drainages (after FWS 1998a)

		Threatened Bull Trout Needs				Mortality		Threat to Population		
Planning Area Basin[a]	Bull Trout Subpopulation	Clean Water[b]	Cold Water[c]	Complex Habitat[d]	Connected Water[e]	PD or Harvest[f]	Non-Native[g]	Magnitude[h]	Imminence[i]	Priority[j]

[a]FWS did not identify bull trout subpopulations in the Lochsa or North Riffe Lake Planning Area Basins
[b]Threats to Clean Water include roads, mining, forestry, grazing, agricultural practices, and water quality (a threat to water quality is counted if the stream is on that state's 303(d) list, or if a water quality threat exists that is not yet listed)
[c]Threats to Cold Water include forestry and water quality
[d]Threats to Complex Habitat include forestry
[e]Threats to Connected Water include dams, mining, and residential development
[f]H-Harvest; PD-Predation by one of the following species: BK—brook trout, BR—brown trout, LT—lake trout, O—other introduced non-native
[g]Non-native fish species: BK—brook trout, BR—brown trout, LT—lake trout, O—other introduced non-native
[h]H—High; M—Medium, L—Low
[i]I—Threat is Imminent; NI—Threat is Not Imminent
[j]3—Highest Priority; 12—Lowest Priority

Table 4.6-5 and earlier discussions of cause-and-effect relationships between management choices and habitat quality. The footnote of Table 4.6-10 explains which threats apply to each of the Four C's. Three levels of impact analysis are presented in this section:

- Reach or resource-specific (Level 1)—Quantitative assessments of prescriptions where their potential effects can be related to fish habitat. Examples include sediment delivery to streams, LWD input, and canopy closure.
- Project Area (Level 2)—Describes expected overall effects of the prescriptions on fisheries and aquatic resources on Plum Creek (Project Area) lands using qualitative and quantitative assessment results.
- Planning Area (Level 3)—Primarily qualitative in nature, and describes potential cumulative effects on fisheries and aquatic resources in the Planning Area that would result from implementing different management regimes (the proposed NFHCP and other action alternatives) in the Project Area. Level 3 includes the cumulative effects of Project Area activities within the context of other management strategies within the Planning Area.

The varying levels of impact analysis are applied, as appropriate, to describe potential effects on aquatic resources. Potential Level 1 and Level 2 effects of the proposed NFHCP and other action alternatives are discussed under the broad headings of the Four C's. Planning Area (Level 3) effects are discussed under the cumulative effects heading. Whether an actual improvement in habitat would occur, or whether degradation of habitat would be reduced, would depend on site-specific conditions at the time conservation measures under any of the alternatives were applied. For example, existing regulations may be adequate to conserve Permit species in certain watersheds that are not currently degraded. But in severely impacted watersheds, perhaps even the most conservative prescriptive measures governing forestry actions, coupled with the most aggressive restoration efforts, may or may not be sufficient to restore native fish habitat within the next 10 to 30 years.

For road and upland commitments under all but the Simplified Prescriptions Alternative, Plum Creek would build approximately 1,300 miles of new road, increasing the total number of roads in the 1.6-million-acre Project Area an additional 7 percent over existing levels. Under the Simplified Prescriptions Alternative, Plum Creek would build only an additional 650 miles of new roads. Some amount of old road rehabilitation would occur under all alternatives, and this set of conservation measures affects overwhelmingly the calculated amount of sediment delivery to streams, more so than any other single factor.

For riparian commitments under all four alternatives, Plum Creek would implement existing regulations for timber harvest in riparian areas, while under the three action alternatives, Plum Creek would implement additional more restrictive prescriptions. The estimated net change in canopy closure among all four alternatives is minimal, so modeled temperature effects show little difference among alternatives from forestry actions. Modeled effects on LWD are more easily identified, with the three action alternatives allowing for greater wood recruitment than the No Action Alternative, and the Simplified

Prescriptions Alternative allowing for the most wood recruitment. Under the proposed NFHCP and the Internal Bull Trout Conservation Plan Alternative, conservation commitments would be focused on bull trout spawning and rearing streams (Tier 1 watersheds). Because of this, the potential benefits to other Permit species from these alternatives is uncertain, but is likely less than for bull trout, to the extent that sensitive life history stages of other Permit species occur in Tier 2 watersheds. In the proposed NFHCP, monitoring and adaptive management commitments would reduce uncertainty regarding the benefits of conservation commitments to other Permit species. Monitoring and adaptive management would allow the Services to work with Plum Creek to develop and implement additional conservation measures using project monitoring data or other information, if initial measures are inadequate to conserve Permit species.

For range management commitments, livestock grazing would occur under all four alternatives. Under Simplified Prescriptions, grazing would be greatly reduced. Under the NFHCP, grazing riparian areas would be reduced through range management techniques. Under the other two alternatives, there would be varying, although fewer reductions in impacts on fish habitat from livestock.

For the remainder of the conservation commitment categories (land use planning, legacy and restoration, administration and implementation, and monitoring and adaptive management) there would be minimal or no conservation benefit to Permit species under the No Action Alternative, and varying levels of benefit under the three action alternatives.

For all action alternatives, adaptive management opportunities would be essential to the success of a Permit. The Services face uncertainty in issuing a long-term Permit over a large geographical area for multiple aquatic species whose status and recovery needs are not entirely known. Therefore, the need for flexibility in ensuring conservation commitments are sufficient is extremely important. Under the No Action Alternative, adaptive management would not occur, and a Permit would not be issued. The Services would exercise and adjust their ESA regulatory authority using new biological information as it becomes available. Under the three action alternatives, some level of adaptive management would be agreed to, with the NFHCP offering the greatest flexibility and opportunity for the Services to help guide adaptive management in the Project Area.

What is Plum Creek's View of the Effects Analysis?

Plum Creek has provided a statement explaining how the company views the context of this effects analysis because this EIS serves as the effects analysis for their NFHCP. This statement is in Section 1 of the NFHCP provided at the end of Chapter 3 of this document.

Existing Regulations—No Action Alternative

Trends and future conditions under the No Action Alternative are described below.

Clean Water (No Action Alternative). Water and substrate of Project Area streams would be cleaner under the No Action

Alternative than at present, primarily because of reduced sediment delivery from forest roads. Sediment reduction would occur primarily through implementation of current forest road management practices on old roads that are not up to current standards. Roads would be brought up to current standards only as those roads were encountered and used to access timber. Historical land and forest road management practices have contributed to aquatic habitat degradation, and the sediment reductions may or may not be enough to offset historic sediment inputs. The effects of road improvements are expected to vary among watersheds, with some watersheds showing improved fish habitat, and others showing no improvement or even further declines in habitat quality from continued sediment inputs. Potential benefits associated with reduced sediment loading, sedimentation, turbidity, and stream substrate embeddedness were described in detail earlier in this section in *Ecological Implications of Land Management Activities on Aquatic Habitat and Fish*. Examples include increased quantity and quality of suitable salmonid spawning gravels, greater survival of salmonid eggs and pre-emergent fry present in the gravels, and increased production of aquatic invertebrates (fish foods) in interstitial spaces among clean cobbles and gravels (Rieman and McIntyre 1993).

Current rates of sediment delivery from roads to streams have declined from historical rates, and generally sediment delivery rates in the future would likely continue to decline under the No Action Alternative.

All estimates of trends in sediment delivery only include inputs from road surface erosion. Sediment inputs from other management-related sources such as mass wasting were not quantified. However, the amount of sediment input from these sources, particularly from mass wasting, was not believed to be large within the Project Area. This is based on results of mass wasting assessments conducted in several watersheds of the Interior Columbia River Basin (Plum Creek 1998a).

Most bull trout subpopulations present in Project Area and Planning Area streams have been identified by the FWS as threatened by sediment (Table 4.6-10).

The resident trout species (bull trout, redband trout, coastal rainbow trout, and westslope and coastal cutthroat trout) and the anadromous coastal cutthroat trout are the most likely species to be directly and adversely affected by sediment contributed from Plum Creek lands, since they spawn on Plum Creek property. However, all of the Permit species that broadcast their eggs, including mountain whitefish and pygmy whitefish, require clean gravels for spawning success and food production, and would be affected by anticipated reductions in sediment deposition.

The trend of reduced sediment delivery from roads to streams would likely continue under the No Action Alternative. Sediment delivery from roads to streams would likely be reduced in Tier 1 and Tier 2 watersheds and in all Planning Area basins. Compared to existing conditions, clean water and salmonid habitat, as indicated through sediment delivery estimates, is likely to improve for the majority of Plum Creek lands, where Plum Creek roads are the principal management-derived sediment source. The magnitude and rate of habitat improvement in quality of spawning gravels is unknown. It is possible that the magnitude of improvement would not be large enough to adequately conserve Permit species throughout the Project Area, and there would be no monitoring or adaptive management commitments to ensure sufficient magnitude of trend is achieved. Project Area subpopulations of bull trout listed in Table 4.6-10 that are threatened by water-quality-limited conditions could benefit from sediment reductions under the No Action Alternative, as would the other Permit species of trout, steelhead, salmon, and whitefish present in Tier 1 and 2 drainages.

Continuing threats from livestock use, land development, and legacy impacts are greatest in four of the thirteen Planning Area basins, including the Middle Kootenai River, Blackfoot River, and Middle Clark Fork River in Montana, and Ahtanum Creek in Washington. These four Planning Area basins together include nearly three-fourths of the total number of stream miles affected by grazing, included in Key Migratory Rivers with potential legacy impacts, and potentially vulnerable to land development activities in the Project Area. Secondary water quality issues potentially affecting the clean water component of the Four C's were addressed in Section 4.4, *Water Quality and Contaminants*, and in Sections 4.2, *Geology and Soils*, and 4.3, *Water Resources and Hydrology*. They include influences of other covered activities described in Section 2.3.1, *Plum Creek's Land Management*, on clean water. Other clean water parameters potentially affected under this alternative include nutrient loading, contaminant loading (such as herbicides and insecticides), and dissolved oxygen levels, as well as sediment delivery associated with silvicultural and other practices related to commercial forestry. Based on assessment results presented in Sections 4.2, 4.3, and 4.4, there would be no change in effects of the continued implementation of forest practices regulations and BMPs on these and other water quality parameters under the No Action Alternative.

Existing regulations guiding management of roads, riparian areas, and grazing in the Project and Planning Areas would affect sediment delivery to streams and soil productivity. With the adoption of state forest practice rules in recent years, forest management practices result in less sediment delivery to streams, compared to historical practices, with current rates of sediment delivery to streams and soil productivity losses being lower than historical rates. Generally, adverse effects are expected to slowly decrease over time as BMPs evolve and are implemented, and as legacy sedimentation sources are reduced. As a consequence, eventually, sediment delivery and mass wasting improvements generally would be realized by all bull trout subpopulations in the Planning Area currently believed to be threatened by forestry, grazing, or roads (refer to Table 4.6-5).

Road-related sediment delivery and mass wasting would be expected to decrease over time through the application of existing regulations. This expectation is supported by the trend of increasing landowner compliance with road BMPs and the related trend of declining water quality impacts per site (Figure 4.6-2) (Fortunate et al. 1998). Audit records indicate that performance by Plum Creek within the Project Area meets or exceeds the statewide averages. State audits also indicate that BMPs are increasingly effective for reducing sediment delivery as intended, and at controlling potential road-related sediment sources (Fortunate et al. 1998; 1996 Forest Practices Audit Team 1997). However, their effectiveness for reducing or removing impacts to Permit

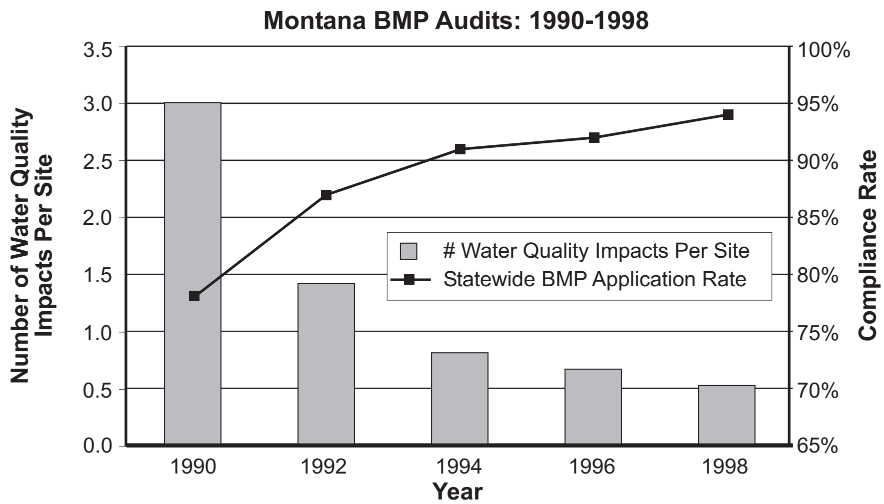


Figure 4.6-2
Summary of Montana BMP Audit Results, 1990-1998

species and their habitats is not currently known. Another evident trend in state road BMPs is increasing rigor in addressing Clean Water Act concerns, as well as aquatic resource protection. Additional details that describe the impacts of BMPs on water quality are described in Section 4.4, *Water Quality and Contaminants*. However, whether decreasing trends in sediment delivery to streams are adequate to conserve Permit species under the No Action Alternative is unknown.

Under this alternative, significant lengths of road surface would continue to drain directly to stream crossings, delivering fine sediment. Plum Creek would continue to upgrade old roads to meet current standards, but the rate of improvements would likely be relatively slow, without commitment to specific rates of repair. In the Project Area, total sediment delivery under the No Action Alternative over the 30-year planning period is estimated to be 546,000 tons (Figure 4.6-3). Of that, a total of 132,000 tons of sediment would be delivered to streams in high priority watersheds (such as Tier 1 watersheds and watersheds with known sediment impacts; see NFHCP, Section 2, Box R-5), and 414,000 tons to streams in other watersheds.

Sediment delivery under the No Action Alternative would decrease annually for 25 years, then remain relatively lower (Figure 4.6-4). The rate would drop from about 24,000 tons of sediment per year initially to about 14,000 tons of sediment per year by Year 25, then remain essentially constant. In high priority watersheds initial sediment delivery of 5,800 tons per year would drop annually by 90 tons. In other watersheds, initial sediment delivery of about 18,500 tons per year would drop annually by 310 tons.

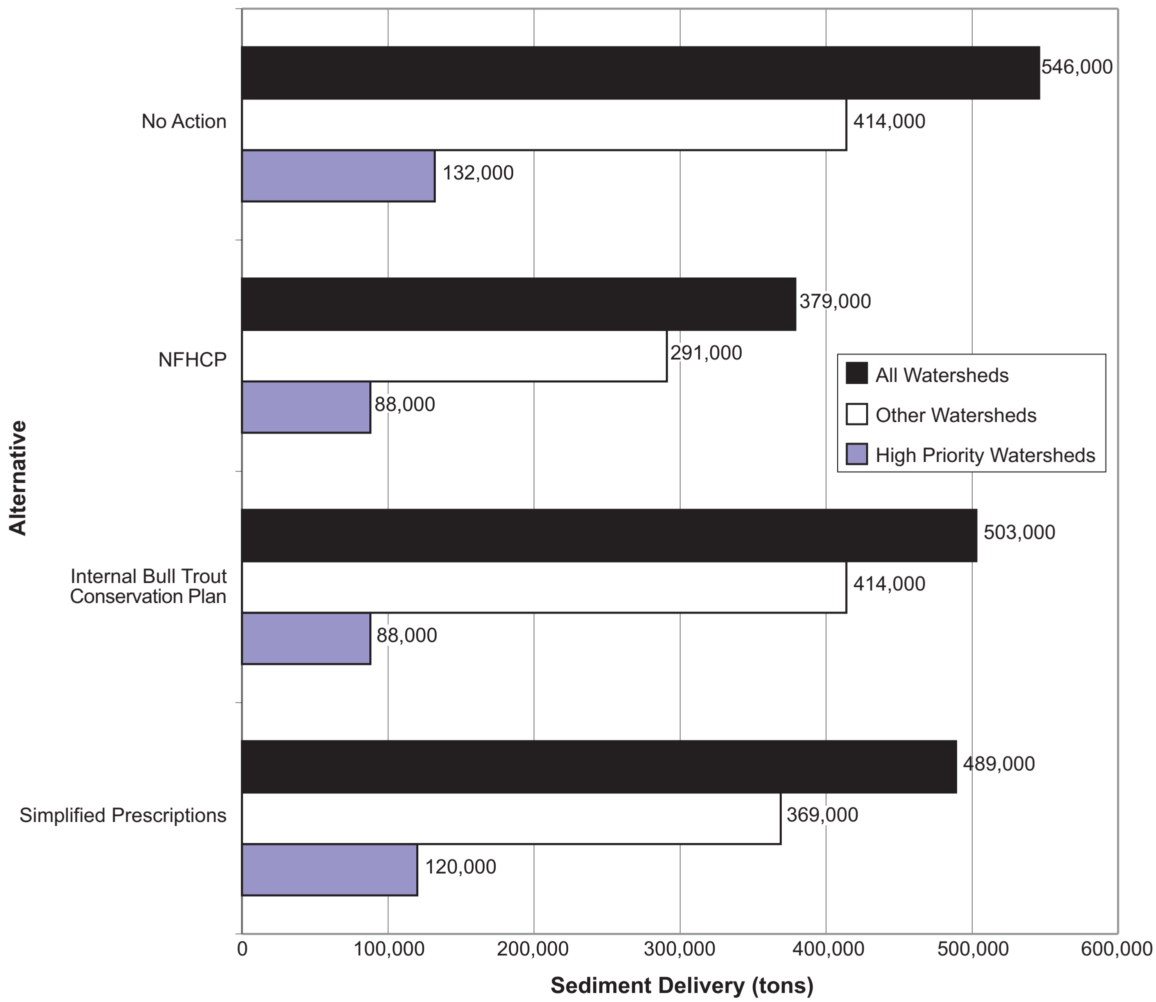


Figure 4.6-3
Cumulative Sediment Delivery from Existing Roads During the 30-Year Planning Period

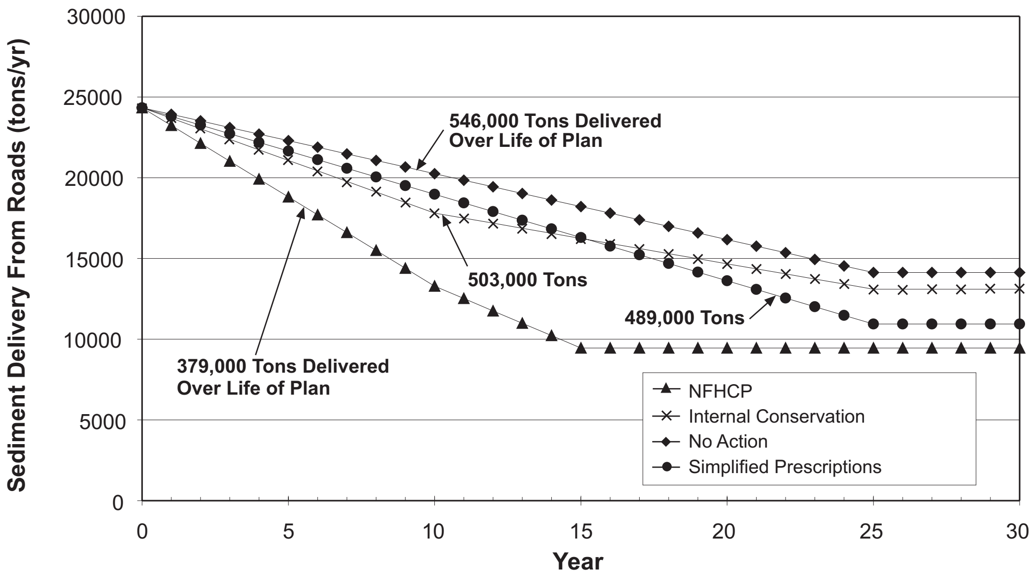


Figure 4.6-4
Total Sediment Delivery from Existing Roads During the Planning Period

This represents a 40 percent reduction in the annual amount of sediment being delivered from roads to streams. Even with this large reduction, sediment delivery may continue to exceed the transport capacity of some streams, and thus provide little or no benefit to fish.

Plum Creek would continue to build new roads to access and manage its lands under the No Action Alternative. The design standards of new roads would be guided by state forest practice regulations and BMPs, which direct that new road construction be minimized. The amount of new road construction would be governed by market demand for products, but up to 1,300 miles of new roads may be constructed over the 30-year life of the plan. For purposes of analysis, it is assumed that one-tenth of the road miles would be built during each year through the first 10 years of the project period. It is also assumed that sediment delivery from new roads would increase over the 10-year project period as more road mileage is built, peak after 10 years when all new roads are completed, then decrease as roads age and revert to lower traffic levels. Sediment delivery would eventually level off after 13 years, after completion of new road construction and peak road use periods.

Over the life of the plan, this estimated quantity of new roadway would deliver about 11,411 tons of sediment to Project Area streams (Figure 4.6-5). Combining all watersheds, sediment delivery would peak in year 10 at approximately 580 tons/year (Figure 4.6-6).

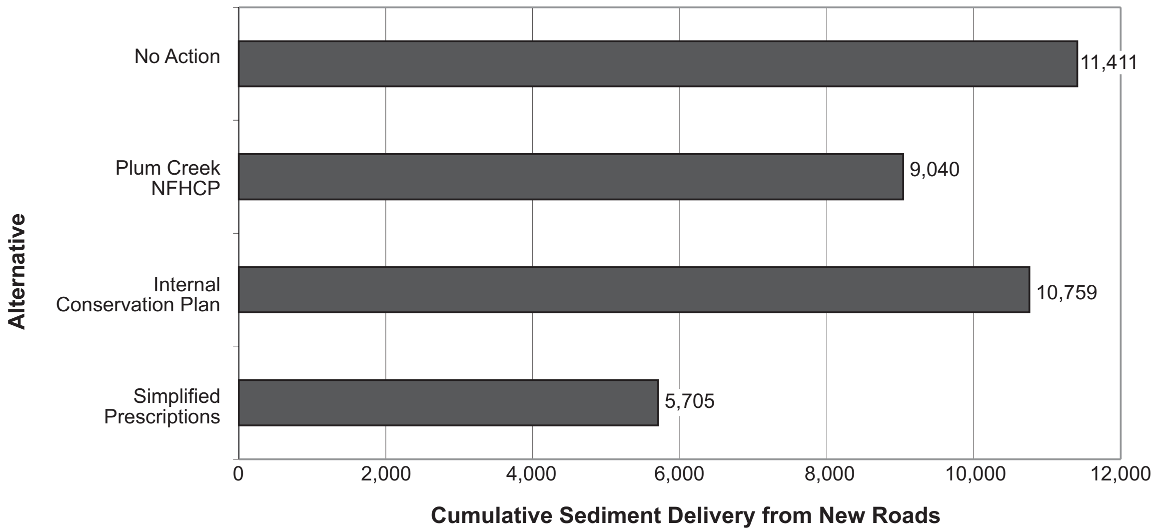


Figure 4.6-5
Cumulative Sediment Delivery from New Roads During the Planning Period

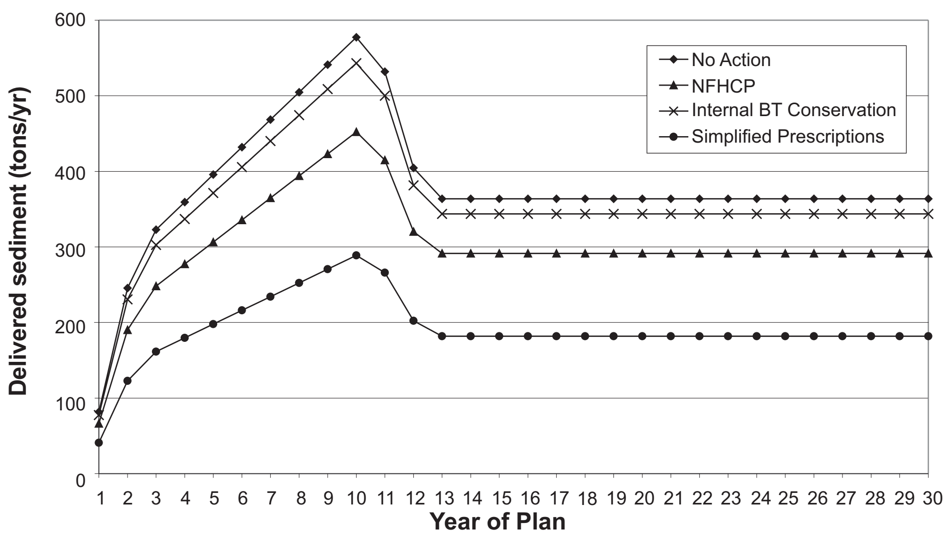


Figure 4.6-6
Total Sediment Delivery from New Roads During the Planning Period

The distribution of new roads would be similar to the distribution of existing roads, and most would be constructed in the Metasedimentary Geologic District, which has the lowest potential for erosion (Figure 4.6-7) (Packer 1967).

The No Action Alternative would treat legacy hot spots concurrently with old road upgrades. Although the total amount of existing hot spots is unknown, hot spots can be the largest sources of sediment delivery to streams in many watersheds. Consequently, sediment delivery would be reduced slowly over time under this alternative. Sediment delivery from improved roads would remain the same under this alternative because periodic maintenance is covered under existing regulations. Figure 4.6-8 shows the expected net reduction in sediment delivery under this alternative, most of which is accounted for by the upgrade of existing roads.

Grazing within the Project and Planning Areas has the potential to increase sediment delivery to streams and affect soil productivity. Under the No Action Alternative, Plum Creek's grazing BMPs would not be implemented during the next 30 years, and no change in delivered sediment from current conditions would be expected. Open range laws would be in effect without mandated management to avoid or minimize grazing-related sediment delivery to streams. Allotment management plans may be in use. Voluntary actions that reflect state grazing BMPs would continue to be taken, but the current relative amounts of moderately and severely affected streamsides probably would remain unchanged in Tier 1 watersheds and Tier 2 lands (Figure 4.6-9). Some uncertainty would exist over future grazing regulations, which may evolve over time, and their ability to control sediment production. Similarly, grazing-related effects on soil productivity would remain about the same as current conditions under the No Action Alternative. Grazing by livestock in riparian areas would continue to reduce soil functional capabilities, including water infiltration (Mosley et al. 1997; Dadkhah and Gifford 1980). No recovery of impacted stream reaches would be expected to occur throughout the Project Area; that is, about 25 percent of riparian areas in grazing allotments would remain moderately disturbed, and about 10 percent severely disturbed.

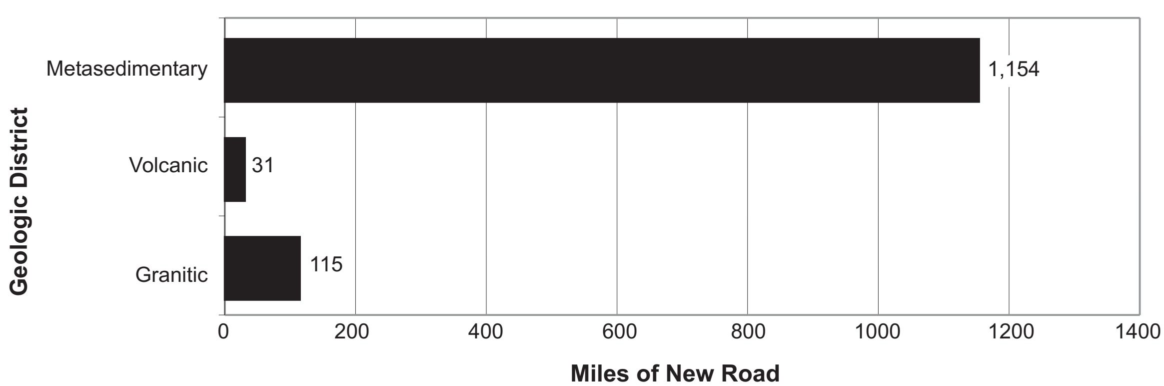


Figure 4.6-7
Approximate Distribution of New Road Construction by Geologic District During the Planning Period

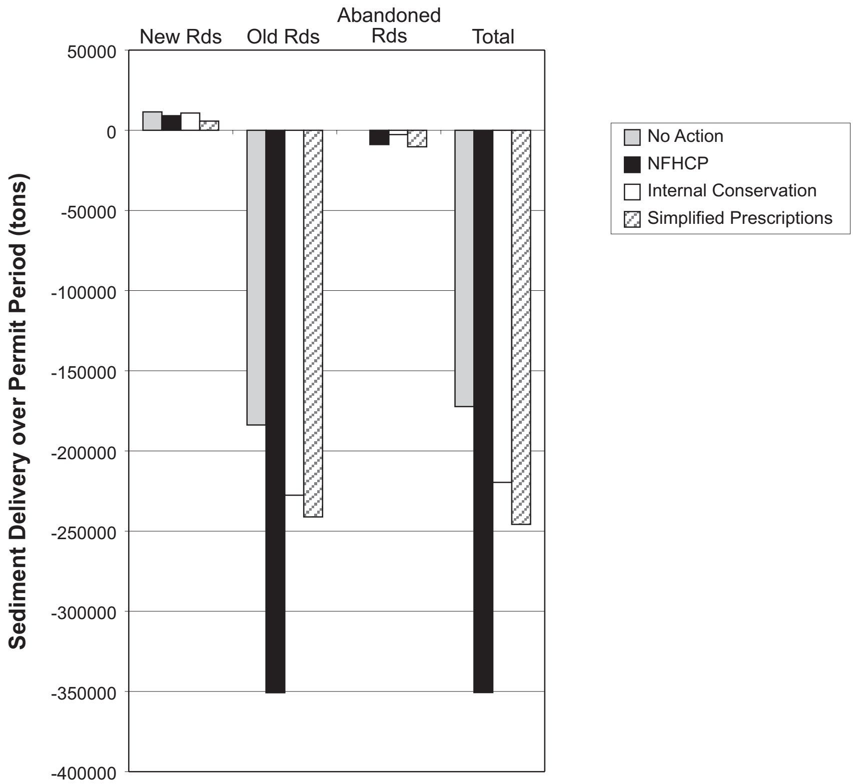


Figure 4.6-8
Expected Net Sediment Delivery by Conservation Category Under the Four Alternatives

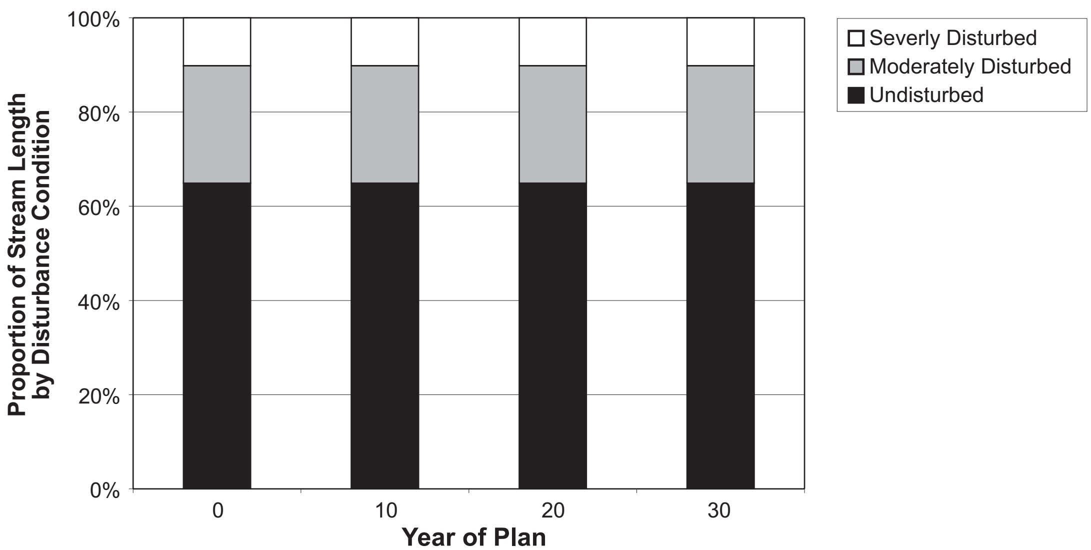


Figure 4.6-9
Proportion of Streams Affected by Three Levels of Grazing Disturbance Under the No Action Alternative

Sediment loading to Project Area streams from the silvicultural practices of site preparation, tree planting, and stand maintenance would be the same as under existing conditions. The amount of soil eroded and delivered to streams from these activities would be minor, consistent with water quality protection under the federal Clean Water Act. By comparison, risk of sediment delivery from these practices would be much less from these activities than that caused by road construction. Plum Creek has indicated they have reduced the extent of intensive site preparation during the last several years, only scarifying large areas when necessary for rapid plant establishment and high seedling survival, and only when erosion and surface water runoff can be controlled. Plum Creek has also indicated that they regenerate harvested forestlands within specified time frames, re-establishing surface cover through natural or artificial (hand planting) reforestation using selected tree species and genetic sources based on physiographic, site, and climatic conditions.

Some of Plum Creek's internal practices aimed at protecting and enhancing environmental values of uplands and riparian areas by minimizing erosion and runoff from timber harvest were described in Section 2.3.1, *Plum Creek's Land Management.* They include complying with all applicable forest practices rules and BMPs and requiring timber falling contractors to accomplish the following:

1. Avoid yarding logs through streams

2. Refrain from causing soil erosion or degrading side slopes

3. Mitigate impacts on natural resources

4. Comply with special conditions such as trail protection or visual sensitivity

The application of forestry BMPs and observance of streamside management zone restrictions to help filter any overland flow of sediment towards stream channels would effectively minimize harvest-related hillslope erosion and subsequent sediment delivery to streams (Plum Creek 1998a).

Cold Water (No Action Alternative). Water temperatures in Project Area streams under the No Action Alternative may decrease very slightly compared to existing conditions, based on changes in potential canopy closure resulting from implementation of forestry actions. The average canopy cover of Tier 1 riparian stands on fish-bearing streams would result in a net increase from about 41 percent to 44 percent over 30 years under the No Action Alternative (Plum Creek 1999a) (Figure 4.6-10). Canopy cover would rise and fall a few percentage points as some stands are partially harvested and then regrow. The pattern is similar for Tier 2 watersheds, although cover in Tier 1 is about four percentage points higher at the beginning and end of the planning period. Although not modeled, the increase in canopy cover over non-fish-bearing streams should show a similar increase, especially where vegetation had been extensively removed from past land management practices (in western Washington, existing regulations for Type 4 waters do not require canopy retention).

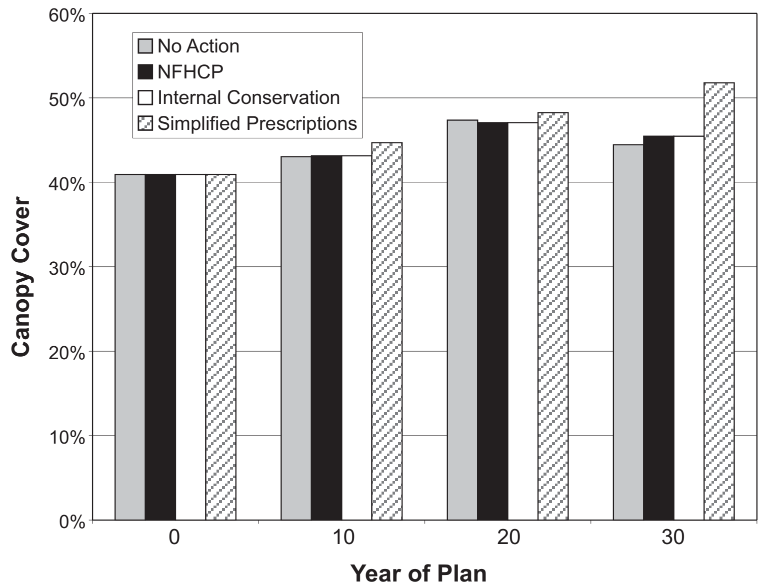


Figure 4.6-10
Projected Changes in Riparian Area Canopy Cover Over 30 Years in Tier 1 Watersheds

Water temperatures are expected to decline about 1°F (about 0.5°C) based on assumed canopy cover and water temperature relationships under the No Action Alternative (Plum Creek 1998a).

It is unlikely that a 1°F decrease in water temperature would affect the growth or survival of salmonids residing in Project Area streams either positively or negatively, although the overall trend would be beneficial. For those streams in the Project Area that are currently impacted by elevated water temperatures, cooling may be greater than the average of 1°F, and benefits to fish populations would also be greater. However, for the most part, future thermal conditions would be similar to present conditions as a result of implementing this alternative.

Reduced sediment delivery to streams, which would occur to some degree under all alternatives, may also contribute to minor decreases in water temperature. Turbidity in streams, as well as sediment deposition on stream bottoms, and shallower, wider channels, increases the amount of solar radiation retained in the water column as the sun warms suspended particles. This effect is usually associated with larger, low-gradient rivers where turbidity is higher and exposure to sunlight is prolonged and pronounced because of less shade. Streams within the Project Area are usually exposed to short-term, high-turbidity events only during snowmelt in the spring and during rain events, few of which typically occur during the hot summer months.

Construction of new roads with stream crossings or maintaining existing roads located in valley bottoms are the only other covered activities described in Chapter 2 that could cause water temperature increases that would adversely affect the capacity of Project Area drainages to meet the cold water needs of any of the Permit species. The potential effects of roads on stream temperature are not evaluated quantitatively, but would be similar under all the alternatives. Since the greatest potential temperature effect of roads is from existing valley bottom roads, the alternatives would be similar since the locations of existing valley bottom roads would not appreciably change under any of the alternatives.

It is most likely that any significant changes in water quality under this alternative, as well as the other three action alternatives, would occur on a site-specific basis. The greatest potential for water quality improvements to affect Permit species is where existing environmental conditions are degraded, and practicing forestry under existing regulations would reduce risk. For example, existing state regulations may not allow harvest of trees in riparian stands that are already degraded because of past management activities. Conversely, at sites where existing environmental conditions are barely adequate to conserve Permit species, implementation of existing regulations may, in some cases, result in impacts that would cause a net reduction in habitat quality, and significantly impact fish.

Threats to cold water habitat for native fish are the same as those described for clean water. Briefly, they include range management, land use planning, and legacy impacts.

Although water temperatures would generally decrease across the Project Area under this alternative, the magnitude would be small, and in some portions of the Project Area, may be inadequate to ensure species conservation. In addition, there would be no commitment to monitor temperatures or alter management to reduce temperatures where needed. Trends in habitat quality in non-forested portions of the Project Area would be less likely to be positive for native fish because of ongoing threats from range management and other activities, such as land development activities that are not regulated adequately to ensure conservation of Permit species.

Complex Habitat (No Action Alternative). Habitat complexity could potentially increase under the No Action Alternative, primarily because of increased availability of larger trees in riparian zones as a result of implementing state forest practice rules. The number of pieces of LWD per 1,000 feet of stream would increase to 33 to 98 pieces for 10-foot-wide streams and to 30 to 73 pieces for 30-foot-wide streams (Plum Creek 1999a). The average LWD loading (pieces per 1,000 feet of stream channel) from unmanaged riparian stands throughout the Planning and Project Areas is estimated to be 78 pieces, but variation is great—commonly 75 percent above or below that amount (Bilby and Wasserman 1989; Hayes 1996; Richmond and Fausch 1995; Plum Creek 1999a). Absent disturbance, LWD after 30 years would increase by 41 to 94 percent for H9 stands; by 44 to 58 percent for H15 stands; by 89 to 104 percent for T9 stands; and by 29 to 41 percent for T15 stands (after Plum Creek 1999a). The effects of LWD recruitment from implementing the No Action Alternative would leave a range of LWD levels that barely overlap with the average number of 78 pieces per 1,000 feet of stream observed for undisturbed streams.

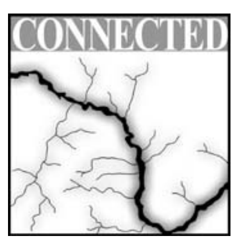
Habitat complexity is affected by forestry prescriptions that influence LWD loading, bank stability, the CMZ, canopy cover, sediment loading, and the hydrologic (flow) regime. While this alternative would allow for an increase in habitat complexity, whether such an increase would actually occur within a given reach would depend on the current condition and trend of existing LWD levels, and the length of time necessary to recruit additional wood to streams from adjacent riparian areas. For example, if a stream reach has experienced little or no recruitment of wood recently, and existing pieces of wood are decaying or being washed downstream out of the reach, then despite the fact that existing regulations may allow for an increase in potential wood recruitment in the future, in-stream levels of wood may continue to decline for some time, and habitat complexity would decrease (Swanson and Fredriksen 1982). The annual and cumulative contribution of LWD to Project Area streams from riparian harvest prescriptions under the No Action Alternative would be similar to existing conditions, or would slightly improve.

Under the No Action Alternative, riparian buffers, established through existing regulations and SMZs, are expected to improve bank stability in riparian areas where previous harvest has created unstable conditions, and is expected to limit reductions in bank stability from future harvests of riparian areas. Similarly, increased canopy cover could occur. Increased canopy provides a greater potential for the recruitment of twigs, leaf litter, and other tree debris, and the temporary formation of stick jams and leaf litter mats in association with more permanent habitat features such as log jams. These temporary features are often dynamic, responding to changes in flow, but provide added cover for fish and insects. In some cases, these features provide feeding sites for salmonids, and generally enhance the complexity and suitability of existing habitat conditions (Kondolf et al. 1996).

Reduced sediment loading under the No Action Alternative could potentially contribute to increased habitat complexity through increased depth, pool frequency, and hiding spaces among larger stream substrate. However, potential increases in habitat complexity, if any, would occur gradually over time, and the extent of any changes in habitat complexity is unknown for any given stream reach. There would be no assurance of changes in management if habitat complexity under the No Action Alternative was inadequate to ensure conservation of fish species.

The No Action Alternative would not result in substantive changes in the existing hydrologic regime or in the magnitude and timing of naturally occurring peak and low flows in Project Area drainages (see Section 4.3, *Water Resources and Hydrology*, for further discussion of flow regimes)

Threats to complex habitat for native fish are the same as those described for clean and cold habitat. Briefly, the threats are range management, land use planning, and legacy impacts.



Connected Habitat (No Action Alternative). There are no supplemental prescriptions under the No Action Alternative specifically directed at fish passage problems associated with culverts or diversion dams. However, existing regulations and BMPs require restoration or maintenance of fish passage during road upgrades and new road construction. Restoration of fish passage would immediately make restored areas available for bull trout and other native fish. Bull trout subpopulations threatened by habitat connectivity issues (Table 4.6-10) would probably continue to be threatened by these same issues under the No Action Alternative. Fixing fish passage barriers caused by road stream crossings would be addressed only when those roads are required to be upgraded by state regulations, as they are used for commercial forestry activities. There would be little assurance of removing habitat connectivity barriers in a comprehensive, effective manner. Threats to habitat connectivity for native fish from range management, land use planning, or legacy impacts would remain unchanged under this alternative, although it is not clear to what extent the absence of these other protective management prescriptions would directly affect habitat connectivity in the Project Area.

Other Factors (No Action Alternative). Factors besides the Four C's of clean, cold, complex, and connected water and habitat affect populations of native salmonids. These other factors include non-native fish introduced to the Project Area, recreational fishing, and illegal fishing. The introduction and presence of non-native fish species in many Project Area streams has been documented in Status Reports by the MBTSG (1995, 1996) as a high risk to the recovery of bull trout subpopulations. The FWS (1998a) has identified non-native fish (such as brook trout, brown trout, and lake trout) as threats to many of the bull trout subpopulations in Planning Area basins (see Table 4.6-10). The Montana Bull Trout Status Reports list other fish species that have been, or could potentially be, introduced to Project Area waters, such as northern pike and various bass and trout species.

Activities associated with recreational fishing may unintentionally adversely affect native salmonids in several ways. These include mortalities associated with the misidentification and removal of a protected species, hooking and handling mortalities, and overharvest of sensitive stocks susceptible to hook and line such as westslope cutthroat trout and bull trout. The No Action Alternative contains no specific prescriptions to address issues related to exotic fish species occurrence or management. Risks to bull trout subpopulations listed in Table 4.6-10 as being threatened by exotic fish species, and to other native fish, would continue under this alternative.

Summary of Effects (No Action Alternative). Overall, habitat conditions related to forestry management activities for native salmonids are expected to improve under the No Action Alternative, but the magnitude of potential changes in fish habitat during the Permit period of 30 years is unknown. Habitat conditions related to range management, land development threats, and habitat restoration activities would remain unchanged. To the extent that habitat conditions impacted by these activities remain unchanged, existing threats to native fish would continue.

Under the No Action Alternative, water and substrate in Project Area streams could become cleaner because of reduced sediment delivery, while average stream temperatures could become slightly cooler because of increased riparian canopy cover. Habitat complexity could increase slightly compared to existing conditions because of the same or slightly greater LWD loading, increased bank stability and canopy cover, reduced sediment delivery and riparian buffer disturbances, and the resultant maintenance of natural streamflows. Habitat connectivity would be restored in streams where impassable culverts are replaced with passable structures during road upgrades and new road construction. Adverse effects of recreational fishing, poaching, and non-native fishes on bull trout and other native salmonids would likely remain similar to present levels.

The net effect of the No Action Alternative on fish habitat quality is unknown, but could potentially be a slight improvement. The overall effect is difficult to predict since habitat quality may decline in some watersheds and improve in others. Where improvements in habitat quality occur, the magnitude of improvement may or may not be adequate to reduce or eliminate all threats identified for Permit species occurring in the Project Area. Depending on site-specific circumstances, existing threats to native fish would continue, or possibly develop as a result of this alternative. In some cases, habitat conditions would improve. Other aquatic species possibly present in the Project Area would also be affected by changes in habitat conditions under the No Action Alternative. These species include native fish (such as sculpin and dace), aquatic invertebrates (such as aquatic insects, clams, and snails), non-native salmonids (such as brook trout and brown trout), other non-native fish (such as walleye), and Pacific lamprey, identified by the FWS as a species of concern. In general, populations of native species and other non-native salmonids would benefit under this alternative because fish habitat would be restored to conditions more similar to what these species evolved with, and require, for maintenance of healthy populations.

Expected trends in aquatic habitat conditions in the Planning Area would be more influenced by management actions on federal lands than non-federal lands because federal lands comprise approximately 60 percent of the Planning Area, whereas Plum Creek lands comprise about 10 percent. The primary manager of adjacent lands in the Planning Area is the Forest Service. The Forest Service must comply with forestry regulations and practices more stringent than those for Plum Creek. Federal land management strategies and actions are directed to a significant degree at maintaining or restoring fish and wildlife habitat, and management effects are likely to achieve improvements in fish habitat quality over time.

Based on the above considerations, overall habitat conditions for bull trout and other native salmonids in the Planning Area could potentially improve from current conditions under the No Action Alternative.

Plum Creek's Proposed NFHCP

Clean Water (Proposed NFHCP). Water and substrate of Project Area streams are expected to be cleaner under the NFHCP than under existing conditions or the No Action Alternative. Sediment delivery from roads would be reduced by 49 percent under this alternative. A greater potential exists under the NFHCP primarily because of greater reductions in sediment delivery from forest roads, and reduced impacts from livestock grazing, in comparison to the No Action Alternative. In general, logging roads have been identified as a major contributing factor to elevated stream sediment levels (Packer 1967; MBTSG 1998), and the effects of roads cannot always be completely controllable by implementation of BMPs (Packer 1967; FEMAT 1993; Furniss et al. 1991). However, Packer (1967) and others have identified several factors related to road design that can reduce erosion potential, including limiting grade steepness, employing appropriate criteria in designing cross-drain spacings, and provision of protective strips to trap sediment. Plum Creek's road commitments, addressing both new construction and existing roads, are likely to result in a road system that would minimize erosion potential to a considerable degree as compared to current conditions.

Elmore and Beschta (1987) emphasized that grazing and riparian function are not necessarily mutually exclusive if considerations for various seasonal use patterns and levels of use and exclusion are considered. The NFHCP grazing commitments are intended to provide this type of direction, which should result in increased riparian function. Bull trout and other salmonids would benefit from sediment reduction in terms of egg survival, emergence success, juvenile survival, and spawning success (Rieman and McIntyre 1993; MBTSG 1998; McPhail and Murray 1979; Fraley and Shepard 1989; Goetz 1989). Potential benefits from reduced sediment delivery, include reduced sediment loading, sedimentation, turbidity, and substrate embeddedness.

The potential rate of change in habitat quality and reduction of impacts would also be greater under the NFHCP than under the No Action Alternative. The number of potential sites in the Project Area at risk of continued adverse impacts from covered activities would be less under the NFHCP. The response of individual streams to improvements in roads and grazing practices is expected to vary among watersheds; while most watersheds are expected to show improved fish habitat, some may show no improvement or even further declines from continued sediments inputs and grazing activities. Compared to the No Action Alternative, sediment delivered from roads to streams over the 30-year Permit period would be reduced 33 percent more because application of enhanced BMPs would occur sooner on existing forest roads that are currently delivering sediment to streams, and surplus roads would be retired. Revised grazing practices would also contribute to cleaner water and further reduce sediment delivery. Such practices include fenced grazing exclosures, installed to prevent trampling of known spawning redds and protect riparian habitat, along with Interface Caution Area restrictions on ground-disturbing actions from timber harvesting activities close to streams.

Implementation of the proposed NFHCP is projected to result in a net sediment delivery reduction of about 50 percent across the Project Area by the end of the proposed 30-year Permit period. This amount of sediment reduction would likely be adequate to remove threats from sediment impacts on Permit species in many, but not all watersheds in the Project Area. It is not certain whether the projected net reduction would be adequate to provide clean habitat in basins where existing management-related sediment loads are already considerably higher than natural background levels. Without site-specific analyses for all watersheds in the Project Area, the Services and Plum Creek cannot ensure adequate conservation would be achieved in all cases. Therefore, this NFHCP alternative allows for monitoring and adaptive management within each Planning Area basin to determine when, where, and if conservation measures are adequate to conserve Permit species. If more aggressive road treatments are required to achieve the biological goal for providing clean water habitat for Permit species, Plum Creek would adapt management to achieve the goal.

The projected reduction in sediment delivery to streams in the Project Area would provide benefits to Permit species faster than any other alternative analyzed. Also, it would significantly reduce the amount of sediment delivered over background levels in the Project Area. According to sediment budgets produced by Plum Creek, of 11 watersheds analyzed in the Planning Area, sediment delivery would be reduced from 137 percent above background before NFHCP implementation, to 77 percent above background after implementation of NFHCP commitments (Plum Creek 1998a). Again, the Services cannot precisely determine the degree to which this level of sediment delivery above background levels would allow for recovery of all Permit species in all portions of the Project Area. However, the direction of the change in habitat improvement toward achieving the clean biological goal is positive, and the magnitude of the change would be evaluated by Planning Area basin over time to ensure it is sufficient to allow for recovery in each Planning Area basin.

Plum Creek would construct about 1,300 miles of new road under the NFHCP. However, conservation measures applied to new road construction (such as no roads in riparian areas and enhanced road drainage features) would minimize sediment delivery to streams during and after construction (Figure 4.6-6). Sediment delivery from new road construction would be highest during periods of construction, and diminish as ground cover is reestablished. In general, Planning Area basins with the greatest amount of new road construction also have the greatest number of existing road miles, potentially worsening any existing sediment problems in those basins. However, those same basins also provide the greatest opportunity to reduce sediment delivery from existing roads, reducing impacts on Permit species more than in basins where Plum Creek has fewer miles of roads. In addition, Plum Creek would upgrade or abandon at least 2 miles of old road in advance or concurrent with every mile of new road constructed (by Planning Area basin). This would ensure an overall downward trend in sediment delivery to streams. Basins where road building potential is highest include the Middle Kootenai River, Blackfoot River, and Upper and Middle Clark Fork River Basins, all in Montana (Table 4.6-3).

Under the NFHCP, sediment delivery would decline annually from Years 1 through 15 of the 30-year Permit period, then remain constant through Year 30. Hot spot treatments of high risk sediment problems on roads (such as large gullies, blown out culverts, unstable fills, and other poorly designed road segments) would contribute to cleaner water during the 30-year period. Harr and Nichols (1993) found that treating hot spot roads (pulling back sidecast, reshaping roads and landings, re-establishing natural drainage patterns, retiring road segments) significantly reduced the amount of sediment entering adjacent streams during rain-on-snow runoff events. Although the precise degree of sediment reduction as a result of hot spot treatment is largely unquantifiable because of, among other factors, variability of sites, such as aspect, steepness, and specific construction deficiency, these types of problem areas can be a major source of sediment delivery to streams in any particular watershed. Prescriptions designed to reduce sediment delivery from these hot spot areas would likely contribute significantly to reducing sediment delivered to native salmonid habitat overall.

Deferral of riparian harvest in certain areas and protection of native fish assemblages are two additional commitments under the NFHCP that potentially would contribute to improved water quality and fish habitat. These two commitments are designed to ensure adequate conservation is provided for Permit species in watersheds that require special treatment. Riparian harvest would be deferred along fish-bearing streams until Year 10 of the Permit in watersheds that meet the following criteria:

- Riparian function may be degraded from past land management actions
- Do not have a very high proportion of federal ownership
- Located in Tier 1 watersheds
- Outside of Planning Area basins with a strong bull trout population (for example, the Swan River drainage)

Deferral of timber harvest is intended to reduce potential risks to fish in areas where a high percentage of riparian areas has been harvested. Deferral would allow riparian vegetation and associated functions to recover. Specifically, riparian harvest would be deferred in the following drainages:

- Rock, Spruce, and Twin Creeks in the Lochsa Basin, Idaho
- Placid Creek in the Blackfoot Basin, Montana
- Big Rock Creek in the Middle Clark Fork Basin, Montana

Native fish assemblage watersheds are designated to enhance protection of habitat quality associated with the Four C's in Tier 1 watersheds that contain key, unique native fish assemblages in eight Planning Area basins. In basins designated as native fish assemblages, watershed and limiting factor analyses would be conducted, and additional conservation prescriptions would be developed and implemented (such as accelerated road upgrades) to increase the certainty of adequate conservation of Permit species. This approach would also meet the NFHCP goal and Montana Bull Trout Restoration Plan concept to "protect the best" (MBTSG 1998). Native fish assemblages were selected based on the following:

- Basin size, bull trout presence
- Bull trout population fitness
- Genetic integrity and richness of other Permit species

Watersheds designated as native fish assemblages are as follows:

- Elk Creek—Swan Planning Area basin, Montana
- Fishtrap Creek above Jungle Creek—Middle Clark Fork Planning Area basin, Montana
- Keeler Creek—Lower Kootenai Planning Area basin, Montana

- North Fork Blackfoot River—Blackfoot Planning Area basin, Montana
- Quartz Creek—Middle Kootenai Planning Area basin, Montana
- Vermillion River—Lower Clark Fork Planning Area basin, Montana
- Pine Creek—Lewis River Planning Area basin, Washington
- Ahtanum Creek—Ahtanum Creek Planning Area basin, Washington

Conditions associated with the Four C's and the Permit species would also potentially benefit from the changed circumstances commitment. This prescription requires the preparation and implementation of a site-specific plan if a large or intense landslide, wildfire, or flood occurs within the Project Area that adversely affects Permit species.

Influences of other covered activities on water quality parameters (nutrient loading, contaminant loading, dissolved oxygen levels, and sediment loading from silvicultural and commercial forestry sources other than roads), water quantity, soils, or vegetation resources, or Permit species habitat, would be similar to those described under the No Action Alternative, with some additional reduction of risk because of NFHCP commitments. Based on impact assessments presented in Sections 4.2, 4.3, and 4.4, and additional discussion under Other Factors in this NFHCP discussion, these parameters would not be significantly adversely affected by implementing the NFHCP. Compared to other alternatives, the NFHCP alternative would result in more immediate reductions in sediment delivery in 20 percent of watersheds on Plum Creek lands, because of commitments for prioritizing conservation measures in native fish assemblages, watersheds that are already determined through other analyses to be impacted, and watersheds in granitic soils. Sediment delivery reductions from the other 80 percent of Project Area lands would be implemented on a slightly longer schedule (within 15 years). Potential improvements in water quality from NFHCP direction for range management, land use planning, and legacy impacts would be much greater than under the No Action Alternative, which does not have these same commitments. The NFHCP includes conservation measures that reduce access of livestock to streams important to Permit species, and in areas where past impacts have occurred. Grazing impacts are an important concern for bull trout in Montana (MBTSG 1998), and to a lesser degree in other parts of the Planning Area. Anadromous fish would not be affected to the same degree as bull trout from changes in grazing, because grazing is not as common on Project Area lands with anadromous fish.

In addition, land use planning measures designed to reduce threats of land development near habitat for Permit species would help ensure long-term conservation goals can be met. Restoration of legacy impacts downstream from forest management activities would reduce stream sediment levels and water temperatures, and reduce threats to fish habitat quality.

Potential benefits from conservation commitments under this alternative affecting livestock use, land development, and legacy impacts in the Project Area provide a significant opportunity to conserve Permit species. These potential benefits are greatest in four of the thirteen Planning Area basins, including the

Middle Kootenai River, Blackfoot River, and Middle Clark Fork River in Montana, and Ahtanum Creek in Washington. A positive trend in habitat improvement from cleaner water and substrate under the NFHCP alternative is expected. The magnitude of change is unknown, but could potentially be greater under the NFHCP than for any other alternative. In addition, whether site-specific issues would be adequately addressed for all portions of the Project Area under the NFHCP is unknown. Although an overall improvement in water quality is expected for the Project Area, water quality in certain streams or watersheds could potentially remain unchanged or become worse. With specific monitoring and adaptive management commitments from Plum Creek, the Services would have the opportunity to revisit certain specific conservation commitments if they are demonstrably inadequate, and work with Plum Creek to implement management changes to ensure adequate conservation is achieved. Plum Creek, through implementation of their core adaptive management projects and dispersed effectiveness monitoring, may detect those specific instances where conservation is inadequate, or other scientific information, as it is developed, could be incorporated into the adaptive management pathway developed by Plum Creek to inform future evaluations of biological adequacy of the NFHCP. This process of implementing specific conservation commitments immediately, coupled with the opportunity to monitor, evaluate, and adapt management in the future, would help ensure that the proposed NFHCP would provide adequate conservation of Permit species over the Permit term.

The most significant commitments for reducing sediment (upgrade of old roads, constructing new roads to high standards, and abandoning old roads) would be implemented on the basis of maximizing conservation benefits for all Permit species equally by focusing on native fish assemblage streams, and streams identified through other processes as being impacted by sediment. Under the proposed NFHCP, all 20,000 miles of road segments (13,000 miles on Plum Creek lands and 7,000 miles of cost-share roads) in the Project Area would be upgraded to enhanced standards beyond state forest road BMPs within 15 years of Permit issuance. All road upgrades in high priority watersheds would be complete by Year 10.

The following watersheds are designated as high priority:

- Papoose Creek
- Western Washington outliers
- Ahtanum Creek
- Crooked Fork, above Brushy Fork
- Upper Brushy Creek
- Elk Creek
- Fish Trap Creek, above Jungle Creek
- Keeler Creek
- North Fork Blackfoot River
- Quartz Creek
- Vermilion River
- Pine Creek

Additional high priority watersheds, with the characteristics listed below, would be designated by the Services and Plum Creek within 2 months of Permit issuance:

- Contain native fish assemblages
- Are most impaired by sediment delivery
- Located in granitic soil types
- Otherwise warrant more immediate action

In the Project Area, total sediment delivery under the proposed NFHCP during the 30-year planning period is expected to be approximately 379,000 tons (Figure 4.6-3). Of that, a total of 88,000 tons of sediment would be delivered to streams in high priority watersheds, and 291,000 tons to streams in other watersheds.

Sediment delivery under the NFHCP road upgrade commitments would decrease dramatically over a 10- to 15-year period, then remain lower than for other alternatives (Figure 4.6-4). The rate would drop from about 24,000 tons of sediment per year initially to about 10,000 tons of sediment per year by Year 15, then remain essentially constant. In high priority watersheds, initial sediment delivery of 5,800 tons per year would drop annually by 340 tons. In other watersheds, initial sediment delivery of about 18,500 tons per year would drop annually by 770 tons. The net effect of this NFHCP road upgrade commitment would be to decrease total sediment delivery by 167,000 tons (29 percent) compared with the No Action Alternative.

Unlike the No Action Alternative, the NFHCP commits to abandon all surplus roads concurrent with the upgrade of adjacent road systems. While there is no current inventory of surplus roads, preliminary estimates are that between 500 and 1,500 miles of road would be abandoned within the first 15 years of the Permit. Surplus roads are roads that Plum Creek determines are no longer needed for forest management. The goal of abandonment would be to place the road in a condition where its environmental impact is eliminated or significantly reduced and the need to perform routine inspections and maintenance on that road is eliminated. Most of the candidate roads for abandonment are old roads constructed long before current road BMPs were developed, and many occur near streams and valley bottoms. While some short-term sediment yield may be associated with abandonment activity, significant long-term benefit would be associated with road removal (Haar and Nichols 1993).

Under the proposed NFHCP, assuming approximately 1,000 miles of roads are abandoned, the reduction of sediment delivery through surplus road abandonment could be about 8,900 tons of sediment (Figure 4.6-11). By Year 15 of the plan, sediment delivery would be reduced by approximately by 450 tons per year (Figure 4.6-12).

The NFHCP would commit to identifying legacy road system and other hot spots, then develop and implement site-specific action plans to remedy the problems. This commitment would result in a major and more rapid improvement in aquatic conditions and reduction of future sediment delivery hazards to streams (Haar and Nichols 1993). The exact nature and number of hot spots would remain unknown until road condition inspections are completed, but most would be repaired within 5 to 10 years. The benefits of hot spot treatments would be greatest in watersheds with large amounts of roads adjacent to streams. Treating hot spots more aggressively than substandard existing roads would lead to more rapid sediment reduction in the early years of the planning period. Also, hot spot treatments could prevent major watershed-scale impacts from occurring where road embankments are perched or road segments are at risk of landslides (Haar and Nichols 1993). Treatment of hot spots that are not associated with roads, but where active erosion is occurring, would provide additional benefits.

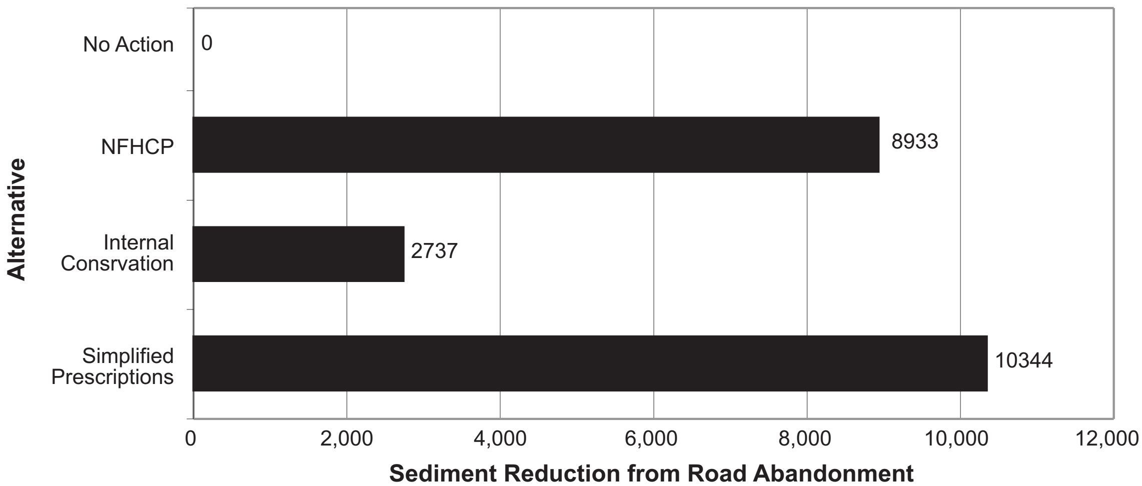


Figure 4.6-11
Potential Sediment Delivery Reduction through Road Abandonment among the Four Alternatives

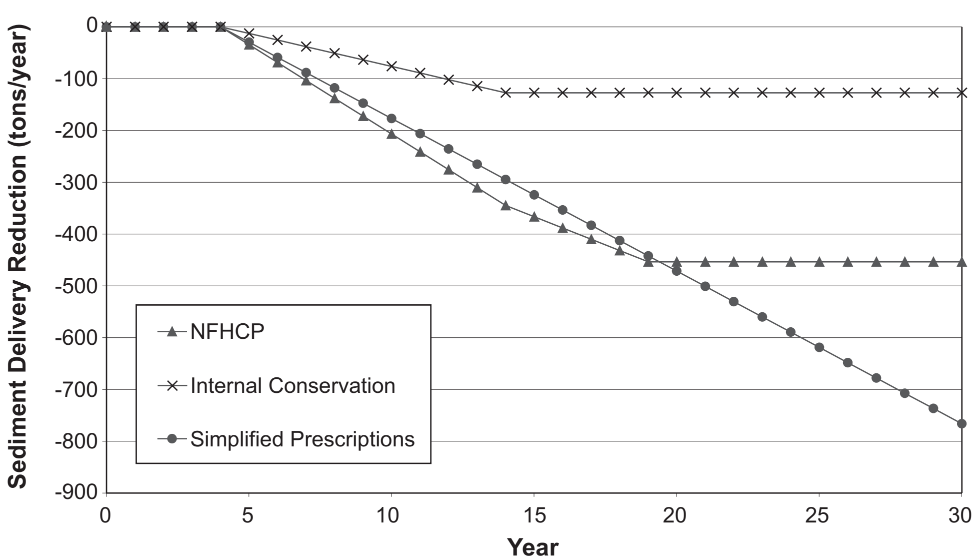


Figure 4.6-12
Total Reduction of Sediment Delivery through Road Abandonment among the Action Alternatives

Like the No Action Alternative, the NFHCP would involve design and construction of new road segments to current state standards for forest roads. Unlike the No Action Alternative, the NFHCP commits to applying enhanced BMP standards to the estimated length of new roads that may be built in the Project Area. Since new roads necessarily involve the disturbance of previously vegetated areas, new road construction has perhaps the greatest potential of any forest management activity to produce sediment delivery to streams, with the risk being greatest for the first few years following construction. The enhanced BMP standards of this NFHCP would minimize undesirable effects. If about 1,300 miles of new roads were constructed under this alternative, new roads would deliver about 9,040 tons of sediment to streams in the Project Area (Figure 4.6-5) during the proposed 30-year Permit period. The increase would be relatively small compared to other NFHCP commitments that result in a much larger total reduction of sediment from upgraded roads, abandoned roads, and hot spot treatment over the life of the planning period (Figure 4.6-4). New road construction standards under the NFHCP alternative would result in 2,400 tons less sediment delivered compared to new road construction under the No Action Alternative.

The NFHCP commits to tracking road conditions, inspecting road conditions, and analyzing road sediment delivery processes. Existing regulations require regular or periodic road maintenance. Under the NFHCP, Plum Creek would enhance the conservation benefits of these activities by committing to periodically re-inspect roads that have been constructed or upgraded to enhanced BMP standards, to perform any maintenance necessary to ensure BMP effectiveness throughout the Project Area, and to put unused roads to sleep. This commitment would enhance the existing regulations and contribute to reducing sediment delivery to streams.

Use of Plum Creek's forest road system would increase maintenance requirements and sediment delivery to streams. Heavily used roads produce substantially more sediment from running surfaces than do low-use roads or roads closed to traffic (Reid and Dunne 1984; Bilby et al. 1989; WFPB 1995; Burroughs et al. 1989; Luce and Black 1999). Under the NFHCP, unauthorized public vehicle access to new roads constructed by Plum Creek would be restricted, where practicable. The provisions for road restrictions under this alternative would have variable benefits for soil resources, depending on the actual level of use, but may have potentially significant site-specific benefits.

During the planning period, the combined effects of NFHCP conservation measures associated with upgrading old roads, constructing new roads, abandoning surplus roads, and treating hot spots would result in an estimated 178,300 fewer tons of sediment delivered to streams in the Project Area compared to the No Action Alternative (Table 4.6-11). More importantly, the majority of this sediment reduction would occur during the first half of the planning period (Figure 4.6-13). This positive effect would be accomplished without a corresponding decrease in road density.

Overall sediment reduction would be roughly uniform across the Project Area since the distribution of Plum Creek's road system is relatively uniform. Figure 4.6-8 shows the expected net reduction in sediment delivery under the NFHCP, most of which is accounted for by the upgrade of existing roads. As such, the Planning Area basins with the highest percentages of Project Area lands, listed below, would experience proportionately greater reduction in sediment delivery to streams:

- Middle Kootenai River
- Flathead River
- Swan River
- Blackfoot River
- Bitterroot River
- Upper Clark Fork River
- Middle Clark Fork River

TABLE 4.6-11
Estimated Reduction in Sediment Delivered to Streams by Implementing the Action Alternatives[a]

Sediment Source	Proposed NFHCP	Internal Bull Trout Conservation Plan	Simplified Prescriptions
	Tons of Sediment Reduced		
New Roads[b]	2,400	600	5,700
Upgrade of Old Roads[c]	167,000	44,000	57,400
Abandoned Roads[d]	8,900	2,700	10,300
Net Benefit	178,300	47,300	73,400

[a] Sediment reduction expressed relative to the estimated amount delivered under the No Action Alternative.
[b] Sediment delivery estimated to increase by about 11,400 tons over the planning period under No Action.
[c] Sediment delivery estimated to decrease by about 184,000 tons over the planning period under No Action.
[d] No change in the amount of sediment delivery is expected over the planning period under No Action.

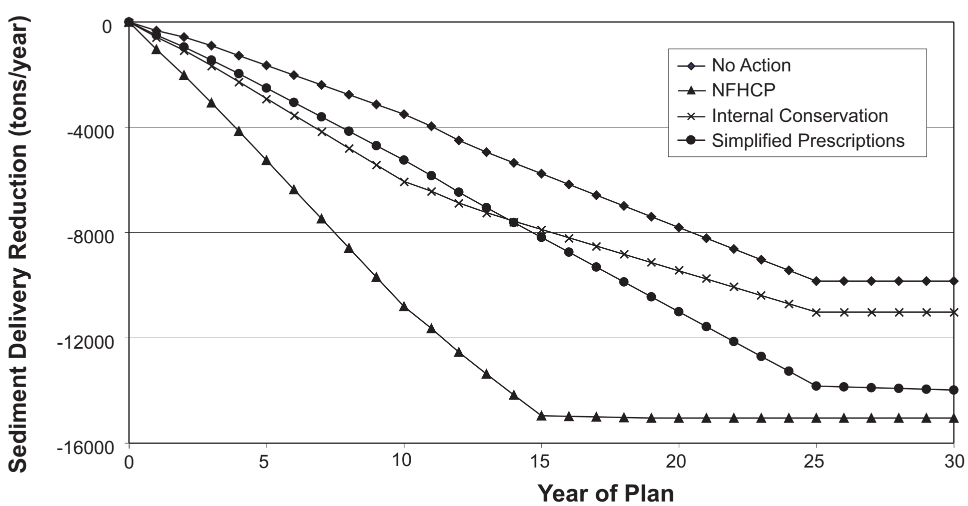


Figure 4.6-13
Estimated 30-Year Trends in Total Sediment Delivery in the Project Area among the Four Alternatives

Eight NFHCP riparian management commitments, described below, would beneficially affect fish-bearing and non-fish-bearing streams within the Project Area by reducing sediment delivery. Many of the riparian commitments include provisions for restricting tree harvest or excluding equipment operation. For example, commitments associated with CMZs either prevent harvest entirely or prohibit equipment operation, except where specific, low-impact conditions are met. One of the commitments would defer riparian harvests along fish-bearing streams in five Idaho and two Montana watersheds until Year 10 of the Permit. This precautionary measure would reduce soil disturbance and the potential for sediment delivery to streams compared to existing conditions while riparian function recovers from historical impacts.

To further minimize the potential for soil disturbance and delivery of sediment to streams, the commitment addressing Interface Caution Areas places conditions on skid trail design, mechanical site preparation, road construction and abandonment, supplemental tree retention, minimize clearcutting, and inclusion of unstable areas. Ground-disturbing activities that could increase the risk of sediment delivery would be moved farther away from the SMZs and streams. The caution area approach serves as an enhanced BMP for minimizing new road construction. The Interface Caution Areas provide an incentive-based approach to minimize road construction where it could have the greatest risk—close to the stream (Reeves and Sedell 1992). Also, the Interface Caution Areas provide incentives for considering surplus road designations. Consequently, the incentives would focus road abandonment where it would do the most good for aquatic habitats. The riparian harvest commitments that restrict or exclude equipment operation in CMZs and Interface Caution Areas, together with the other caution area requirements and conditions listed above, would reduce soil disturbance and benefit long-term soil productivity in the Project Area beyond requirements of the existing regulations.

The extent of grazing in the Project Area provides an opportunity for conservation benefit through NFHCP commitments. Under this alternative, Plum Creek's five grazing management commitments, including their grazing BMPs (Plum Creek 1999c), have the potential to beneficially affect streams within the Project Area by reducing sediment delivery (Figure 4.6-14) by the end of the 30-year Permit period.

An environmental trend indicator of Plum Creek's grazing BMPs would maintain streambank stability by confining livestock-caused bank disturbance to no more than 10 percent of streambanks on leased grazing lands. This environmental trend indicator should maintain or improve streambank conditions, especially when combined with rancher training and training of appropriate Plum Creek personnel (Ehrhart 1998). The streambank stability standards defined in Plum Creek's grazing BMPs should maintain functioning riparian areas and improve those that are functioning below proper levels.

Plum Creek's grazing BMPs, such as offsite water development, salting away from streams, and rotating pastures, have proven successful at reducing livestock impacts and helping to control sediment delivery to streams (Ehrhart 1998). However, uncertainty exists about the degree to which the overall management system would lead to improved conditions over time. The success of Plum Creek's grazing BMP program would be dependent on the rigor of lease administration and lease-level monitoring of trends. Four years of experience with Plum Creek's grazing BMPs indicate that riparian conditions would improve (Plum Creek 1998f)).

Unlike the No Action Alternative, Plum Creek would provide for the construction of cattle exclosures along stream reaches in lease areas. Exclusion of livestock through fencing is a riparian management technique that has proven successful (Ehrhart 1998; Ehrhart and Hansen 1997; Bock et al. 1993; Schulz and Leininger 1990). Complete exclusion would be the most effective way to improve degraded areas (Elmore and Kauffman 1994; Platts and Wagstaff 1984; Keller and Burnham 1982; Dahlem 1979; Duff 1979). Fencing

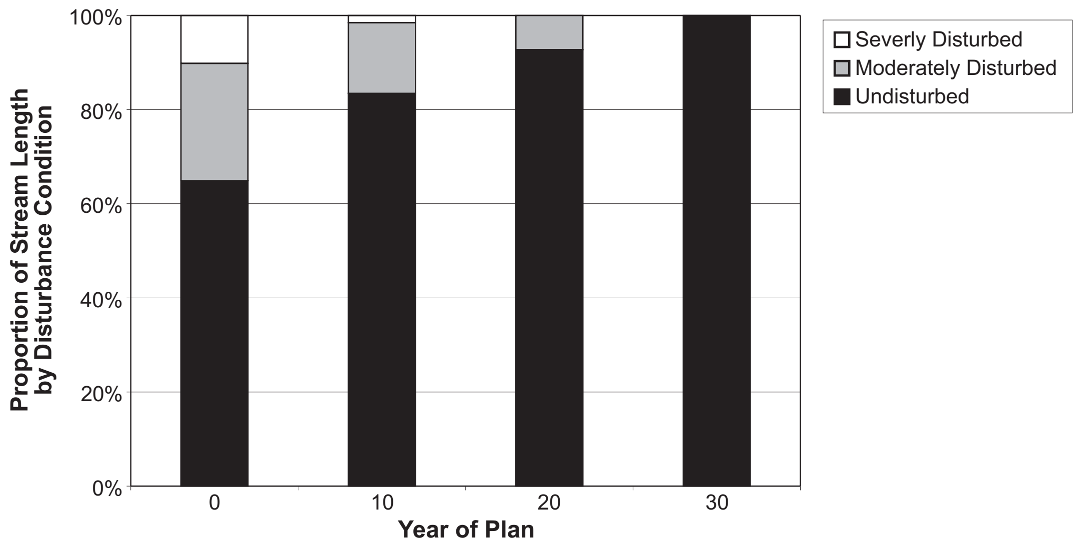


Figure 4.6-14
Proportion of Streams Affected by Three Levels of Grazing Disturbance Under Plum Creek's Proposed NFHCP

may be appropriate for springs and seeps where streams originate or along reaches that have been over-grazed. Gap fencing in conjunction with gullies, cliffs, and other natural barriers could be used in some instances to regulate trailing or loafing by cattle (Leonard et al. 1997).

The proposed NFHCP would require exclusionary fencing of severely-disturbed reaches primarily along Tier 1 streams and Key Migratory Rivers. Conservation benefits would include channel narrowing, increased pool formation, improved bank stability, and increased grass/forb/shrub recovery (Plum Creek 1998f). The associated reduction in soil disturbance in forested rangelands is expected to benefit long-term soil productivity in the Project Area beyond what is required under existing regulations.

Another environmental trend indicator contained in Plum Creek's grazing BMPs would reduce riparian compaction by limiting soil affected by livestock hoof displacement or compaction to less than 10 percent of riparian areas. The measurement of this indicator would address compaction throughout the riparian area, not just along streams (Ehrhart 1998). Other NFHCP grazing management commitments would advance the body of knowledge of modern grazing practices through training, monitoring, and learning. These actions would have long-term institutional benefits to reduce grazing impacts in riparian areas and further reduce delivery of sediment to streams in the Project Area, and potentially on adjacent lands where livestock are grazed.

The NFHCP contains a commitment to evaluate the status of vacated leases before re-leasing them for grazing. Where lease renewal is deferred because of unaccept-able riparian conditions, benefits would be similar to riparian exclosures. In cases where impacts are particularly severe, leases may not be renewed at all. Permit species would benefit significantly from grazing commitments under this alternative because the threat of livestock impacts on streams would be greatly reduced, more so than under any of the other alternatives. Livestock may impact fish habitat by impacting stream banks, increasing sediment delivery to streams, reducing stream shade, and reducing habitat complexity. Removal of livestock, and reducing access to streams, as provided for under this alternative, would contribute to Permit species conservation.

The combination of the NFHCP grazing commitments are expected to reduce the number of reaches that would be classified as moderately or severely disturbed to zero. This estimate of restoration rates is based upon broad estimates (Plum Creek 1999g) as well as some limited field measurements (Plum Creek 1999c). It is not certain how quickly the removal of disturbance would result in recovery of fish habitat components. Therefore, Plum Creek would be conducting an Adaptive Management study that would establish meaningful success metrics and a feedback loop process for improving range management methods if needed to meet NFHCP biological goals.

Plum Creek's operation of four mill sites in the Project Area would likely pose very little risk of impact to clean water habitat for Permit species. All four sites are managed for zero discharge of process water or storm water, there is no other discharge of materials from the sites, and none of the four sites divert surface water for use in timber processing operations.

Three of the four Plum Creek mill sites—in Pablo, Kalispell, and Columbia Falls, Montana, do not occur in proximity to Permit species habitat, and result in no discharge of materials into surface waters with Permit species. There is virtually no risk of impact on Permit species habitat from operation of these three mill sites. Plum Creek's Kasanka mill site in Fortine, Montana, occurs adjacent to a stream with westslope cutthroat trout and mountain whitefish present. However, this mill site also is managed for zero discharge of process water or stormwater. There is risk that in extremely high precipitation events, occurring probably less than once every decade, some stormwater runoff could reach surface waters beyond the mill site. However, such water would be very diluted during a high precipitation event, and pollutants present in the water would be minimal, resulting from runoff of chemical residue primarily from driveway and equipment parking areas; no process water would be liberated into surface waters during these events. In addition, some streamside rehabilitation has occurred at this mill site within the last 5 to 10 years by Plum Creek to help minimize or eliminate impacts on riparian vegetation and stream channel integrity from site management. Riparian buffers with tall willows and other vegetation separate the site grounds from the stream bank. There is a small diversion point present along the stream channel for diverting water into a fire pond for use in case of a fire on the site, but this diversion is almost never used, and any potential use would occur over a very short period of time.

Cold Water (Proposed NFHCP). The NFHCP contains a number of prescriptions that are expected to supplement existing regulations. These prescriptions contribute to cooler water temperatures than at present or under the No Action Alternative as a result of changes in road and upland management, riparian management, range management, legacy management, and land use planning commitments. Management changes under the NFHCP are expected to reduce stream water temperatures by 1°C through an increase in canopy cover, which could potentially vary by 0 to 44 percent across the Project Area. Increase in shade and decreases in stream temperatures would result from riparian management commitments (MBTSG 1998; Beschta et al. 1987); improved bank stability and riparian habitat through range management prescriptions; restoration of badly degraded riparian areas through legacy management actions; and reduction of sediment delivery through land use planning commitments and road improvements. Deferral of riparian harvest and development of special prescriptions for watersheds with native fish assemblages could also reduce water temperatures by improving riparian function. The degree of actual changes in water temperature from the above practices are unknown, except for changes associated with canopy cover that have been estimated through forest simulation models.

The changes in canopy cover under this alternative would be similar to the No Action Alternative, but slightly greater canopy cover would be retained because more dense stands with bigger trees would be retained and many stands would not be disturbed (Figure 4.6-10). Both alternatives would result in about the same proportion of high or very high density stands with moderate to large trees (H9, H15, T9, and T15 riparian stands), which have similar ranges of canopy cover values. Under the NFHCP, the increases would be similar at fish-bearing and non-fish-bearing streams, and would be slightly, but not measurably greater in Tier 1 watersheds than in Tier 2. Across the Project Area in Tier 1 watersheds, during the proposed Permit period, riparian canopy cover would increase from approximately 41 to 44 percent under the No Action Alternative, 41 to 45 percent under the NFHCP, and 41 to 52 percent under Simplified Prescriptions. The Simplified Prescriptions Alternative represents the greatest potential increase in canopy cover possible because of extensive no-cut buffers under that alternative. Deferral of riparian harvest along fish-bearing streams in five sensitive watersheds in Idaho and two sensitive watersheds in Montana until Year 10 would contribute to increased canopy cover and improved riparian function under the proposed NFHCP. Riparian condition and function would also be evaluated as a part of watershed analysis and development of special prescriptions for six watersheds in Montana and two in Washington that contain unique, diverse assemblages of native fish species.

Riparian harvest prescriptions under the NFHCP would generally reduce canopy cover by approximately 5 percent (Plum Creek 1998e) in those mature stands harvested during the Permit period. Canopy cover is expected to increase in most younger stands because most younger stands would not be harvested at all. Overall, canopy closure would be higher at the end of the Permit period than at present under all of the alternatives. The potential water temperature effects from changes in cover resulting from riparian NFHCP harvest prescriptions would be similar for three of the four alternatives, with an expected average reduction of about 1°F. Temperature reduction would approach 2°F under the Simplified Prescriptions Alternative. The lack of a wide variation in temperature reductions among alternatives is because existing regulations preclude riparian harvest in essentially all younger riparian forest stands, which includes most riparian buffer areas in the Project Area, during the 30-year planning period.

Plum Creek anticipates accessing only 20 percent of their riparian buffer areas throughout the Project Area during the first 10 years of the proposed Permit period under the NFHCP alternative. Plum Creek could enter as much as an additional 56 percent of streamside riparian stands in the Project Area between Years 10 and 30. The remaining 24 percent of streamside riparian stands would not be entered during the proposed 30-year Permit period because trees are too small or lightly stocked to expect a commercial harvest.

Adaptive management commitments offered by Plum Creek under this alternative would allow the Services to revisit the adequacy of riparian buffer prescriptions implemented in riparian areas every 5 years. This would allow the Services to evaluate riparian buffer adequacy early in the plan so that if inadequacies are detected, management adaptations can be made before the majority of the streamside riparian stands are harvested.

Implementation of existing state forest management regulations, coupled with the additional conservation commitments offered by Plum Creek under this alternative, would ensure that adequate conservation of Permit species is achieved in many, but probably not all, watersheds in the Project Area. This NFHCP alternative would allow for an increase in stream shading amounting to about half of the maximum amount of increase that could be achieved under the most risk-averse approach to riparian buffers, as represented in the Simplified Prescriptions Alternative. The extent of the estimated increase in canopy cover among alternatives is consistent with the estimated 1°F reduction in stream temperatures from the proposed NFHCP, and the potential maximum possible 2°F reduction in stream temperatures from the Simplified Prescriptions Alternative.

The Services have identified increased water temperature as a threat to Permit species in the Project Area. This alternative would reduce water temperature, but only half as much as the most risk-averse approach (Simplified Prescriptions Alternative). If adequate increases in canopy cover are not achieved in certain cases in the Project Area, and if the rate of improvement—or the magnitude of the trend of decreasing water temperatures—must be greater, Plum Creek has committed to adapt management to ensure canopy cover increases and water temperature decreases are achieved.

All the alternatives have a low risk of adverse impacts on stream temperature as a result of timber harvest for the following reasons:

- **A small portion of streamside riparian stands are affected.** Only a small amount of streamside riparian stands in the Project Area would be affected, particularly within the first 5 to 10 years.

- **Most Planning Area lands are federally managed.** All of Plum Creek's lands (mostly comprised of upland, non-riparian habitat areas) comprise about 10 percent of the Project Area. Most of the remaining lands in each Planning Area basin are managed by federal agencies, which allows the Services the opportunity under the ESA to achieve additional conservation.

- **Potential differences among alternatives for meeting the cold water biological goal are small.** The degree of difference in estimated canopy cover and associated stream temperature reduction among alternatives is not great. None of the alternatives would affect temperature, on average, more than 1^{o}F or reduce canopy cover more than 5 percentage points.

The NFHCP provides an additional reduction in risk because of the following commitment:

- **Monitoring and adaptive management.** Monitoring data gathered over the early portions of the plan implementation period would better inform when and where management can be adapted to better achieve this biological goal, if adaptation is necessary. Roughly three-quarters of streamside riparian stands would not be harvested until after Year 10 of the NFHCP.

Thermal buffers would be created from the riparian management zones along perennial headwater streams in Montana, Idaho, and Washington and from Interface Caution Areas encompassing the riparian-upland interface where special requirements and conservation guidance would be followed. Reductions in stream temperatures resulting from increases in canopy cover in Tier 2 watersheds would not be measurably different than in Tier 1 watersheds, although there is obviously some increase in assurance of adequate conservation of Permit species habitat in Tier 1 watersheds with wider, more densely vegetated riparian buffers. Provisions in Plum Creek's monitoring and adaptive management commitments would allow the Services to ensure habitat needs of all Permit species are adequately addressed. First, Plum Creek would seek to better understand the occurrence and distribution of Permit species through additional surveys and cooperation with states throughout the Planning Area. Second, Plum Creek would monitor implementation and determine effectiveness of their conservation measures in all watersheds to ensure biological goals of the NFHCP are met for all Permit species occurring there.

Water temperature decreases may also occur in certain areas from range management and legacy and restoration commitments, but the magnitude of this potential is unknown. The range management commitments discussed under the clean water discussion are expected to result in similar recovery trends for cold water.

Legacy and restoration commitments that would reduce water temperatures include enhancement of native riparian vegetation such as reducing the presence of exotic grasses and forbs and promoting growth of native willow species. The effects of restoring riparian vegetation could result in locally large increases in stream shading, especially in downstream reaches that are less affected by forestry actions, and potentially at greater risk of high water temperatures. The magnitude of potential temperature decreases from the above practices is likely to be greatest in Planning Area basins with large amounts of Key Migratory Rivers or stream miles grazed. These basins include the Middle Kootenai River, Blackfoot River, and Middle Clark Fork River in Montana, and Ahtanum Creek in Washington (Table 4.6-3).

The effects of this alternative on microclimate variables in riparian areas adjacent to streams include reduced impacts compared to the No Action Alternative, but not as much reduction as would be achieved under the Simplified Prescriptions Alternative. Microclimate variables include air temperature and humidity, soil temperature and humidity, solar radiation, and wind speed. Actions that cause microclimate to become warmer and drier in the summertime could either allow for heating of the stream itself, or allow for heating of groundwater adjacent to the stream channel, or impede the ability of streambanks to maintain subsurface flows (Elmore and Beschta 1987). If groundwater temperature adjacent to the stream channel increases significantly, it could cause increases of in-stream water temperatures because of interchange of water flow between the channel and adjacent riparian groundwater areas.

The link between protection of microclimate variables adjacent to streams and protection of fish habitat is not clear (Brosofske et al. 1997). However, given the lack of information and the extended Permit periods being evaluated, the Services have concerns about the future importance of microclimate considerations and believe the use of adaptive management is necessary to minimize these concerns. The proposed NFHCP provides the greatest assurance that microclimate variables would be adequately protected, other than the Simplified Prescriptions Alternative. The Services would rely on opportunities in monitoring and adaptive management under the proposed NFHCP and future independent research to better understand problems with stream water temperature protection, potentially including inadequate protection of microclimate variables, and to identify remedies to those problems. The additional effects on water temperatures from the variety of conservation commitments discussed above, together with increased canopy cover in riparian areas, would potentially contribute to a positive trend of habitat improvement for bull trout (Table 4.6-10) and other native salmonids occurring in Project Area streams.

Complex Habitat (Proposed NFHCP).

Habitat complexity in Project Area streams as affected by LWD loading, bank stability, CMZ protection, canopy cover, sediment loading, and hydrologic regime is expected to be greater under the NFHCP than under the No Action Alternative because the NFHCP prescriptions would leave more wood standing closer to streams than the No Action Alternative. LWD input resulting from implementation of NFHCP riparian prescriptions would range from 36 to 166 pieces per 1,000 feet of stream length. This spans the natural average observed in the Project Area of approximately 78 pieces per 1,000 feet of stream length. Under the proposed NFHCP, tree harvest would be limited or precluded throughout CMZs and adjacent terrace slopes, and retention trees in riparian management zones would be concentrated in areas where they are most likely to contribute to aquatic habitat. Compared to the No Action Alternative, especially for streams important to native salmonids, the NFHCP would add no-cut zones, extend state forestry BMPs farther away from streams, and require that at least 50 percent of larger trees (greater than 8 inches average diameter) be retained. Because of this management approach, the total LWD contribution to many streams would be closer to the amount produced by unmanaged stands. LWD is a critical component of native salmonid habitat because it helps maintain natural stream function by contributing to sediment control, cover, channel complexity, the ability of the stream to process organic matter, presence of prey items, and hydrological stability. (MBTSG 1998; Kondolf et al. 1996). An overall increase in LWD presence under the proposed NFHCP would contribute to improving baseline conditions, with associated benefits to the Permit species.

The average in-channel LWD load (pieces per 1,000 feet of stream channel) from unmanaged riparian stands throughout the Planning and Project Areas is estimated to be 78 pieces (Bilby and Wasserman 1989; Hayes 1996; Richmond and Fausch 1995; Plum Creek 1999g). Under the No Action Alternative, cumulative LWD load after 30 years is expected to be approximately 33 to 98 pieces per 1,000 feet for 10-foot wide streams, and 30 to 78 pieces per 1,000 feet of stream for 30-foot side streams. Based on modeling, the proposed NFHCP is expected to provide LWD loading of approximately 48 to 107 pieces per 1,000 feet of stream for 10-foot-wide streams, and 36 to 93 pieces per 1,000 feet of stream for 30-foot-wide streams. The NFHCP would provide more LWD over time to stream reaches than the No Action Alternative, especially to reaches used by native salmonids that may be most sensitive to LWD inputs for maintaining fish habitat (that is, high sensitivity stream channel types), and would be closer to the middle of the range of the amount of LWD produced by unmanaged stands (78 pieces per 1,000 feet, plus or minus 75 percent). Compared to the No Action Alternative, the NFHCP would increase LWD recruitment at high sensitivity streams by 25 to 55 percent along small streams and by 25 to 75 percent along large streams over the 30-year planning period, depending on riparian stand type (Plum Creek 1999a).

Compared to the No Action Alternative, the proposed NFHCP would result in a 25 to 75 percent increase in LWD loads at moderately sensitive streams with CMZs over the 30-year planning period, depending on stream size and riparian stand type. For low sensitivity streams, the NFHCP would provide levels of LWD similar to the No Action Alternative (Plum Creek 1999a). The provision of Interface Caution Areas under the NFHCP would increase the probability that projected LWD loading would be maintained. Effects of this alternative would vary among locations. It is possible that actual and potential habitat complexity from LWD could decrease in some portions of the Project Area from reductions in riparian tree density at the time of harvest, and in circumstances where more wood leaves a stream reach than is recruited. However, in the long term, LWD levels should increase across most of the Project Area as younger stands mature. Potential increases in complexity would be greatest in Tier 1 streams because more wood would be left standing closer to streams than along Tier 2 streams. Habitat complexity would also increase because of engineered fish habitat restoration using LWD, boulders, or bank stabilization techniques that would be implemented under the NFHCP legacy and restoration management program. Similar restoration activities would not occur under any other alternative.

The potential effect of CMZ-related riparian management commitments on improved bank stability would be greater than under the No Action Alternative because the CMZs are not given specific protections under that alternative. Improved stream bank stability provides greater habitat complexity, benefiting fish populations by providing additional hiding and foraging habitats for Permit species. Effects of changes in canopy cover under the NFHCP on fish habitat complexity would be similar to those described for the No Action Alternative except on perennial non-fish-bearing streams in Washington and some segments in Idaho where reductions in canopy cover would be significantly less than the No Action Alternative. This is because commitments in the NFHCP would leave trees standing by these streams, whereas state forest practice rules would not require trees to be left.

Potential improvements in habitat complexity from sediment delivery to streams would be greater under the NFHCP than under any other alternative, as described. Potential effects of reductions in sediment delivery under the NFHCP include increased pool depth and frequency, increased hiding spaces among larger substrate, and improved deeper-water and improved over-winter cover (MBTSG 1998). The general trend in habitat complexity expected under this alternative would be positive for fish, and the magnitude of change is potentially large, particularly in Tier 1 watersheds. The magnitude of change in Tier 2 watersheds would be less. To the extent that sensitive life history stages of other Permit species occur in Tier 2 watersheds, conservation commitments here may or may not adequately conserve these species. However, complex habitat conditions would improve, compared to the No Action Alternative for Permit species in Tier 2 watersheds. Monitoring and adaptive management commitments would help ensure adequate conservation of other Permit species in Tier 2 watersheds because the Services can use project monitoring data or other information to work with Plum Creek to increase the values of conservation measures to fish where necessary.

The NFHCP proposes an exception in riparian prescriptions for small streams, less than 10 feet wide (bank full width), 500 feet or more upstream from a confluence with a larger stream. This exception, which allows some trees to be harvested on terrace slopes adjacent to CMZs, does pose some additional but unquantifiable risk of impact on Permit species habitat. Bull trout spawning and juvenile rearing typically occur in smaller tributaries and headwater streams (Rieman et al. 1997). Kondolf et al. (1996) maintain that riparian vegetation has a greater influence on channel processes and aquatic habitat in smaller channels than in larger ones. The effect of roots in stabilizing banks, the role of LWD in channel processes, the importance of terrestrial food sources as opposed to food production within the channel (such as aquatic plants), and the shading effect of bank vegetation are all relatively more important in small channels (Vannote et al. 1980; Kondolf et al. 1996). However, these functions may be achieved more readily in smaller stream channels than in larger channels because smaller channels are less likely to move pieces of wood downstream, and these channels can benefit more from inputs of smaller wood. In those portions of Tier 1 watersheds where this exception applies, adequacy of conservation commitments would need to be carefully monitored to ensure adequate conservation is achieved through adaptive management, if necessary.

Connected Habitat (Proposed NFHCP). Habitat connectivity and fish passage would be improved under the NFHCP by finding and removing passage barriers at irrigation and stock-watering diversions, and by finding impassable road culverts and either replacing them or modifying them to restore fish passage. Implementation of the NFHCP would result in removal of essentially all known fish passage barriers in the Project Area, provided that removal of the barrier enhances recovery of Permit species (that is, barrier removal would not allow incursion of exotic species into habitat occupied by Permit species). Connectivity has been identified as a significant factor affecting bull trout and other salmonids (Rieman and McIntyre 1993; Brown 1992). Isolation of subpopulations resulting from a lack of connectivity can subject both the subpopulation and other populations to greater risks of extinction (Rieman and McIntrye 1993; Lee et al. 1997). Correcting connectivity problems under the NFHCP would improve overall baseline conditions for the covered Permit species. Efforts to eliminate fish passage barriers would be greater under the NFHCP than under any of the other alternatives. A management plan would be prepared that includes irrigation diversion BMPs and a cooperative action plan to be implemented with water-right holders. The goal would be to virtually eliminate any fish passage issues associated with diversion dams, and related issues such as fish entrainment into irrigation canals, by the end of the Permit period. Benefits to Permit species from this commitment would extend beyond the 30-year planning period. In addition, land use planning commitments under the NFHCP call for restrictions on development activities or any land transfers that may otherwise impact aquatic areas. This would reduce the occurrence of impacts caused by residential developments that have been identified as threats to some bull trout subpopulations in Planning Area basins (Table 4.6-10). Land transactions would be managed by Plum Creek to stay within a predetermined range of conservation certainty that would be beneficial to native salmonids and their habitat. Land use prescriptions under the NFHCP would potentially contribute to an increasing trend in habitat connectivity more than expected under the No Action Alternative.

During summer 1998, Plum Creek evaluated all road stream crossings encountered during their BMP inspections for fish passage capability on the Clearwater Unit in the northeast portion of the Project Area. Of the 86 stream crossings evaluated, 18 were bridges that provided adequate fish passage, and one was on a stream gradient exceeding 20 percent where fish passage was deemed unnecessary. The 67 other stream crossings were culverts, and of those 67, 16 (24 percent) were likely barriers to fish movement, primarily because of perched culvert outlets or steep gradients. Foresters were not able to determine passage efficacy for an additional 13 (19 percent) of culverts, requiring follow-up evaluation by a fish biologist. This sample occurred in a small portion of the Project Area, and is not intended to represent an accurate sample of stream crossings across the Project Area. However, this example provides some indication of the extent of conservation benefits to native salmonids from addressing habitat connectivity disruptions through Plum Creek's commitment to upgrade old roads.

Historically, habitat connectivity for Permit species was variable because of natural, random events such as landslides. However, these disruptions in connectivity occurred over time scales large enough, and were infrequent enough across the landscape, that Permit species could recolonize areas that became disconnected for periods of time. As a result of past management impacts, habitat connectivity has been disrupted more frequently and rapidly than what naturally occurred on unmanaged landscapes, resulting in threats to Permit species. Under this alternative, Plum Creek would identify and remove human-caused barriers to habitat connectivity (such as at some road stream crossings) at an accelerated rate. Habitat connectivity would be restored as completely as possible for a managed landscape condition under this alternative, and would exceed the rate and degree of connectivity restoration under each of the other three alternatives.

Adaptive Management (Proposed NFHCP). The NFHCP adaptive management strategy would rely on implementation, monitoring, evaluation, and management response. Effectiveness monitoring information would be gathered under 6 broad scientific studies. This scientific information would then be evaluated against the NFHCP Biological Goals and specific habitat objectives using habitat component metrics and triggers or thresholds to determine when mandatory management responses are required. For example, under the biological goal for clean water, one of the specific habitat objectives is to reduce sediment delivery from existing roads. One of the studies would measure actual sediment reduction achieved. The measurement used for evaluation is the percent reduction in sediment delivery from the beginning of the Permit with the trigger set at a significant difference from 49 percent. If the trigger is not met, then Plum Creek and the Services would evaluate whether this is relevant for fish, what was the cause of falling short of the goal, and then revise road prescriptions if necessary to better meet the goal. Table 4.6-12 summarizes adaptive management commitments by Plum Creek. These commitments are organized by Plum Creek's 4 Biological Goals and 15 Specific Habitat Objectives (listed in Table 4.6-2), designed to help ensure effectiveness of NFHCP conservation measures. For a more detailed explanation of Plum Creek's adaptive management process, including the specific, relevant NFHCP commitments, the types of monitoring data to be collected, the specific triggers to be used, and the management responses to be employed, refer to NFHCP Section 8, Table NFHCP 8-1 (the NFHCP is presented at the end of Chapter 3).

The NFHCP adaptive management commitments would mitigate for uncertainty associated with the active and focused conservation measures and ensure that sufficient conservation would be applied to achieve the NFHCP Biological Goals. In addition to requiring management responses when triggers are observed, the triggers could be changed. A process is specified whereby monitoring data or other new scientific information could be used to set more appropriate triggers. This feature would reduce uncertainty with respect to triggers that were chosen at the outset of the Permit period when better scientific information becomes available at a later date during the 30-year period. Should management

TABLE 4.6-12
Summary Table of Effectiveness Monitoring and Adaptive Management Commitments

Specific NFHCP Habitat Objectives	NFHCP Commitments	Performance Metrics (Success Indicators)	Triggers (If…)	Management Response (Then…)
Cold Biological Goal: Specific Habitat Objectives 1-3 include minimizing impacts on canopy closure from timber harvest; restoring riparian vegetation; and creating a net increase in canopy closure in the Project Area	Riparian and Range Management	• Water temperature is suitable for fish • Riparian vegetation trends are positive • Canopy closure increases	• Stream temperature increases by 1°C with timber harvest • Inadequate trend in riparian vegetation status • No net increase in canopy cover	• Revise or create riparian prescription enhancements • Revise grazing BMPs
Clean Biological Goal: Specific Habitat Objectives 4-7 include minimizing sediment delivery to streams from ongoing activities; reducing sediment delivery to streams from existing roads; ensuring a net reduction in sediment delivery; and restoring riparian and in-stream habitat	Road and Upland, and Legacy and Restoration	• Net sediment reduction • Riparian and in-stream habitat restoration is effective	• Significantly less than 49% reduction in net sediment delivery • Inadequate riparian and in-stream habitat restoration effectiveness	• Revise or create enhanced BMPs for new roads or old road upgrades • Revise habitat restoration efforts
Complex Biological Goal: Specific Habitat Objectives 8-12 include minimizing impacts on LWD recruitment and bank stability in harvested streamside stands; restoring grazed and harvested riparian areas; and providing a net improvement in riparian function and in LWD	Riparian, Range Management, and Legacy and Restoration	• LWD recruitment models are valid • Riparian vegetation trends improve • Riparian and in-stream habitat restoration is effective • Riparian stand composition improves	• Original LWD forecasts are wrong • Inadequate trend in riparian vegetation status • Inadequate riparian and in-stream habitat restoration effectiveness • No increase in size or relative density of trees in riparian stands	• Revise or add enhanced riparian prescriptions to increase LWD recruitment and pool formation • Revise grazing BMPs • Revise habitat restoration efforts
Connected Biological Goal: Specific Habitat Objectives 13-15 include avoiding creating fish passage barriers; restoring fish passage where existing road stream crossings restrict passage; and cooperating to restore fish migration where restricted by other means	Road and Upland, and Legacy and Restoration	• Observe increase in connectivity • Verify by third-party audit	• Third-party audit determines fish passage is not being provided in all documented cases where passage must be improved	• Develop and implement an action plan for providing adequate fish passage
Compensation for Underperformance: The adaptive management plan requires specific actions if habitat objectives are not met. Additional mitigation may be required if significant impacts on Permit species occur before the adaptive management solution is implemented.		Compliance with NFHCP commitments as determined by state or external audits, or observed by the Services	A major departure from NFHCP compliance, with significant impacts to achieving any of the 4 Biological Goals	A plan to mitigate for riparian function lost because of departure would be developed and implemented within 1 year

not be adapted, or triggers not reset adequately, the Services and Plum Creek have options for relinquishing, suspending, or revoking the Permit. The intent of including such flexibility in adaptive management commitments in this NFHCP is to ensure that the combined effect of Plum Creek's proposed conservation commitments are adequate to meet the biological goals and Permit issuance criteria.

The NFHCP relies on the conservation commitments and prescriptions. Adaptive management provides a mechanism to improve the commitments if needed. Additionally, Section 10.3 of the Implementing Agreement, allows the Services to suspend or revoke Plum Creek's permit if there is significant and unreconcilable disagreement over the need to adapt management to ensure the NFHCP biological goals and ESA permit issuance criteria are met.

The commitments of the NFHCP were constructed using the best science available and provide a reasonable level of certainty that biological goals will be met. Ideally, the plan will be successful and no management responses will be required. However, should the NFHCP not achieve the stated biological goals or continue to meet permit issuance criteria, the Services have the ability to ask Plum Creek to adapt management to ensure goals and permit issuance criteria are met. Should Plum Creek refuse, and if the Services and Plum Creek cannot negotiate an acceptable agreement, then Plum Creek or the Services have the opportunity to terminate the agreement.

In order to provide Plum Creek some measure of regulatory assurance in the face of such flexibility in the Implementing Agreement, the adaptive management approach requires the Services and Plum Creek to complete several review steps, and to then negotiate management changes with the other party, before any permit relinquishment, suspension, or revocation decisions are made. These steps are intended to serve as checks, or safety valves, on any premature actions by either party to the agreement. The concern is that superfluous management change will be sought from Plum Creek without careful evaluation and documentation, and that the Services might seek to terminate the permit prematurely and lose the broad array of conservation benefits of the NFHCP. The Services believe they should use the same level of rigor to push for management adaptation or consider permit suspension or revocation as was used to issue the permit in the first place.

The adaptive management process seeks to balance power over future management changes equally among the Services and Plum Creek. Neither party has "veto power" over the other party's decisions within the adaptive management framework. For example, if a trigger is tripped, and the Services demonstrate their belief the effects are "biologically relevant," Plum Creek cannot summarily dismiss this assertion without risk of losing their Permit. Both parties can also use the latest, best scientific data available at any point during the process to inform their determinations of changes to adaptive management triggers, and biological relevance and causal linkage determinations. So even if Plum Creek's Core Adaptive Management Projects fail to prove effective at measuring impacts or benefits to Permit species and their habitat in any way, the Services can ultimately use other scientific data to support arguments that management must be adapted.

The goal of this approach to adaptive management and permitting flexibility is to create an agreement where the challenge that both parties face is how to maintain the creative partnership necessary to build the NFHCP and permit and continue to gain the associated benefits; not how to get out of the agreement.

Other Factors (Proposed NFHCP). The presence of non-native fish species has been identified as a threat to bull trout and other native salmonids (Rieman and McIntyre 1993; MBTSG 1998). The NFHCP would begin to address the issue of non-native fish species in the Project Area by instituting an experimental brook trout suppression program in Gold Creek (or another suitable Tier 1 stream) in cooperation with the Montana Department of Fish, Wildlife, and Parks (MDFWP). The purpose of this program would be to reduce hybridization and habitat competition between bull trout and brook trout, and to reduce habitat competition between brook trout and westslope cutthroat trout. Bull trout in Gold Creek are in the Blackfoot River Planning Area basin, which contains brook trout. If successful in Gold Creek, Plum Creek would evaluate opportunities to institute similar suppression experiments under their adaptive management program in other Project Area drainages that would benefit bull trout and other Permit species.

Public access to Plum Creek roads in the Project Area would be reduced slightly under the NFHCP compared to the No Action Alternative as described in Section 4.9, *Recreation Resources.* Restricting public access may reduce the potential for illegal introductions of non-native fishes that compete with native species. Reduction or elimination of vehicle access to historical and high-risk poaching sites on Plum Creek lands through surplus road abandonment would also benefit bull trout. Finally, Plum Creek would work with state fish and game agencies in Idaho, Montana, and Washington to increase and focus enforcement activities on violations, such as illegal fishing, that impact native fish on Plum Creek lands.

Implementation of the combination of conservation commitments in the proposed NFHCP would serve to reduce impacts and multiple threats to Permit species and their habitat based on which threats are most significant in a particular area. For example, if water diversion from a stream on Plum Creek lands poses the greatest impact to Permit species, the commitment to reduce or eliminate that impact may far outweigh other road or riparian commitments. Conversely, if a watershed harbors large spawning and rearing stream reaches for Permit species, riparian commitments may be the most important contribution of the proposed NFHCP to conserving Permit species. Or, if the stream is a Native Fish Assemblage stream under the NFHCP, additional conservation opportunities may be identified by Plum Creek and the Services for implementation. An example of other benefits of potential significance include legacy restoration commitments in the Thompson River watershed, where past impacts from channel straightening, construction of a duplicate road system, diversion of surface water for irrigation, and elimination of native willows to enhance livestock grazing have severely impacted foraging, migration, and overwintering habitat for bull trout and other Permit species. While implementation of these commitments could benefit Permit species substantially, the Services are unable to precisely quantify these benefits because of the large size of the Project Area. However, combined with benefits from increased riparian buffer commitments, and commitments to reduce sediment delivery from roads, the combination of native salmonid habitat protection and restoration actions would contribute significantly to removing threats to and conserving Permit species.

Figure 4.6-15 is an actual example of NFHCP application in the Project Area. Schroder Creek is a Tier 1 watershed in the Thompson River Basin in northwest Montana. It shows specific NFHCP conservation measures and the locations and dates they are likely to be applied. For example, an irrigation diversion near the mouth of Schroder Creek is thought to have prevented bull trout passage and isolated a small resident population for 100 years. Successful removal of this barrier would restore migration opportunity for bull trout. Riparian stand recovery upstream provides for restoration of riparian function in bull trout and westslope cutthroat spawning reaches upstream. Additional active conservation measures include legacy and restoration of lower portions of the stream, livestock exclusion, and road rehabilitation. Land use planning commitments would also help minimize risks of construction development in this watershed. The combination of active conservation measures applied on the Thompson River, a Key Migratory River, begins a restoration process for riparian function in migration and overwintering habitat while intermingled federal ownership in headwater streams allows for a more conservative federal approach to complement these active measures. Not all watersheds in the Project Area would require or provide the opportunity for wide range of conservation measures, but Figure 4.6-15 illustrates how the comprehensive approach of the NFHCP would address a spectrum of threats to reduce the risk that limiting factors for Permit species are allowed to persist.

Other covered activities would not pose a significant risk of impact to Permit species under this alternative. For commercial forestry and associated activities, the greatest risk to clean water for Permit species is from sediment delivery from roads. Additional risks include sediment delivery from other silvicultural activities, including timber harvest, site preparation, tree planting, and stand maintenance. Risks would be very small under this alternative from other silvicultural activities for several reasons. Ground disturbing activities from these other silvicultural activities would be significantly reduced compared to the No Action Alternative through commitments to avoid certain types of log skidding, site preparation, and other activities within the Interface Caution Areas, which would be a minimum average distance of 150 feet from streams. Tree planting does not cause a significant amount of ground disturbing activity that would result in a significant risk of soil entering streams. Burning on Project Area lands would be restricted to burning slash, or burning certain stand types for site preparation, or to enhance wildlife habitat. Burning would not occur near streams, and would occur over a very limited (less than 5 percent) portion of the Project Area. Other stand maintenance activities include pre-commercial thinning of overstocked timber stands. Thinning would occur over a limited portion of the Project Area, and generally would not occur in riparian buffer areas. However, to the extent that thinning may occur near streams, it could actually help increase the rate of LWD recruitment, increasing habitat complexity. The risk of impact to Permit species from gravel quarrying is limited because no gravel quarries would

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be used within the Interface Caution Areas adjacent to streams; most occur on ridges where gravel deposits are most conveniently accessed. In addition, state regulations prohibit gravel quarrying within equipment exclusion zones. All of these activities are either not likely to impact Permit species or the existing mitigation measures would adequately reduce any minor impacts that do occur.

Implementation of conservation actions by Plum Creek, including building fencing to keep livestock away from sensitive stream segments, implementing engineered fish habitat restoration, reducing impacts from irrigation diversions that originate or cross their lands, repairing landslide areas, or conducting stream surveys, are all activities that are likely to benefit Permit species, and pose very little risk of impact. Permitting of electronic facility sites on Plum Creek lands would cause little or no effect on Permit species because these sites are on ridge tops, far away from Permit species habitat, and they cause little disturbance that could negatively impact fish habitat. Permitting recreational activities is likely to cause little impact on Permit species under this alternative because Plum Creek would do so consistent with road closure commitments, and under the guidance of their Environmental Principles commitments. Risk of impact from such activities is also low because they usually do not involve the disturbance of Permit species habitat. These activities are also either not likely to impact Permit species or the existing mitigation measures would adequately reduce any minor impacts that do occur.

The intent of the NFHCP would be that conservation would be applied with the greatest benefit to Permit species in those areas where conservation is most needed. In those stream reaches where bull trout spawn and rear, that are most sensitive to LWD input, the widest riparian buffer protection would be applied. In those watersheds where sediment impacts from roads are the most significant impact on Permit species, road upgrade and other commitments should reduce sediment delivery significantly. In those watersheds where livestock grazing impacts pose a significant threat to Permit species, implementation of grazing commitments would result in a significant reduction of those threats.

Summary of Effects (Proposed NFHCP). Overall, habitat conditions for native salmonids in Project Area streams would improve to a greater extent under the NFHCP than the No Action Alternative. Compared to other alternatives, the NFHCP is expected to result in the greatest reduction in sediment delivery, the most attention to connectivity problems, the most attention to non-native species problems, the most concentrated attention to important native fish assemblages, and a higher average canopy closure after 30 years than the No Action Alternative. In-channel LWD loads and associated habitat complexity are expected to be greater. Habitat connectivity and fish passage in Project Area streams would be improved from remediating or avoiding potentially adverse effects of diversion dams, culverts, stream crossings, and residential developments. Poaching, predation, and competition from non-native salmonids, and possible trampling of known spawning redds by livestock, would be reduced under the NFHCP in Project Area streams. Potential improvements in habitat quality associated with riparian harvest deferrals and native fish assemblages would benefit the Permit species in selected drainages. The changed circumstances commitment would aid habitat and Permit species if impacted by large landslides, fires, or floods, regardless of Project Area location.

Other aquatic species possibly present in the Project Area would also be affected, generally in a positive manner, by changes in habitat conditions under the NFHCP. These species are the same as listed for the No Action Alternative and include native fish (for example, Pacific lamprey), aquatic invertebrates, non-native salmonids, and non-native fish. Native salmonids in the Project Area generally have similar habitat requirements, including the Four C’s. Therefore, to the extent that this alternative benefits bull trout, it would also generally benefit other native salmonids. Pygmy whitefish would likely not be affected by this or any of the other alternatives because they occur primarily in lacustrine environments. Mountain whitefish have less restrictive habitat requirements than other Permit species, and would likely benefit relatively equally under all four alternatives. Westslope cutthroat trout, bull trout, redband trout, and other resident and anadromous fish in the Project Area would benefit relatively more from this alternative than the other three alternatives. Most of the activities and prescriptions intended to improve fish habitat quality under the NFHCP would occur in Tier 1 streams and in sensitive streams of Tier 2 watersheds. Because of this, effects would vary among species, depending on their distribution, relative to the application of different prescriptions for Tier 1, Tier 2, and sensitive streams. Bull trout, in particular, would be positively affected to the greatest extent under the NFHCP than under the No Action Alternative.

Based on the above considerations, overall habitat conditions for bull trout and other native salmonids in the Planning Area would improve. The magnitude of change expected under the NFHCP would be greater than that expected for the No Action Alternative, as a result of the more comprehensive commitments made under the NFHCP.

Certainty of effectiveness of the riparian conservation commitments, related to riparian timber harvest, under the proposed NFHCP is less than for several other aquatic HCP’s approved by the Services because the number of trees left close to streams is generally less. The reasons for developing an aquatics species plan such as the NFHCP with reduced levels of certainty regarding riparian prescriptions are as follows:

1. Only 20 percent of streamside forest stands on Plum Creek lands would be accessed within the first 10 years of the NFHCP, which minimizes negative effects if conservation benefits of riparian prescriptions are inadequate in some cases.

2. Under the NFHCP alternative, Plum Creek is offering significant additional conservation commitments for road upgrades, range management, land use planning, and legacy and restoration than other approved aquatic HCPs.

3. Plum Creek is offering significant adaptive management flexibility to accommodate increased uncertainty associated with these less conservative riparian prescriptions and other commitments.

4. Most other HCPs with wider riparian buffers cover a larger number of aquatic and riparian-dependent species, and in some cases, offer increased regulatory certainty.

Optional 10- and 20-Year Permit Lengths (Proposed NFHCP). Optional Permit lengths of 10 or 20 years would be less likely to provide benefits to Permit species because of the shorter period of time. Specifically, effects of riparian commitments such as increased LWD recruitment may not be realized until well into the planning period (Swanson and Fredriksen 1982), and optional Permit lengths of 10 or 20 years would not offer the same opportunities to assess and improve on prescriptions, if needed, as the 30-year Permit. However, road sediment reductions would be largely realized within the first 10 to 15 years of the plan; therefore, there would be less of a difference in the effects of Permit length on sediment. The 30-year Permit length was specifically selected based on the biology of bull trout, a concept that also generally applies to the other Permit species. The 30-year Permit length provides an initial 15-year period, which represents three generations of bull trout, to implement conservation measures, then a second 15-year period (three more generations of bull trout) to monitor the effectiveness of the conservation measures (conservation and monitoring efforts would occur throughout the life of the Plan). Many of the prescriptions implemented during the initial 15 years, as well as maintenance prescriptions directed at conservation certainty throughout the 30-year period, would also be carried out during the second 15 years. This same rationale for identifying conservation measures to be implemented over time was used in early discussions by the Montana Bull Trout Restoration Team.

Overall, a 30-year Permit has a higher risk from unknown factors that cannot be anticipated at this time, but is also more likely to have beneficial effects by allowing more time for effects of restoration activities and improved management practices to be realized. Examples of time-dependent effects that would not be fully realized under Permit lengths of 10 or 20 years include the following:

- Reductions in sediment delivery from roads to Project Area drainages through continued implementation of road and upland management commitments

- Full recovery of severely disturbed streams and riparian areas through range management commitments

- A desired balance in land transactions and conservation certainty that would assure a resultant net benefit to aquatic resources through land use planning commitments

- A variety of riparian vegetation improvements achieved through riparian commitments such as the following:

  - Increased LWD loading
  - More desirable vegetation structure and more balanced structural diversity
  - Increased canopy cover and slightly reduced water temperature

Mitigation (Proposed NFHCP). Mitigation measures under the following conservation commitment categories combine to reduce or offset impacts from covered activities. The following is not an all-inclusive discussion of mitigation, but it summarizes the highlights of this alternative.

Administration and Implementation. In addition to the conservation practices under the No Action Alternative, the NFHCP would increase the certainty that management systems are in place to ensure implementation. Administration and implementation commitments are aimed to achieve NFHCP success by reporting performance metrics, providing third-party audits of practices, and training personnel and contractors in NFHCP conservation practices. The actual success of the NFHCP and need for additional mitigation would be evaluated through a series of programs that would monitor the implementation and effectiveness of all categories of conservation commitments. Administration and implementation commitments describe the processes and schedules for conducting and reporting monitoring results to the Services. Some of the adaptive management commitments would provide opportunities to modify NFHCP prescriptions if those modifications are needed to adequately conserve Permit species. They include core adaptive management projects in demonstration watersheds to evaluate the effectiveness of road BMPs and Plum Creek's grazing BMPs, the effect of riparian management on woody debris loads and fish habitat diversity, and the effectiveness of NFHCP prescriptions at minimizing stream temperature increases. Besides these programs, the changed circumstances commitment requires site-specific plans to address the adverse effects on Permit species of events that can be reasonably expected to occur, such as large or intense landslides, fires, or floods.

Why Mitigate for a Mitigation Plan?

Typically, an EIS specifies mitigation measures applied to the action alternatives that would accompany the federal action being considered. Evaluating an HCP as a direct result of a federal action (issuance of a Permit) is somewhat unique because the HCP is by nature a package of measures specifically designed to minimize and mitigate for the impacts associated with covered activities. Because the Services provide assistance to the HCP applicant, mitigation believed to be required for approval is built into the applicant's proposal. In this EIS, this section is used to summarize the mitigation provided by the proposed NFHCP and highlight measures that have been included to reduce the uncertainty of the Services in issuing a 30-year Permit.

Roads. For road impacts, Plum Creek proposes to eliminate up to 98 percent more sediment than it would produce by constructing new roads (15,000 tons per year compared to 300 tons per year) by Year 15 of the Plan. Reduction of sediment would exceed sediment delivery increase because 1) Plum Creek began implementing enhanced sediment delivery reductions on Project Area lands in 1996, and 2) they would upgrade old roads at twice the rate at which new roads would be constructed.

Riparian. Under the NFHCP, Plum Creek anticipates accessing only 20 percent of their riparian buffer areas throughout the Project Area over the first 10 years of the proposed Permit period. Plum Creek could enter as much as an additional 56 percent of streamside riparian stands in the Project Area between Years 10 and 30.

For those riparian areas Plum Creek would harvest, some unquantifiable level of impacts may occur on 10 to 20 percent of the Project Area for the first 10 years of the Plan. These impacts would be minimized with the increased buffer widths and other commitments provided in the riparian commitments in the NFHCP, along with grazing, legacy and restoration, and possibly other commitments. The resulting impacts would occur on less than 20 percent of streamside riparian stands in the first 10 years. The remainder of riparian areas on Plum Creek lands would be providing increasing benefits because they would remain unharvested. Although not specifically quantifiable, the rate of increasing benefits would likely exceed the rate of impacts for the following reasons:

1. Any likely impacts on Permit species resulting from riparian harvest would be restricted to 20 percent of the Project Area the first 10 years of the NFHCP.

2. Mitigation from increasing conservation benefits would be applied over 80 or 90 percent of the Project Area within the first 5 or 10 years, respectively.

3. The cumulative value of conservation benefits from other conservation commitments applied within the same time frame would exceed impacts.

In addition, Plum Creek has already begun implementing some legacy and restoration commitments on their lands that have resulted in increased stream shading and channel complexity (for example, vegetation management in the Thompson River watershed). This has resulted in improved Permit species habitat prior to when take authorization would commence under this alternative.

Range Management. Livestock grazing on Plum Creek lands likely results in an unquantifiable level of impacts. However, if Plum Creek eliminated all permitted livestock grazing on their lands, impacts on salmonids would not end; open range grazing laws in the Project Area would result in a significant level of trespass livestock grazing on Plum Creek lands in an unmanaged fashion, impacting fish and fish habitat. The number of impacts from livestock management activities authorized under the NFHCP would be substantially less during a 30-year period than the impacts that would occur without Plum Creek's livestock permitting program. The rate at which such impacts would be reduced would be greater from the beginning of NFHCP implementation and continuing throughout the life of the Permit than the lower rate of improvement under the No Action Alternative. Most impacts would be minimized or eliminated by Year 15 of the Permit period. In addition, Plum Creek began minimizing livestock effects on Permit species habitat by implementing components of the NFHCP grazing conservation commitments starting 4 years ago, resulting in improved Permit species habitat before take authorization would commence under this alternative.

Legacy and Restoration. The legacy and restoration measures evaluated in this alternative are important because they go beyond the basic requirement for HCPs to mitigate for current activities by specifying measures for addressing the lingering effects of past activities. Under this alternative, the Services have the opportunity to gain conservation commitments that may not otherwise be available.

Land Use Planning. The Service's evaluation of the overall value of the NFHCP assumes that the package of conservation measures specified would be applied upon the land-base represented as Plum Creek ownership at the outset of the Permit period. Plum Creek has stated that a key aspect of their business is to sell HBU lands as real estate. Plum Creek owns lands adjacent to important Permit species habitat, and the Services have identified the threat of land development as a significant threat factor to at least one Permit species—bull trout. The sale of HBU land itself does not impact fish habitat, but it introduces uncertainty that the effects of the NFHCP evaluated as a part of this EIS would continue to accurately represent the expected conservation benefit of the NFHCP as a whole. Therefore, the IA specifies that when the net change in land ownership changes so much that the conclusions of the EIS may be no longer valid, an amendment to the Permit would be required for additional land transactions. This would require a review of the analysis of effects.

The NFHCP land use planning commitments represent an approach that defines an applicable range of land transactions that would occur within the scope of this effects analysis. Provided that land transactions do not exceed this range, then the risk is sufficiently minimized to prevent a change in the conclusions represented by the effects analysis. It is also a mitigation package that reduces or mitigates for the uncertainty associated with the sale of lands by providing incentives to Plum Creek to succeed in land transactions that improve certainty of future conservation to offset the effects of other land sales that reduce the certainty of future conservation.

In past HCPs, the Services have set a simple cap for land sales at a small number of acres that could be sold without re-evaluation of the Permit. Under the proposed NFHCP, lands sold unrestricted by conservation measures and without a Permit amendment would be limited to 8 percent of the Project Area. This could mean that 8 percent of the Project Area could be sold or exchanged without conservation measures attached to the land. The Services anticipate that this would not compromise the overall conservation value of the NFHCP for the following reasons:

- Ninety-two percent of Project Area lands would continue to receive conservation benefits from the NFHCP.
- Incentives for Plum Creek to place conservation requirements that stay with lands in perpetuity are greatest for those lands that are more sensitive for fish.
- There are mandatory requirements to place deed restrictions on certain lands, if they are sold, that are important for fish.
- Some conservation would be achieved on many of the Project Area lands before they are likely to be sold.

The net effect of the sales would be to allow more unrestricted land sales in areas that are less important for Permit species in exchange for successful conservation outcomes for lands sold in areas that are important for Permit species.

If Plum Creek wishes to add lands to the Permit, under this alternative, the Services would review each proposal on a case-by-case basis, as provided for under Section 11.1.2 of the IA. The Services would agree to add lands as a minor amendment to the Permit only if any potential increase in take of Permit species is commensurate with minimization and mitigation measures that would be applied as agreed to in the NFHCP, as required in sub-paragraph (g) of the IA.

The effect of this approach to adding lands to the Permit would be to ensure that

Permit issuance criteria are continually met in all cases. This would allow for propagating the conservation value of the Permit across more lands, further reducing threats to Permit species. If a proposal to add lands results in impacts that are greater than can be compensated for in the minimization and mitigation measures agreed to in the NFHCP, a major amendment to the Permit would be required, including greater public disclosure and participation in the decision-making process.

Other Covered Activities. Other authorized activities by Plum Creek are likely to result in little or no take of Permit species. For example, there is no take of Permit species associated with Plum Creek selling land. However, the potential conservation benefit from Plum Creek's land use planning commitments would benefit Permit species by reducing the threat of development in watersheds important to Permit species. Any take that may occur would be under exceptional circumstances. For example, take associated with operation of mill sites might only occur with the Ksanka Mill Site near Fortine, Montana, since this is the only mill site that could possibly discharge materials into surface waters with Permit species. Take at this site would only be likely if a large precipitation event resulted in Plum Creek's inability to completely contain stormwater runoff. Under such unusual circumstances, take first would have been minimized for the time period with no discharges occurring, and take would be further minimized during such a discharge event because it would only occur when stream flows are very high, diluting the effects of stormwater runoff. Finally, any take that may occur would be mitigated through implementation of land use planning, legacy and restoration, and other commitments not specifically intended to mitigate for more direct, forestry-related take (such as road building and riparian timber harvest). Take from tree planting, timber marking, gravel quarrying, communication site use, and other activities under this alternative would be at such low levels as to be virtually zero.

Pay-as-You-Go. Plum Creek would be allowed to relinquish the Permit at any point during the Permit period should it choose to do so without any post-termination mitigation obligations. This would be allowed because Plum Creek would implement the terms of the Permit such that the amount of mitigation provided would exceed the amount of take authorized at any point over the life of the Plan. Unlike some previous HCPs in the northwestern United States, Plum Creek does not propose to front load take under the NFHCP, or back load conservation benefits. That is, take would not occur disproportionately early in the proposed 30-year Plan implementation period, as compared to later in the Plan implementation period. Most mitigation measures would be fully implemented during the first 15 years of the proposed Permit period. The combination of take minimization from their forestry activities—primarily from road construction and use and timber harvest in riparian areas—and take mitigation from implementation of a variety of conservation commitments, would result in conservation benefits occurring at a sufficient rate to exceed the rate at which take is authorized.

Converse to Plum Creek's ability to relinquish the Permit with no post-termination mitigation obligations, the Services could suspend the permit if Plum Creek fails to adequately implement the terms of the Permit, including if Plum Creek fails to adapt management of their lands, or modify adaptive management triggers, under the Permit consistent with its terms, as agreed to. Ultimately, the Services could revoke the Permit if the amount of mitigation provided is so inadequate that it would likely jeopardize the continued existence of one or more Permit species, and Plum Creek could not or would not adapt the plan to remove jeopardy. This approach provides maximum flexibility for either party to exit the terms of the Permit, should it be in their best interest to do so. Ultimately, however, this HCP is designed to provide incentives for both the Permittee and the Services to seek opportunities to not relinquish, suspend, or revoke the Permit because of the loss of take coverage for the Permittee, and the loss of species conservation for the Services.

Unavoidable Adverse Impacts (Proposed NFHCP). Implementation of prescriptions and all covered activities associated with the NFHCP would not result in additional unavoidable adverse impacts on fisheries and aquatic resources in Project Area drainages compared to existing conditions. Some unavoidable adverse effects from timber harvest, roads, and grazing would continue under the NFHCP; however, potential adverse effects are expected to be diminished through NFHCP commitments.

Cumulative Impacts (Proposed NFHCP). The cumulative effects of continued timber harvest, grazing, and roads on fish habitat quality under the NFHCP are unknown because many uncontrolled factors may influence habitat quality, and variable conditions exist across the Planning Area. It is anticipated that implementation of the NFHCP would generally result in improvements in fisheries and aquatic resources in the Planning Area, on average, during the Permit period. However, cumulative effects in areas of mixed ownership could be driven by activities on lands that Plum Creek does not own. Potential improvement in fish habitat quality would exceed those anticipated under the No Action Alternative and Internal Bull Trout Conservation Plan.

Overall, habitat conditions for bull trout and other native salmonids in the Planning Area would be expected to be better under the NFHCP than under the No Action Alternative. A positive trend of gradually improving habitat conditions for bull trout and other native salmonids would be expected over the 30-year Permit period. The trend in improvement would be less certain for other Permit species in Tier 2 watersheds because of the reduced levels of conservation commitments there. This improving trend would reflect the combined positive influences of careful, low risk habitat management strategies for native salmonids and at-risk species on federal lands, the predominance of federal lands within the Planning Area, and the benefits to native salmonid habitat in the Project Area from implementing the NFHCP.

Allowing for Recovery. The Services believe that, although the plan is likely to result in improving conditions, we cannot know how quickly and by how much. This uncertainty, coupled with the fact that we are unsure what recovery goals are for listed Permit species, or conservation goals for unlisted Permit species, means that it is difficult to precisely determine the degree to which the NFHCP will contribute to the recovery of Permit species. Without this kind of information, the Federal team working on the project initially was asked in the fall of 1997 whether the FWS had enough information even to enter into conservation planning with Plum Creek. Despite existing information gaps, all office biologists from the Services agreed that enough information was available to engage in conservation planning with Plum Creek, and that the opportunity for gaining substantial conservation for native salmonids on Plum Creek lands was significant.

An HCP must meet all issuance criteria, including that it will avoid "jeopardizing" species, or not appreciably reduce the survival and recovery of the species in the wild. With this NFHCP, the initial conservation commitments are intended to provide an increased likelihood that conditions will improve at a rate sufficient to allow for recovery, or avoid "jeopardizing" species in most cases in the Project Area. In addition, NFHCP commitment AM2 would allow the Services to intervene in those cases where commitments are determined to not be adequate to conserve Permit species, and ask Plum Creek to do more to conserve species.

In summary, the Services define adequacy of the NFHCP as achieving a direction and magnitude of change in habitat quality sufficient to allow for recovery (EIS Section 1.4.3, p. 1-14). This is accomplished in the NFHCP by the "up-front" commitments **combined** with the ability to change these commitments through adaptive management measures, and ultimately to suspend or revoke the Permit if the biological goals of the NFHCP are not being met or recovery of any Permit species is not being allowed for. Since recovery needs will likely not be defined until after a Permit decision is rendered for most, if not all species, adequate flexibilities must be available to adjust the plan to achieve recovery goals as they are determined. Also, recovery plans provide no assurance of conservation, on public land or private land, so the FWS seeks to take advantage of the opportunity provided by Plum Creek to conserve species starting right away under the HCP process.

The NFHCP and FEIS provide estimates of potential improvements in all of the Four Cs. The Services believe that impacts to Permit species' habitat will occur (hence the proposed incidental take authorization). However, the rate and degree of impacts that would occur would be reduced from current levels, and overall habitat conditions across the Project Area would improve at a rate sufficient to allow for recovery of Permit species through implementation of the up-front conservation commitments combined with the ability to modify the NFHCP if the biological goals are not being met.

Because the Services have not completed recovery plans for any of the listed Permit species, and are not currently considering managing unlisted Permit species under the ESA, we do not yet have a clear picture of the what the overall efforts to conserve all Permit species may ultimately look like. However, the Services have sought to help Plum Creek design this NFHCP in a manner consistent with the likely recovery needs of all Permit species on a broader scale, as they are determined. For example, the Services have sought to include enough adaptive management flexibility to ensure Plum Creek's management can be adapted to meet recovery goals or be consistent with recovery tasks as they are identified.

In addition, the clear majority of lands occupied by bull trout, and most of the anadromous Permit species in the Planning Area, are owned and managed by the federal government. Therefore, the Services have the opportunity through future consultation with these land management agencies under Section 7 of the ESA to ensure actions they carry out promote recovery of listed species, and complement other, ongoing state and private species conservation and restoration activities.

The Services also based their technical assistance to Plum Creek in large part on information provided in other, existing planning processes, including the state plans for bull trout restoration in Idaho and Montana, and the draft ICBEMP. Information from these plans is also being incorporated into the FWS' bull trout recovery planning process.

The Services believe that HCPs should not supplant development of recovery plans. Ideally, range-wide recovery plans would be completed before HCPs are developed, but conservation planning can continue absent approved recovery plans provided enough information is available to ensure adequate conservation. The FWS coordinated the development of the NFHCP with the bull trout recovery team coordinator, and obtained input from recovery team members to help ensure development of the NFHCP was consistent with the recovery teams current views on what is needed for adequate conservation.

The proposed NFHCP is designed to benefit habitat and potentially populations of bull trout and other Permit species occurring on lands within the 1.6-million acre Project Area. These actions would also incrementally benefit habitat and potentially populations of Permit species occurring on lands in the considerably larger 16.5-million acre Planning Area. However, most lands occupied by bull trout, and most of the anadromous Permit species in the Planning Area, are owned and managed by the federal government. Federal actions are, therefore, prominent in overall Planning Area efforts to conserve and protect habitat of native salmonids.

Nearly 9.6 million acres of federal lands lie within the Planning Area, representing approximately 58 percent of the total Planning Area acreage. The FS manages approximately 92 percent and the BLM approximately 2 percent of these lands. Resource management plans for both agencies have been amended by programmatic, interim fish protection strategies (INFISH, PACFISH) intended to provide protection against extinction or further endangerment of fish stocks. Federal land management agencies recognize their prominent role in administering much of the remaining habitat used by salmonids for spawning and rearing. For example, most watersheds with known or predicted strong populations of representative Permit species are on federal lands, including more than 90 percent for bull trout and westslope cutthroat trout, 70 percent for steelhead, and 88 percent for stream-type chinook salmon (ICBEMP 1997a, 1997b). Continuing federal management and recovery efforts aimed at maintaining good-quality habitats and populations, as well as increasing the distribution of high-quality spawning and early rearing habitats, are dominant components in achieving habitat viability and sustainability for all Permit species in the Planning Area.

Specific programs or actions intended to contribute directly or indirectly to the protection or recovery of salmonids and their habitat in the Planning Area include, but are not limited to, the following:

- Section 7 consultation with FWS or NMFS on any proposed activity potentially affecting protected or sensitive resident and anadromous fish species and their habitat

- Enforcement of the federal Endangered Species Act, Clean Water Act, Clean Air Act, and National Environmental Policy Act

- Implementation of FS and BLM land and resource management plans currently amended by PACFISH and INFISH, and potentially guided in the long term by broad-scale, science-based management direction contained in the Interior Columbia Basin Ecosystem Management Project

- Application of Bull Trout Interim Conservation Guidance prepared by FWS, and proposed or draft steelhead and chinook salmon recovery plans prepared by NMFS

- Implementation of evolving and strengthened state forest practices regulations and BMPs on state and private lands in the Planning Area, which comprise about 25 percent of the total Planning Area acreage

- Implementation of state-based bull trout restoration and aquatic habitat management programs in the Planning Area, including the Montana Bull Trout Restoration Plan, Idaho Bull Trout Plan, and Washington Forests and Fish Report

- Benefits previously described from implementing the proposed NFHCP on Project Area lands, which comprise about 10 percent of the total Planning Area acreage.

Internal Bull Trout Conservation Plan Alternative

Clean Water (Internal Bull Trout Conservation Plan). Estimated sediment reduction and expected improvement in salmonid habitat under this alternative would likely be intermediate to conditions described for the No Action Alternative and the NFHCP. Anticipated habitat effects would be similar to those described for the other alternatives; however, the potential benefits to habitat and Permit species would be less than under the NFHCP because fewer and less rigorous road and upland, riparian, and range management prescriptions directed at sediment reduction would be implemented under the Internal Bull Trout Conservation Plan Alternative. Conservation value in Tier 2 watersheds for other Permit species would be reduced because this alternative would only seek to conserve currently listed species.

Analysis of this action alternative indicates sediment delivered from roads to all Project Area streams over the 30-year Permit period would be reduced by about 43,000 tons, an 8 percent greater reduction than the No Action Alternative. Potential improvements in salmonid habitat under this alternative would not be as great as under the NFHCP. Under the Internal Bull Trout Conservation Plan Alternative, sediment delivery would decline annually, from Years 1 through 25 of the 30-year Permit period, then remain nearly constant through Year 30.

Reductions in sediment delivery beyond the No Action Alternative would occur primarily in Tier 1 drainages within the

Planning Area basins under the Internal Bull Trout Conservation Plan Alternative. The potential magnitude and rate of habitat improvement would be intermediate to those under the No Action Alternative and the NFHCP. Permit species present primarily in Tier 1 Project Area drainages are expected to be affected by sediment reductions to a greater extent than species in Tier 2 watersheds.

Influences of covered activities on water quality parameters (nutrient loading, contaminant loading, dissolved oxygen levels, and sediment loading from silvicultural and commercial forestry sources other than roads) would be the same as described under the No Action Alternative.

The total sediment delivery from old roads under this alternative would be about 503,000 tons over 30 years; 88,000 tons of sediment to high priority (Tier 1) streams and 414,000 tons to other (Tier 2) streams (Figure 4.6-3). The net effect of the road upgrade commitment would be to decrease total sediment delivery by 43,000 tons (8 percent) compared to the No Action Alternative (Figure 4.6-4).

This alternative would apply enhanced BMPs to all new roads designed and constructed in watersheds with bull trout spawning and rearing streams (Tier 1 watersheds) and along Key Migratory Rivers, rather than throughout the entire Project Area (as in the proposed NFHCP). Although sediment delivery from new roads in Tier 1 watersheds would increase to the same degree as in the proposed NFHCP, it also would be reduced by 600 tons (5 percent) compared to the No Action Alternative. However, sediment delivery to streams in Tier 2 lands during road construction would be equivalent to that under the No Action Alternative.

Like the proposed NFHCP, this alternative would identify and abandon surplus roads in bull trout (Tier 1) watersheds, resulting in about the same degree of reduced sediment delivery. However, in Tier 2 lands no surplus road abandonment would occur. Therefore, the benefits of reduced sediment delivery to streams on Tier 2 lands would not occur as provided by the proposed NFHCP.

Also, this alternative would treat legacy road system hot spots and other defined hot spots in Tier 1 watersheds, resulting in reduced sediment delivery similar to the proposed NFHCP. However, in Tier 2 lands, hot spot treatments would occur concurrently with road upgrades, similar to the No Action Alternative. Therefore, the benefits of expedited treatments to address hot spot sediment delivery to streams on Tier 2 lands would not occur as provided by the proposed NFHCP.

The effects of other road management commitments are similar to those described under the proposed NFHCP. One exception is that road condition inspections would be limited to bull trout (Tier 1) watersheds only, excluding the benefit of a programmatic road risk assessment from Tier 2 lands. Likewise, road sediment delivery analyses would be limited to bull trout (Tier 1) watersheds and Plum Creek lands, excluding the benefits of sediment delivery analysis and prioritization on adjacent lands within Tier 1 watersheds or any Tier 2 lands.

Like the proposed NFHCP, this alternative would inspect, and maintain as needed, road segments every 5 years in Tier 1 watersheds, resulting in the same degree of attention to potential problems. However, in Tier 2 lands, roads would be maintained as needed to comply with state BMPs, like the No Action Alternative. Therefore, the benefits of heightened attention to minimize sediment delivery to streams on Tier 2 lands would not occur as provided by the proposed NFHCP.

This alternative proposes a level of road restrictions greater than the No Action Alternative but less than the proposed NFHCP. The resulting reduction in sediment delivery from this alternative would be intermediate to the No Action Alternative and proposed NFHCP.

The combined effect of conservation strategies for road upgrades, new roads, roads abandonment, and hot spot treatments would result in a cumulative reduction of about 47,300 tons of sediment delivered to streams in the Project Area compared to the No Action Alternative during the proposed 30-year Permit (Table 4.6-5). Figure 4.6-8 shows the expected net reduction in sediment delivery under this alternative, most of which, like the other alternatives, is accounted for by the upgrade of existing roads. Streams in the Swan River, Blackfoot River, and Middle Clark Fork River Planning Area basins probably would experience the greatest reduction in sediment delivery.

Like the proposed NFHCP, several riparian commitments include provisions for restricting or excluding harvest equipment in Tier 1 CMZs. Similarly, the benefits of reducing or eliminating soil disturbance to minimize or avoid sources of sediment delivery to streams are also achieved. However, this alternative does not restrict equipment in Tier 2 CMZs beyond that required under state BMPs, as would be provided by the proposed NFHCP.

In Tier 1 watersheds, riparian soil productivity conservation would be similar to the proposed NFHCP. In Tier 2 lands, riparian soil productivity would be similar to the No Action Alternative. Under this alternative, benefits of the Environmental Principles that provide for maintaining soil productivity would be in place, but subject to change at any time.

Like the NFHCP, this alternative would better maintain riparian soil productivity on Tier 1 watersheds because of equipment limitations in riparian CMZs compared to the No Action Alternative. However, unlike the NFHCP, this alternative would not provide better maintenance of soil productivity on Tier 2 lands than the No Action Alternative.

Like the NFHCP, this alternative would implement Plum Creek's grazing BMPs in all Tier 1 watersheds, and would implement fenced exclosures in Tier 1 watersheds and along Key Migratory Rivers where conditions are severely impacted. This would result in a positive improvement in riparian conditions under open range grazing similar to that under the proposed NFHCP (Figure 4.6-14). However, in Tier 2 lands, these measures would not be applied. Like the No Action Alternative (Figure 4.6-9), current levels of riparian disturbance in Tier 2 lands would remain unchanged. Furthermore, like the No Action Alternative, there would be no monitoring of riparian function associated with grazing and no rancher training. Therefore, unlike the proposed NFHCP, the benefits of grazing BMPs of maintaining bank stability and minimizing sediment delivery to streams would not apply to Tier 2 lands, and the benefits of monitoring and training would not apply to Tier 1 watersheds.

Like the NFHCP, this alternative would result in reduced livestock trampling on Tier 1 watersheds, which would maintain riparian soil productivity above that under the No Action Alternative. However, unlike the NFHCP, this alternative would not provide better maintenance of soil productivity on Tier 2 lands than the No Action Alternative.

Cold Water (Internal Bull Trout Conservation Plan). Similar to the other alternatives, water temperature may be slightly reduced in Project Area streams under this alternative because of expected increases in canopy cover. Potential temperature reductions would be similar to the NFHCP and the No Action Alternative because of similar increases in canopy cover. Compared to the NFHCP, the Internal Bull Trout Conservation Plan Alternative contains some similar but often less rigorous prescriptions (such as selected riparian, grazing, legacy and restoration, and land use planning commitments) that could potentially contribute to further reductions in water temperature.

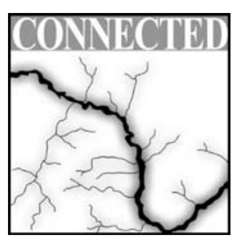
Complex Habitat (Internal Bull Trout Conservation Plan). Potential improvements in habitat complexity in Project Area streams under the Internal Bull Trout Conservation Plan Alternative are expected to be greater than under the No Action Alternative, but less than under the NFHCP. This reflects the expected overall net effects of prescriptions that would be implemented under the Internal Conservation Plan. Additional prescriptions beyond existing regulations are focused on Tier 1 streams.

Anticipated increases in LWD loading in high-sensitivity and moderate-sensitivity streams under the Internal Bull Trout Conservation Plan Alternative would generally be similar to those described for the NFHCP. The exception would be near smaller fish-bearing streams where there would be more riparian harvest, and potentially less LWD loading, under this action alternative than the NFHCP.

Effects associated with the protection of a range of fish-bearing and non-fish-bearing CMZs and improved bank stability under this alternative would be generally similar to those described for the NFHCP. The exception is Tier 2 and small stream CMZs that may support fish where Forest Practice Act regulations and guidelines would apply.

Changes in canopy cover under the Internal Bull Trout Conservation Plan Alternative would be similar to those described for the NFHCP and No Action Alternative.

Sediment loading from Project Area roads to streams would be greater than under the NFHCP but less than under the No Action Alternative.



Connected Habitat (Internal Bull Trout Conservation Plan). Improvements to habitat connectivity and benefits to fish passage under this alternative would exceed those of the No Action Alternative but would be much less than under the NFHCP. For example, hot spot treatments would occur under the Internal Bull Trout Conservation Plan Alternative, but only in Tier 1 streams. Other road and upland management commitments and land use planning commitments would be more rigorous than under the No Action Alternative, but would provide fewer potential benefits than under the NFHCP. In addition, no irrigation diversion management program would be implemented under the Internal Bull Trout Conservation Plan Alternative. Some habitat connectivity threats for bull trout subpopulations listed in Table 4.6-10 would probably continue on Project Area lands.

Other Factors (Internal Bull Trout Conservation Plan). Unlike the NFHCP, the Internal Bull Trout Conservation Plan Alternative contains no prescriptions specifically directed at non-native fishes or poaching. Threats associated with these two factors would continue to be about the same under this alternative. Possible exceptions are any benefits resulting from opportunistic road closures under this alternative based on bull trout conservation (such as reducing the possibility of poaching or the illegal introduction of non-native fishes). Potential benefits would exceed those of the No Action Alternative but not those of the NFHCP.

Summary of Effects (Internal Bull Trout Conservation Plan). Overall, habitat conditions for native salmonids in Project Area streams are expected to improve to a greater extent under this alternative than under the No Action Alternative, but to a lesser extent than under the NFHCP. The Internal Bull Trout Plan is expected to have the greatest influence on Tier 1 drainages, where bull trout are concentrated, and less influence on the other native salmonid Permit species that occur in Tier 2 drainages. No prescriptions would be specifically directed at the adverse effects of poaching and non-native salmonids on Permit species under this alternative.

The net effect of the Internal Bull Trout Conservation Plan Alternative on habitat quality is unknown, but could potentially be an overall improvement in Tier 1 streams, and have varied effects in Tier 2 streams. Because of different conditions across the Project Area, habitat quality may decline in some watersheds, and improve in others. Where improvements in habitat occur, the potential magnitude of improvement would likely be intermediate to the NFHCP and the No Action Alternative, and may or may not be adequate to reduce or eliminate all of the threats identified for Permit species in the Project Area. Other aquatic species possibly present in Project Area Tier 1 streams would also be affected by changes in habitat conditions. These species include native fish, aquatic invertebrates, non-native fish, and Pacific lamprey.

Optional 10- and 20-Year Permit Lengths (Internal Bull Trout Conservation Plan). If the Services issue a Permit for the Internal Bull Trout Conservation Plan, Permit lengths of 10 or 20 years would not provide the Permit species as many benefits or for as long a period of time as would a Permit length of 30 years. Reasons for this are generally the same as described for the NFHCP, although prescriptions would generally be fewer and less rigorous under the Internal Bull Trout Plan than under the NFHCP. Improved habitat conditions in the Project Area associated with the Four C’s under the Internal Plan, and potential cumulative benefits to native salmonids, would not extend to as many generations of Permit species during a 10-year Permit (two generations of bull trout) or 20-year Permit (four generations) as during a

30-year Permit (six generations). Not all commitments could be fully implemented by the end of a 10-year Permit, and results of long-term implementation and effectiveness monitoring that could be used to improve management prescriptions, if needed, would be limited or lacking at the end of 10 or 20 years. However, a shorter Permit term would reduce the Service's concerns about uncertainty associated with even longer-term commitments of up to 30 years.

Mitigation (Internal Bull Trout Conservation Plan). In addition to the conservation practices under the No Action Alternative, the Internal Bull Trout Conservation Plan Alternative would include internal audits on the effectiveness of Plum Creek's Environmental Principles, and training personnel and contractors in Internal Bull Trout Plan conservation practices. If the Services issue a Permit for this alternative, federal oversight would be provided and reports on HCP implementation and effectiveness prepared. Adaptive management efforts would consist of possible revisions of HCP practices based on results of compliance monitoring. Plum Creek would also incorporate new conservation measures as required by federal and state laws. Not all of the mitigation measures are included here because most of them were described as part of the Internal Bull Trout Conservation Plan.

Unavoidable Adverse Impacts (Internal Bull Trout Conservation Plan). Implementation of prescriptions and all covered activities associated with the Internal Bull Trout Conservation Plan Alternative would not result in additional unavoidable adverse impacts on fisheries and aquatic resources in Project Area drainages compared to existing conditions. Some unavoidable adverse effects from timber harvest, roads, and grazing would continue under the Internal Bull Trout Conservation Plan; however, potential adverse effects are expected to be diminished through the internal plan's commitments.

Cumulative Impacts (Internal Bull Trout Conservation Plan). The cumulative effects of continued timber harvest, grazing, and roads on fish habitat quality under the Internal Bull Trout Conservation Plan Alternative are unknown, because many uncontrolled factors may influence habitat quality, and variable conditions exist across the Planning Area. It is anticipated that implementation of the Internal Bull Trout Conservation Plan would generally result in improvements in fisheries and aquatic resources in Tier 1 streams, with little or no difference from the No Action Alternative in Tier 2 streams. Potential improvement in fish habitat quality of Tier 1 streams would exceed those anticipated under the No Action Alternative, but they would not be as extensive or wide-ranging as those anticipated under the NFHCP. The overall trend in the Planning Area over the 30-year Permit period would reflect gradual improvement in habitat conditions.

Simplified Prescriptions Alternative

Clean Water (Simplified Prescriptions). Estimated sediment reduction and expected improvement in salmonid habitat under this alternative would be intermediate to conditions described for the NFHCP and the Internal Bull Trout Conservation Plan Alternative.

Anticipated effects on habitat and Permit species would be similar to other alternatives. However, the potential magnitude of sediment reduction under the Simplified Prescriptions Alternative would be less than under the NFHCP because of fewer, less targeted road and upland, riparian, and range management prescriptions.

Sediment delivery from roads to Project Area streams over the 30-year Permit period would be reduced by about 73,000 tons, a 13 percent reduction, compared to the No Action Alternative. Potential improvements in salmonid habitat under this alternative would be greater than under the No Action Alternative, but not as great as under the NFHCP. Under the Simplified Prescriptions Alternative, sediment delivery would decline annually from Years 1 through 25 of the 30-year Permit period, then remain about constant through Year 30.

Reductions in sediment delivery would occur in Tier 1 and Tier 2 lands within the Planning Area basins under the Simplified Prescriptions Alternative. The potential magnitude and rate of improvement would be greater than the potential magnitude and rate of improvement under the Internal Bull Trout Conservation Plan Alternative but less than under the NFHCP.

The Simplified Prescriptions Alternative would reduce the overall density of roads within the Project Area. It focuses on constructing fewer roads and abandoning more roads, both of which would reduce sediment delivery and soil productivity impacts. However, this alternative may trigger abandonment of roads that are desired for long-term forest management.

This alternative would upgrade road segments in the Project Area to limited enhanced BMP standards, resulting in a slightly greater reduction in sediment delivery compared to the No Action Alternative. Like the No Action Alternative, the reduction of sediment would be gradual during the first 25 years of the planning period. The total sediment delivery from old roads under the Simplified Prescriptions Alternative over 30 years is expected to be 489,000 tons; about 120,000 tons of sediment would be delivered to high priority (Tier 1) streams and 369,000 tons to other (Tier 2) streams (Figure 4.6-3). The net effect of this road upgrade commitment would be to decrease total sediment delivery by 58,000 tons (11 percent) compared to the No Action Alternative (Figure 4.6-4).

In addition to constructing about half the amount of roads, this alternative would apply limited BMP enhancements to approximately 650 miles of new roads that may be constructed in the first 10 years of the planning period. Although sediment delivery to streams from new roads would increase, the total from new roads only would be about 5,700 tons, lower than any of the other alternatives. Also, compared to other action alternatives, this alternative would have a higher rate of sediment delivery per mile in Tier 1 watersheds because the proposed BMP enhancements are less rigorous.

This alternative commits to abandoning 3 miles of road for each mile of new road constructed, or about 1,950 miles. This commitment is part of the strategy to reduce overall road density in the Project Area. Roads would be abandoned evenly over the 30-year plan. The lack of a defined or strategic program for targeting road abandonment opportunities that provide the greatest conservation benefits or effectiveness would limit the effectiveness of the road abandonment provision. Uncertainties regarding the correlation of road density management with aquatic integrity and fish health would remain. Management to reduce road density may not be the appropriate strategy within the Project Area. Evidence of increasing redd counts in recent years in the Swan River basin could suggest that existing regulations, including road BMPs, may be adequate by reducing sediment delivery at the source, rather than by reducing overall road densities.

Conservation benefits from hot spot treatments would be similar to the proposed NFHCP. Like the proposed NFHCP, high hazard areas would be treated first, as priorities.

The total sediment delivery under this alternative related to abandoning roads in the Project Area is expected to be about 10,345 tons (Figure 4.6-11). By the end of the plan, sediment delivery would be reduced by approximately 765 tons per year annually (Figure 4.6-12).

The combined effect of upgrading old roads, constructing fewer new roads, abandoning more surplus roads, and treating hot spots would result in a reduction of 73,400 tons of sediment delivered to streams in the Project Area compared to the No Action Alternative (Table 4.6-11). Figure 4.6-8 shows the expected net reduction in sediment delivery under this alternative.

Under the Simplified Prescriptions Alternative, grazing would be eliminated or greatly reduced throughout the Project Area. Although Plum Creek land would not be leased for grazing, the open range law would mean that trespass cattle would occupy Plum Creek land. The alternative would require fenced exclosures of impacted streams where grazing would occur. These fenced areas would show overall recovery consistent with exclosure use under the proposed NFHCP (Figure 4.6-16). Total recovery would be more rapid compared to the proposed NFHCP, occurring nearly one decade earlier in the Permit period.

Cold Water (Simplified Prescriptions). Riparian harvest prescriptions would result in greater increases in canopy cover and a potentially greater reduction in water temperature under this alternative than under the NFHCP or the other alternatives. Water temperature in Project Area streams would be expected to decrease about 2°F (about 1°C) under the Simplified Prescriptions Alternative compared to expected decreases of about 1°F (about 0.5°C) under the NFHCP and other alternatives. Compared to the NFHCP, the Simplified Prescriptions Alternative contains fewer additional prescriptions (such as land use planning and legacy and restoration management) that potentially may further reduce water temperature.

Water temperatures are moderated in headwater streams by intact canopies and cool groundwater (Beschta et al. 1987; MBTSG 1998). Riparian vegetation plays an important role in supplying terrestrial food sources to small streams (Kondolf et al. 1996). As modeled, average canopy cover of riparian forests along fish-bearing streams would gradually increase from about 38 to 48 percent under the Simplified Prescriptions Alternative, a greater increase than under the other alternatives. The changes in riparian area canopy cover in Tier 1 watersheds would be similar to the changes in Tier 2 watersheds, but about four percentage points higher at the beginning and end of

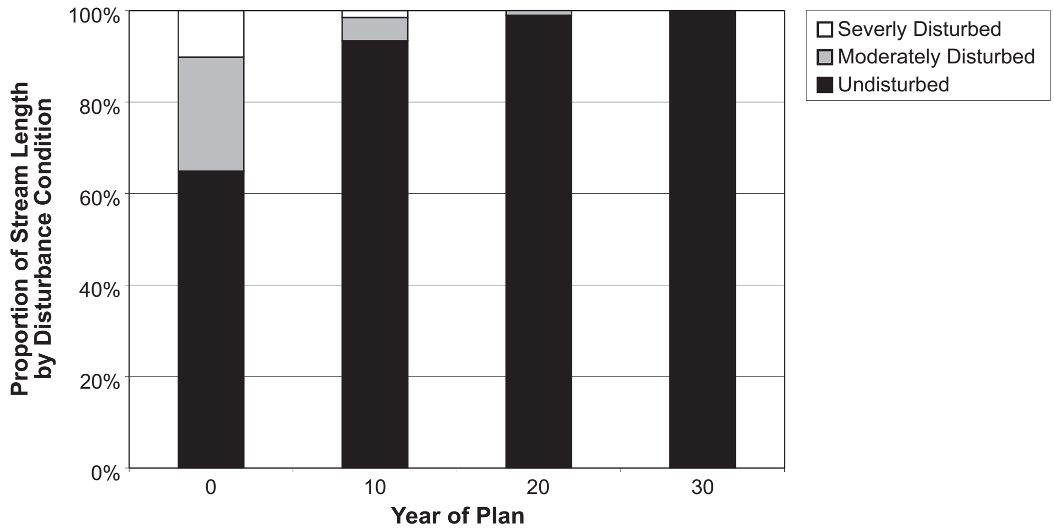


Figure 4.6-16
Proportion of Streams Affected by Three Levels of Grazing Disturbance Under the Simplified Prescriptions Alternative

the planning period (Figure 4.6-10). Canopy cover changes over non-fish-bearing streams would follow a similar pattern, and would result in the greatest amount of canopy cover among the alternatives as a result of no-cut buffers and greater tree retention.

Complex Habitat (Simplified Prescriptions). Expected increases in habitat complexity under the Simplified Prescriptions Alternative would generally be greater than those described for the NFHCP. Changes in canopy cover would be similar in Tier 1 and Tier 2 streams. Implementation of riparian harvest prescriptions under this alternative could potentially result in more LWD loading than under the NFHCP or the other alternatives. Compared to the No Action Alternative over the 30-year planning period and depending on stream size, stream type, and stand type, LWD loading under the Simplified Prescriptions Alternative could potentially increase 60 to 160 percent in fish-bearing streams and 25 to 75 percent in perennial non-fish-bearing streams over current levels. This would be significantly more LWD recruitment than the No Action Alternative of implementing state regulations throughout the Project Area. Overall, the Simplified Prescriptions Alternative could potentially provide the greatest amount of habitat complexity in fish-bearing streams of Tier 1 and 2 watersheds and in non-fish-bearing waters as a result of increased LWD.

Potentially increased habitat complexity associated with the protection of CMZs and improved bank stability under the Simplified Prescriptions Alternative would be comparable to, or slightly greater than, described for the NFHCP. Under the Simplified Prescriptions Alternative, there would be one CMZ prescription for all fish-bearing streams, a second CMZ prescription for all non-fish-bearing perennial, connected headwater streams, and a third CMZ for all disconnected perennial and intermittent headwater streams. These prescriptions would be more risk-averse than CMZ prescriptions under the NFHCP, although both sets of CMZs are expected to provide greater habitat complexity than the No Action Alternative.

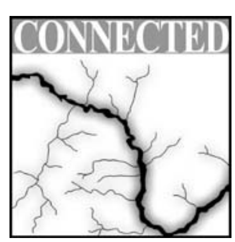
Removal of riparian vegetation can sometimes reduce future stream habitat complexity by decreasing the amount of LWD available for recruitment into the stream (MBTSG 1998). The Simplified Prescriptions Alternative would implement similar conservation measures for LWD recruitment for all watersheds, regardless of their importance to native salmonids. It provides for three different riparian area harvest prescriptions, depending on stream type:

- **Fish-bearing streams.** This alternative avoids tree harvest within CMZs and 50 feet beyond, and requires 40 to 60 retention trees per acre up to 200 feet from the CMZ. The modeled amount of LWD provided to streams under this alternative is slightly greater than under the proposed NFHCP, and somewhat greater than existing regulations. This alternative would be expected to increase LWD loading over a 30-year period by about 25 to 140 percent compared to existing regulations. The LWD benefits to streams would be greatest in western Washington because the site-potential tree height is nearly double that of the ICRB.

- **Perennial non-fish-bearing streams.** This alternative would increase LWD recruitment by about 25 to 75 percent over the 30-year period compared to the No Action Alternative.

- **Intermittent non-fish-bearing streams.** This alternative would restrict harvest within 50 feet of the stream, then apply existing regulations. Effects on LWD loading would vary because streamside harvest regulations that address intermittent streams vary, but most situations would be similar to existing regulations. For example, for Montana’s Class 2 intermittent streams, which periodically contribute substantial flows, this alternative would default to existing regulations because the riparian management prescription would provide considerably less LWD than the state forest practices BMPs. For Montana’s Class 3 streams, where existing regulations do not require retention trees, this alternative would provide somewhat greater amounts of LWD, depending on the riparian stand type. A similar effect would occur for intermittent streams in western Washington.

Canopy cover would increase more under the Simplified Prescriptions Alternative than under the NFHCP or other alternatives. Increased canopy cover can potentially increase the amount of associated habitat complexity components, such as stick jams, leaf litter, and overhead cover, especially in small streams, compared to the NFHCP and other alternatives.



Connected Habitat (Simplified Prescriptions). Improvements to habitat connectivity and benefits to native salmonids under this alternative would be greater than under the No Action Alternative but less than under the NFHCP. Several of the prescriptions described for the NFHCP that would improve fish passage would be implemented under the Simplified Prescriptions Alternative, such as road hot spot treatment of fish passage barriers throughout the Project Area. However, a number of NFHCP prescriptions would not be implemented, including the irrigation diversion management program and land use planning commitments directed at avoiding potential impacts on aquatic habitat from residential development. Some habitat connectivity threats for bull trout subpopulations are likely to continue under the Simplified Prescriptions Alternative.

Other Factors (Simplified Prescriptions). The Simplified Prescriptions Alternative contains no prescriptions specifically directed at non-native fishes or illegal fishing. However, public access would be limited to about 10 percent of Plum Creek roads (primary roads) under this alternative, which could reduce the possibility of illegal introductions of non-native fishes or illegal fishing for protected species. Non-native fishes and angler harvest threats to bull trout would be reduced compared to existing conditions but less so than under the NFHCP.

Summary of Effects (Simplified Prescriptions). Habitat components affected by the Simplified Prescriptions Alternative would be similar to those affected under the NFHCP and other alternatives, but expected improvements in habitat quality would sometimes be less and sometimes be greater than under the NFHCP. This would depend on the extent and rigor of prescriptions associated with the various conservation categories, as summarized below.

Water and substrate in Project Area streams would potentially be cleaner under the Simplified Prescriptions Alternative than at present because of reduced sediment delivery. The potential magnitude of sediment reduction would be intermediate to the NFHCP and the Internal Bull Trout Conservation Plan Alternative. Average stream temperatures under the Simplified Prescriptions Alternative are expected to be about 2°F cooler than at present, compared to about 1°F cooler under the NFHCP and other alternatives, because of increased canopy closure.

Potential improvements in habitat complexity would be greater than for the NFHCP, although the degree of improvement in the individual components of habitat complexity would vary. Under the Simplified Prescriptions Alternative, expected increases in LWD loading and canopy cover would be greater, and reductions in sediment delivery would be less than under the NFHCP. Expected improvements in habitat connectivity would be less under the Simplified Prescriptions Alternative than the NFHCP. Unlike the NFHCP, the Simplified Prescriptions Alternative would contain no commitments regarding native fish assemblages, riparian harvest deferrals, adverse effects of non-native salmonids, illegal fishing for Permit species, or directed adaptive management evaluation programs.

Effects of forest activities on other aquatic species present in Project Area streams, including non-native salmonids, would generally be the same as described for the NFHCP.

Overall, habitat conditions for native salmonids in Project Area stream are expected to improve to a greater extent than the No Action Alternative, for each of the Four C's, and to a lesser extent than under the NFHCP, because the range of management prescriptions is more generic and narrower under the Simplified Prescriptions Alternative. Anticipated improvements would occur in streams of Tier 1 watersheds and Tier 2 lands, and would result in wide-ranging benefits to bull trout subpopulations and the other Permit species.

Optional 10- and 20-Year Permit Lengths (Simplified Prescriptions). Optional Permit lengths of 10 or 20 years under the Simplified Prescriptions Alternative would provide the Permit species fewer benefits and for a shorter period of time than would a Permit length of 30 years. Reasons for this are generally the same as described for the NFHCP and the Internal Bull Trout Conservation Plan. Improved habitat conditions in the Project Area associated with the Four C's under the Simplified Prescriptions Alternative, and potential cumulative benefits to native salmonids described for a 30-year period, would not extend to as many generations of Permit species during a 10-year Permit (two generations of bull trout) or 20-year Permit (four generations). Not all commitments could be fully implemented during a 10-year Permit, and new scientific information that could be used to improve management prescriptions, if needed, would be limited or lacking at the end of 10 or 20 years. However, a shorter Permit term would reduce the Service's concerns about uncertainty associated with even longer-term commitments of up to 30 years.

Mitigation (Simplified Prescriptions). The simple, risk-averse conservation strategies of the Simplified Prescriptions Alternative provide an extra margin of safety for reducing potential effects on microclimate, hyporheic zone, mass wasting, and debris torrent events and other unspecified effects of near-stream activities. Not all of the mitigation measures are included here, because most of them were described as part of the Simplified Prescriptions Alternative.

Unavoidable Adverse Impacts (Simplified Prescriptions). Implementation of the Simplified Prescriptions Alternative and associated covered activities would not result in additional unavoidable adverse impacts on fisheries and aquatic resources in Project Area drainages, compared to existing conditions. In the Project Area east of the Cascade Crest, the effects of fire suppression, combined with a no-harvest strategy of riparian protection, could change forest structure and increase risk of large fires or disease. Some unavoidable adverse effects from timber harvest, roads, and grazing would continue under the Simplified Prescriptions Alternative, however, potential adverse effects are expected to be diminished by the prescriptions.

Cumulative Impacts (Simplified Prescriptions). The cumulative effects of timber harvest, grazing, and roads on fish habitat quality under the Simplified Prescriptions Alternative are unknown because many uncontrolled factors may influence habitat quality, and variable conditions exist across the planning area. It is anticipated that implementation of the Simplified Prescriptions Alternative would generally result in improvements in fisheries and aquatic resources in the Planning Area during the 30-year permit period. Potential improvements in fish habitat quality would be similar to, but possibly less than those anticipated under the NFHCP.