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Memorandum October 24, 2000

To: Field Supervisor, U.S. Fish and Wildlife Service, Snake River Basin Office, Boise, Idaho

Acting Regional Administrator, Northwest Region
National Marine Fisheries Service

From: Field Supervisor, U.S. Fish and Wildlife Service, Montana Field Office, Helena, Montana

Assistant Regional Administrator, National Marine Fisheries Service, Northwest Region, Habitat Conservation Division

Subject: Biological and Conference Opinions Regarding Issuance of a Section 10(a)(1)(B) Incidental Take Permit to Plum Creek Timber Company for the Proposed Native Fish Habitat Conservation Plan in the States of Washington, Idaho, and Montana

The attached document represents the U.S. Fish and Wildlife Service's and National Marine Fisheries Service's Biological/Conference Opinion concerning proposed issuance of an incidental take permit to Plum Creek Timber Company, Inc. pursuant to section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C.1531 et seq.) (Act), on the effects of issuing an incidental take permit for 17 species pursuant to section 10(a)(l)(B) of the Act, as implemented by 50CFR 17.22(b)(1) an 17.32 (b)(1), and signing an Implementation Agreement with Plum Creek Timber Company. The proposed incidental take of up to17 species would occur as a result of actions related to forest management and associated activities on Plum Creek lands in the states of Washington, Idaho, and Montana, as described in the Plum Creek Native Fish Habitat Conservation Plan, prepared by Plum Creek in support of its incidental take permit application dated December 1999 which are hereby incorporated by reference.

Through my signature, I approve the Biological/Conference Opinion on behalf of the Fish and Wildlife Service and through this transmittal I submit, the Opinion to Ms. Donna Darm for

approval, as evidenced by signature in the signature block below, on behalf of the National Marine Fisheries Service.

R. Mark Wilson

Attachment

cc: FWS, R-1, Portland
FWS, R-6, Denver
MFWP, R-1, Kalispell
NMFS, Seattle

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STATEMENT OF APPROVAL

On on behalf of the National Marine Fisheries Service (NMFS) I approved the Biological and Conference Opinions for covered species and designated critical habitat under the jurisdiction of NMFS, Regarding Issuance of an Incidental Take Permit to the Plum Creek Timber Company, Inc., Seattle, Washington.

For each of the covered species under NMFS jurisdiction I concur with the finding of no jeopardy and the finding of no adverse modification to proposed critical habitat.

Ms. Donna Darm
Acting Regional Administrator
Northwest Region
National Marine Fisheries Service

BIOLOGICAL/CONFERENCE OPINION

PLUM CREEK TIMBER COMPANY
NATIVE FISH HABITAT CONSERVATION PLAN (NFHCP)

October 23, 2000

TABLE OF CONTENTS

INTRODUCTION 2
CONSULTATION HISTORY 3
Grizzly bear 5
Background 5
Introduction 11
Consultation history 11
Biological opinion 11
Incidental take statement 17
Conservation recommendations 17
Reinitiation notice 18
BIOLOGICAL AND CONFERENCE OPINIONS 18
DESCRIPTION OF PROPOSED ACTION 18
Plum Creek Timber Company lands 19
Action area 19
Covered activities 20
Changed or unforseen circumstances 24
Components of the proposed action and plan structure 25
Environmental principles 26
Forest road and upland management 26
Riparian management 26
Range management 27
Land use planning 27
Legacy and restoration 27
Administration and implementation 28
Monitoring and adaptive management 28
The adaptive management pathway 28
"Pay-as-you-go" 30
STATUS OF THE SPECIES (Rangewide) 30
Bull trout 30
Taxonomy 31
Description 31
Historical and current distribution 32
Biological status 34
Life history characteristics 34
Habitats utilized 35
Habitat component requirements 36
Temperature 37
Sediments 38
Channel complexity/stability 38
Stream flow 39

Migratory corridors 40
Factors affecting viability 40
Habitat degradation 40
Water management activities 41
Overharvest 42
Introduced species 42
Population structure 43
Isolation and fragmentation 43
Rangewide conservation needs of the bull trout 44
Relationship of subpopulations to survival and recovery of bull trout in a DPS 44
Westslope cutthroat trout 45
Distribution and status 46
Life history characteristics 47
Habitat relationships 48
Spawning and incubation 49
Juvenile rearing 49
Adults and subadults 50
Factors affecting WCT status 51
Redband trout 54
Distribution 54
Life history characteristics 56
Habitat relationships 57
Spawning and rearing 58
Factors affecting the status of RBT 59
Mountain whitefish 60
Pygmy whitefish 61
Coastal cutthroat trout 63
Distribution 63
Life history 64
Habitat requirements 65
Status 66
Factors affecting coastal cutthroat trout 67
Coastal rainbow trout 68
Distribution and status 68
Life history characteristics 69
Factors affecting rainbow trout 69
Anadromous salmon and steelhead 69
Definitions under the Endangered Species Act 69
Critical habitat 70
Conservation 70
Threatened and endangered species 70

Summary of status reviews and species listings 71
Summary of factors affecting anadromous salmonids 71
Habitat loss 71
Overutilization 72
Disease and predation 72
Inadequate regulations 72
Other natural and manmade factors 72
Chinook salmon life history and ecology 73
ESU determinations 75
Status of chinook salmon ESUs 75
Lower Columbia River ESU 75
Middle Columbia River spring-run ESU 77
Upper Columbia River summer and fall-run ESU 78
Snake River fall-run ESU 78
Snake River spring and summer-run ESU 79
Steelhead life history and ecology 80
ESU determinations 82
Status of steelhead ESUs 82
Lower Columbia River ESU 82
Middle Columbia River ESU 84
Snake River ESU 86
Coho salmon life history and ecology 88
ESU determinations 90
Status of coho salmon ESUs 90
Lower Columbia River/SW Washington Coast ESU 90
Chum salmon life history and ecology 91
ESU determinations 93
Status of chum salmon 93
Columbia River ESU 93
ENVIRONMENTAL BASELINE 95
Baseline common to all sub-basins within the action area 96
Plum Creek lands 96
Federal land management 98
State land management/bull trout policies 100
Baseline conditions for covered species in the action area 103
Montana sub-basins 103
Upper Kootenai River sub-basin 103
Middle Kootenai River sub-basin 106
Lower Kootenai River sub-basin 108
Flathead River basin/Flathead Lake 110
Swan River sub-basin 112
Upper Clark Fork River sub-basin 114

Middle Clark Fork River sub-basin 116
Lower Clark Fork River sub-basin 117
Blackfoot River sub-basin 119
Bitterroot River sub-basin 120
Idaho sub-basins 122
Lochsa River sub-basin 122
Washington sub-basins 124
Yakima River basin 124
Ahtanum Creek sub-basin 125
Naches River sub-basin 127
Lewis River sub-basin 129
Kalama River sub-basin 132
Cowlitz River sub-basin 134
EFFECTS OF THE ACTION 136
Introduction/background 137
Habitat approach to effects analysis 138
Specific effects of forest, road, and range management activities on fish habitat under the proposed NFHCP 141
Stream temperature 142
Forest/Silvicultural management 142
Range management 150
Adaptive management 156
Sedimentation 158
Background studies on sediment from roads 158
Effects of NFHCP on sediment from roads 160
Road density 164
Existing roads 166
Abandonment of surplus roads 167
Adaptive management 168
Forest/Silvicultural management 170
Harvest deferrals 173
Native fish assemblages 174
Riparian prescriptions 175
Interface caution areas 178
Range management 179
Adaptive management 182
Legacy and restoration commitments 183
Land-use planning measures 184
Summary of NFHCP effects on sediment 185
Large woody debris 185
Forest/Silvicultural management 185
Road management 190

Range management 191
Legacy and restoration commitments 192
Adaptive management 193
Water quantity and quality 194
Forest/Silvicultural, road, and range management 194
Channel morphology 201
Riparian management 202
Range management 205
Road management 206
Forest/Silvicultural management 208
Adaptive management 210
Passage Barriers 210
Refugia 213
Timber-related and non-timber resource-related activities 215
Forest fire suppression activities 215
Gravel quarrying for roads 216
Forest nurseries and seed orchards 217
Forest product mill sites 218
Commercial outfitting 220
Recreation and other special forest uses 222
Electronic facility sites 223
Legacy/restoration/scientific surveys 224
Summary effects on westslope cutthroat trout in Montana 226
Summary effects on redband trout in Montana 229
Summary effects on anadromous fish in the Lochsa 230
Summary effects on Western Cascade species 231
CUMULATIVE EFFECTS 236
CONCLUSION 238
INCIDENTAL TAKE STATEMENT 240
Amount or extent of take 240
Listed species 240
Unlisted species 247
Effect of take 251
Reasonable and prudent measures and terms and conditions 251
Reporting requirements 252
CONSERVATION RECOMMENDATIONS 252
REINITIATION NOTICE 253
APPENDIXES 254
LITERATURE CITED 255

LIST OF FIGURES

Figure 1. Proportion of stream length affected by grazing disturbance by decade on NFHCP covered lands. 155

LIST OF TABLES

Table 1. Open motorized road density, total motorized road density, and percent core area in the Alice Creek BMU sub-unit on the Helena National Forest. 14

Table 2. Ratings of baseline environmental habitat indicators for covered species in the Upper Kootenai River sub-basin, Montana. 105

Table 3. Ratings of baseline environmental habitat indicators for covered species in the Middle Kootenai River sub-basin, Montana. 108

Table 4. Ratings of baseline environmental habitat indicators for covered species in the Lower Kootenai River sub-basin, Montana. 110

Table 5. Ratings of baseline environmental habitat indicators for covered species in the Flathead River/Flathead Lake basin, Montana. 112

Table 6. Ratings of baseline environmental habitat indicators for covered species in the Swan River sub-basin, Montana. 114

Table 7. Ratings of baseline environmental habitat indicators for covered species in the Upper Clark Fork River sub-basin, Montana. 115

Table 8. Ratings of baseline environmental habitat indicators for covered species in the Middle Clark Fork River sub-basin, Montana. 117

Table 9. Ratings of baseline environmental habitat indicators for covered species in the Lower Clark Fork River sub-basin, Montana. 118

Table 10. Ratings of baseline environmental habitat indicators for covered species in the Blackfoot River sub-basin, Montana. 120

Table 11. Ratings of baseline environmental habitat indicators for covered species in the Bitterroot River sub-basin, Montana. 122

Table 12.	Ratings of baseline environmental habitat indicators for covered species in the Lochsa River sub-basin, Idaho.	124
Table 13.	Ratings of baseline environmental habitat indicators for covered species in the Ahtanum Creek sub-basin, Washington.	126
Table 14.	Ratings of baseline environmental habitat indicators for covered species in the Naches River sub-basin, Washington.	128
Table 15.	Ratings of baseline environmental habitat indicators for covered species in the Lewis River sub-basin, above Merwin Dam, Washington.	131
Table 16.	Ratings of baseline environmental habitat indicators for covered species in the Lewis river sub-basin, below Merwin Dam, Washington.	131
Table 17.	Ratings of baseline environmental habitat indicators for covered species in the Kalama River sub-basin, Washington.	133
Table 18.	Ratings of baseline environmental habitat indicators for covered species in the Cowlitz River sub-basin, above Mayfield Dam, Washington.	136
Table 19.	Harvest prescriptions for Streamside Management Zones under the NFHCP.	144
Table 20.	Prescriptions for non-fish bearing headwater streams connected to fish-bearing streams.	146
Table 21.	Interface caution area (ICA) requirements.	147
Table 22.	Active and vacant grazing leases in Tier 1 watersheds and Tier 2 lands.	150
Table 23.	Miles of bull trout streams on Plum Creek land within active and inactive grazing leases in the NFHCP area.	151
Table 24.	Stream miles within suitable grazing lands on Plum Creek ownership in the Tier 1 watersheds and Tier 2 lands.	152
Table 25.	Environmental trend indicator for grazing BMP under the NFHCP.	154

Table 26. WCT stream miles on Plum Creek NFHCP lands in Tier 1 watersheds by abundance and genetic purity. 227

Table 27. WCT stream miles on Plum Creek NFHCP lands in Tier 2 watersheds by abundance and genetic purity. 228

Table 28. RBT occurrence on Plum Creek NFHCP lands in Montana. 229

Table 29. Percentage of land ownership in action area sub-basins. 238

INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (FWS) and National Marine Fisheries Service's (NMFS) biological/conference opinion (Opinion) concerning proposed issuance of an incidental take permit to Plum Creek Timber Company (Plum Creek) for forest management activities on Plum Creek lands in the states of Washington, Idaho, and Montana, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (Act). The permit would be issued pursuant to section 10(a)(1)(B) of the Act based on the Plum Creek Native Fish Habitat Conservation Plan (NFHCP or plan), prepared by Plum Creek in support of its incidental take permit application.

At issue are the effects of proposed permit issuance on eight Federally listed species "covered" by the permit, specifically the federally threatened bull trout (*Salvelinus confluentus*) Columbia River Distinct Population Segment (DPS), Snake River steelhead Evolutionarily Significant Unit (ESU) (*Oncorhynchus mykiss*), lower Columbia River steelhead ESU (*Oncorhynchus mykiss*), mid-Columbia River steelhead ESU (*Oncorhynchus mykiss*), Snake River spring/summer chinook salmon ESU (*Oncorhynchus tshawytscha)*, Snake River fall chinook salmon ESU (*Oncorhynchus tshawytscha)*, lower Columbia River chinook salmon ESU (*Oncorhynchus tshawytscha)*, and Columbia River chum salmon ESU (*Oncorhynchus keta)*. As defined in the NFHCP, "covered species" are species that are addressed in the plan and for which incidental take authority would be granted under the proposed section 10(a)(1)(B) permit.

In addition to these species, the permit applicant is seeking assurances of permitted future take for nine currently unlisted species, one of which is proposed for listing and one which is a candidate for listing. Each of these species would be included in the section 10(a)(1)(B) permit. The permit would become effective as to a particular species concurrently with its listing as threatened or endangered. In Plum Creek's NFHCP, these nine species are treated as if they are proposed and are treated likewise by the FWS and NMFS for purposes of this biological opinion. Therefore, the FWS and NMFS will conference on these unlisted species in this biological opinion. These species are the lower Columbia River/Southwest Washington coho salmon ESU (*Oncorhynchus kisutch)*, a Federal candidate species; coastal cutthroat trout (*Oncorhynchus clarki clarki)*, a species currently proposed for Federal listing; westslope cutthroat trout (*Oncorhynchus clarki lewisi*), a species "not warranted" for Federal listing at this time; the redband trout (*Oncorhynchus mykiss gairdneri*), a Federal species of concern; and the coastal rainbow trout (*Oncorhynchus mykiss irideus*) (Behnke 1992), mountain whitefish (*Prosopium williamsoni*), pygmy whitefish (*Prosopium coulteri*), upper Columbia River summer/fall chinook salmon ESU (*Oncorhynchus tshawytscha)*, and mid-Columbia River spring chinook salmon ESU (*Oncorhynchus tshawytscha)*, each of which currently has no Federal listing status.

In addition to the covered species listed above, this intra-Services' consultation addressed certain listed, proposed, and candidate species that are not covered by the proposed permit but that may

be affected by the timber forest management, grazing, and non-timber activities described in the NFHCP. Listed or proposed species of this type are the federally endangered gray wolf (*Canis lupis*) and marbled murrelet (*Brachyramphus marmoratus marmoratus*); the federally threatened grizzly bear (*Ursus arctos horribilis*), bald eagle (*Haliaeetus leucocephalus*), northern spotted owl (*Strix occidentalis caurina*), Ute ladies' tresses (*Spiranthes diluvialis*), Macfarlane's four o'clock (*Mirabilis macfarlanei*), and water howellia (*Howellia aquatilis*); and contiguous U.S. DPS Canada lynx (*Lynx canadensis*).

This Opinion is based primarily on the following: 1) a Draft Environmental Impact Statement and Native Fish Habitat Conservation Plan, Proposed Permit for Taking of Federally Protected Native Fish Species on Plum Creek Timber Company Lands (USDI, USDC, Plum Creek Timber Company, and CH2M Hill 1999; hereafter cited as DEIS/NFHCP [1999]); 2) Final Environmental Impact Statement (FEIS) and amended Native Fish Habitat Conservation Plan (NFHCP), Proposed Permit for Taking of Federally Protected Native Fish Species on Plum Creek Timber Company Lands (USDI, USDC, Plum Creek Timber Company, and CH2M Hill 1999; hereafter cited as FEIS [2000]); 3) 13 technical reports and four "white papers" prepared by Plum Creek and containing the detailed scientific information and rationale that supports the NFHCP (these reports are described in the DEIS/NFHCP 1999); 4) the Biological Opinion for the Effects to Bull Trout from the Continued Implementation of Land and Resource Management Plans and Resource Management Plans as Amended by the Interim Strategy for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and portions of Nevada (INFISH), and the Interim Strategy for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and portions of California (PACFISH) (FWS 1998a); and 5) other information contained in FWS and NMFS files.

CONSULTATION HISTORY

The proposed action is the result of a decision by Plum Creek to pursue a Habitat Conservation Plan, and a meeting between the Services and Plum Creek in June 1997 in which both parties agreed to work together to develop the NFHCP. Technical planning for the NFHCP commenced in August 1997. On December 12, 1997, the FWS and NMFS (Services) published a Notice of Intent to Prepare an Environmental Impact Statement in the *Federal Register*, initiating the National Environmental Policy Act (NEPA) process. At approximately the same time, Plum Creek and the Services decided to develop a combined DEIS and NFHCP, which would satisfy NEPA and Act requirements in a single document. Six scoping meetings in which the public was invited to help determine the scope of the DEIS/NFHCP were held in January 1998; the scoping report was published in August 1998. In September 1998, Plum Creek submitted to the Services a draft report outlining its initial NFHCP conservation proposals. By May 1999, a first internal draft of the NFHCP was mostly completed, and a final draft NFHCP was released for public review and comment on December 15, 1999. The public comment period for the NFHCP ended on March 17, 2000.

The intra-Services' section 7 consultation/conference for issuance of a section 10(a)(1)(B) permit was initiated on February 16, 2000, by memorandum sent from the Chief, Division of Consultation and Planning, Portland, Oregon (Region 1) to the Supervisor, Helena Fish and Wildlife Office, Helena, Montana (Region 6). This memorandum, received in the Montana Field Office on February 28, 2000, requested initiation of formal consultation on the proposed action on issuance of the section 10(a)(1)(B) permit to Plum Creek. Prior to this request informal consultation was underway regarding threatened and endangered species not covered in the permit and that may occur in the vicinity of the proposed action.

Informal consultation was completed with concurrence of the "may affect, not likely to adversely affect" determination for listed non-permit species that may be affected by implementation of the NFHCP. Incidental take coverage of these species was not requested by Plum Creek under this NFHCP and will not be authorized under the section 10(a)(1)(B) permit. Impacts on these species will continue to be considered in accordance with existing laws and regulations. Because these species are not covered under the permit it is illegal to "take" them without authorization. Plum Creek indicated that if any of these species should be found on Plum Creek lands, they would implement appropriate measures to avoid the potential risk of take (DEIS/NFHCP 1999). These species are the endangered gray wolf and threatened bald eagle, Canada lynx, water howellia, Ute ladies' tresses, Macfarlane's four o'clock, marbled murrelet, and northern spotted owl. The Montana Field Office in Region 6, Helena, Montana concurred with the FWS's Chief, Division of Consultation and Planning, Portland, Oregon (Region 1) "may affect, not likely to adversely affect" determination. Potential negative impacts from implementation of the forest management, grazing and non-timber activities and minimization and mitigation commitments associated with the NFHCP are expected to be negligible or discountable.

The FWS Chief, Division of Consultation and Planning, Portland, Oregon (Region 1) determined that the action of issuing the proposed permit for the NFHCP "may affect, likely to adversely affect" the Federally threatened grizzly bear (*Ursus arctos horribilus*). The Montana Field Office in Region 6, Helena, Montana concurred with this finding. This species is addressed below under the section "Grizzly Bear."

The FWS Chief, Division of Consultation and Planning, Portland, Oregon (Region 1) concluded that the action of issuing the proposed permit for the NFHCP would have "no effect" on other threatened and endangered species, including plant species, that may occur on or in the vicinity of the action area (i.e., planning area sub-basins where Plum Creek lands are covered under the NFHCP). This list of species is in Appendix C of the DEIS/NFHCP (1999). Consultation is not required for these species and therefore will not be addressed further in the biological and conference opinion.

Grizzly Bear

This section of the intra-Services Opinion addresses effects to grizzly bears (a non-covered species) of issuing a section 10(a)(1)(B) permit to Plum Creek that authorizes incidental take of Federally listed native fish species from implementation of the NFHCP, prepared by Plum Creek in support of its incidental take permit application. This Opinion is comprehensive in scope regarding the analysis of 17 covered species, whereas the grizzly bear evaluation is a relatively small, although very important, part of this overall Opinion. To clarify for the reader and facilitate presentation of the grizzly bear material in this Opinion, the grizzly bear portion will be conferred entirely in the following section below, and where appropriate, conform to the standard FWS's Opinion format and section 7 analysis described in the Endangered Species Consultation Handbook (FWS and NMFS 1998).

Background

The NFHCP covers 1.6 million acres of Plum Creek lands, from Washington east to the crest of the Rocky Mountains in Montana. It encompasses portions of two of the five grizzly bear ecosystems in the United States, the Cabinet-Yaak Ecosystem (CYE) in northwest Montana and the Northern Continental Divide Ecosystem (NCDE) that in northcentral Montana. The other grizzly bear ecosystems, Northern Cascades in northcentral Washington, the Selkirk Ecosystem in northeastern Idaho, and the Yellowstone Ecosystem in southwestern Montana, northwestern Wyoming and southeastern Idaho are not affected by the NFHCP. A proposal to reintroduce grizzly bears to the Bitterroot Ecosystem in southwest Montana is currently being evaluated (FWS 2000a).

Plum Creek has lands covered by the NFHCP that are within grizzly habitat in the CYE and NCDE. In general, Plum Creek lands within these ecosystems occur in either large parcels or large blocks or small, scattered parcels in areas where road management under the NFHCP may be a concern. Road management may be impacting bears in some of these areas that have high road densities (see grizzly bear effects section below).

Impacts to grizzly bears are analyzed within area units called Bear Management Units (BMUs), or in subunits of a BMU, which are used for habitat evaluation and population monitoring (FWS 1993). In some areas, Plum Creek lands are scattered parcels and constitute a small portion of a BMU. Other Plum Creek lands occur in larger parcels or large blocks. Plum Creek access management likely has more impacts on grizzly bears where Plum Creek lands occur in large blocks.

The Swan Valley Agreement (Agreement) signed in 1995 by Plum Creek, Montana Department of State Lands, U.S. Forest Service (USFS), and the FWS addressed the conservation of grizzly bears in the Swan Valley in western Montana. Of the 369,299 acres of land included under the

Agreement, 82,718 acres are managed by Plum Creek. The primary issue addressed in the Agreement were the impacts of roads and road access on grizzly bears. Within each BMU the density of open roads shall be managed so that no more than 33 percent of any given BMU subunit exceeds one mile per square mile, with the long-term goal that no more than 21 percent of BMU subunit exceed and open road density of one mile per square mile. Cover in riparian areas would be managed as uneven-aged forest stands and not even-aged cutting units. In addition, provisions in the Agreement required that no more than four of the eleven BMU subunits have active timber harvesting during any 3-year period (except in winter when bears are hibernating). As a result, timber harvest activity in each BMU subunit would be followed by at least 3 to 6 years of inactivity.

Under the NFHCP, management of Plum Creek lands in the Swan Valley related to grizzly bear conservation will not change, pursuant to the Agreement. Substantial benefits to native fish covered species in the area, primarily bull trout and westslope cutthroat trout, will occur because of the restrictions on roads and road access for grizzly bears. Lower erosion rates are likely to occur as a result of less traffic due to the lower density of open roads, which in turn will reduce the potential for sediment delivery to streams. Furthermore, the extended periods of inactivity for BMU subunits that are rested for 6 years will also provide water quality benefits in that roads that would have normally been active will be allowed to revegetate thus reducing the potential of elevated sediment delivery to streams. Riparian zones, to include wetlands, potholes, and streamside areas cannot be harvested to the extent allowed under the State's Streamside Management Zones (SMZ) rules, which in effect result in wider buffer areas and increased shading, sediment filtration, bank stability, and large woody debris recruitment.

In the Swan Valley in western Montana, the Agreement will continue to provide adequate protection for grizzly bears (FWS 1995a). Plum Creek will be expected to continue to comply with the terms of the Agreement under the NFHCP. Consequently, grizzly bears on these Plum Creek lands within the NFHCP covered lands are not expected to be impacted by the NFHCP provisions.

This section of the Opinion assesses the potential impacts to grizzly bears from implementation of the NFHCP within 2 BMUs and 3 BMU subunits where Plum Creek has larger blocks of NFHCP covered lands and are outside the boundaries of the Agreement. In 2 BMUs in the CYE, the NFHCP will have minimal impacts, if any; in two BMUs subunits in the NCDE, Plum Creek lands are not covered under the NFHCP until Plum Creek amends the NFHCP to include them; and in one BMU subunit in the NCDE there is a likelihood of some adverse impact.

Status, Distribution, and Life History

The grizzly bear was classified as threatened under provisions of the Act on July 28, 1975 (40 FR 31736). The FWS identified the following as factors establishing the need to list: 1) present or

threatened destruction, modification, or curtailment of habitat or range; 2) overutilization for commercial, sporting, scientific, or educational purposes; and 3) other manmade factors affecting its continued existence.

The Grizzly Bear Recovery Plan (hereafter referred as the Recovery Plan) details recovery objectives for each of the grizzly bear recovery zones in the ecosystems where grizzly bear populations persist, the Yellowstone, NCDE, CYE, and Selkirk ecosystems. The estimated total population of grizzly bears in the conterminous United States is 800 to 1,000 individuals (FWS 1993).

In the NCDE, results from monitoring grizzly bears during 1987 through 1996 indicate the Recovery Plan criteria for several population recovery parameters were met, including: 1) numbers of females with cubs, 2) numbers of BMUs with family groups, 3) occupancy requirements for BMUs, and 4) total human-caused grizzly bear mortality. However, female grizzly bear mortality exceeded recovery criteria limits through 1993, and again during 1997-1999.

Neither the CYE nor the Selkirk Ecosystem grizzly bear populations have ever attained the Recovery Plan criteria for females with cubs. In 1999, the 6-year average number of female with cubs in the CYE was 1, compared to the recovery goal of 6 females with cubs over a 6-year period. The recovery goal of 18 of 22 BMUs with sightings of females with young (calculated as a sum of observations over a 6-year period) compared to an actual 12 of 22 BMUs with sightings of females with young from 1994-1999. Recovery Plan criteria for known, but human-caused mortality in the CYE is no more than 0.72 bears.

The actual human-caused mortality of 0.5 met the recovery goal. The female human-caused mortality criteria is 0.22 bears compared to an actual 0.17 bears averaged over the 6 years. Therefore, Recovery Plan human-caused mortality limits were not exceeded in the CYE. However, the mortality goal for the CYE is zero due to low population size and precarious status of this population. The actual mortality exceeded that goal.

The Selkirk Ecosystem Recovery Plan criteria include at least 6 females with cubs (over a 6-year average), however in 1999 the 6-year average was 0. The Recovery Plan human-caused mortality limit for the ecosystem is no more than 0.4 bears, but the 6-year average was 1.33 bears. Further, the human-caused female mortality limit is 0.12 bears averaged over 6 years, but in 1999 the average over the past 6 years was 0.17. The Recovery Plan calls for 7 of 10 BMUs be occupied by females with young over a 6-year period, but from 1994 and 1999 the number of occupied BMUs was 4. The Recovery Plan population criteria for the Selkirk Ecosystem has not been attained.

In addition to Recovery Plan monitoring, grizzly bear population trend analyses were conducted in the early 1990s for the Selkirks Ecosystem, CYE, and the NCDE (Servheen et al. 1994). However, data were insufficient to determine population trends in the CYE and the NCDE. A declining trend was suggested for the Selkirks Ecosystem (Servheen et al. 1994). New computer modeling techniques indicated a slight increase in lambda using data for the CYE and Selkirks (FWS, 64 FR 26725-26733), but wide confidence intervals suggested the population trends should be cautiously evaluated. The FWS determined that the combined Selkirk-CYE grizzly bear recovery zones were warranted endangered but precluded in 1999 and suggested that the two populations might be inter-connected. (FWS, 64 FR 26725-26733).

Grizzly bear recovery efforts in the Bitterroots Ecosystem and North Cascades Ecosystem are in the planning stages. In the North Cascades Ecosystem, most of the grizzly bear population occurs north of the Canada - U.S. border, but a few grizzlies persist south of the border. Grizzly bears were eliminated from the Bitterroot Ecosystem decades ago, however suitable habitat occurs. A draft Environmental Impact Statement has been released for public comment to address the impacts of reintroducing grizzly bears into the Bitterroot Ecosystem in east central Idaho (FWS 2000a).

Grizzlies are large, averaging 400-600 lbs for males, and 250-350 lbs for females. Grizzly bears are long-lived (up to 20-30 years in the wild) omnivorous, opportunistic feeders that require foods rich in protein or carbohydrates in excess of maintenance requirements in order to survive seasonal pre-and post-denning requirements. Bears are homeo-hypothermic hibernators, meaning their body temperature drops no more than 5 °C (approx. 10 °F) during winter when deep snow, low food availability, and low ambient air temperatures appear to make winter sleep essential to bears' survival (Craighead and Craighead 1972a, 1972b). They excavate dens and need secure environments well-covered with a blanket of snow for up to 5 months, generally beginning in fall (September-November) and extending until spring (March-April) (Craighead and Craighead 1972b; Pearson 1975).

Their search for energy-rich food appears to be a driving force in their behavior, habitat selection and intra/inter-specific interactions. Grizzlies historically used a wide variety of habitats across North America, from open to forested, temperate through alpine and arctic habitats, once occurring as far south as Mexico. They are highly dependent upon learned food locations within their home ranges. Adequate nutritional quality and quantity are important factors for successful reproduction. Diverse structural stages that support wide varieties of nourishing plants and animals are necessary for meeting the high energy demands of these large animals. They follow phenological vegetative, tuber or fruit development, will seek out concentrated food sources including carrion, live prey (fish, mammals, insects), and are easily attracted to human food sources including gardens, grain, compost, bird seed, livestock, hunter gut piles, bait, and garbage. Bears that lose their natural fear and avoidance of humans, usually as a result of food

rewards, become habituated, and may become food-conditioned, both behaviors that increase chances of human-caused mortality as a result of real or perceived defense of property or life actions.

Adult bears are individualistic and normally solitary, except females with cubs, or during short breeding relationships. They will tolerate other bears at closer distances when food sources are concentrated, and siblings may associate for several years following weaning (Murie 1944, 1962; Jonkel and Cowan 1971; Craighead 1976; Egbert and Stokes 1976; Glenn et al. 1976; Herrero 1978). Grizzlies may have one of the lowest reproductive rates among terrestrial mammals, resulting primarily from the late age at first reproduction, small average litter size, and the long interval between litters. Mating occurs from late May through mid-July. Females in estrus will accept more than one adult male (Hornocker 1962), and can produce cubs from different fathers the same year (Craighead et al. 1995). Age of first reproduction and litter size may be nutritionally related (Herrero 1978; Russell et al. 1978). Average age at first reproduction in the lower 48 states for females is 5.5 years, and litter size ranges from 1 to 4 cubs who stay with the mother up to 2 years. Males may reach physiological reproductive age at 4.5, but may not be behaviorally reproductive due to other dominant males preventing mating.

Natural mortality is known to occur from intra-specific predation, but the degree this occurs in natural populations is not known. Parasites and disease do not appear to be a significant cause of natural mortality (Jonkel and Cowan 1971; Kistchinksii 1972; Mundy and Flook 1973; Rogers and Rogers 1976). As animals highly dependent upon learned habitat, displacement into unknown territory such as subadult dispersal may lead to submarginal nutrition, reduced or curtailed reproduction or greater exposure to adult predatory bears or human food sources which can lead to human-caused mortality. Starvation and loss in dens during food shortages have been surmised, but have not been documented as a major mortality factor. Natural mortality in rare, relatively secretive animals such as grizzlies can be extremely difficult to document or quantify.

Human-caused mortality has been slightly better quantified, but recent models speculate that reported mortality may be up to 50 percent of actual mortality (McLellan et al. 1999). Between 1800 and 1975, grizzly populations in the lower 48 states have declined drastically. Fur trapping, mining, ranching, and farming pushed westward, altering habitat and directly killing bears. Bears historically were targeted in predator control programs in the 1930s. Predator control was probably responsible for extirpation in many states that no longer support grizzlies. More recent human-caused mortality in Montana includes legal hunting up to 1991, management control actions, defense of life, defense of property, mistaken identity by black bear or other big game hunters, poaching, and malicious killing.

Grizzly bears normally avoid people, possibly as a result of many generations of bear sport hunting and human-caused mortality. Displacement away from human activities has been

documented to reduce fitness of bears affecting survival in some instances. Avoidance of roads can lead bears to either avoid essential habitat along roads, or could put them at greater risk of exposure to human-caused mortality if they do not avoid roads.

NFHCP Covered Lands Within Grizzly Bear Management Units or Subunits

CY-9 and Mt. Hedley BMUs in the CYE: Two BMUs occur in the CYE, CY-9 (also referred to by Plum Creek as Ruby Creek) in the Kootenai National Forest and Mt. Hedley in the Lolo National Forest. Plum Creek lands constitute 9.3 percent of CY9 and 8.7 percent of Mt. Hedley (pers. comm,. John Woods, Plum Creek Timber Company, 2000). Considering only the large block of Plum Creek land in CY9, none of this property occurs in a Tier 1 watershed (known as primary bull trout spawning and rearing areas). Further, less than 2 percent occurs in Tier 1 in the Mt Hedley unit and these lands are scattered parcels. The remaining portion of each BMU is predominantly USFS land, managed under the Forest Plan grizzly bear standards and guides and subject to section 7 regulations.

Plum Creek lands in the two CYE BMUs that do occur in Tier 1 watersheds do not occur in large blocks, but rather occurs in scattered sections and partial sections. Access resulting from dispersed ownership would have a lower impact on bears than blocked ownership for the following reasons. Interspersed USFS lands adjacent to Plum Creek lands are managed for bear habitat following Forest Plan grizzly bear standards and guidelines (USFS 1987, 1982). Under the standards and guidelines security habitat for bears is generally greater than the voluntary measures provided on private lands. Many dispersed Plum Creek lands must be accessed by crossing USFS lands. Private actions that require authorization from a Federal agency, such as use of Federal roads would require section 7 consultation under the Act, which generally leads to greater protection for listed species than would result from actions not requiring consultation. For private lands that do not require Federal access, the amount of land affected by roads would be a small percentage of the entire BMU. Adjacent areas would have Federal protection, providing some protection for a bear using that BMU. Plum Creek lands within grizzly habitat would be managed under the Plum Creek grizzly bear best management practices and would receive greater habitat protection in riparian areas under the NFHCP.

Plum Creek lands within these areas would be managed by Plum Creek using their grizzly bear best management practices. Of primary importance is maintaining open road densities to 1 mile/mile^2 or less. Seasonal avoidance of sensitive bear habitats (den sites or documented spring habitat, avalanche chutes and slab rock formations) can prevent displacing bears from these important habitats and reduce adverse impacts. Plum Creek also maintains high cover percentages on their lands as an attempt to improve habitat security for bears, and strictly enforces public road closures. The restriction of public use of roads reduces the chance of adverse interactions between bears and humans. Plum Creek would manage these lands on case by case basis to avoid risk of take of grizzlies.

Lazy Creek and Mission Range BMU Subunits in the NCDE: Plum Creek has project lands inside the NCDE but outside of the Swan Valley Agreement that occur in grizzly bear habitat in Tier 1 watersheds where road management may be impacting bears. Some of these lands are small, scattered parcels where impacts from roads would be discountable, but some are larger blocks of lands.

The FWS identified and assessed two BMU subunits, Lazy Creek and Mission Range in the NCDE, where Plum Creek ownership was significant within the BMU subunit and these blocks of lands occur in Tier 1 watersheds. The assessment indicated that road densities may have adverse effects to grizzly bears. However, although these lands were analyzed in the NFHCP, they are not included as "covered lands" (all NFHCP lands that would be covered by the incidental take permit) and therefore not part of the NFHCP permit area and not analyzed in this Opinion. Plum Creek has informally agreed to add these lands at a later time through an amendment to the NFHCP, in which case the effects to bears from the covered activity of road management would be analyzed.

Alice Creek BMU Subunit in the NCDE: The following discussion in this Opinion addresses the effects on grizzly bears within the Alice Creek BMU subunit from issuing a section 10(a)(1)(B) permit to Plum Creek that authorizes incidental take of Federally listed native fish species from implementation of the NFHCP. Formal consultation on the grizzly bear in the Alice Creek BMU subunit is presented here in its entirety to facilitate analysis and review.

Introduction

During the course of evaluating the effects to Federally listed species not covered under the NFHCP, the FWS determined that implementation of the NFHCP may impact the grizzly bear on lands owned by Plum Creek and covered under the NFHCP within the Alice Creek BMU subunit.

Consultation History

Refer to the above section on "Consultation History".

Biological Opinion

This part of the Opinion on the effects to grizzly bears in the Alice Creek BMU subunit is based on information in the NFHCP, Draft Environmental Impact Statement (USDI, USDC, Plum Creek Timber Company, and CH2M Hill 1999), and Final Environmental Impact Statement (USDI, USDC, Plum Creek Timber Company, and CH2M Hill 2000) for the proposed action of issuing the 10(a)(1)(B) permit to Plum Creek. It is also based on information and data collected during informal consultation. The FWS received data and information from the USFS and Plum Creek on various occasions through telephone calls and email exchanges. In addition, grizzly bear

literature and FWS biological opinions were used in this evaluation. A complete administrative record of this consultation on grizzly bears is on file at the FWS's Montana Field Office.

Proposed Action

The FWS and NMFS propose to issue section 10(a)(1)(B) incidental take permits to Plum Creek for forest management activities on Plum Creek lands in the states of Washington, Idaho, and Montana. Issuance of the permit would be based on the NFHCP prepared by Plum Creek in support of its permit application. Duration of the proposed permit is 30 years. See the section below under "Description of the Proposed Action. The Alice Creek BMU subunit (Alice Creek) is the action area for this analysis.

Environmental Baseline and Status of the Grizzly Bear (action area)

(See above discussion on Status, Distribution, and Life History for Rangewide Status)

Alice Creek is a BMU subunit within the Helena National Forest and in a Tier 1 watershed under the Plum Creek NFHCP. The Helena National Forest manages this area primarily for cattle grazing and recreation (pers. comm., Sadie Campbell, Helena National Forest, 2000). Alice Creek is rated as a Management Situation II BMU subunit (IGBC 1986). Management Situations (MS) were delineated by the USFS to prioritize grizzly management on Federal lands. MS I lands are those areas that contain grizzly populations centers and/or habitat that is needed for the survival and recovery of the species. Land uses that can affect grizzly bears and/or their habitat will be made compatible with grizzly needs, or such uses will be disallowed or eliminated. MS II lands do not contain grizzly population centers, but grizzlies occur. Management accommodates grizzly populations and/or habitat where feasible, but not to the extent of exclusion of other land uses (FWS 1993).

Alice Creek is the southeastern-most BMU subunit in the NCDE. The 70,200 acre subunit is 70.5 percent USFS Lands, which occur in the northern two-thirds of the subunit. Bordered on the southern boundary by Highway 200, approximately 9 miles east of Lincoln, elevations in Alice Creek range from 5,000 feet in the south to over 8,000 feet in the northwest. About 18,272 acres (26 percent) of the subunit is classified as Scapegoat Wilderness Area, which occurs entirely on USFS lands. The southern third of the subunit is intermingled state and private parcels comprising 3.5 percent and 16.2 percent, respectively. Plum Creek lands are blocked in the southeastern end of the subunit and constitute 9.7 percent by area of the subunit. The Plum Creek lands in Alice Creek are bordered on the south and west by private land, on the north by USFS lands, and on the east by intermingled private and USFS lands.

The higher elevation USFS lands in the northern two-thirds of the subunit have a wider diversity of grizzly bear habitat, predominantly moist montane timber types interspersed with alpine tundra,

avalanche chutes, and relatively broad riparian flood plains along the lower elevation stream segments of upper Dearborn River, upper Alice Creek, upper Copper Creek and the East Fork of the North Fork Blackfoot River. High and moderate elevation wet meadows also occur.

The southern portions of the subunit are mixed private, state and Plum Creek ownership and support dryer sage-brush/fescue meadows interspersed with early seral lodgepole pine stands, occasional aspen groves in moister depressions, and a few narrow riparian bands along the lower reaches of Alice Creek and Bartlett Creek. These dryer habitat types are generally less productive, in terms of grizzly bear vegetative food, than the mesic forest and riparian types that are more common on USFS lands in the north, but can be seasonally important during early green-up.

The entire lower valley, including private and Plum Creek lands provides good usable and occupied spring habitat (pers. comm., Micheal Herrin, Helena National Forest, 2000). Plum Creek lands form an elevational and habitat type transition between the low elevation dry meadow complexes on private lands and the moist montane communities on USFS lands. As such, they are adjacent to ranch lands which are attractive to bears in the spring and can lead to potential problems related to depredation on livestock. Plum Creek manages two cow-calf allotments (total of 182 animal unit months) from June through September 30 in Alice Creek. Bears are also attracted to winter-killed elk and deer in the winter range areas of the BMU in the spring. Plum Creek estimates that at least 60 percent of their ownership block within Alice Creek qualifies as hiding cover, assuming a sight distance less than 200 feet (pers. comm., Greg Watson, Plum Creek Timber Company, 2000).

Using the slope and elevation means that Mace and Waller (1997a) found in the Swan Valley as a guide, no denning habitat occurs in the Plum Creek portion of Alice Creek. Plum Creek lands are generally lower in elevation and have gentler slopes than typical denning habitat. The greatest slopes on higher elevation Plum Creek lands in Alice Creek were 48 percent, as compared with the range of 58-63 percent in denning episodes (n=78 episodes, n=30 bears) documented by Mace and Waller (1997a). Most of the Plum Creek ownership is near 5,000 feet as compared with the >6,000 foot average denning elevation documented in Swan Mountains (1942-2005 meters). Plum Creek generally defines mesic or riparian habitats 5,200 feet and below as spring habitat. The Plum Creek lands within Alice Creek rather provide a transition zone between the low elevation habitat primarily on private land and the higher elevation more mesic habitats on USFS to the north.

Habitat security for grizzly bears has been defined as the area greater than 0.3 miles from open roads and high-use trails. In addition to roads, Alice Creek may have two trails (#438 and 477) along the edge of the BMU subunit that qualify as high use (pers. comm., Kathy Ake, Flathead National Forest, 2000).

Habitat quality for grizzly bears varies in different portions of Alice Creek. Further, roads are not evenly distributed across the subunit. Non-Plum Creek private road densities are greatest, Plum Creek road densities are intermediate, and the USFS has the lowest road densities.

GIS Moving Windows analysis conducted by Plum Creek incorporated information from the Helena National Forest, which was the best available information at that time. The results of the analysis are shown below in Table 1. The road layer from the Helena National Forest lacked attributes, and road closure information was incorporated using the best available information (pers. comm., John Woods, Plum Creek Timber Company, 2000).

Table 1. Open motorized road density (OMRD), total motorized road density (TMRD), and percent core area in the Alice Creek BMU sub-unit on the Helena National Forest.

Road Density	Description	Percent
OMRD	Percent of the subunit having open roads greater than one mile per square mile as calculated by GIS moving windows	40.8%
TMRD	Percent of the subunit having total roads greater than two miles per square mile as calculated by GIS moving windows	37.9%
Core Area (habitat security)	Percent of secure habitat after open roads and high use trails are deleted	54%

Plum Creek linear road densities within Alice Creek were also calculated as a baseline measure, since the grizzly bear best management practices use a linear road density standard of less than one mile per square mile in grizzly habitat. The linear baseline measures revealed the following: 1) total linear open road density in the entire subunit equaled 1.66 miles per square mile, and 2) total linear open road density on Plum Creek lands within the subunit measured 2.53 miles per square mile. (Alice Creek is currently not managed under the Plum Creek best management practices since it is classified by the USFS as MS II habitat). Although linear open roads cannot be meaningfully compared to the calculations of open roads calculated by moving windows analysis, linear road density does provide an inferential baseline assessment.

Effects of the Action

The effects of roads on bears have been well documented in research reviewed in the Grizzly Bear Compendium (IGBC 1987) and the Swan Valley Agreement biological opinion (FWS 1995b). Details of all the research will not be repeated here, but important recent research that more

rigorously addressed road effects on bears will be noted. The general impacts of roads on bears can be summarized in the following general effects:

1. avoidance/displacement of grizzly bears away from roads and road activity;
2. changes in grizzly bear behavior, especially habituation, due to ongoing contact with roads and human activities conducted along roads;
3. habitat loss, modification and fragmentation due to roads and road construction, including vegetative and topographic disturbances; and
4. direct mortality from road kills, legal and illegal harvest, and other factors resulting from increased human-bear encounters.

Mace and Manley (1993) suggested that grizzly bears can persist in areas with roads, but spatial avoidance will increase and survival will decrease as traffic levels, road densities and human settlement increases. Grizzly bears used habitat that had more than one mile of open road per square mile (as calculated by moving windows) less than expected and also used habitat having total road densities over 2 miles per square mile less than expected–even if those roads were closed. Females selected home ranges with more large portions of unroaded habitat. More rigorous analysis followed in Mace et al. (1996), Mace and Waller (1997b), and Mace et al. (1999). These reports confirmed that displacement effects of roads on grizzly bears increased as levels of motorized use of roads and/or road densities increased.

Alice Creek has high OMRD and TMRD, and core is low as compared to the NCDE access recommendation of OMRD of greater than 1 mile per square mile in no more than 19 percent of a subunit. TMRD of greater than 2 miles per square mile in no more than 19 percent of a subunit, and a core of 68 percent (FWS 1995a).

Alice Creek is a large subunit of 70,174 acres, of which the USFS administers 70.9 percent or 49,258 acres. Wilderness encompasses 26 percent of the USFS lands within the subunit. Plum Creek owns 9.7 percent of this subunit in the southern most portion of the subunit. Plum Creek lands typically encompass lower quality bear habitat than the more mesic habitat on the USFS ownership, although it does provide important spring habitat.

The grizzly bear best management practices, if implemented on Plum Creek lands in the future, would be advantageous by reducing open road densities, maintaining some habitat protection through irregular edges of selective tree cuts. By planning roads to avoid openings and sensitive habitats, road disturbance in these areas would be reduced.

Once the NFHCP is amended and grizzly bear best management practices are incorporated into Alice Creek, open road densities would be reduced and habitat improvements would occur. Timing operations in sensitive bear habitats is also an important grizzly best management practice that would reduce the impacts of roads on bears, particularly in spring habitat.

Prior to the grizzly bear amendment to the NFHCP, implementation of the NFHCP would have some important benefits to bears, although it does not directly address grizzly bears. Riparian areas are important to bears particularly in spring if they are free from snow, and can also provide important berry habitat in the fall. The NFHCP would close roads in many riparian areas, reducing the potential for displacement of grizzly bears from essential habitat. Riparian protective measures would also improve habitat for grizzly bears throughout the season and could help provide some connections between habitats that provide some cover. This would be a considerable improvement in grizzly bear habitat over the existing situation.

However, current impacts to grizzly bears due to the high OMRD and TMRD in the subunit cannot be discounted. Any new road construction on Plum Creek lands may increase the risk of additional adverse affects to grizzly bears by disturbing essential behavior attributes. However, the Service does not anticipate that such road construction would constitute "take" of grizzly bears as a result of the implementation of this NFHCP. Grizzly bears using the BMU subunit and surrounding habitat have options for obtaining necessary life requisites. The proportion of Plum Creek ownership in the subunit is relatively small and habitat quality for bears varies. Large areas of good quality grizzly bear habitat exist to the north on the 70 percent of the BMU subunit under Forest Service management. Finally, management of habitat will improve to some extent as a result of implementing NFHCP objectives, as described earlier.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in Alice Creek. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. (50 CAR 402.14 (b)(3) and (4).

Potential future private timber harvest activities, private land development or new roads and trails could be anticipated in Alice Creek. Future recreational impacts in the subunit are also likely. It is expected there could be an increase in human use of the trail to Alice Creek/Lewis and Clark Pass by travelers involved in the Lewis and Clark 200-year celebration coming up in 2006 or 2007 (pers. comm., Micheal Herrin, USFS, 2000). Good quality adjacent habitat is present if bears are displaced by such activities however, and the trail may be closed by the USFS if there are conflicts between grizzly bears and humans. The FWS considers residential or business developments in Alice Creek a concern for grizzly bears, due to the potential for habituation and food-conditioning of grizzly bears. Although its unknown, should future expansion of livestock grazing in the subunit occur, it may impact the grizzly bear due to potential depredation problems resulting in management control actions.

Conclusion

After reviewing the current status of the grizzly bear in Alice Creek, the environmental baseline, the effects of the NFHCP and related actions, and the cumulative effects of future non-federal actions, the FWS believes that implementation of the NFHCP, as proposed by Plum Creek, would result in adverse impacts to grizzly bears in Alice Creek, but not to the extent of take, and therefore is not likely to jeopardize the continued existence of the grizzly bear. No critical habitat has been designated for grizzly bears, so no adverse modification of critical habitat would occur.

Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap capture or collect, or to attempt to engage in any such conduct. Harm is further defined by Federal regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

Amount or Extent of Anticipated Take

The FWS believes that implementation of the NFHCP would result in adverse impacts to grizzly bears in Alice Creek, but not to the extent of take. No critical habitat has been designated for grizzly bears, so no adverse modification of critical habitat would occur.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The FWS advises the following conservation measures be implemented:

1) The FWS discuss with Plum Creek implementation of their grizzly bear best management practices on their ownership in Alice Creek.

2) The FWS and Plum Creek work together on amending the NFHCP to include grizzly bears, or alternatively discuss other options to address grizzly bears.

Reinitiation Notice

This concludes formal consultation on proposed issuance of a section 10(a)(1)(B) incidental take permit to Plum Creek. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

BIOLOGICAL AND CONFERENCE OPINIONS

DESCRIPTION OF THE PROPOSED ACTION

The U.S. Fish and Wildlife Service and National Marine Fisheries Service (herein referred to as the "Services" unless otherwise noted) propose to issue section 10(a)(1)(B) incidental take permits to Plum Creek for forest management activities on Plum Creek lands in the states of Washington, Idaho, and Montana. Issuance of the permit would be based on the Plum Creek Native Fish Habitat Conservation Plan (NFHCP), as amended and documented in the FEIS (2000), prepared by Plum Creek in support of its permit application. Duration of the proposed permit is 30 years. The original NFHCP actually appears as a component in a combined DEIS/NFHCP (USDI, USDC, Plum Creek, and CH2M Hill 1999); however, for convenience the NFHCP portion of this combined document will be referred to separately when referencing only Plum Creek's conservation plan, whereas, other portions of the combined document will be referenced as DEIS/NFHCP 1999. In this Opinion, the NFHCP refers to the NFHCP in the DEIS as amended as shown in the FEIS (2000).

The FWS and NMFS also propose to provide long-term regulatory assurances to Plum Creek under the "No Surprises" rule codified at 50 CFR §§17.3, 17.22(b)(5) and (6), and 17.32(b)(5) and (6) (Service), and 50 CFR §§222.3 and 222.22 (NMFS). On February 23, 1998, the Services jointly published a final rule for the No Surprises Policy for Habitat Conservation Plans (HCPs) (Fed. Reg. Vol. 63, No. 35, Pp. 8859-8873). Under the final rule, the Services will only provide assurances to applicants for the species that are adequately covered in the NFHCP and specifically

identified on the permit. Therefore, all the covered species are addressed in this Opinion as if they are either listed or proposed, including currently unlisted species. This Opinion, includes a conference opinion on the currently unlisted species, treating them as though they are proposed for listing, and these species will be on the permit immediately, but only activated upon the effective date of the species being listed. Note, however, that all mitigation and minimization measures will be implemented immediately by Plum Creek, regardless of the current listing status of the individual species. At the time of listing of a new species that is on the permit, the Services will review the effects analyses contained within this document, and update or revise the conclusions, as necessary. If the new analysis indicates that retaining a newly-listed species on the permit would result in a potential jeopardy situation for that species, the Services may delete that species from the permits, but only after exhausting other remedies.

Plum Creek Lands

The NFHCP describes a comprehensive program to conserve the covered species during ongoing timber harvest activities within covered lands. The NFHCP covered lands consists of 1.6 million acres of lands owned by Plum Creek in Montana (1,460,000 acres, or 93 percent of the NFHCP covered lands total), northern Idaho (40,000 acres, or 3.1 percent), and Washington (70,000 acres, or 4.3 percent). The "covered lands" is where the NFHCP would actually be implemented and where incidental take of the covered species would be authorized. The NFHCP also describes a 16.5 million-acre "planning area," which surrounds the covered lands and consists of 15 planning area (or watershed) sub-basins (see Map 1.3-1 in the FEIS, page 35). The planning area includes Plum Creek lands as well as U.S. Forest Service (USFS), National Park Service, state, tribal, and other public and privately owned lands, and provides a basis for evaluating the effects of the NFHCP within a regional context.

Action Area

The "action area" is defined as all the areas to be affected directly or indirectly by the Federal action , not merely the immediate area involved in the action (50 CFR §402)(see Environmental Baseline Section below). Although activities that would be covered by the proposed permit are restricted to Plum Creek lands (i.e., the 1.6 million acre NFHCP covered lands), the effects of the proposed action on the covered species may extend beyond this area. For this consultation, we therefore define the action area to include the 16.5 million acre planning area, which is partially intermingled in a checkerboarded ownership pattern with about 14.9 million acres of lands owned and managed by the USFS, state, tribal, and other private owners, and areas outside the planning area in Idaho and Washington. The action area in Idaho includes the Lochsa River sub-basin, and the mainstem Clearwater River below the confluence with the Lochsa River. The action area in Washington includes the Yakima, Cowlitz, Kalama, and Lewis river sub-basins. The action area consists of 15 planning area sub-basins where covered species are known to occur, and those sub-

basins in Idaho and Washington (above) where covered activities may affect designated critical habitat or listed species downstream from the planning area. The action area consists of 15 planning area sub-basins where covered species are known to occur. Table 2.2-1 (FEIS, page 47) depicts each of the ten sub-basins in Montana, one in Idaho, and four in Washington and the associated land ownership in each planning area sub-basin plus a few outliers, which occur outside, but near the 15 planning area sub-basins. The majority of the NFHCP lands are located in Montana, approximately 1.4 million acres or 94 percent with the greatest Plum Creek ownership in Middle Clark Fork River, Middle Kootenai River, and Blackfoot River sub-basins. In Idaho, Plum Creek lands are located in the Lochsa River Basin only and total 40,424 acres (3 percent). Plum Creek NFHCP lands in Washington occur in four sub-basins that total 70,462 acres (4 percent); Yakima, Lewis, Cowlitz, and Kalama River sub-basins.

The incidental take that would be permitted under the section 10(a)(1)(B) permit applies to lands where covered activities occur and Plum Creek lands to which the NFHCP's conservation and mitigation measures apply. These lands include all lands owned by Plum Creek as a matter of public record on the effective date when the Implementing Agreement is signed within the planning area sub-basins identified on Map 2.2-1 in the FEIS (page 45) and those lands located outside of the planning area sub-basins identified in the Implementing Agreement. Lands covered under the NFHCP also include those lands owned by others but on which Plum Creek holds timber cutting rights of 30-years duration or longer. Additionally, other lands covered under the NFHCP include lands owned or managed by others over which Plum Creek holds access easements, rights-of-way, access permits, or which are subject to a road cost-share agreement to which Plum Creek is a party, and which access NFHCP lands owned by Plum Creek.

Covered Activities

Current management activities on Plum Creek lands that Plum Creek seeks coverage for under the Incidental Take Permit (Permit) consist of commercial forestry and associated activities. These include silvicultural activities (tree planting, site preparation, prescribed burning, timber harvest in riparian and upland areas, stand maintenance, forest nurseries, and seed orchards), as well as related actions of logging road construction and maintenance and gravel quarrying for roads. Other forestry activities include forest fire suppression, open range cattle grazing, miscellaneous forest and land product sales, and conservation activities. Additional land use activities that are non-forest actions and special forest uses include commercial outfitting, recreation, electronic facility sites, and mill site facilities that manufacture various forest products.

Montana Best Management Practices (BMPs) encourage "rapid" reforestation of harvested areas to re-establish protective vegetation to avoid erosion. Plum Creek is required by Idaho and Washington state laws to regenerate harvested forestlands within specified time frames. Although natural regeneration plays a much greater role in reforestation of Plum Creek lands, Plum Creek

still plants over 2 million seedlings annually in the NFHCP area to ensure adequate stocking where natural regeneration success is less likely, and to supplement naturally occurring tree establishment and species diversity. Planting is done by hand, although machine planting has been used on a limited basis in the past and may be used again in the future.

Plum Creek sometimes prepares sites for forest regeneration within 1 year following harvest, if needed. Site preparation consists of clearing slash and competing vegetation and exposing adequate mineral soil for subsequent tree planting or natural regeneration. This is accomplished using one or more techniques, such as tractors or excavators, tree planting hoes, and broadcast burns. The main use of prescribed burns on NFHCP lands is to reduce slash loads, thereby complying with state laws to minimize fire hazards associated with logging debris. Plum Creek's use of slash burning is less today because more of the tree is used to create forest products, which minimizes the amount of slash left after harvest. Large broadcast burns are no longer used by Plum Creek as a standard management tool.

Plum Creek uses even-aged and uneven-aged timber harvesting methods in riparian and upland habitat types in the NFHCP area. Even-aged methods include clearcuts, seed-tree harvests (where 20 or fewer trees per acre remain after harvest), and overstory removal (where large trees are harvested and a fully stocked stand of young trees remains after harvest). Uneven-aged methods include shelterwood harvest (where 20 to 50 trees per acre remain after harvest), encouraging regeneration in the understory; commercial thinning (where 70 or more merchantable trees per acre remain after harvest); and other selective harvesting. Combining uneven-aged harvesting methods can be effective in maintaining diverse wildlife habitats. Shelterwood harvests are normally followed 10 to 20 years later by a shelterwood removal harvest, and Plum Creek varies the approach to accomplish site-specific objectives, such as maintaining structural diversity.

Uneven-aged silvicultural practices are typically used by Plum Creek in Montana, Idaho, and Washington east of the Cascades where arid conditions prevail, and stand structure and species composition are more varied. Even-aged silviculture is widely used by Plum Creek in Washington west of the Cascades. This harvesting technique favors tree species, such as Douglas fir, that grow best in open conditions with full sunlight.

Timber harvest operations in even-aged and uneven-aged stands include felling trees, then moving (yarding) them to landing sites where they are limbed and bucked (trimmed). Methods of moving trees depend on terrain slope, road access, worker safety, and other factors. Tractor-based systems are usually used on relatively flat slopes, cable yarders are used on steeper slopes, and helicopters are used where there is limited road access or slopes are very steep. Logs are loaded on trucks at the landings, then transported over private and public roads to mills where they are processed. In some cases, small logs or tree tops may be manufactured into wood chips on site and transported in chip vans to paper or pulp mills.

Stand maintenance is promoted by precommercial and commercial thinning. Thinning of overstocked even-aged stands concentrates the site's growth potential on fewer trees and promotes tree growth. Pre-commercial thinning occurs about 15 years after stand regeneration. Commercial thinning begins at about 35 years. Retained (leave) trees are selected for even spacing across a site so that each benefits from greater growing space. Thinned trees are processed onsite or harvested for transport to mills where they are processed.

Other common commercial forestry activities include the operation of forest nurseries and seed orchards. Plum Creek operates two forest nurseries and two seed orchards in Montana, and one forest nursery and one seed orchard in Washington. These are confined facilities without known influences on riparian and aquatic areas.

Plum Creek constructs new logging roads and upgrades existing roads to minimize impacts on the landscape and to use for forest management activities. Roads are planned and located considering the terrain, soils, and timber type. Plum Creek's typical road design and construction standards are single lanes with occasional turnouts, surface width of 12 feet, and grade less than 15 percent. Roads are typically constructed with native surfacing and are outsloped without a ditch, but may consist of 15 feet of subgrade with a 2-foot drainage ditch. Excavated soil is used as part of the subgrade fill or disposed at a stable site. Culverts or bridges are placed at all water crossings. Erosion control measures typically used by Plum Creek during road construction include installing cross drainage or ditch-line relief features to minimize water velocity, armoring (stabilizing) culvert head walls, constructing stable cut-and-fill slopes, and using grass seeding, sediment filters, straw matting, ditch-line energy dissipaters, and appropriately placed riprap.

Plum Creek inspects and maintains roads to provide proper drainage function and subgrade stability. Plum Creek's road maintenance plans are intended to reduce the potential effects of roads and their use on streams and riparian habitat by the following: 1) minimize road building activities through regular maintenance; 2) minimize disruption of natural hydrologic flow patterns; 3) restrict sidecasting to prevent sediment from entering streams and riparian areas; 4) minimize erosion at road sites using advanced erosion control techniques; 5) identify roads and associated drainage features that pose a potential risk; and 6) close or stabilize roads based on short-term and long-term transportation needs in each watershed. Also, Plum Creek surfaces some of its roads with gravel to improve the road standard and reduce the potential for road-related erosion. Gravel is normally obtained from nearby gravel pits on Plum Creek lands.

Immediate actions are taken to fight and suppress forest fires to minimize the total number of acres that could potentially be affected by unwanted wildfires. However, Plum Creek fights fires, as needed, using currently accepted standard techniques and tools that include fire trucks, hoses, shovels, and tractors.

At present, Plum Creek has 764,560 acres within grazing leases or allotments in the NFHCP area, most of which are in Montana (98 percent). Livestock have grazed portions of NFHCP area lands for more than a century. Over 90 percent of this area is classified as "open range" under state law and 46 percent is leased or allotted for grazing.

Plum Creek occasionally sells miscellaneous forest and land products. These activities represent a very small fraction of the overall commercial activities on Plum Creek lands and require no additional facilities or equipment beyond those routinely used in Plum Creek's commercial forestry operations. Examples of miscellaneous forest and land product sales include the following: stones collected from roadsides and talus slopes for landscaping and chimney construction; gravel for roads to nearby landowners; Christmas trees to commercial tree sellers; conifer branches collected for making Christmas boughs; Pacific yew bark for making medicine; stumps for certain chemicals they contain; and sawdust and wood chips.

Plum Creek performs stream habitat enhancement and constructs engineered fish habitats under various cooperative agreements with landowners, agencies, and organizations. These types of conservation activities include stream enhancement projects, livestock exclusions, engineered fish habitat restoration, irrigation diversion management, landslide repairs, and scientific surveys and studies. Projects include development of pool structures and removal of fish passage obstructions. Scientific surveys and studies are conducted by Plum Creek staff, contractors, resource agency staff, and independent researchers. The research focuses on commercial forestry, fish and wildlife, water quality and hydrology, and related natural resource topics.

A special forest use permit is required from Plum Creek when professional outfitters wish to use Plum Creek lands to conduct their business. Outfitters must conduct their business on Plum Creek lands in compliance with Plum Creek's Environmental and Land Use Principles, applicable state fishing and hunting regulations, and other state regulations directed specifically at commercial outfitting. Similarly, a special forest use permit may be required by Plum Creek for various categories of recreation activities, such as mountain bike riding.

Plum Creek leases sites for the construction and operation of electronic transmission facilities. The sites are located at the tops of mountains, which are numerous on Plum Creek lands. There are less than two dozen electronic transmission sites in the NFHCP area. Existing roads provide access to these sites.

Forest products manufacturing facilities are located in Columbia Falls, Kalispell, Fortine, and Pablo, Montana. The facilities produce finished products of lumber, plywood, and medium-density fiberboard for retail, industrial, and other specialty markets. Some facilities that are near aquatic areas, have onsite water treatment and stormwater control practices as well as erosion control structures to prevent discharges of wastewater or polluted stormwater into nearby streams.

Changed and Unforeseen Circumstances

A changed circumstance is an event identified under the NFHCP affecting a covered species that can be reasonably certain to occur during the permit period. Because a changed circumstance is anticipated, the NFHCP can accommodate a plan of action immediately after a changed circumstance is discovered. Under the NFHCP, Plum Creek could be required to provide additional mitigation in response to the changed circumstances identified in the NFHCP (Section 8.0, AM3 in the DEIS). These circumstances apply for three types of environmental events: forest fires, floods, and landslides, which were identified by the Services and Plum Creek as most relevant to the NFHCP. Unforeseen circumstances that could not have been reasonably anticipated by Plum Creek or the Services at the time of the NFHCP's development. The NFHCP does not specify what management actions are required if unforeseen circumstances occur. If unforeseen circumstances occur, the Services can work with Plum Creek to develop mitigation measures to address environmental problems. Plum Creek would not be responsible for additional mitigation consisting of additional commitments of land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources with regard to the covered species.

Changed circumstances considered possible on covered lands in the NFHCP, including their specific lower and upper ranges, are as follows: 1) forest fires that are stand replacement fires (i.e.,sufficient intensity to kill 90 percent or more of the trees) between 300 and 5,000 contiguous acres in size within the covered lands, or that directly affect between 25 and 50 percent of covered lands stream length within a given fourth order watershed; 2) flooding when the flood has a recurrence interval between 25 and 100 years based on stream gauging station data in the Action area; and 3) landslides between 500 and 5,000 square yards in size that deliver sediment to streams.

In the event of changed circumstances related to environmental events, Plum Creek will develop a site-specific management plan with the Services assistance (if desired by the Services). Plum Creek must submit to the Services within 30 days of observing the changed circumstances. The plan must be completed and agreed upon by Plum Creek and the Services within 60 days of submission of Plum Creek's proposed plan. If this has not occurred, the matter will be resolved using the NFHCP dispute resolution provisions (see IA, in Appendix A of the DEIS, Section 13.4). If the Services do not comment on the submitted plan within 30 days of receiving it, the plan shall be implemented as proposed. The management planning framework outlined in section 8 of the NFHCP will be followed and the implementation timing will be specified in the action plan and shall be as prompt as is reasonably practicable. This process provides the Services with additional assurance that certain actions will take place that provide a level of conservation certainty given a relatively predictable but unplanned event.

Components of the Proposed Action and Plan Structure

The NFHCP consists of eight categories of conservation commitments: 1) Environmental Principles; 2) Forest Road and Upland Management; 3) Riparian Management; 4) Range Management; 5) Land Use Planning; 6) Legacy and Restoration; 7) Administration and Implementation; and 8) Monitoring and Adaptive Management. These commitments would be implemented based on a set of biological goals and business goals established by the NFHCP. The plan's biological goals are defined as "the broad guiding principles for the operating conservation program,...the rationale behind the minimization and mitigation strategies." There are four biological goals, which in turn are linked to four characteristics of aquatic environments that are important to fish; these are known as the "Four C's" (Clean, Cold, Complex, Connected). The NFHCP's biological goals are as follows:

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.

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.

Complex – Protect instream 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.

Connected – Protect and contribute to restoration of connectivity among sub-populations of native fish in the project area.

Thus, each biological goal would contribute to maintenance and improvement of aquatic habitat conditions in one of the four categories. The biological goals are further broken down into 15 "specific biological objectives," which are subsets of the four biological goals and represent specific measurable targets for achieving the goals. For example, three specific habitat objectives under the "Cold" biological goal would seek to maintain and improve canopy closure over streams in the covered lands. The NFHCP then establishes 53 individual conservation commitments in the eight categories described above, all designed ultimately to meet the plans biological goals. The NFHCP's business goals were established to balance the biological goals with Plum Creek's business interests. They are as follows: 1) long-term sustainability and business certainty; 2) cost-effective conservation; 3) scientific credibility; and 4) operational practicality and flexibility. These business goals are intended to ensure regulatory predictability, cost-effective conservation measures, and management flexibility as the NFHCP is implemented.

Much of the NFHCP's conservation strategy is based on bull trout biology, because: 1) the bull trout is the most widespread species within covered lands; 2) of the covered species, bull trout is considered the most biologically specialized, resulting in specific habitat selection, and limited, localized distribution; and 3) bull trout is one of the most imperiled of the covered species. Further, anadromous covered species on Plum Creek land is found in only locations. Site-specific prescriptions were developed for these areas used by salmon and steelhead, when information was available on habitat condition. The NFHCP would be further guided by a prioritization system designed to weigh the biological importance of specific covered lands, especially with respect to bull trout, when applying the plan's conservation commitments. Considered most important are "Tier 1 Watersheds" and "Key Migratory Rivers." Tier 1 Watersheds are those containing streams known to be important for bull trout spawning and rearing. Key Migratory Rivers are those known to connect habitats where bull trout are capable of a full migratory life form. These are generally rivers that bull trout use to migrate from a lake or big river to a Tier 1 spawning or rearing stream. "Tier 2 lands" are Plum Creek lands that occur outside of Tier 1 watersheds (i.e., all other covered lands). Habitats associated with Tier 2 lands are important for other native salmonid covered species, as well as other life history stages of the bull trout.

Specific components of the eight conservation commitment categories are summarized below. Another feature of the plan, the "pay-as-you-go" approach, is also described.

Environmental Principles

In 1991, Plum Creek developed a set of Environmental Principles to address environmental needs on the landscape while continuing to utilize its lands to produce forest products. The principles include measures to ensure sustainable forest management and to protect water quality, air quality, fish and wildlife resources, ecological and structural diversity, among other things. Under this conservation commitment category, Plum Creek commits to continue implementing its Environmental Principles throughout the term of the permit.

Forest Road and Upland Management

Conservation commitments in this category include measures designed to minimize the impacts (especially sedimentation) of new road construction on rivers and streams. Also included are measures to mitigate ongoing impacts of old roads built before development of modern erosion control standards. Specific commitments include compliance with applicable state-issued BMPs, road condition tracking and inspections, abandonment of surplus roads, and road upgrades.

Riparian Management

Conservation commitments in this category are designed to provide a continuous supply of large woody debris (LWD) to streams, to maintain streamside shade and prevent temperature extremes

harmful to bull trout and anadromous fish, and to provide a filter for sediment generated from upslope (non-riparian) locations. Under these measures, Plum Creek would apply state mandated riparian rules as a base prescription for riparian management, and, depending on the biological sensitivity of the specific stream, would apply additional measures such as greater tree retention, wider streamside management zones, and no harvest restrictions. In addition, timber harvest in streamside riparian stands would be deferred for the first decade of the plan in seven watersheds.

Range Management

Generally, covered lands under the proposed NFHCP have been grazed for up to 100 years and many still carry grazing leases. Range management commitments under the NFHCP would minimize the impacts of ongoing grazing activities and would attempt to repair the effects of past grazing activities where appropriate. Specific measures provide for establishment of BMPs, rancher training, grazing exclosures to protect biologically important stream reaches, establishment of criteria that must be satisfied prior to re-leasing vacated leases, and monitoring the effectiveness of the riparian restoration techniques being used within the covered lands.

Land Use Planning

Over the course of the proposed permit, Plum Creek may periodically acquire or sell land within or near the action area. Conservation commitments in this category are designed to ensure that such acquisition and sales are consistent with the NFHCP's biological goals and to minimize the impacts to fish habitat resulting from land uses or development for purposes other than forest management. Specific measures include incentives to find buyers who will keep land in forestry when land is sold or otherwise to discourage development, where appropriate to include land use restrictions or to pass on NFHCP restrictions on land sold, and a system to track the conservation outcome of land sales and acquisitions overall.

Legacy and Restoration

Plum Creek lands have a long history of landowners and uses and portions of the covered lands have only recently come into Plum Creek ownership. Conservation commitments in this category seek to identify problems remaining from past land use practices and to correct such problems where feasible. Specific measures include surveys of all Key Migratory Rivers to identify restoration opportunities, implementation and monitoring of restoration projects, correction of habitat damage resulting from irrigation diversions, and a brook trout suppression project. Also included are commitments that Plum Creek will participate in watershed groups and enforcement agreements with state agencies where appropriate and will share information with neighboring landowners.

Administration and Implementation

Conservation commitments in this category would ensure that Plum Creek properly implements the measures described in the NFHCP and that the plan is periodically evaluated to ensure that its biological goals are being met. Specific measures include development of a field implementation manual, forester and contractor training programs, a logger certification and training program, and periodic internal and external audits of plan performance.

Monitoring and Adaptive Management

The NFHCP proposes a monitoring and Adaptive Management program designed to monitor biological conditions on covered lands, and, where appropriate, to adjust or adapt specific plan measures in response to such monitoring. The NFHCP's Adaptive Management program would consist of four basic processes: 1) monitoring; 2) evaluation of monitoring data; 3) response (i.e., determining a specific response to a specific need for adjustment); and 4) Adaptive Management commitments, or those measures that Plum Creek would undertake to implement the Adaptive Management program.

Consistent with the Service's draft "five-point policy" (64 FR 11485), the NFHCP's Adaptive Management program consists of two types of monitoring: 1) implementation monitoring; and 2) effectiveness monitoring. Implementation monitoring would consist of various measures to ensure that the conservation commitments described in the NFHCP are being fully implemented (i.e., that specific required actions are actually completed). Effectiveness monitoring is more complex, involving a determination that the NFHCP is achieving its biological goals and specific habitat objectives (i.e., that the plan is actually resulting in conservation of the covered species).

Effectiveness monitoring would be supported by several studies, the results of which would, where appropriate, guide Adaptive Management decisions. Four "Core Adaptive Management Projects" (CAMPs) are proposed: 1) evaluation of the effectiveness of NFHCP commitments for road construction and maintenance activities (CAMP 1); 2) a study of the effects of riparian management under the plan on habitat diversity and LWD loads (CAMP 2); 3) an evaluation of NFHCP effectiveness at avoiding stream temperature increases (CAMP 3); and 4) evaluation of the long-term effectiveness of Plum Creek's grazing BMPs (CAMP 4). Two additional projects to support Adaptive Management decisions are also proposed, 1) a study to determine the effectiveness of riparian restoration along Key Migratory Rivers; and 2) a brook trout suppression project on Gold Creek.

The Adaptive Management Pathway

Crucial to the long-term success of the NFHCP, both biologically and operationally, is how Adaptive Management decisions will be made and implemented. In summary, implementation of

the NFHCP is based on four biological goals, 15 specific habitat objectives, and 53 conservation commitments. Under the Adaptive Management program, the NFHCP's biological goals would remain constant; however, the conservation commitments would be subject to modification to ensure that the commitments are actually meeting the plan's goals and objectives. This would be determined through implementation and effectiveness monitoring, including the Core Adaptive Management Projects described above. The Adaptive Management pathway under the NFHCP is as follows.

For each conservation commitment the NFHCP establishes one or more "performance metrics," which are measurements or checkpoints designed to evaluate the success of the applicable commitment or action. Some performance metrics are relatively simple and would be used for implementation monitoring (e.g., the metric is simply completion of an assigned task); others are more quantitative (e.g., sedimentation loads in streams) and would be used for effectiveness monitoring. For each performance metric, the NFHCP also establishes a "trigger," a defined threshold which when satisfied, met, or exceeded, depending on the case, initiates an Adaptive Management response.

Once an Adaptive Management response is triggered, a "biological relevance" determination and "causal linkage" determination would also be made. The biological relevance determination is intended to discover whether a departure from expected results (e.g., excessively high sediment loads in streams) is biologically significant or is affecting the biological goals of the plan. The causal linkage determination would seek to determine whether the departure from expected results is due to management actions under the NFHCP or to another source independent of Plum Creek actions or management. These considerations would ensure that a specific management response by Plum Creek is justified.

The NFHCP identifies three possible types of Adaptive Management response: 1) a pre-defined mandatory management response; 2) a mandatory collaborative management response; and 3) a cooperative management response. The pre-defined mandatory response would be implemented most commonly in cases where the problem and response is relatively simple or easily predicted (e.g., when implementation monitoring determines that a specific required task has not been done). A mandatory collaborative response would be mandatory if a specific triggering condition is observed, but the NFHCP does not describe in advance exactly what that response would be. This means that Plum Creek, the FWS, and NMFS would need to "collaborate" and mutually determine an appropriate response, culminating in an agreement between the Services and Plum Creek to institute a specific change in management. A cooperative management response would be utilized in cases where no specific monitoring trigger has been tripped, but where the Services and Plum Creek jointly recognize that a management improvement can be made and then jointly determine what specific change will be implemented.

"Pay-as-You-Go"

Another important component of the NFHCP is its "pay-as-you-go" feature. This means that mitigation under the plan (in the form of the above conservation commitments) will typically occur prior to the impacts resulting from Plum Creek's forestry activities, and that the plan is expected to have a net positive balance between conservation benefits and adverse impacts throughout the term of the permit. It also means that Plum Creek can voluntarily request termination of the permit and its obligations under the NFHCP, so long as mitigation equals or exceeds impacts.

STATUS OF THE SPECIES (Rangewide)

Bull Trout *(Salvelinus confluentus)*

The bull trout has been the subject of much discussion since the late 1970s when the species was formally recognized as distinct from Dolly Varden (*Salvelinus malma* Girard). Fisheries managers previously had little concern for them and, in some cases, tried to exterminate them. Habitat degradation and other factors also contributed to a long-term decline. Most recently, concern for bull trout has stemmed from its greater vulnerability to legal and illegal harvest and recognition of its narrower environmental tolerances when compared to other salmonids.

Bull trout were listed under the Act as threatened within the coterminous United States on November 1, 1999 (64 FR 58910) (see legal status below). Bull trout are estimated to occur in approximately 45 percent of their historical range in the Columbia River basin (Quigley and Arbelbide 1997 *in* 63 FR 31647). Currently, 141 subpopulations of the bull trout are known to occur in the basin. The FWS considers 71 of these subpopulations to be at risk of extirpation from naturally occurring events due to their depressed status (63 FR 31647). The listing rule characterizes the Columbia River DPS as having some strongholds, but generally occurring as isolated subpopulations, without a migratory life form to maintain the biological cohesiveness of the subpopulations, and with trends in abundance declining or of unknown status.

The listing rule specifies that, in recognition of the scientific basis for the identification of bull trout DPSs (i.e., population segments are disjunct and geographically isolated from one another with no genetic interchange between them due to natural and man-made barriers), for the purposes of consultation and recovery planning these DPSs will serve as interim recovery units in the absence of an approved recovery plan. On that basis, the geographic scope of jeopardy analyses for actions under formal consultation will be at the DPS level as opposed to the entire coterminous United States range of this species.

Extensive habitat loss and fragmentation of subpopulations have been documented for bull trout in the Columbia River basin and elsewhere within its range (Rieman and McIntyre 1993). Reductions in the amount of riparian vegetation and road construction in the Columbia River basin due to timber harvest, grazing, and agricultural practices have contributed to habitat degradation through elevated stream temperatures, increased sedimentation, and channel embeddedness. Mining activities have further compromised habitat conditions by discharging waste materials into streams and diverting and altering stream channels. Residential development has also threatened water quality by introducing domestic sewage and altering riparian conditions. Dams of all sizes (i.e., mainstem hydropower and tributary irrigation diversions) have severely limited migration of bull trout in the Columbia River basin.

Bull trout in the Columbia River basin, despite their relatively widespread distribution, have declined in both their overall range and numbers. Numerous extirpations of local subpopulations have been reported, with bull trout eliminated from areas ranging in size from relatively small tributaries of currently occupied, though fragmented, habitat, to large river systems comprising a substantial portion of the species' previous range. Bull trout in the Columbia River population segment are currently limited to 141 isolated subpopulations, which indicates habitat fragmentation and geographic isolation. Many remaining bull trout occur as isolated subpopulations in headwater lakes or tributaries with migratory life histories lost or restricted. Few bull trout subpopulations are considered "strong" in terms of relative abundance and subpopulation stability. These remaining important strongholds tend to be found in large areas of contiguous habitats in the Snake River basin of central Idaho Mountains, upper Clark Fork and Flathead rivers in Montana, and the Blue Mountains in Washington and Oregon. The decline of bull trout is due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, and the introduction of non-native species. Most bull trout subpopulations are affected by one or more threats (63 FR 31647).

Taxonomy

Bull trout are a member of the char family, which also includes the arctic char (*Salvelinus alpinus*) and the Dolly Varden trout. Bull trout are closely related to Dolly Varden trout and are sympatric with Dolly Varden over part of their range, most notably in the Puget Sound Region of Washington State. The taxonomic classification between these two char has been fraught with difficulty. For years, the bull trout and Dolly Varden were combined under one name, the Dolly Varden (*Salvelinus malma* Walbaum). In 1991, with the support of the American Fisheries Society, bull trout and Dolly Varden were recognized as two distinct species.

Description

Characteristics distinguishing the two species as well as a taxonomic description of bull trout are presented by Haas and McPhail (1991). Two of the most useful characteristics in separating the

two species are the shape and size of the head (Cavender 1978). The head of a bull trout is more broad and flat on top, being hard to the touch, unlike Dolly Varden. Bull trout have an elongated body, somewhat rounded and slightly compressed laterally, and covered with cycloid scales numbering 190-240 along the lateral line. The mouth is large with the maxilla extending beyond the eye and with well-developed teeth on both jaws and head of the vomer (none on the shaft). Bull trout have 11 dorsal fin rays, 9 anal fins, and the caudal fin is slightly forked. Although they are often olive green to brown with paler sides, color is variable with locality and habitat. Their spotting pattern is easily recognizable showing pale yellow spots on the back, and pale yellow and orange or red spots on the sides. Bull trout fins are tinged with yellow or orange, while the pelvic, pectoral, and anal fins have white margins. Bull trout have no black or dark markings on the fins.

Historical and Current Distribution

Bull trout are native to North America and are distributed from 41 to 60° North latitude along the Cascade and Rocky Mountain ranges (Meehan and Bjornn 1991). Bull trout also occur in the headwaters of North and South Saskatchewan Rivers of the Hudson Bay drainage in Alberta, and in the headwaters of the Athabaska, Peace, and Laird Rivers tributary to the Mackenzie River system in Alberta and British Columbia (Cavender 1978; Haas and McPhail 1991). South of the 49th parallel, bull trout occur mainly west of the continental divide in river systems that drain the Columbia River basin, except in Montana and Oregon (Platts et al. 1993). The historical range of bull trout was restricted to North America (Cavender 1978; Haas and McPhail 1991). Bull trout have been recorded from the McCloud River in northern California, the Klamath River basin in Oregon and throughout much of interior Oregon, Washington, Idaho, western Montana, and British Columbia, and extending into Hudson Bay and the St. Mary's River in Saskatchewan.

Bull trout are believed to have developed pariglacially and to be a glacial relict (McPhail and Lindsey 1986), and their broad distribution has probably contracted and expanded periodically with natural climate change (Williams et al. 1997). Genetic variation suggests an extended and evolutionarily important isolation between populations in the Klamath and Malheur basins and those in the Columbia River basin (Leary et al. 1993). Populations within the Columbia River basin are more closely allied and are thought to have expanded from common glacial refugia or to have maintained higher levels of gene flow among populations in recent geologic time (Williams et al. 1997).

Bull trout are now extinct in California and only remnant populations are found in much of Oregon (Ratliff and Howell 1992). A small population still exists in the headwaters of the Jarbidge River, Nevada, which represents the present southern limit of the species' range. Bull trout are estimated to have occupied about 60 percent of the Columbia River basin (Quigley and Arbelbide 1997).

It is unlikely that bull trout occupied all of the accessible streams at any one time. Distribution of existing populations is often patchy even where numbers are still strong and habitat is in good condition (Rieman and McIntyre 1993; Rieman and McIntyre 1995). Habitat preferences or selection is likely important (Dambacher and Jones 1997; Goetz 1994; Rieman and McIntyre 1995) but more stochastic extirpation and colonization processes may influence distribution even within suitable habitats (Rieman and McIntyre 1995).

However, multiple human-induced factors have strongly influenced the present day distribution of anadromous salmonid species; included among them are the creation of migration blockages (dams, diversions, etc.), in-river and ocean harvest, and estuarine and freshwater habitat alteration. These limiting factors were analyzed by Watson and Hillman (1997) and are included herein by reference. The present day anadromous salmonid distribution reflects these natural and human-induced factors.

The historical distribution of bull trout in Washington includes most of the State except that portion south and east of the Columbia River, but north of the Snake River, in eastern Washington; and, in the extreme southwest portion of the State, that portion west of the Lewis River to Grays Harbor, but south of the Nisqually River Basin (Mongillo 1993). Reductions in the historical distribution of bull trout have occurred mainly in eastern Washington. As an example, bull trout populations are currently absent from the Chelan, lower Yakima, and Okanogan sub-basins (Brown 1992b). Although it is presumed that bull trout were once widely distributed throughout the Columbia River basin, presently they are only occasionally observed in the Columbia and Snake Rivers (Brown 1992a).

The Columbia River distinct population segment encompasses the entire Columbia River basin and all its tributaries, excluding the isolated bull trout populations found in the Jarbidge River, and includes the eastern Cascades. The FWS recognizes 141 subpopulations in the Columbia River DPS within Idaho, Montana, Oregon, and Washington with additional subpopulations in British Columbia (63 FR 31647).

Within the action area areas where bull trout are currently distributed occur in 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 drainage). 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 action area, but they are generally limited to a few headwater streams. Map 4.6-2 in the FEIS (page 221) shows bull trout distribution in major sub-basins in Montana, Idaho, and Washington.

Table 4.6-4 in the FEIS (page 223) lists the status and trend for each subpopulation of bull trout present in sub-basin drainages as assessed by FWS (1998b). 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 in the FEIS, page 223).

Biological Status

Rangewide, populations are generally isolated and remnant. The Columbia River DPS has declined in range and numbers. Though still widespread, there have been numerous extirpations reported throughout the Columbia River basin. Migratory life histories have been lost or limited throughout the range (Goetz 1994; Jakober 1995; Montana Bull Trout Scientific Committee, in preparation; Pratt and Huston 1993; Ratliff and Howell 1992; Rieman and McIntyre 1993, 1995) and fluvial bull trout populations in the upper Columbia River portion of the distinct population segment appear to be nearly extirpated. Resident populations existing in headwater tributary reaches are isolated and generally low in abundance (Thomas 1992). Bull trout in Flathead Lake and Lake Pend Oreille appear to be declining, while the Swan Lake adfluvial population appears to be the healthiest remaining population and is increasing (USDA and USDI 1998). Generally, where status is known and population data exists, bull trout populations in the entire Columbia River DPS are declining (Thomas 1992; Pratt and Huston 1993). Presently bull trout in the Columbia River basin occupy about 45 percent of their estimated historic range (Quigley and Arbelbide 1997). The Columbia River DPS is composed of 141 subpopulations, which indicates the level of habitat fragmentation and isolation. Of the 141 subpopulations, 75 are at risk of natural extirpation through physical isolation. Many of the remaining bull trout occur as isolated subpopulations in headwater tributaries, or in tributaries where the migratory corridors have been lost or restricted. Few bull trout subpopulations are considered "strong" in terms of relative abundance and subpopulation stability. Those few remaining strongholds are associated with large areas of contiguous habitats such as portions of the Snake River basin in Central Idaho, the Upper Flathead River in Montana, and the Blue Mountains in Washington and Oregon.

Life History Characteristics

Like other char, bull trout have multiple life-history forms (morphologies), complex age structures, behavior, and maturation schedules. Two distinct life-history forms, migratory and resident, occur throughout the range of bull trout (Pratt 1992; Rieman and McIntyre 1993). Migratory forms rear in natal tributaries for several years before moving to larger rivers (fluvial form), lakes (adfluvial or lacustrine form), or the ocean (anadromous) to mature (Goetz 1989; Brown 1992a; Rieman and McIntyre 1993). Migratory bull trout may use a wide range of habitats ranging from first to sixth order streams and varying by season and life stage. Resident populations are generally found in small headwater streams where they spend their entire lives. Stream-resident bull trout occupy small, high-elevation streams. They rarely move and are seldom larger than 30 centimeters (Goetz 1989). Many "resident" subpopulations were once migratory, but now they only occupy remnants of their range.

Bull trout become sexually mature from 4 to 9 years old (Shepard et al. 1984). Most bull trout spawning occurs between late August and early November (McPhail and Murray 1979; Pratt 1992; Shepard et al. 1984; Rieman and McIntyre 1996). Bull trout require a long period of time (over 220 days) from deposition of eggs until emergence. Hatching occurs in winter or early spring, and alevins may stay in the gravel for extended periods. Growth is variable with different environments, but first spawning is often noted after age four, and the fish may live 10 or more years (McPhail and Murray 1979; Pratt 1992; Rieman and McIntyre 1993). Bull trout spawn in consecutive or multiple years (Shepard et al. 1984; Pratt 1992).

Although spawning typically occurs in second to fifth order streams, juveniles may move upstream of reaches used by adults for spawning, presumably to forage in other accessible waters (Fraley and Shepard 1989). Although some individuals may spend their entire life in a small segment of a stream, most are highly migratory, traveling to headwater streams to spawn and later migrate back to larger stream segments or lakes to rear (McPhail and Murray 1979). Seasonal movements by adult bull trout may range up to 300 km as migratory fish move from spawning and rearing areas into overwinter habitat in the downstream reaches of large sub-basins (Shepard et al. 1984). Post-spawning mortality, longevity, and repeat-spawning frequency are not well known (Rieman and McIntyre 1996).

Adfluvial bull trout mature in lakes or reservoirs and spawn in tributary streams. Fluvial forms have a similar life history as adfluvial forms, except they move frequently between mainstem rivers and smaller tributary streams. Juveniles remain between1 to 6 years in nursery streams before migrating downstream to either rivers (i.e., fluvial forms) or lakes (i.e., adfluvial forms) (Fraley and Shepard 1989; Brown 1992a). Anadromous bull trout spawn and rear initially in streams, and migrate to saltwater where they grow and mature (Brown 1992a). They feed on a variety of water-column organisms and bottom dwellers (Shepard et al. 1984; Pratt 1984).

Habitats Utilized

Even though bull trout may move throughout whole river sub-basins seasonally, spawning and juvenile rearing appear to be limited to the coldest streams or stream reaches. The lower limits of habitat used by bull trout are strongly associated with gradients in elevation, longitude, and latitude, that likely approximate a gradient in climate across the Basin (Goetz 1994). The patterns indicate that spatial and temporal variation in climate may strongly influence habitat available to bull trout. While temperatures are probably suitable throughout much of the northern portion of the range, predicted spawning and rearing habitat are restricted to increasingly isolated high-elevation or headwater "islands" toward the south (Goetz 1994; Rieman and McIntyre 1995). Although bull trout may be present throughout large river sub-basins, spawning and rearing fish are often found only in a portion of available stream reaches. Migratory forms may use much of the river basin through their life cycle, but rearing and resident fish often live only in smaller tributaries.

Bull trout typically spawn in cold, low-gradient second- to fourth-order tributary streams, over loosely compacted gravel and cobble having groundwater inflow (Shepard et al. 1984; Brown 1992a; Rieman and McIntyre 1996). Spawning sites also seem to be near cover (Brown 1992a) such as logs, undercut banks, and boulders. Preferred bull trout rearing habitat occurs in small headwater and tributary streams. Juveniles may move upstream of reaches used by adults for spawning, presumably to forage in other accessible waters (Fraley and Shepard 1989; Ratliff 1992). Juveniles (less than 100 mm) are primarily bottom-dwellers, occupying positions above, on, or below the bottom. Juveniles require cold-water tributaries with good cover (rocks and debris) and relatively little streambed sediment. Fry are found in shallow, slow, backwater side-channels and eddies (Shepard et al. 1984).

Older individuals are found in deeper and faster water compared to juveniles. Adults are often found in pools sheltered by large, organic debris or "clean" cobble substrate (McPhail and Murray 1979). Migratory bull trout may use a wide range of habitats ranging from first-to-sixth order streams and varying by season and life stage. In intermountain areas, lower-elevation lakes and rivers constitute important habitats for maturing and overwintering fluvial and adfluvial bull trout. Resident populations are generally found in small headwater streams where they spend their entire lives. Stream resident bull trout occupy small, high-elevation streams.

Habitat Component Requirements

Rieman and McIntyre (1993) stated that bull trout appear to have more-specific habitat requirements than other salmonids. They list the habitat characteristics of temperature, cover, substrate composition, channel stability, and migratory corridors as important influences in bull trout distribution and abundance. Bull trout growth, survival, and long-term population persistence appear to be dependent upon these five habitat characteristics. In general, it is believed bull trout need habitat providing cold, clean water, complex cover, stable substrate with a low percentage of fine sediments, high channel stability, and stream/population connectivity. Although bull trout may be present throughout large river sub-basins, spawning and rearing fish are often found only in a portion of available stream reaches. Migratory forms may use much of the river basin through their life cycle, but rearing and resident fish often live only in smaller tributaries.

Bull trout are strongly associated with various components of habitat complexity, including cover in the form of large woody debris, side channels, undercut banks, boulders, pools, and interstitial spaces in coarse substrate. Bull trout occupy a variety of habitat types during their life but are strongly associated with pools and large woody debris in the stream. Large pools, consisting of a wide range of water depths, velocities, substrates, and cover are characteristic of high-quality bull trout habitat (Watson and Hillman 1977). Preferred bull trout rearing habitat occurs in small headwater and tributary streams. As bull trout mature they move from slow backwater areas with large woody debris into deeper and faster water, such as runs and mainstream pools, but these pools are typically associated with large woody debris. Cover includes undercut banks, large

woody debris, boulders, and pools which are used as rearing, foraging, and resting habitat, and protection from predators (USDA and USDI 1998). Deep pools also help minimize and moderate stream temperatures and offer refuge from warmer water temperatures during summer low-flow conditions. Stream temperatures and substrate types are especially important to bull trout. Spawning occurs in the upper reaches of clear streams in areas of flat gradient, uniform flow, and uniform gravel or small cobble. Spawners require hiding cover such as logs and undercut banks. Strict habitat requirements make spawning and incubation habitat for bull trout limited and valuable (Fraley and Shepard 1989).

Surface/groundwater interaction zones, which are typically selected by bull trout for redd construction, are increasingly recognized as having high amounts of dissolved oxygen; constant cold water temperatures; and increased macro-invertebrate production. The maintenance of riparian vegetation is essential for controlling stream temperature, providing cover, and protecting against lateral erosion. Maintenance of streamside vegetation contributes to canopy density (shading) and reduces sedimentation. Suppressing solar radiation avoids artificially raising stream temperatures, thereby assisting spawning, hatching, and rearing survival. Keeping sedimentation to near-natural levels contributes to the maintenance of spawning habitat and the diversity of aquatic invertebrates and other food items (MBTSG 1998).

Temperature

Rieman and McIntyre (1993) state that water temperature is consistently recognized by researchers more than any other factor as influencing bull trout distribution. Thermal barriers have contributed to the disruption and fragmentation of bull trout habitat (MBTSG 1998). Temperature is likely a critical habitat characteristic. Cold water temperatures are required for successful bull trout spawning and development of embryos and juveniles; cold water temperature also influence the distribution of juveniles (Bjornn and Reiser 1991; Goetz 1989; McPhail and Murray 1979; Pratt 1992; Fraley and Shepard 1989). Bull trout are associated with the coldest stream reaches within sub-basins. Bull trout spawning typically occurs in areas influenced by groundwater (Allan 1980; Shepard et al. 1984; Ratliff 1992; Fraley and Shepard 1989). In a recent investigation in the Swan River drainage, bull trout spawning-site selection occurred primarily in stream reaches directly influenced by groundwater upwellings or directly downstream of these upwelling reaches (Watson and Hillman 1997). Warmer summer stream temperatures, as well as extreme winter cold temperatures that can result in anchor ice, may be moderated by groundwater upwellings. Distribution is thought to be limited by temperatures above 59 °F, while optimum incubation and rearing temperatures are thought to be much lower, 35.6 - 39.2 °F and 39.2 - 46.4 °F, respectively (Goetz 1989; Pratt 1992). Water temperature seems to be an important factor in determining survival in the early life history of juvenile bull trout, with cool water temperatures resulting in higher egg survival and faster growth rates for fry and juveniles (Pratt 1992).

In one study by Goetz (1994), juvenile bull trout were not found in water temperatures above 53.6 °F. Some studies have indicated that temperatures must drop below 50 °F before spawning occurs (McPhail and Murray 1979). Egg survival decreases as water temperature increases, with higher survival levels documented at 35.6 - 39.2 °F (McPhail and Murray 1979). The best bull trout habitat in several Oregon streams had temperatures which seldom exceeded 59 °F (Buckman et al. 1992; Ratliff 1992). Maintaining cold water temperatures is important for bull trout. Water temperature is controlled not only by shade (as influenced by canopy coverage of adjacent riparian stands), but by groundwater sources, sedimentation, influx of water from upstream areas, presence of large woody debris, elevation, and other factors.

Sediments

Sedimentation is shown to cause negative effects on bull trout, although no thresholds can be set as clear tolerance limits for population maintenance (Rieman and McIntyre 1993). Preferred spawning habitat includes low-gradient streams with loose, clean gravels (Fraley and Shepard 1989). Because bull trout eggs incubate about seven months in the gravel, they are especially vulnerable to fine sediments and water-quality degradation (Fraley and Shepard 1989). Fine sediments can fill spaces between the gravel that are needed by incubating eggs and fry. Juveniles can be similarly affected, as they also live on or within the stream-bed cobble (Oliver 1979; Pratt 1984).

Bull trout are more strongly tied to the stream bottom and substrate than other salmonids (Pratt 1992). Substrate composition has repeatedly been correlated with the occurrence and abundance of juvenile bull trout (Rieman and McIntyre 1993) and spawning-site selection by adults (Graham et al. 1981; McPhail and Murray 1979). Fine sediments can influence incubation survival and emergence success (Weaver and White 1985) but may also limit access to substrate interstices that are important cover during rearing and overwintering (Goetz 1994; Jakober 1995). Emergence success of fry appears to be affected by the proportion of sediment in the substrate (Pratt 1992). Rearing densities of juvenile bull trout have been shown to be lower when there are higher percentages of fine sediment in the substrate (Shepard et al. 1984). The close association of young bull trout with the stream bed appears to be more important to bull trout than for other species (Pratt 1992; Rieman and McIntyre 1993). Due to this close connection to substrate, bed-load movements and channel instability can also negatively influence the survival of young bull trout.

Channel Complexity/Stability

Bull trout distribution and abundance is also positively correlated with complex forms of cover and with pools (Rieman and McIntyre 1993). Cover that bull trout are usually associated with consists of large or complex woody debris and undercut banks, but may also include coarse substrates (cobble and boulder). Studies conducted with closely related Dolly Varden showed that

population density declined with the loss of woody debris after clearcutting or the removal of logging debris from streams (Murphy 1995; Dolloff 1986; Elliott 1986).

Bull trout are exceptionally sensitive to activities that directly or indirectly affect stream-channel integrity. Juvenile and adult bull trout frequently inhabit areas of reduced water velocity, such as side channels, stream margins, and pools. These areas can be eliminated or degraded by management activities (Rieman and McIntyre 1993).

The association with substrate appears more important for bull trout than for other species, bull trout usually associate with complex forms of cover and with pools. Juveniles live close to in-channel wood, substrate, or undercut banks. Young-of-the-year use side channels, stream margins, and other areas of low velocity. The association with substrate suggests that highly variable stream flows, bed-load movements, and channel instability will influence the survival of young fish. Older fish use pools and areas with large or complex woody debris and undercut banks. Woody debris and habitat complexity (e.g., boulders and large rubble) has been significantly correlated with bull trout density estimates. Channel morphology is mainly a product of geomorphology, climate, and vegetation. Other factors include discharge, sediment load, bank characteristics, and channel roughness.

Stream Flow

Bull trout are also sensitive to activities that alter stream flow. Incubation to emergence may take up to 200 days during winter and early spring. The fall spawning period and strong association of juvenile fish with stream-channel substrates make bull trout vulnerable to flow-pattern changes and associated channel instability (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993; Rieman and McIntyre 1993).

Patterns of stream flow and the frequency of extreme flow events that influence substrates are anticipated to be important factors in population dynamics (Rieman and McIntyre 1993). With overwinter incubation and a close tie to the substrate, embryos and juveniles may be particularly vulnerable to flooding and channel-scour associated with the rain-on-snow events common in some parts of the range (Rieman and McIntyre 1993). Channel dewatering tied to low flows and bed-aggradation has also blocked access for spawning fish resulting in year-class failures (Weaver 1992). Recently, several investigations have explored the synergistic relationships between ground-water upwellings, stream gradient, substrate, and other habitat characteristics with the distribution and abundance of bull trout spawning (Watson and Hillman 1997; Ratliff 1987; Shepard et al. 1984; and Allan 1980).

Other recent work has highlighted the importance of tributary mouths to mainstem rivers in providing haven from excessive stream velocities and in providing seasonally cooler water (Swanberg 1996). The presence of shrubs and gravel bars in many mainstem rivers is similarly being investigated as important for escape from excessive stream velocities.

Migratory Corridors

Migratory bull trout ensure interchange of genetic material between populations, thereby promoting genetic variability. Unfortunately, migratory bull trout have been restricted or eliminated due to stream-habitat alterations, including seasonal or permanent obstructions, detrimental changes in water quality, increased temperatures, and the alteration of natural stream-flow patterns. Migratory corridors tie seasonal habitat together for anadromous, adfluvial, and fluvial forms, and allow for dispersal of resident forms for recolonization of recovering habitats (USDA et al. 1993). Dam and reservoir construction and operation have altered major portions of bull trout habitat throughout the Columbia River basin. Dams without fish passage create barriers to fluvial and adfluvial bull trout which isolates populations, and dams and reservoirs alter the natural hydrologic regime, thereby affecting water temperature, water quality, and forage (USDA and USDI 1998).

Factors Affecting Viability

Factors limiting bull trout populations are complex and in some cases dependent upon the activities occurring within a particular watershed or sub-basin. Throughout all sub-basins State-wide, it appears that habitat destruction or modification is the most common factor affecting bull trout populations, followed by inadequate streamflow and water quality. Bull trout are sensitive to environmental disturbance at all life stages. Habitat degradation, impoundments and diversions, overharvest, and introduced species have each impacted bull trout in some way, and pose risks to bull trout in the Columbia River DPS.

Habitat Degradation

Bull trout are threatened by land-management activities and water-management activities which destroy, modify, or preclude use of their habitat. Logging and road-building activities affect bull trout through increased sediment production and delivery to streams, loss of large pools, increased stream temperatures, and loss of large woody debris.

Grazing can impair the function of riparian and aquatic habitats by promoting streambank erosion and sedimentation. Grazing can drastically limit the growth of riparian vegetation important for temperature control, streambank stability, fish cover, and detrital input, and can increase input of organic nutrients into streams (Platts 1991).

Watershed disruption has played a role in the decline of bull trout. Intermountain lakes and rivers at lower elevations which serve as overwintering habitat have been especially degraded by human activities, resulting in fragmented, isolated, local bull trout populations (MBTSG 1998). Within the range of the Northwest Forest Plan (see Appendix A and the Environmental Baseline section),

there has been a 58 percent reduction in number of large, deep pools from historic levels. Changes in or disruptions of watershed processes likely to influence characteristics of stream channels are also likely to influence the dynamics and persistence of bull trout populations. Consequently, bull trout have been more strongly associated with pristine or lightly disturbed sub-basins (Brown 1992a; Clancy 1993; Cross and Everest 1995; Ratliff and Howell 1992). There are several recent treatments of the effects of forest management, especially forest roads, on bull trout (Baxter et al. 1999; Quigley and Arbelbide 1997; Quigley et al. 1996; and Thurow et al. 1997). Thurow et al. (1997) determined that increasing road densities and their related effects are associated with declines in four non-anadromous salmonid species (including bull trout). They found that most subwatersheds with strong salmonid communities have no roads or very low road densities. The remaining strong populations are generally located in areas with low-density road systems. They concluded, therefore, that addressing impacts from roads is extremely important when trying to protect critical bull trout habitat requirements through the development of land-management guidelines. However, they did not establish a causal linkage to roads. Roads may have been associated with other factors such as ownership patterns, topography, and access which also are known to affect bull trout in various ways.

Plum Creek Timber Company (1998a) noted several weaknesses in the above-referenced analysis including assumptions and estimates of road densities and subjective ratings regarding the "health" of bull trout. They addressed the applicability of road density as a proximal predictor of bull trout density or habitat quality. Regression analysis was performed on 16 years of redd count data from 9 drainages in the Swan Valley. They analyzed road density and density of streams deemed important to bull trout based upon geomorphological conditions. None of the regressions comparing road density with bull trout population indicators were significant. The only regressions that were significant were those that compared stream guilds with bull trout density indicators. They concluded that any relationship that may be suggested between road density and bull trout density, is neither statistically relevant nor predictive in explaining bull trout "health". Consequently, it has less value than other physical habitat parameters that should be incorporated into landscape planning. They further stated that proximal effects of roads (e.g., sediment) on bull trout habitat can be better addressed by assessing road design, drainage conditions, and implementation of best management practices, rather than addressing road density alone.

Water Management Activities

Impoundments and diversions can create passage barriers to fish and can also be sources of direct mortality. These activities can contribute to low summer flows resulting in additional thermal barriers. Barriers to passage can break seasonal, exploratory, and population/genetic exchange movements. Impoundments provide opportunities for exotic species to become established and gain a competitive advantage. Private ponds can be a problem in some areas; illegal introduction is a serious and growing problem. Water-management activities represent a combination of direct mortality, habitat destruction, fragmentation/isolation, flow alteration, and introduced species.

Physical blockages at mainstem impoundments have isolated whole sub-basins, and water diversions and thermal barriers have barred access to former habitat. Development of means for downstream passage of adult bull trout past such barriers has not been addressed, and the efficiency of passing these individuals through juvenile passage facilities, or via spill, has not been thoroughly examined.

Overharvest

In some areas, angling has been and continues to be a threat to the bull trout. Bull trout may be vulnerable to over-harvest (Ratliff and Howell 1992; Rieman and Lukens 1979). Poaching may also be an important cause of mortality (FWS 1998b). It is generally believed that current harvest levels are not the most limiting factor. A number of public-awareness campaigns have been launched to promote recovery efforts. The slogan "No black — put it back" is becoming widespread with the assistance of streamside signage and public awareness programs. Existing information clearly indicated bull trout had experienced serious declines in both historical abundance and distribution.

Overharvest of bull trout in the Columbia River basin, historically, likely contributed to their decline. In the past, harvest included legal recreational angling, poaching, and State-sponsored eradication programs (Thomas 1992). Bull trout were often targeted for removal by anglers and government agencies because bull trout preyed on salmon and other desirable species (Simpson and Wallace 1982; Bond 1992). As recently as 1990, State and Federal agencies instituted programs to eradicate bull trout through bounties and poisoning of waterways (June 10, 1998, Federal Register [63 FR 31647]).

Introduced Species

Introduced species also influence bull trout. More than 30 introduced species occur within the present distribution of bull trout. Non-native brook trout (*S. fontinalis*), lake trout (*S. namaycush*), and brown trout (*Salmo trutta*) may hybridize with or compete with bull trout. Some introductions like kokanee (*Oncorhynchus nerka*) may benefit bull trout by providing forage (Bowles et al. 1991). Others such as brown, brook, and lake trout are thought to have depressed or replaced bull trout populations (Donald and Alger 1992; Howell and Buchanan 1992; Leary et al. 1993; Ratliff and Howell 1992). Brook trout are seen as an especially important problem (Leary et al. 1993) and may progressively displace bull trout through hybridization and higher reproductive potential (Leary et al. 1993). Brook trout now occur in the majority of watersheds representing the current range of bull trout. Introduced species may pose greater risks to native species where habitat disturbance has occurred. Bull trout and other char often thrive in waters too cold for other salmonid species. Cold temperatures can reduce the likelihood of invasion by brook trout and other non-native fish into bull trout watersheds (Clancy 1993; Frissell et al. 1995). Brook trout, which inter-breed with bull trout, may be more competitive and may displace

bull trout in streams containing more fine sediment and higher temperatures (Clancy 1993). Some man-made barriers may have unintentionally benefitted bull trout by preventing invasion of species such as brook trout or lake trout.

Population Structure

There are two ways that the above impacts of habitat land-use activities, water-management activities, overharvest, and introduced species might manifest themselves: 1) direct impacts to a given population or 2) affecting the link between populations.

Changes in sediment delivery; aggradation and scour; wood loading, riparian canopy and shading, or other factors influencing stream temperatures; and the hydrologic regime (winter flooding and summer low flow) are all likely to affect some, if not most, populations. Significant long-term changes in any of these characteristics or processes represent important risks for many remaining bull trout populations. Populations are likely to be most sensitive to changes that affect critical spawning and rearing reaches, existing population strongholds, or habitats supporting remnant (relictual) resident populations. Important refuge habitats are currently found primarily in undisturbed headwater areas and are a high priority for protection.

Isolation and Fragmentation

Historically bull trout populations were well-connected throughout the Columbia River basin. Habitat available to bull trout has been fragmented, and in many cases populations have been isolated. Dams have isolated sub-basins (Brown 1992a; Pratt and Huston 1993; Rieman and McIntyre 1993). Irrigation diversions, culverts, and degraded mainstem habitats have eliminated or seriously depressed migratory life-forms effectively isolating resident populations in headwater tributaries (Brown 1992a; Ratliff and Howell 1992; Rieman and McIntyre 1993). Introduced species like brook trout may displace bull trout in lower stream reaches, further reducing the habitat available in many remaining headwater areas (Adams 1994; Leary et al. 1993). Loss of suitable habitat through watershed disturbance may also increase the distance between good or refuge habitats and strong populations, thus reducing the likelihood of effective dispersal (Frissell et al. 1995). Because many of the bull trout populations in the Columbia River basin have been fragmented and isolated, those that remain are now very important for the conservation of the species. Of special importance are those populations that are documented to be reproducing, for which there is limited knowledge. Lack of connections places isolated stocks at greater risk to episodic and catastrophic events and stochastic localized extirpation without recolonization from nearby stocks. Migratory pathways allowing connections between these isolated strongholds or refugia or between key spawning and rearing reaches are necessary for the persistence and interaction of local populations as well as for long-term survival and recovery of the species. Disruption of migratory corridors can increase stress, reduce growth and survival, and lead to the loss of migratory life-history forms.

Rangewide Conservation Needs of the Bull Trout

Recovery of bull trout in the Klamath River, Columbia River, and Coastal-Puget Sound DPSs is likely to be enhanced through future reductions in the adverse effects resulting from timber harvest and road building, including remedying legacy effects from past activities. Improved grazing practices will benefit bull trout in the Klamath and Columbia River DPSs. Providing for both upstream and downstream passage at dams and culverts of all sizes will facilitate recolonization of previously occupied habitat and promote genetic exchange throughout the Columbia River, Coastal-Puget Sound, Jarbidge, and St. Mary-Belly River DPSs. Screening water diversions will prevent entrainment of bull trout throughout the Columbia River, Klamath River, and St. Mary-Belly River DPSs. Improvement of agricultural practices affecting water quality will benefit bull trout within the Columbia River, Klamath River, and Coastal-Puget Sound DPSs. Similarly, improved approaches to increased urbanization, such as requiring setbacks from stream banks and avoiding contamination of streams, will contribute to the recovery of the Coastal-Puget Sound and Columbia River DPSs.

Relative to other salmonids, bull trout survival is likely to be more dependent on habitat conditions that more closely resemble the historical, undisturbed environment because 1) they are top carnivores that are more vulnerable to environmental disturbances and more prone to extinction than species at lower trophic levels (M. Gilpin *in litt.* 1996); 2) their delayed sexual maturity (5 to7 years; Rieman and McIntyre 1993) is likely to prolong recovery time from the effects of adverse actions; 3) unlike anadromous salmon, bull trout display little or no anadromy (i.e., none for the Columbia River, Jarbidge River, St. Mary-Belly River, and Klamath River DPSs) and, therefore, spend their entire life cycle in freshwater habitat, making them especially vulnerable to habitat disturbance; 4) bull trout require a long incubation and nursery period of time (220+ days) prior to fry emergence, making them especially vulnerable to water temperature changes, sediment deposition, and bedload movement; 5) bull trout juveniles are strongly associated with cover, including the interstitial spaces in the substrate, which makes them especially vulnerable to effects of sediment deposition, bedload movement, and changes in channel morphology (Weaver and Fraley 1991a); 6) bull trout are vulnerable to hybridization with brook trout, a widely introduced species, as well as competition with other introduced exotics (e.g., lake trout) that can displace native bull trout; and 7) bull trout require colder water temperature than other native salmonids (Rieman and McIntyre 1993), thus restricting the available habitat compared to other salmonids and making them especially vulnerable to habitat alterations that affect stream temperatures.

Relationship of Subpopulations to Survival and Recovery of Bull Trout in a DPS

Leary and Allendorf (1997) reported evidence of genetic divergence among bull trout subpopulations, indicating relatively little genetic exchange between them. Recolonization of habitat where isolated bull trout subpopulations have been lost is either unlikely to occur (Rieman

and McIntyre 1993) or will only occur over extremely lengthy time periods. Remnant or regional populations without the connectivity to refound or support local populations have a greater likelihood of extinction (Rieman and McIntyre 1993; Rieman et al. 1997; Montana Bull Trout Scientific Group 1998).

Healy and Prince (1995) reported that, because phenotypic diversity is a consequence of the genotype interacting with the habitat, the conservation of phenotypic diversity is achieved through conservation of the subpopulation within its habitat. They further note that adaptive variation among salmonids has been observed to occur under relatively short time frames (e.g., changes in genetic composition of salmonids raised in hatcheries; rapid emergence of divergent phenotypes for salmonids introduced to new environments). Healy and Prince (1995) conclude that while the loss of a few subpopulations within an ecosystem might have only a small effect on overall genetic diversity, the effect on phenotypic diversity and, potentially, overall population viability could be substantial. This concept of preserving variation in phenotypic traits that is determined by both genetic and environmental (i.e., local habitat) factors has also been identified by Hard (1995) as an important component in maintaining intraspecific adaptability (i.e., phenotypic plasticity) and ecological diversity within a genotype. He argues that adaptive processes are not entirely encompassed by the interpretation of molecular genetic data; in other words, phenotypic and genetic variation in adaptive traits may exist without detectable variation at the molecular genetic level, particularly for neutral genetic markers. Therefore, the effective conservation of genetic diversity necessarily involves consideration of the conservation of biological units smaller than taxonomic species (or DPSs). Reflecting this theme, the maintenance of local subpopulations has been specifically emphasized as a mechanism for the conservation of bull trout (Rieman and McIntyre 1993).

Based on this information, the FWS concludes that each bull trout subpopulation is an important phenotypic, genetic, and distributional component of its respective DPS. Therefore, adverse effects that compromise the functional integrity of a bull trout subpopulation will be considered an appreciable reduction in the likelihood of survival and recovery of the DPS by reducing its distribution and potential ecological and genetic diversity.

Westslope Cutthroat Trout *(Oncorhynchus clarki lewisi)*

Westslope cutthroat trout (WCT) are classified as a species of concern at the federal level and in all three states of the NFHCP action area, Montana, Idaho, and Washington. On June 6, 1997, the FWS received a formal petition to list WCT as threatened throughout their range under the Act and to designate critical habitat. On June 10, 1998, the FWS published a notice in the Federal Register (63 FR 31691) of a 90-day finding that the amended WCT petition contained substantial information that indicated the listing of the subspecies may be warranted. On April 14, 2000, the FWS published in the Federal Register (65 FR 20120) that after review of all the available scientific and commercial information, the listing of WCT was not warranted at that time.

Distribution and Status

WCT were first recorded in 1805 by the Lewis and Clark expedition (Behnke 1992). Early explorers' journals suggest that WCT were extremely abundant and widely distributed (Trotter and Bisson 1988).

WCT were once abundant through most of the north and central Columbia River basin and were probably the earliest salmonid to populate the headwaters of the basin. Behnke (1992) thought that WCT originally populated the upper Columbia River basin prior to formation of barrier falls, enabling them to colonize the upper drainages above what are now impassable upstream barriers that have limited the distribution of other species in the basin. Behnke (1992) suggested that populations in the John Day drainage of Oregon and along the eastern slope of the Cascades in Washington may have been established from the core distribution in what is now Idaho and Montana, through glacial Lake Missoula floods 15,000 to 12,000 years ago. Schultz (1941) believed that headwater transfers probably accounted for distributions in the upper Missouri and South Saskatchewan river basins east of the Continental Divide, and Behnke (1992) believed such factors accounted for WCT distributions in central Idaho as well.

Currently, WCT appear to be more restricted compared to historical conditions (Rieman and Apperson 1989, Liknes and Graham 1988). The known and predicted status information analyzed by Quigley and Arbelbide (1997) indicated that WCT remain widely distributed within their historical range, inhabiting at least 85 percent of the historical range. In addition, the historical range of WCT represented about 35 percent of the Columbia River basin. They reported that some extension of the natural distribution has also occurred through hatchery introductions. Of the historical range within the Columbia River basin, WCT remain strong in only 22 percent of that range (Thurow et al. 1997).

Where habitat remains in relatively good condition WCT are often found in most streams accessible to them (Rieman and Apperson 1989; Rieman and McIntyre 1993) and probably also occupy many natural lakes within the range as well (Quigley and Arbelbide 1997). Although this species is widely distributed, local extirpations are evident throughout its range and there appear to be few remaining healthy populations outside the Central Idaho Mountains and potentially the Northern Cascades. Therefore, WCT may be seriously compromised by habitat loss and genetic introgression (McIntyre and Rieman 1995, Rieman and Apperson 1989). Between 1966 and 1972 WCT were listed in the Service's Redbook of endangered and threatened species. Presently, fish management agencies consider it a sensitive or vulnerable species in Washington, Oregon, Idaho, and Montana (Quigley and Arbelbide 1997).

Rieman and Apperson (1989) estimated that strong WCT numbers persisted in 11 percent of the historical range in Idaho, and populations that were both numerically strong and genetically pure existed in 4 percent of the historical range. Liknes and Graham (1988) estimated that the

subspecies still occupied 27 percent of the historical range in Montana, and were genetically pure in only 2.5 percent. Quigley and Arbelbide (1997) suggested that the largest extirpations may have occurred outside the Columbia River basin because their analysis indicated that WCT still occupy nearly 80 percent of that portion of historical range within the Columbia River basin in Montana. Discrepancies in their results may be from resolution of the data because their summary was based on subwatersheds rather than on stream reaches. Regardless, Quigley and Arbelbide's (1997) information supported the notion that few strong WCT populations are left in Montana and WCT continue to decline as first documented over 25 years ago (Hanzel 1959).

Presently, the native distribution of WCT 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, WCT 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). WCT also occur in the Salmon and Clearwater drainages of the Snake River system (Behnke 1992). Within the NFHCP action area, WCT are widely distributed throughout many river drainages (mainstems and tributaries), as indicated on Map 4.6-4 (Montana, Idaho, and Washington) in the FEIS (page 237).

Life History Characteristics

Three life-history forms of WCT are commonly identified as adfluvial, fluvial, or resident. All three may occur in a single basin. Adfluvial forms migrate up lake tributaries to spawn, and live and grow in large lakes. Fluvial fish spawn in small tributaries of larger river systems, spend 2 to3 years in the tributary, and then migrate downstream to larger rivers where they live and grow. They return to their natal streams at age 4-5 to spawn. Resident fish spend their entire life in tributary streams, and generally remain less than 11.8 inches in length and may predominate in headwater areas. Migratory forms are more common in mid- and lower basin habitats (Averett and MacPhee 1971; Rieman and Apperson 1989; McIntyre and Rieman 1995).

In the portions of the Columbia River basin supporting WCT most waters are relatively cold and nutrient poor (Liknes and Graham 1988; Rieman and Apperson 1989). Growth varies widely and is probably influenced by stream and lake productivity. Growth is also consistently higher for migrant forms that spend some period in larger rivers or lakes (Rieman and Apperson 1989). Growth likely has an important influence on the relative productivity and resilience of populations to disturbance and increased mortality (Rieman and Apperson 1989). The patterns of movement and distribution suggest that landscapes may play an important role in the expression of life history.

Habitat Relationships

WCT will use all available types of habitat (for example, pools, riffles, glides, rapids, and pocket water) (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 (Ireland 1993). WCT have been found in stream reaches with 20 percent to 80 percent of the channel as pools and often in pools of fair to very poor quality (Platts 1974). Pools also provide important winter habitat for WCT (McIntyre and Rieman 1995).

WCT occur over a wide range of substrate types. Weaver and Fraley (1991b) observed that high levels of fine sediments can negatively influence embryo survival, emergence success, and winter rearing of juvenile trout. Accurately predicting the effects of fine sediment on wild populations remains difficult (Chapman 1988). Platts (1974) found WCT in sites with a range of 0 to 60 percent fine sediments.

WCT 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 (1974) observed WCT 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. They tend to be found in cooler stream reaches. 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).

Some research indicates that WCT do not exhibit preference for certain habitat types (e.g., large amounts of LWD), but instead WCT use habitats in proportion to their availability. Plum Creek Timber Company (1999) reported that frequencies of WCT occurrences, when plotted against the distribution of percent surface fine sediments within habitat units, and against the density of LWD per 100 meters (328 feet) of stream length, show that relative WCT distributions of occurrence is roughly equal to the frequency of occurrence of the habitat variables. If WCT exhibited a preference, the distribution of WCT would be skewed in the direction of preference, which is not the case corresponding to Plum Creek's research. Hence, these data suggest WCT tend to use habitats 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 therefore uncertain.

Spawning and Incubation

WCT trout mature at age three, but first spawning occurs mostly at age four or five. Spawning usually occurs between March and July when water temperatures are near 50 °F (Roscoe 1974; Shepard et al. 1984). Sexually maturing fluvial and adfluvial fish move near spawning tributaries in fall and winter where they remain until migrating upstream in the spring (Liknes 1984). Spawning occurs predominantly in smaller, low order headwater streams (Rieman and Apperson 1989). Individuals may only spawn every other year (Shepard et al. 1984). Male-to-female sex ratios of spawners range from 1:1 to as much as 1:6.2 (Huston et al. 1984), and repeat spawners comprise less than 25 percent of the adult populations (Shepard et al. 1984). Most adults return to the larger rivers and lakes after spawning (Rieman and Apperson 1989; Behnke 1992).

Spawning WCT use low gradient areas with gravel/cobble substrate ranging in size from 2 mm to 75 mm, mean water depths between 17 and 20 cm, and mean velocities ranging from 0.3 to 0.4 m/sec (Liknes 1984; Shepard et al. 1984). Proximity of cover for adult fish before and during spawning is an important habitat component. Spawning occurs primarily in small tributaries (McIntyre and Rieman 1995). Egg incubation period varies depending upon water temperature, from 19 days at 60 °F to 80 days at 40 °F (Piper et al. 1982). Successful incubation of embryos requires cold water temperatures below 50 °F (Shepard et al. 1984), gravel/cobble substrate with high permeability to allow water to flow over incubating eggs, and low levels of fine sediment (sediment particles smaller than 0.25 inches in diameter) (Weaver and Fraley 1991b). Mortality of eggs or fry can be caused by scouring during high flows, superimposition of redds, or deposition of fine sediments or organic materials that smother the eggs or fry (MBTSG 1998). Weaver and Fraley (1991b) demonstrated a negative relationship between emergence success and the percentage of fine sediments. Entombment appeared to be the largest mortality factor in incubation studies in the Flathead drainage (Weaver and Fraley 1991b). Groundwater influence probably plays a large role in embryo development and survival by mitigating mortality factors.

Juvenile Rearing

Juvenile fry typically emerge in mid-June to mid-July at a length of approximately .79 inches (Shepard et al. 1984). Many then disperse downstream, coincident with peak flows. Juveniles remain in first to fourth order natal streams from 1 to 4 years before migrating downstream to larger rivers or lakes where they mature, grow, and live (Thurow and Bjornn 1978, Huston et al. 1984; Liknes and Graham 1988; McIntyre and Rieman 1995). Fry generally occupy the stream margins, low velocity areas, backwater, and side channels (McIntyre and Rieman 1995), and then move into main channel pools as they grow larger.

Juvenile WCT are most often located in pools and runs with cold summer water temperatures (44.6 °F - 60.8 °F), sufficient surface and groundwater flows, and complex forms of cover (Fraley and Graham 1981; McIntyre and Rieman 1995). They generally forage near the bottom, and tend

to use the interstitial space in the substrate for cover and feeding (Peters 1988). Therefore, high sediment levels and embeddedness can result in decreased rearing densities, as well as lower invertebrate production. Highly embedded substrates have been negatively correlated with juvenile abundance (Thurow 1987) and may be particularly harmful to trout that enter the substrate in winter (Peters 1988; Wilson and others 1987). Nevertheless, some populations clearly persist in systems with very high sediment levels (Magee and others 1996). Increased fine sediments in substrates must be viewed as an increased risk for any population, but precise quantification of expected losses is unrealistic (Quigley and Arbelbide 1997).

WCT are most abundant in stream reaches with a 6 to14 percent gradient (Fausch 1988). Brook trout are most abundant at gradients less than 3 percent, so higher gradient waters may also provide a refuge from brook trout (Fausch 1988). Highly variable streamflow, reduction in large woody debris and other cover, bedload movement, and other forms of channel instability can limit the distribution and abundance of juvenile WCT. Warmer temperatures are associated with lower WCT densities, and can increase the risk of invasion by other species with higher thermal tolerances that could displace, compete with, or prey on juvenile WCT (Mullan et al. 1992).

Adults and Subadults

The distribution and abundance of larger (>6 inches) WCT has been strongly associated with the number and quality of pools (Ireland 1993; Peters 1988; Pratt 1984; Shepard 1983). High quality pools appear to be especially important as wintering habitats (Lewynsky 1986; Peters 1988). Pool habitat should comprise 35-60 percent or the total area, and at least 30 percent of pools should be high quality (Hickman and Raleigh 1982). Habitats that provide some form of cover also seem to be strongly preferred (Griffith 1970; Lider 1985; Pratt 1984). Fraley and Graham (1981) found the best models for predicting the distribution of trout in the Flathead River basin included cover as an independent variable.

Both migratory and stream-resident WCT move in response to developmental and seasonal habitat requirements. Migratory individuals can move long distances in response to spawning, rearing, and habitat needs (Bjornn and Mallet 1964; Liknes 1984). Resident trout also migrate within tributary stream networks for spawning purposes, as well as in response to changes in seasonal habitat requirements and conditions. Instream movement is often associated with seasonal changes in water temperatures, and is influenced by habitat quality. In areas with an abundance of high quality pools, very little movement of WCT has been observed (Peters 1988). In areas with fewer pools, WCT often migrate considerable distances, presumably in search of suitable thermal conditions (Lewynsky 1986; Peters 1988). Migration out of tributaries by most sub-adults occurs during spring and early summer, and most migration occurs at night (Huston et al. 1984).

Most migratory WCT rear in smaller tributaries for 1 year or more (usually 2 to 3 years) before moving into large rivers (third order and greater) downstream (McIntyre and Rieman 1995). Once they reach large river habitats, they can remain there for brief periods, or for as long as several years, before either moving into lakes or returning to tributary streams to spawn. During their river residency, WCT are most often located in pools with overhead cover and cool water. Commonly, they make long-distance annual or seasonal movements among various riverine habitats, apparently in search of foraging opportunities and refuge from warm, low-water conditions in mid-summer and ice in winter. Little is known about these movement patterns among sub-basins, but it is likely that river residency and migratory behavior in each stock largely reflects local adaptation to the specific array of suitable habitats historically available in the basin (MBTSG 1998).

Lakes and reservoirs are critically important to adfluvial WCT populations. Large bodies of standing water form the primary habitat for rearing of migratory subadults and provide food and cover for fish to achieve growth and maturation (MBTSG 1998). Growth rates of subadults and adults increase substantially as they enter large river and lake environments with higher productivity (Rieman and Apperson 1989). In lakes, WCT are generally located in the top of the thermocline, provided water temperatures there are less than 59 °F (McIntyre and Rieman 1995).

Introduced species, especially lake trout *(Salvelinus namaycush)* and Mysis shrimp *(Mysis relicta)* in combination, have been implicated in drastically altering the food web where they occur, which has likely led to declines or extinctions of WCT in many lakes (McIntyre 1998). Behnke (1992) speculated that non-native kokanee, lake trout, and lake whitefish are important causes of decline through predation and competition in lakes. Mysis have also been introduced in several lakes in Idaho and Montana and might influence WCT populations (Bowles and others 1991).

Factors Affecting WCT Status

Introduced species have played a key role in the current status of WCT. Non-native salmonids have been introduced throughout the range of WCT including Glacier National Park (Marnell 1988). Behnke (1992) concluded that brown, brook, and rainbow trout along with changes in flow and water quality, were responsible for the demise of some WCT populations in the Spokane and Clark Fork river drainages. Fausch (1988, 1989) suggested that the persistence of WCT is jeopardized in streams also supporting brook or brown trout. Brook trout are thought to have replaced many WCT populations in headwater streams (Behnke 1992), but the mechanism of interaction is not clear (Fausch 1988; Griffith 1988). When the two species coexist, WCT seem to predominate in the higher gradient reaches (Griffith 1988), while brook trout may prevail in lower gradients (Fausch 1989).

Although closely related, WCT and rainbow trout have remained reproductively distinct (Behnke 1992) where they evolved together. However, where non-native rainbow trout have been

introduced, hybridization is widespread (Behnke and Zarn 1976; Rieman and Apperson 1989). Yellowstone cutthroat trout have also been widely introduced into the WCT range and hybridization between these two forms is common (Liknes 1984; Rieman and Apperson 1989). Genetic introgression was believed to be the most important cause for decline of WCT populations in Montana (Liknes and Graham 1988), and may compromise populations throughout the range.

Angling is an important factor affecting the status of these fish. WCT are highly susceptible to angling (Behnke 1992; Lewynsky 1986), and many populations have increased in response to harvest restrictions (Johnson and Bjornn 1978; Peters 1988; Rieman and Apperson 1989; Thurow and Bjornn 1978). Rieman and Apperson (1989) found evidence of a depensatory effect in fishing (mortality increased with decline in population size) and speculated that harvest could lead to the elimination of some small populations. Harvest restrictions may be necessary to maintain most WCT populations (Rieman and Apperson 1989). Most state fish management agencies limit harvest of native WCT with restrictive angling regulations.

Habitat disruption is a factor consistently identified in the decline in the status of WCT. Habitat loss and degradation are primary concerns for persistence of WCT (Liknes 1984; Liknes and Graham 1988; Rieman and Apperson 1989). Accumulation of fine sediments has been a primary concern for biologists dealing with fish habitat relations (for example, Rieman and Apperson 1989; Stowell et al. 1983). In watersheds within the belt geologies of northern Idaho and western Montana, excessive bedload transport and scour are problems associated with watershed disruption and increased peak flow events (Cross and Everest 1995). In low gradient channels bed aggradation may result both in the loss of pools or pool volume, and in channel dewatering during low flow periods. The relatively simple, unstable channels that result from intensive management of these sub-basins were overlooked as problems as earlier concerns focused on fine sediments (Gamblin 1988; Rieman and Apperson 1989). Intensive management may lead to habitat disruption through a variety of mechanisms.

The current abundance of WCT appears to be restricted from historical conditions (Behnke 1992; Bjornn and Liknes 1986; Liknes and Graham 1988; Rieman and Apperson 1989). Local extirpations are also evident in portions of the range. Construction of dams, irrigation diversions, or other migration barriers has isolated or eliminated WCT habitats that were once available to migratory populations (Rieman and Apperson 1989). Resident forms may persist in isolated segments of streams but the loss of the migratory life-history and the connection with other populations potentially important to gene flow or metapopulation dynamics, may seriously compromise the potential for long-term persistence (McIntyre and Rieman 1995). Climate change might be important in further restriction of WCT populations (Mullan and others 1992; Rieman and McIntyre 1995). Although small and often isolated populations appear to persist throughout the range, the long-term outlook for many of these is poor (Quigley and Arbelbide 1997).

There is little chance that populations strongly influenced by introgressive hybridization can ever be recovered as genetically pure. Because most of the genetic variation in the subspecies occurs among rather than within populations (Allendorf and Leary 1988) maintenance of the few remaining strong populations could be critical to preservation of remaining genetic diversity.

According to Quigley and Arbelbide (1997), the core of the distribution for strong populations is clearly associated with the central Idaho mountains, and many populations there appear secure. Other important regions of known or likely habitat are in Idaho and Montana within the upper Clark Fork and northern glaciated mountains. These later areas, however, are more fragmented and restricted to a relatively smaller portion of the historical distribution than the core of subwatersheds associated with central Idaho. Further erosion of remaining strongholds could influence both the broad representation of and the potential for long-term persistence of WCT.

WCT distribution and status in the Northern Cascades is poorly known. WCT were probably never widely distributed within the Blue Mountain or Columbia Plateau and only remnant or strongly isolated populations are found there now (Quigley and Arbelbide 1997). Conservation of the remaining populations within the latter three regions may be more difficult but particularly important to conservation of the historical distribution and evolutionary legacy of WCT. Increased attention to the plight of native fishes has slowed the decline of WCT in Montana, although populations continue to become extirpated (MFWP 1998).

The causes for decline of WCT are varied. Many strong populations in Idaho and Montana occurred largely in roadless and wilderness areas or national parks (Liknes 1984; Liknes and Graham 1988; Marnell 1988; Rieman and Apperson 1989) suggesting that human activities have been an important factor in WCT declines. In general, strong populations are thought to be primarily associated with areas of limited human influence and the potential effects of fishing, watershed disturbance and non-native introductions (Rieman and Apperson 1989). The association of current distributions with areas of lower road density and with wilderness or low management impact in the classification-tree analysis is consistent with this view.

According to a recent summary by the USDI (1999) of the factors affecting WCT these include, but are not limited to the following: 1) habitat loss and degradation, 2) recreational over- fishing, 3) predation, particularly by non-native introduced species, 4) disease, especially whirling disease which can affect WCT populations where they overlap with rainbow trout, 5) inadequacy of existing regulatory mechanisms, 6) introduced species which compete for food resources and hybridize with WCT, and 7) fragmentation of habitat due to human-caused physical barriers, thermal barriers, and dewatered sections of streams. Strongholds of WCT are generally in unroaded areas that have potential to maintain natural processes and function as refugia (Liknes and Graham 1988; Marnell 1988; Van Eimeren 1996).

Although there is little data available regarding trends in individual populations, it is apparent that the population of WCT as a whole, has declined dramatically over the past several decades. As inferred above past and current causes of decline include habitat degradation resulting from a variety of land management practices, construction of dams and other barriers, alteration of water quality and quantity, overutilization, and introduction of normative fishes that compete with, prey on, and hybridize with WCT.

Redband Trout *(Oncorhynchus mykiss gairdneri)*

The rainbow trout is a widely distributed western North America native salmonid. The historical range of all forms of redband trout (RBT), a form of the rainbow, included freshwaters west of the Rocky Mountains, extending from northern California to northern British Columbia, Canada (Behnke 1992). RBT were widely distributed and occupied most accessible waters from the southern desert sub-basins to the high mountain coniferous forests (Behnke 1992; the following are as cited in Quigley and Arbelbide 1997 - Cope 1879; Cope 1889; Gilbert and Evermann 1895; Jordan 1892; Jordan and Evermann 1896; Jordan and others 1930; Snyder 1908).

Behnke (1992) divides the species into RBT and coastal rainbow trout (*O. m. gairdneri* and *O. m. irideus*). Redbands were subdivided into two major subdivisions: 1) interior Columbia River RBT upstream of Celilo Falls, including the Fraser and Athabasca rivers in Canada, the upper Klamath River basin, and the isolated interior sub-basins of Oregon; and 2) the Sacramento-San Joaquin RBT. Redbands and coastal rainbow forms do not show clear-cut distinctions as do some subspecies. However, they do reflect a continuum of differentiation that indicates a high degree of diversity and adaptive specialization (Howell 1997). Redbands, like coastal rainbows, have various migratory and resident life histories. Even though there are obvious physical and behavioral differences between resident redbands and steelhead (anadromous *O. mykiss*), the extent of reproductive isolation where they occur sympatrically remains uncertain (Howell 1997). Although the systematics are incomplete, physical characteristics and genetic studies support the view that Behnke's rainbow trout forms warrant sub-specific recognition (Quigley and Arbelbide 1997).

Distribution

Oncorhynchus mykiss in the Columbia River basin have two distinct life histories, anadromous (steelhead) and nonanadromous (Quigley and Arbelbide 1997). Quigley and Arbelbide (1997) considered allopatric RBT those that evolved outside the historical range of steelhead and assumed the allopatric form was potentially genetically and evolutionarily distinct from other RBT because of this isolation. They considered sympatric RBT to be the non-anadromous form historically derived from or associated with steelhead. Morphologically, anadromous and non-anadromous *Oncorhynchus mykiss* juveniles are indistinguishable, and it's likely that the life history differences have evolved repeatedly from a single form throughout the basin (Quigley and

Arbelbide 1997). Inland, or resident, freshwater RBT consist of three major groups (Behnke 1992): 1) RBT of the Columbia River basin east of the Cascade Mountains and the upper Fraser River basin (a subspecies present within the NFHCP action area); 2) RBT of the Sacramento River basin; and 3) coastal rainbow trout. Other subspecies of RBT have been described, but they have not been consistently distinguished from these three groups (Behnke 1992).

The interior RBT was more widely distributed within the Columbia River basin than any other salmonid (Behnke 1992). The only major areas within the Columbia River basin that did not support RBT were the Snake River upstream from Shoshone Falls, tributaries to the Spokane River above Spokane Falls, Eastern Rocky Mountain sub-basins in Montana, and portions of the northern Great Basin in Oregon (Quigley and Arbelbide 1997). RBT probably replaced native cutthroat trout in many sub-basins within the last 30,000 years, perhaps favored by climatic and hydrologic events during and following glaciation (Behnke 1992). Native RBT are likely being replaced by introgressed forms of RBT, hybrids with introduced rainbow or cutthroat trout.

Based on known and predicted status and distribution, Quigley and Arbelbide (1997) reported that RBT remain the most widely distributed key salmonid in the Columbia River basin, with sympatric and allopatric forms jointly known or predicted to occupy 47 percent of the entire basin. They estimated that RBT occur in 64 percent of their combined historical range, but despite their broad distribution, less is unknown about the current distribution of RBT than any of the other key salmonids. About 30 percent of the historical range was not classified (unknown occurrence) and another 37 percent of the historical range was judged to support RBT but too little information was available to evaluate status (Quigley and Arbelbide 1997).

Despite their broad distribution, relatively few strong sympatric RBT populations were identified by Quigley and Arbelbide (1997). Known or predicted strong areas included 17 percent of the potential historical range and 24 percent of the present distribution. Allopatric RBT had fewer strong populations, including 9 percent of the potential historical range and 18 percent of the present distribution (Quigley and Arbelbide 1997). Allopatric RBT populations are least well distributed in the Northern Great Basin and Columbia Plateau where they are believed absent in 72 percent of the potential historical range and few strong populations were known or predicted within the present distribution (Quigley and Arbelbide 1997).

The long history of stocking rainbow trout within the Columbia River basin, and the proclivity for redband and rainbow trout to hybridize, suggested to Quigley and Arbelbide (1997) that the true distribution and status of the original genotypes could be more depressed than their estimates indicate. Preliminary status reviews in Idaho, Oregon and Montana generally support this concern (Perkinson 1995). Introgressive hybridization is viewed as one of the most pervasive problems in the management of other non-anadromous native salmonids (Allendorf and Leary 1988; Liknes and Graham 1988) and may be a serious threat to many fishes in general (Quigley and Arbelbide 1997).

Those RBT found in the action area are Columbia River basin inland RBT and are predominantly residents of freshwater streams. However, a few lacustrine (lake dwelling) populations of Columbia River basin RBT are present in the upper Columbia River and Fraser River basins, and are commonly referred to as Kamloops trout (Behnke 1992). Within the action area, most RBT are found in tributaries to the Kootenai River, which is a major tributary to the upper Columbia River. RBT distribution in Action area sub-basins is shown on Map 4.6-5 in the FEIS (page 243).

The RBT is considered a species of special concern by the American Fisheries Society, and is classified as a sensitive species by the USFS and BLM (Williams and others 1989). In 1994, the Kootenai River RBT in northern Idaho and Montana was petitioned for listing under the federal Act and are identified as a species of concern in the states of Montana and Idaho. Columbia River Basin RBT are undergoing a status review at the federal level.

Life History Characteristics

The life history and habitat requirements of the different subspecies of rainbow trout are essentially the same; however, there are several forms whose life histories are variable and have been described including adfluvial and fluvial migratory forms, non-migratory resident or stream-dwelling forms. Their main differences are in geographic location/isolation and morphological characteristics (physical appearance) (Behnke 1992). In most areas, interior RBT have adfluvial life histories, migrating between highly productive rearing areas in lakes and spawning areas in streams, or between productive marshes and streams. Adfluvial RBT (such as Kamloops rainbow trout) migrate from lentic waters to tributaries and fluvial RBT remain in flowing waters throughout their entire life cycle, using streams ranging from small tributaries to large rivers (Moyle and others 1989). Smaller stream-resident RBT are typically insectivorous while larger lake-residents eat small fish as well as insects.

The ecology of RBT remains largely unknown although many early life-history characteristics may be similar to those for steelhead. Other rainbow trout may also be representative, but because of the potential effects of introgression with introduced forms, that representation is not clear. It appears that steelhead confined above barriers adopt a non-anadromous lifestyle appropriate to the habitats available (Moffit and Bjornn 1984) but retain the potential for anadromy (Mullan and others 1992).

Allopatric RBT are isolated in small patches of habitat above migration barriers and persist with only minimal movements. Movement among populations may be an important mechanism for maintenance of genetic variability in populations (Leary and others 1992) and for their persistence in variable environments.

Little is known about the interaction of RBT with other species. Where redband and westslope cutthroat trout are naturally sympatric, the two species appear to have evolved segregative strategies (Rieman and Apperson 1989).

Habitat Relationships

RBT may be found in a wide range of conditions, often more extreme than those associated with other species. The species inhabit a variety of stream types and has been observed at stream gradients of 0.1 to 24 percent (Quigley and Arbelbide 1997), although Muhlfeld (1999) observed a negative relationship between stream gradient and RBT densities in sloped box canyon streams in Montana. Populations are found inhabiting desert environments with turbid and alkaline waters that range from near freezing to over 77 °F. RBT are often found in warmer waters than other salmonids. Growth has been positively associated with temperature in forested streams (Mullan and others 1992), but there are likely limits to their tolerance, however. In warmer and drier environments the loss of riparian cover has been associated with reduced numbers and production of fish (Li et al. 1994; Tait et al. 1994).

RBT are broadly distributed within the Columbia River Basin and occupy a wide range of biophysical settings (Quigley and Arbelbide 1997). RBT were more likely to be present or strong in watersheds less influenced by land management on USFS administered land, in mid-size or smaller streams, and in higher gradient streams, with more solar radiation, precipitation greater than about 12 inches, and mean temperatures less than 46.4 - 48.2 °F (Quigley and Arbelbide 1997).

Muhlfeld (1999) observed that RBT in small forested streams in western Montana were limited in distribution primarily to lower gradient headwater reaches (>4 percent) and no RBT were found in gradients steeper than 10 percent due to barriers to fish migration and inadequate habitat conditions. Suitable RBT habitat was associated with small low-gradient reaches with abundant pool habitat and narrow widths. This compares with other research on cutthroat trout and brook trout where distribution was found to be limited to channel slopes less than 10 percent, particularly in high elevation streams (Bozek and Hubert 1992; Kruse et al. 1997; Chisholm and Hubert 1986). It has been established that often brook trout dominate rainbow trout in slow, low-gradient streams, which led Muhlfeld (1999) to reason why the abundance of RBT is lower in the low-gradient reaches of the Yaak River in Montana where non-native brook trout were introduced.

Habitat use patterns of redband are generally similar to other salmonids (Quigley and Arbelbide 1997). Thurow (1988) found RBT most abundant in pool habitats and in association with cover components including undercut banks, large woody debris, and overhanging vegetation. Muhlfeld (1999) reported that low gradient stream reaches with abundant pool habitat supported the highest densities of RBT during summer. RBT, like steelhead, may be associated with higher

gradient channels, often in riffles or with substrates dominated by boulders, cobbles and pocket water (Kunkel 1976). Water depth was postulated to be an important microhabitat feature in summer for old-aged fish in two small-sized streams in western Montana (Muhlfeld 1999).

Spawning and Rearing

RBT are primarily spring spawners (February-June) (Quigley and Arbelbide 1997) depending on geographic location, although they may reproduce at any time of the year (Kunkel 1976). Spawning occurs when water temperatures exceed about 35 to 39 °F (Stolz and Schnell 1991). RBT spawn exclusively in flowing waters and typically migrate to spawning areas. Thurow (1990) observed allopatric RBT migrating upstream to suitable spawning locations in spring. Migration timing is likely effected by water temperature and stream flow. Following spawning allopatric RBT may maintain restricted home ranges until migrating to overwintering areas in the fall (Thurow 1990).

During the rearing season, resident RBT are found in cool, clear, fast-flowing permanent streams where riffles tend to predominate over pools (Moyle 1976). Migratory juveniles typically move downstream to their ancestral lake or river after1 to 3 years of rearing in or near their natal area. Sexual maturity typically occurs at 3 to 5 years. Growth is variable but likely dependent on genetic and environmental conditions. Use of substrate and cover by juvenile and adult RBT did not show an apparent preference for any particular substrate size (Muhlfeld 1999). In summer, adults and juvenile fish used more cover than expected; however, young-of-the-year age class were found along stream margins with virtually no cover (Muhlfeld 1999).

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. Juvenile and adult RBT were observed more than expected in deeper, slower habitats with more total cover and smaller substrates, but appeared to occupy higher velocities during higher flows in order to maintain positions in deep areas of the stream (Muhfeld 1999). These sites may include near-bank instream cover, an undercut bank, instream wood, or boulders and cobbles in riffles (Stolz and Schnell 1991). Fry and small juveniles tend to school in slow, shallow inshore waters or eddies. Preferred water temperatures for rearing RBT 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 the Status of RBT

Environmental factors potentially affecting RBT are essentially the same as those for bull trout and WCT. Hybridization, fragmentation and isolation of habitats, and habitat degradation are the major environmental risk factors affecting the status of RBT.

Hybridization and competition are biotic factors influencing RBT status. At least 35 non-native species have been introduced within the range of RBT in the Columbia River Basin. Introduced fishes create risks of genetic introgression, competition for food and space, predation, and increased exposure to disease (Fausch 1988). Introduced rainbow trout are now the most widely distributed fish in the basin and have contributed to losses of the native RBT genotype through introgression (Behnke 1992). In attempts to reduce introgression some hatchery programs use native brood stocks; however, the practice of selecting for traits that improve fish performance in hatcheries followed by widespread outplanting of a few stocks may also lead to losses of local adaptions (Fausch 1988). Brown trout are widely introduced and represent a potentially important predator and competitor, particularly in the southern range where RBT are associated with warmer water temperatures. In attempts to sustain remaining native RBT, several state agencies have suspended all stocking of non-native species in isolated watersheds.

Fragmentation and isolation of habitats also influence RBT status. If watershed disturbances result in loss of corridors or connecting habitats, remaining RBT populations can be progressively isolated into smaller and smaller patches of productive habitats. Corridors that provide habitat for migration, rearing, and overwintering may be critical to the conservation of species where connections among populations are important (Rieman and McIntyre 1993).

Habitat degradation is a third factor influencing RBT status. Interior RBT habitats have been altered by a host of land use practices (Perkinson 1995; Williams and others 1989). Water diversions for irrigation threatens many populations. Thurow (1988) reported four principal effects of water diversions: dewatering of stream reaches, loss of fish in unscreened diversions, blockage of migration corridors, and alteration of stream channels by earthmoving equipment. The loss or conversion of riparian cover has been caused by grazing, timber harvest, mining, urbanization and agriculture (Meehan 1991). Channel alterations associated with attempts to control flooding, develop floodplains, and construct roads have been extensive. Channel alterations adversely effect stream hydraulics, nutrient pathways, invertebrate production (Behnke 1992) and fish production. In Idaho, unaltered stream reaches supported eight to ten times the densities of RBT observed in altered channels (Thurow 1988).

Although RBT appear to be widely distributed within the Columbia River Basin their status is uncertain taxonomically because of more than a century of stocking non-native rainbow trout and steelhead (Behnke 1992). Habitat degradation, hybridization or competition with introduced species, and a restricted range for some populations are the principal threats to conservation of

remaining RBT populations (Williams and others 1989). RBT appear to have evolved over a broader range of environmental conditions than the other key salmonids and appear to have less specific habitat requirements (Quigley and Arbelbide 1997). Their apparent persistence even in some heavily disturbed sub-basins suggests they are less strongly influenced by habitat disruption than other salmonids. Remaining populations of native RBT in the Columbia River Basin appear to be highly fragmented and restricted to small patches of known or potential habitat.

Mountain Whitefish (*Prosopium williamsoni*)

Mountain whitefish are widely distributed over western United States. It is the most common whitefish species in the Northwest. This species occurs from the Lahontan Basin in Nevada, north through the states of Wyoming, Montana, and Idaho to the Yukon-British-Columbia Border (Scott and Crossman 1973). It occurs in the Great Basin and is widespread and abundant in most of the Columbia River Basin.

Mountain whitefish inhabit lakes and streams, but prefer larger streams over smaller ones. It may be found in small, turbid pools as well as cold deep lakes, but typically frequents the upper 15-20 feet (Scott and Crossman 1973). It rests in deep pools and feeds in riffle areas. It is primarily a bottom feeder foraging on a variety of organisms, but mostly aquatic insect larvae, and occasionally small molluscs and fishes. When bottom fauna is lacking however, mountain whitefish will eat midwater plankton and surface insects (Scott and Crossman 1973). It will also eat eggs of its own as well as that of other species. Mountain whitefish are known to feed more actively in winter than trout and are often sought after by fishermen at this time of year.

Mountain whitefish migrate within stream systems over the course of a year. Whitefish migrate from feeding areas in smaller streams during summer to congregating and spawning areas in medium and larger streams during fall. Whitefish 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. Whitefish also migrate to overwintering areas that consist of deeper-water habitat in larger streams (Shepard et al. 1984; Northcote and Ennis 1994).

Spawning occurs in late fall or early winter (October through early December) when water temperature is less than 48 °F. In Idaho and Montana spawning usually occurs during late October and early November when water temperatures range between 40-45 °F. Spawning occurs almost exclusively in streams, where the eggs are broadcast over the stream bottom, and almost always at night (Brown 1971). This fish is normally a stream spawner but has been found spawning along lake shores in shallow water, although spawning success in lakes 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. It is not unusual to find concentrations of spawners in the lower reaches of some tributaries just prior to spawning. Whitefish will spawn in depths that range from 5 inches to 4 feet and lays its eggs over gravel beds or small rubble where the current is sufficient to keep it

clean. The eggs are small and females produce an average 5,000 or more per fish. Eggs hatch in 35 to 40 days at 52 °F with emergence usually 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.

Mountain whitefish mature sexually at age 3 or 4. Age and growth is highly variable in different drainages in Montana. Under favorable conditions after 1 year of age these fish can reach 4 inches in length, and after 4 and 6 years of age can reach 13 and 16 inches, respectively. Several reports of larger fish, upwards of 20 inches, have been noted.

McPhail (1999) implied mountain whitefish exhibit a geographically patterned genetic variation and distinctive local adaptations of the fluvial life form. However, there is a large gap in knowledge on genetics of this species as well as homing patterns not only to spawning areas, but over-wintering and summer foraging sites. Some evidence indicates that over-wintering foraging sites can be used by more than one population and that large concentrations restricted to wintering areas may be a common phenomenon in this species, which could make them vulnerable to overexploitation (McPhail 1999). McPhail (1999) cautioned that continued increases human exploitation of this species may lead to unexpected impacts.

Pygmy Whitefish (Prosopium coulteri)

The pygmy whitefish is a small species of fish, usually less than 6 inches long. Females are generally larger than males after the first year. Pygmy whitefish can live to be 7 years of age, but average 3 to 4 years (Brown 1971). Although considered a game fish, because of their small size they provide little or no recreational fishing and are mainly a forage fish (Wydoski and Whitney 1979). Pygmy whitefish are known prey for larger piscivorus fish such as kamloop rainbow trout and lake trout, but little is known regarding their importance as forage for larger fish. They are found in lakes and cold streams in the Northwest, although their distribution is the most limited of all the native salmonid Covered species. Where they occur sympatrically, lake whitefish is likely its primary food competitor (Weisel et al. 1973).

During the ice age this species may have been widely distributed across North America (Quigley and Arbelbide 1997). After the glaciers retreated, however, most likely only isolated populations remained (Wydoski and Whitney 1979). Little is known or understood about this species, which has 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 distribution in the Columbia River Basin is also discontinuous. Pygmy whitefish appear to be isolated to a few lakes in the Basin, but lack of information on distribution and abundance makes its current status uncertain. Quigley and Arbelbide (1997) were unable to find abundance data on these populations, and found no reports that confirmed pygmy whitefish presence below Grand Coulee Dam on the Columbia River. Pygmy whitefish are only found in a few locations in Montana, Idaho, and Washington.

Pygmy whitefish life history and habitat requirements are poorly understood and poorly documented. Their habitat is typically deep, cold-water lakes, often glacial lakes. The species is also found in cold streams that have moderate to swift currents and may be silty or clear (Hallock and Mongillo 1998). Pygmy whitefish have been observed in lakes with depths ranging from 15 feet to 120 feet in Canada (Quigley and Arbelbide 1997). No change in depth distribution in relation to season has been noted and it has been suggested that shallower distributions may be related to low dissolved oxygen levels on lake bottoms (Quigley and Arbelbide 1997). Quigley and Arbelbide (1997) postulated that a key factor influencing the status of pygmy whitefish may be increased lake eutrophication caused by nutrient loading from human development, and sediment input from land management activities and practices in watersheds. These factors may affect persistence of this species.

Pygmy whitefish become sexually mature as early as 1 year, produce 400-600 eggs per female (Simpson and Wallace 1982), and often only live 3 to 4 years (Brown 1971). Female pygmy whitefish spawn in consecutive years in Flathead Lake in Montana (Weisel et al. 1973). They spawn in streams and lakes from late summer to early winter, depending on geographic location and elevation. In the Pacific Northwest, spawning occurs from November to January. Pygmy whitefish probably scatter their eggs over coarse gravel, primarily at night, like other whitefish (Brown 1971; Hallock and Mongillo 1998). In Idaho spawning occurs from late October to early November, and in Montana from November to January, after the fish have moved into streams or shallow areas along lake shores.

Food includes plankton, zooplankton, and small aquatic insect larvae. Weisel et al. (1973) observed that pygmy whitefish shifted food items from month to month according to availability, but primary food items were cladocera and chironomid larvae and pupae. Also, Brown (1971) reported cladocera and their ephippia, some copepods and midge larvae were observed in stomach samples from Flathead Lake, Montana. In Lake Pend Oreille, Idaho, pygmy whitefish fed primarily on zooplankton and aquatic insect larvae, mostly midge larvae (Simpson and Wallace 1982). Weisel et al. (1973) observed in a December collection of pygmy whitefish that they actively feed during their spawning period.

Coastal Cutthroat Trout *(Oncorhynchus clarki clarki)*

The following information on the status of this species is mostly derived from Johnsen [and others] 1999, unless otherwise noted.

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. Steelhead is the only other anadromous trout species in the western United States (Behnke 1992).

Distribution

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. In Washington and Oregon, coastal cutthroat trout are widespread west of the crest of the Cascade Mountains. Historically, the range of anadromous *O. c. clarki* may have extended past the Cascade Crest into tributaries of the Columbia River, as far eastward as the Klickitat River. At present, freshwater forms (migrants and nonmigrants) are found at least to the Klickitat River on the Washington side of the Columbia River. At present the Washington Department of Fish and Wildlife (WDFW) has identified 46 individual stocks in Washington.

NMFS has identified six ESUs or DPSs within the range of west coast coastal cutthroat trout in the Pacific Northwest. The action area contains 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 action area, populations belonging to this DPS occur primarily in the Lewis River Basin and the Cowlitz River Basin (North Riffe Lake Planning Area sub-basin) in western Washington, as shown in Map 4.6-4 of the FEIS (page 237).

The Services have proposed that the Southwestern Washington/ Columbia River coastal cutthroat trout ESU be listed as threatened under the Act (Federal Register Vol. 64, No. 64. pages 16397-16414). Restoration of native runs of this DPS is being considered for the Lewis River and Cowlitz River portions of the action area above fish migration barriers. Habitat above such barriers may be considered necessary for species recovery.

Life History

The nonmigratory coastal cutthroat trout life-history form includes fish generally found in small streams and headwater tributaries near spawning and rearing areas. These fish typically undertake only small-scale migrations and maintain relatively small home territories compared to forms that make more extensive migrations. In general, nonmigratory coastal cutthroat trout appear to grow more slowly than other life-history forms of trout, are smaller at maturity, and rarely live longer than 2 to 3 years.

The freshwater-migratory coastal cutthroat trout or potamodromous life-history form includes fish that migrate entirely within fresh water. A variety of distinctive population migrations are frequently recognized within this general classification, including populations that migrate from large tributaries to small tributaries to spawn (fluvial-adfluvial), populations that inhabit lakes and migrate upstream to spawn in the lake inlet (lacustrine-adfluvial), and populations that live in lakes and migrate downstream to spawn in the lake outlet (allucustrine). These freshwater-migratory populations are best documented in rivers and lakes with physical barriers to anadromous fish. Only rarely have nonanadromous river-migrating schools of coastal cutthroat trout been reported below barriers or in locations with access to anadromous fish.

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. Spawning typically starts in December and continues through June, with peak spawning in February (Wydoski and Whitney 1979). In California, spawning is reported to begin in November, with peak spawning in late December in larger river sub-basins and late January and February in the smaller coastal rivers and streams.

Anadromous coastal cutthroat trout spawn in the smaller headwater streams and tributaries of coastal rivers to which they have access (Wydoski and Whitney 1979). Spawning occurs upstream of coho salmon and steelhead spawning zones which may be a means to reduce competition for suitable spawning sites and reduce competitive interactions between young-of-the-year coastal cutthroat trout and other salmonids. These spatial separations may limit hybridization between coastal cutthroat trout and rainbow trout or steelhead. In many drainages where rainbow and coastal cutthroat trout coexist, a slight difference in spawn timing between the two species is believed to reduce the opportunity for hybridization.

Eggs begin to hatch within 6-7 weeks of spawning, depending on temperature; alevins emerge as fry between March and June, with peak emergence in mid-April. Coastal cutthroat trout typically emerge later and at a smaller size than fry of anadromous salmonid other species. At emergence, fry quickly migrate to channel margins and backwaters, where they remain throughout the summer. Coastal cutthroat trout parr generally remain in upper tributaries until they are 1 year of age, when they may begin moving more extensively throughout the river system before moving

downstream to larger streams where they can live for 2 to 9 years. Researchers have found that coastal cutthroat trout that enter the sea generally do so after 2 to 4 years in the freshwater environment. In Washington, most migrate to the ocean when they are 3 years old. Out-migration 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).

Coastal cutthroat trout may return to freshwater feeding/spawning areas from late June through the following April. Re-entry timing has been found to be temporally consistent from year-to-year within streams, but varying widely between streams. As in other species of anadromous salmonids, entry to large rivers seem to occur consistently earlier than to shorter coastal rivers. In small streams, peak returns occur in December and January, and fish may continue to return through March. Northcote (1997) suggested the life history of coastal cutthroat trout may be the most diverse of any Pacific salmonid. Their populations show a bewildering diversity in size and age at migration, timing of migrations, age at maturity, and frequency of repeat spawning. Part of this diversity reflects the way individual fish can move between feeding, refuge, and spawning areas. Even populations where the vast majority of fish are anadromous may have members that do not migrate to sea every year. In other populations, some coastal cutthroat trout simply remain in headwater tributaries, while others may migrate within rivers or lakes and return to headwater tributaries only to spawn. Some lake forms remain in the lakes for their entire life cycle, spawning in shallow inlets or outlets (Behnke 1992; Northcote 1997).

Habitat requirements

Coastal cutthroat trout use a large variety of habitat types, including large and small river systems with a diversity of stream gradients, estuaries, sloughs, ponds, and lakes. Because these fish make extensive use of river sub-basins throughout all or a large portion of their life cycle, they are exposed to a variety of potentially adverse conditions associated with land-use activities. 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). The anadromous form is much more piscivorous than the resident forms while rearing in freshwater (Behnke 1992).

Adults spawners build redds primarily in the tails of pools in streams with low stream gradient and low flows. Coastal cutthroat fry are more abundant in pools, use riffles and glides as well, but have also been found to be fairly evenly distributed between all three habitat types when in sympatry with coho salmon. The reduced use of pools while in sympatry has been interpreted as evidence that coastal cutthroat trout are relegated to riffles by socially dominant coho salmon.

Under-yearling coastal cutthroat trout select the shallower and faster waters in riffles, but may reduce their use of this habitat type in the presence of steelhead. In winter, coastal cutthroat trout move to pools near log jams or overhanging banks.

Coastal cutthroat trout that enter near-shore coastal waters reportedly move moderate distances along the shoreline but do not cross large bodies of open water. It is not clear how far offshore coastal cutthroat trout migrate. Most researchers have found that the subspecies remains in near-shore waters. In Alaska coastal cutthroat trout, whether initial or seasoned migrants, remained at sea an average of only 91 days, with a range of 5 to 158 days. The majority of coastal cutthroat trout seemed to migrate in similar patterns from year-to-year, rarely crossed bodies of water more than 5 miles in width, and closely followed shorelines, sometimes for up to 44 miles.

The relatively brief exposure of sea-run cutthroat trout to seawater, compared to other anadromous salmonids, may vary among populations, at least on relatively large geographic scales, depending on conditions in estuaries and near-shore habitats. In some coastal cutthroat trout populations, only a small proportion of the individuals may be anadromous. Thus, although the marine phase can be very important to sea-run cutthroat trout in enhancing opportunities for growth and dispersal to neighboring drainages, the freshwater phase may be relatively more important for juvenile growth and survival in sea-run cutthroat trout than for other anadromous salmonids, at least in some populations where estuaries are small or near shore habitat is limited.

Status

On December 5, 1997, NMFS received a petition to list what petitioners called sea-run cutthroat trout *(O. c. clarki)* along the coasts of California, Oregon, and Washington under the Act. The petitions asserted that available data indicate natural coastal cutthroat trout populations along the California and Oregon coasts are at "seriously low levels" and "in danger of becoming threatened or endangered." Exceptions to this scenario are populations in the Smith and Winchuck rivers on the California-Oregon border, which the petitioners asserted are "more robust than any of those around them." The petitioners also concluded that the only "healthy populations" along the west coast are north of the Snohomish River in Puget Sound, Washington.

According to the Washington Department of Fish and Wildlife, the southwestern Washington-Lower Columbia River region historically supported healthy and highly productive coastal cutthroat trout populations. Coastal cutthroat trout, especially the freshwater forms, may still be widely distributed in most river sub-basins in this region, although probably in numbers lower than historical population sizes. Severe habitat degradation throughout the lower Columbia River area has contributed to dramatic declines in anadromous coastal cutthroat trout populations and two near extinctions of anadromous runs in the Hood and Sandy rivers. Currently there are extremely low population sizes of anadromous cutthroat trout in lower Columbia River streams and it is thought that the Southwestern Washington/Columbia River ESU may become endangered in the foreseeable future.

In the southwestern Washington portion of this ESU, trends in anadromous adults and outmigrating smolts are all declining. Returns of both naturally- and hatchery-produced coastal cutthroat trout in almost all lower Columbia River streams have been declining markedly for the last 10 to 15 years. There is concern about the widespread declines in abundance and small population sizes of anadromous cutthroat trout throughout the lower Columbia River. The severe reductions in abundance of this life-history form could have deleterious effects on the ability of this ESU to recover from widespread declines. Reductions in the quantity and quality of near-shore ocean, estuarine, and riverine habitat have probably contributed to declines, but the relative importance of these risk factors is not well understood.

Factors Affecting Coastal Cutthroat Trout

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 (Federal Register Vol. 64, No. 64. pages 16397-16414) 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.

A significant risk factor for coastal cutthroat trout in this ESU is reduction in life-history diversity. The limited information available suggests that, in many streams, freshwater forms of coastal cutthroat trout are widely distributed and in high abundances relative to anadromous cutthroat trout in the same stream. It is believed that smolt production by freshwater forms does occur, but that it has not resulted in demonstrably successful reestablishment of anadromous forms. Habitat degradation in stream reaches accessible to anadromous cutthroat trout and poor ocean and estuarine conditions probably have combined to severely deplete this life-history form throughout the lower Columbia River Basin. Without the appropriate freshwater and estuarine habitat for expression of the anadromous life history, a greater risk of extinction may occur.

Negative effects of hatchery coastal cutthroat trout may be contributing to the risks facing natural coastal cutthroat trout in this ESU. The lower Columbia River tributaries are the only streams in Washington still receiving hatchery-origin coastal cutthroat trout, although the total numbers of released hatchery fish have been substantially curtailed recently. The ultimate effects of hatchery fish depend on the relative sizes of hatchery and natural populations, the spatial and temporal overlap of hatchery and natural fish throughout their life cycles, and the actual extent to which hatchery fish spawn naturally and interbreed with naturally produced fish. In addition, the extent to which natural coastal cutthroat trout are incidentally harvested in fisheries targeting hatchery coastal cutthroat trout and other salmonids also affect the magnitude of the risks to coastal cutthroat trout due to hatchery fish.

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. As mentioned above, likely reasons for the decline of the anadromous form include habitat degradation in streams, recreational fishing, and poor ocean and estuarine conditions.

Coastal Rainbow Trout *(Oncorhynchus mykiss irideus)*

Behnke (1992) divides *O. mykiss* into RBT and coastal rainbow trout. Redbands and coastal rainbow forms do not show clear-cut distinctions as do some subspecies. However, they do reflect a continuum of differentiation that indicates a high degree of diversity and adaptive specialization (Howell 1997). Coastal rainbow trout, have various migratory and resident life histories. Additionally, they may overlap with steelhead (anadromous *O. mykiss*), and the extent of reproductive isolation between the two forms is unknown (Howell 1997).

Coastal rainbow trout are a popular game fish throughout most of their distribution. They currently have no special status with either State or Federal agencies in the Planning Area. Because of their popularity as an introduced target of recreational fishing, they have been the subject of artificial propagation efforts throughout the western United States. Concerns for maintaining the genetic diversity of the wild stocks of rainbow trout have been noted by Behnke (1992), and reflect the concerns with hatchery operations for chinook salmon, coho salmon, steelhead, and other salmonids listed under the Act.

Distribution and Status

Oncorhynchus mykiss, including subspecies such as coastal rainbow trout, are a popular game fish that historically occurred from Alaska to Baja California, Mexico. In Washington, coastal rainbow trout (*Oncorhynchus mykiss irideus*) occur in drainages west of the crest of the Cascade mountains. However, specific information on the distribution and status of coastal rainbow trout in Washington is scarce. This situation is exacerbated by 1) numerous introductions of both native and non-native stocks of rainbow trout in lakes and streams of the northwest (Wydoski and Whitney 1979), 2) the likelihood that *O. mykiss* may at times mature in fresh water and spawn prior to ocean migrations, 3) the likelihood that anadromous *O. mykiss* can produce non-anadromous offspring, and 4) the likelihood that anadromous *O. mykiss* can breed with non-anadromous *O. mykiss* (Shapovalov and Taft 1954 *in* NMFS 1997). Further, human development has resulted in the establishment of numerous migration barriers that have isolated populations of formerly anadromous steelhead that may overlap the distribution of coastal rainbow trout or further cloud the picture relative to coastal rainbow trout distribution. With these caveats in mind, "rainbow trout" have often been identified as an indigenous fish stock found in streams on the western slopes of the Cascade Mountains (e.g., Upper Lewis River; USFS 1995).

Life History Characteristics

As indicated for redband trout, above, coastal rainbow trout are likely to be adaptable to different environments, although the range of extremes throughout their distribution is less than that for redband. See discussion under Redband Trout, above.

Factors affecting Rainbow Trout

Factors affecting rainbow trout are similar to those affecting redband trout and other salmonids in the northwest, including competition and genetic disruption from introduced hatchery/non-native fish, habitat alteration affecting water quality, and migration barriers isolating populations. See discussion under Redband Trout, above.

Anadromous Salmon and Steelhead *(Oncorhynchus spp.)*

Definitions Under the Act

Species and ESUs: To qualify for listing as a threatened or endangered species, the identified populations of salmonids must be considered "species" under the Act. The Act defines a "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." NMFS published a policy (56 FR 58612, November 20, 1991) describing the agency's application of the Act definition of "species" to anadromous Pacific salmonid species. NMFS' policy provides that a Pacific salmonid population will be considered distinct and, hence, a species under the Act if it represents an Evolutionarily Significant Unit (ESU) of the biological species.

A population must satisfy two criteria to be considered an ESU: 1) it must be reproductively isolated from other conspecific population units, and 2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation must be strong enough to permit evolutionarily important differences to accrue in different population units. The second criterion is met if the population contributes substantially to the ecological and genetic diversity of the species as a whole. Guidance on the application of this policy is contained in a scientific paper "Pacific Salmon (Oncorhynchus spp.) and the Definition of 'Species' under the Endangered Species Act" (Waples 1991) and a NOAA Technical Memorandum "Definition of 'Species' Under the Endangered Species Act: Application to Pacific Salmon" (NMFS F/NWC-194).

Major types of information for ESUs evaluated by the NMFS Biological Review Team (BRT) included: 1) The physical environment--geology, soil type, air temperature, precipitation, river flow patterns, water temperature, and vegetation; 2) biogeography--marine, estuarine, and

freshwater fish distributions; 3) life history traits--age at smolting, age at spawning, river entry timing, and spawning timing; and 4) genetic evidence for reproductive isolation.

Critical Habitat

Critical habitat is defined in section 3(5)(A) of the Act as 1) the specific areas within the geographical area occupied by the species on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species upon a determination by the Secretary of Commerce that such areas are essential for the conservation of the species.

In designating critical habitat, NMFS considers the following requirements of the species: 1) Space for individual and population growth, and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, or rearing of offspring; and, generally, 5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (see 50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation (see 50 CFR 424.12(b)).

Conservation

The term "conservation," as defined in section 3(3) of the Act, means "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary."

Threatened and Endangered Species

The Act defines the term "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range."

The term "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

NMFS has identified a number of factors that should be considered in evaluating the level of risk faced by an ESU, including: 1) Absolute numbers of fish and their spatial and temporal distribution; 2) current abundance in relation to historical abundance and current carrying capacity of the habitat; 3) trends in abundance; 4) natural and human-influenced factors that cause

variability in survival and abundance; 5) possible threats to genetic integrity (e.g., from strays or outplants from hatchery programs); and 6) recent events (e.g., a drought or changes in harvest management) that have predictable short-term consequences for abundance of the ESU (Weitkamp et al. 1995).

Summary of status reviews and species listings

Concerns about the status of Pacific salmon have prompted and numerous petitions to list various west coast salmonid species under the Act. Status reviews about life history, biology, and assessment of extinction risk have been conducted for chinook salmon (Matthews and Waples 1991; Waples et al. 1991; Meyers et al. 1998), sockeye salmon (Waples, Johnson, and Jones 1991; Gustafson et al.1997), chum salmon (Johnson et al.1997), and steelhead (Busby et al. 1996). Listings, status, and date of listing for those salmonids found within the NFHCP area include: Snake River spring/summer chinook salmon and Snake River fall chinook salmon, threatened, April 1992; Lower Columbia River chinook; Columbia River chum salmon, threatened, March 1999; Snake River steelhead, threatened, August 1997; Lower Columbia River steelhead, threatened, March 1998; Mid-Columbia River steelhead, threatened, March 1999; Lower Columbia River/Southwest Washington coho salmon, candidate, July 1995; Mid-Columbia River spring chinook, not warranted, March 1998; and Upper Columbia River summer/fall chinook, not warranted, March 1998.

Summary of Factors Affecting Anadromous Salmonids

A wide range of activities may affect populations and habitat of listed salmon and steelhead. Often, these activities include water and land management actions undertaken or authorized by Federal agencies such as the U.S. Forest Service, U.S. National Park Service, U.S. Army Corps of Engineers, Federal Energy Regulatory Commission, and Federal Highways Administration. State and private projects can have similar effects that occur unabated because there is no requirement for section 7 consultation.

Habitat Loss

Hydropower development has resulted in blockage and inundation of habitat, turbine related juvenile mortality, increased predation, and migration delays for outmigrating smolts and spawning adults. Irrigation diversions, grazing, logging, mining, farming, dredging, filling, and bank stabilization projects, and urban development have all degraded anadromous salmonid habitat.

In most western states, about 80 to 90 percent of the historic riparian habitat has been eliminated. Further, it has been estimated that during the last 200 years, the lower 48 states have lost over 50

percent of all wetlands and the majority of the rest are severely degraded. Loss of habitat complexity has also contributed to the decline of salmonids. For example, in national forests in Washington, there has been a 58-percent reduction in large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large wood. Similarly, in Oregon, the abundance of large, deep pools on private coastal lands has decreased by as much as 80 percent. Sedimentation from land use activities is recognized as a primary cause of habitat degradation in the range of west coast salmonids.

Overutilization

Overutilization of anadromous fish stocks can occur through commercial and recreation fisheries. Additional takings can occur for scientific or educational purposes. Current ocean and river harvest levels have been greatly restricted for all fisheries, including Indian, due to low escapement and efforts to protect Act listed fishes.

Disease and Predation

Although the extent to which disease and predation impact anadromous fish populations are unknown, there are a number of general observations that indicate impacts. Predator populations, such as northern pikeminnow, terns, and cormorants, have increased dramatically since hydropower development has created ideal foraging opportunities. Marine mammal numbers, particularly harbor seals and sea lions, are increasing on the West Coast and increases by pinnipeds have been noted in all Northwest salmonid fisheries.

Inadequate Regulations

A wide variety of Federal and state laws and programs have affected the abundance and survival of anadromous fish populations in the Columbia River system; however, despite numerous efforts to halt and reverse declining trends, it is clear that the status of many native, naturally-reproducing west coast populations has continued to deteriorate. Past efforts and programs to address the conservation needs of these stocks have proven inadequate, including efforts to reduce mortalities and improve the survival of these stocks through all stages of their life cycle. While many of the ongoing protective efforts are likely to promote the conservation of salmon and steelhead, they do not achieve conservation at a scale that is adequate to protect, conserve, or recover ESUs. Existing efforts often lack some of the critical elements needed to provide a high degree of certainty that the efforts will be successful. These elements include: 1) Identification of specific factors for decline; 2) immediate measures required to protect the best remaining populations and habitats and priorities for restoration activities; 3) explicit and quantifiable objectives and time lines; and 4) monitoring programs to determine the effectiveness of actions.

Other Natural and Manmade Factors

Natural climatic conditions have served to exacerbate the problems associated with degraded and altered riverine and estuarine habitats. Persistent drought conditions reduce already limited spawning, rearing, and migration habitat. Further, unfavorable climatic conditions can decrease ocean productivity while favorable climatic conditions can increase ocean productivity and potentially, to some degree, offset degraded freshwater habitat conditions.

Artificial propagation programs have also affected anadromous fish populations through taking of fish for broodstock, mortality of wild fish through fishing, behavioral and genetic influences, competition, predation, and spread of disease. In an attempt to mitigate the loss of habitat, extensive hatchery programs have been implemented throughout the range of salmon and steelhead on the West Coast. While some of these programs have been successful in providing fishing opportunities, the impacts of these programs on native, naturally reproducing stocks are not well understood, and the dependence on hatchery programs, rather than habitat, may prove detrimental to maintaining healthy, fully-functioning ecosystems.

Introductions of non-native species and habitat modifications have resulted in increased predator populations in numerous river systems, thereby increasing the level of predation experienced by salmonids. Predation by marine mammals is also of concern in areas experiencing dwindling salmon and steelhead run sizes.

Chinook Salmon Life History and Ecology

Chinook salmon (*O. tshawytscha*) are distinguished from other Oncorhynchus species by their large size. Adults weighing over 120 pounds have been caught in North American waters. Chinook salmon are similar to coho salmon (*O. kisutch*) in appearance while at sea (blue-green back with silver flanks), except for their large size, small black spots on both lobes of the tail, and black pigment along the base of the teeth.

Chinook salmon adults migrate from a marine environment into the fresh water streams and rivers of their birth (anadromous) where they spawn and die (semelparous). Adult female chinook prepare a redd, or gravel spawning bed, in a stream area with suitable gravel composition, water depth and velocity. Redds vary widely in size and in location within the stream or river. The adult female chinook may deposit eggs in 4 to 5 "nesting pockets" within a single redd. After laying eggs in a redd, adult chinook guard the redd from 4 to 25 days before dying. Chinook salmon eggs hatch, depending upon water temperatures, between 90 and 150 days after deposition. Stream flow, gravel quality, and silt load all significantly influence the survival of developing chinook salmon eggs. Juvenile chinook may spend from 3 months to 2 years in freshwater after emergence and before migrating to estuarine areas as smolts, and then into the ocean to feed and mature. Historically, chinook salmon ranged as far south as the Ventura River, California, and their northern extent reaches the Russian Far East.

Among chinook salmon, two distinct races have evolved. One race, described as a "stream-type" chinook, is found most commonly in headwater streams. Stream-type chinook salmon have a longer freshwater residency, and perform extensive offshore migrations before returning to their natal streams in the spring or summer months. The second race is called the "ocean-type" chinook, which is commonly found in coastal streams in North America. Ocean-type chinook typically migrate to sea within the first three months of emergence, but they may spend up to a year in freshwater. They also spend their ocean life in coastal waters. Ocean-type chinook salmon return to their natal streams or rivers as spring, winter, fall, summer, and late-fall runs, but summer and fall runs predominate (Healey 1991). The difference between these life history types is also physical, with both genetic and morphological foundations.

Juvenile stream- and ocean-type chinook salmon have adapted to different ecological niches. Ocean-type chinook salmon tend to utilize estuaries and coastal areas more extensively for juvenile rearing. The brackish water areas in estuaries also moderate physiological stress during parr-smolt transition. The development of the ocean-type life history strategy may have been a response to the limited carrying capacity of smaller stream systems and glacially scoured, unproductive, watersheds, or a means of avoiding the impact of seasonal floods in the lower portion of many watersheds (Miller and Brannon, 1982).

Stream-type juveniles are much more dependent on freshwater stream ecosystems because of their extended residence in these areas. A stream-type life history may be adapted to those watersheds, or parts of watersheds, that are more consistently productive and less susceptible to dramatic changes in water flow, or which have environmental conditions that would severely limit the success of sub-yearling smolts (Miller and Brannon 1982; Healey 1991). At the time of saltwater entry, stream-type (yearling) smolts are much larger, averaging 73-134 mm depending on the river system, than their ocean-type (sub-yearling) counterparts and are therefore able to move offshore relatively quickly (Healey 1991).

Coastwide, chinook salmon remain at sea for 1 to 6 years (more commonly 2 to 4 years), with the exception of a small proportion of yearling males (called jack salmon) which mature in freshwater or return after 2 or 3 months in salt water (Rutter 1904; Gilbert 1912; Rich 1920; Mullan et al. 1992). Ocean and stream-type chinook salmon are recovered differentially in coastal and mid-ocean fisheries, indicating divergent migratory routes (Healey 1983 and 1991). Ocean-type chinook salmon tend to migrate along the coast, while stream-type chinook salmon are found far from the coast in the central North Pacific (Healey 1983 and 1991; Myers et al. 1984). Differences in the ocean distribution of specific stocks may be indicative of resource partitioning and may be important to the success of the species as a whole.

A number of studies show that chinook salmon return to their natal streams with a high degree of fidelity (Rich and Holmes 1928; Quinn and Fresh 1984; McIssac and Quinn 1988). Salmon may have evolved this trait as a method of ensuring an adequate incubation and rearing habitat. It also

provides a mechanism for reproductive isolation and local adaptation. Conversely, returning to a stream other than that of one's origin is important in colonizing new areas and responding to unfavorable or perturbed conditions at the natal stream (Quinn 1993).

Chinook salmon stocks exhibit considerable variability in size and age of maturation, and at least some portion of this variation is genetically determined. The relationship between size and length of migration may also reflect the earlier timing of river entry and the cessation of feeding for chinook salmon stocks that migrate to the upper reaches of river systems. Body size, which is correlated with age, may be an important factor in migration and redd construction success. Roni and Quinn (1995) reported that under high density conditions on the spawning ground, natural selection may produce stocks with exceptionally large-sized returning adults.

Early researchers recorded the existence of different temporal "runs" or modes in the migration of chinook salmon from the ocean to freshwater. Freshwater entry and spawning timing are believed to be related to local temperature and water flow regimes (Miller and Brannon 1982). Seasonal "runs" (i.e., spring, summer, fall, or winter) have been identified on the basis of when adult chinook salmon enter freshwater to begin their spawning migration. However, distinct runs also differ in the degree of maturation at the time of river entry, the thermal regime and flow characteristics of their spawning site, and their actual time of spawning. Egg deposition must occur at a time to ensure that fry emerge during the following spring when the river or estuary productivity is sufficient for juvenile survival and growth.

ESU Determinations

Based on the best available scientific and commercial information, NMFS has identified 17 ESUs of chinook salmon from Washington, Oregon, Idaho, and California. Genetic data were the primary evidence considered for the reproductive isolation criterion, supplemented by inferences about barriers to migration created by natural geographic features and human-induced changes resulting from artificial propagation and harvest. Factors considered to be most informative in evaluating ecological and genetic diversity pertain to the physical environment, ocean conditions and upwelling, vegetation, estuarine and freshwater fish distributions, river entry, and spawning timing. Most of the ESUs include multiple spawning populations of chinook salmon, and most also extend over a considerable geographic area. However, considerable diversity in genetic or life history traits or habitat features exists within most ESUs, and maintaining this diversity is critical to their overall health. Of the 17 west coast chinook ESUs, five are found within the Plum Creek lands of the NFHCP area: 1) Lower Columbia River ESU, 2) Mid-Columbia River Spring-Run ESU, 3) Upper-Columbia River Summer-and Fall-Run ESU, 4) Snake River Fall-Run ESU, and 5) Snake River Spring- and Summer-Run ESU.

Status of Chinook Salmon ESUs

Lower Columbia River ESU

Status: The Lower Columbia River ESU was listed as a threatened species on March 24, 1999. The ESU includes all naturally spawned populations of chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run chinook salmon in the Clackamas River.

Critical Habitat: Critical habitat for this ESU was designated on February 16, 2000. It includes all river reaches accessible to listed chinook salmon in Columbia River tributaries between the Grays and White Salmon Rivers in Washington and the Willamette and Hood Rivers in Oregon, inclusive. Also included are areas above Mayfield Dam, in the Cowlitz River, where listed fish transported and released, are adjacent riparian zones, as well as river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to The Dalles Dam. Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 6,338 square miles in Oregon and Washington.

Factors Affecting ESU: All sub-basins are affected (to varying degrees) by habitat degradation. Major habitat problems are primarily related to blockages, forest practices, urbanization in the Portland and Vancouver areas, and agriculture in floodplains and low-gradient tributaries. Substantial chinook salmon spawning habitat has been blocked (or passage substantially impaired) in the Cowlitz (Mayfield Dam 1963, RKm 84), Lewis (Merwin Dam 1931, RKm 31), Clackamas (North Fork Dam 1958, RKm 50), Hood (Powerdale Dam 1929, RKm 7), and Sandy (Marmot Dam 1912, RKm 48; Bull Run River dams early 1900s) Rivers (WDF et al. 1993; Kostow 1995).

Trend: Except for the relatively large and apparently healthy fall-run population in the Lewis River, production in this ESU appears to be predominantly hatchery-driven with few identifiable naturally spawned populations. Hatchery programs to enhance chinook salmon fisheries abundance in the lower Columbia River began in the 1870s, expanded rapidly, and have continued throughout this century. Available evidence indicates a strong influence of hatchery fish on natural populations throughout this ESU, including both spring-and fall-run populations (Howell et al. 1985; Marshall et al.1995). In addition, the exchange of eggs between hatcheries in this ESU has led to the extensive genetic homogenization of hatchery stocks (Utter et al.1989). The large numbers of hatchery fish in this ESU make it difficult to determine the proportion of naturally produced fish.

Harvest rates on fall-run stocks are moderately high, with an average total exploitation rate of 65 percent (1982-89 brood years) (PSC 1994). The average ocean exploitation rate for this period was 46 percent, while the freshwater harvest rate on the fall run has averaged 20 percent, ranging

from 30 percent in 1991 to 2.4 percent in 1994. Harvest rates are somewhat lower for spring run stocks, with estimates for the Lewis River averaging 24 percent ocean and 50 percent total exploitation rates in 1982-89 (PSC 1994). In in-river fisheries, approximately 15 percent of the lower river hatchery stock was harvested, 29 percent of the lower river wild stock was harvested, and 58 percent of the Spring Creek hatchery stock was harvested, while the average in-river exploitation rate of the stock as a whole was 29 percent during the 1991-1995 period (PFMC 1996b).

There have been at least six documented extinctions of populations in this ESU, and it is possible that extirpation of other native populations occurred but was masked by the presence of naturally spawning hatchery fish. Long-and short-term trends in abundance of individual populations are mostly negative, some severely so. About half of the populations comprising this ESU are very small, increasing the likelihood that risks due to genetic and demographic drift processes in small populations will be important. NMFS concluded that chinook salmon in this ESU are not presently in danger of extinction but are likely to become endangered in the foreseeable future.

Middle Columbia River Spring-Run ESU

Status: The Middle Columbia River Spring-Run ESU was determined to be not warranted for Act listing in March 1998.

Critical Habitat: Since this ESU is not listed under Act, there is no critical habitat designated.

Factors Affecting ESU: Habitat problems are common in the range of this ESU. There are no large blockages to spawning areas for spring chinook salmon. Spawning and rearing habitat are affected by agriculture including water withdrawals, grazing, and riparian vegetation management. Mainstem Columbia River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat.

Trend: Total abundance of this ESU is low relative to the total basin area, and 1994-96 escapements have been very low. Several historical populations have been extirpated, and the few extant populations in this ESU are not widely distributed geographically. In addition, there are only two populations (John Day and Yakima Rivers) with substantial run sizes. However, these major river sub-basins are predominantly comprised of naturally produced fish, and both of these exhibit long-term increasing trends in abundance. Additionally, recent analyses done as part of the PATH process indicates that productivity of natural populations in the Deschutes and John Day Rivers has been more robust than most other stream-type chinook salmon in the Columbia River (Schaller et al. 1996).

Hatchery production accounts for a substantial proportion of total escapement to the region. However, screening procedures at the Warm Springs River weir apparently minimize the potential for hatchery-wild introgression in the Deschutes River basin. Although straying is less of a

problem with returning spring-run adults, the use of the composite, out-of-ESU Carson Hatchery stock to reestablish the Umatilla River spring run would be a cause for concern if fish from that program stray out of the basin.

Stocks in this ESU experience very low ocean harvest rates and only moderate instream harvest. Harvest rates have been declining recently (PSC 1996).

Despite low abundances relative to estimated historical levels, long-term trends in abundance have been relatively stable, with an approximately even mix of upward and downward trends in populations. NMFS concluded that chinook salmon in this ESU are not presently in danger of extinction, nor is it likely to become endangered in the foreseeable future.

Upper Columbia River Summer-and Fall-Run ESU

Status: The Upper Columbia River Summer/Fall-Run ESU was determined to be not warranted for Act listing in March 1998.

Critical Habitat: Since this ESU is not listed under Act, there is no critical habitat designated.

Factors Affecting ESU: Like other chinook ESUs, habitat problems are common in the range of this ESU. Spawning and rearing habitat are affected by agriculture including water withdrawals, grazing, and riparian vegetation management. Mainstem Columbia River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat. Also, the proportion of naturally spawning summer chinook salmon of hatchery origin has been increasing rapidly. There is corresponding concern about the possible genetic and/or life-history consequences to the sustainability of natural populations in that area from the shift in hatchery releases from sub-yearlings to yearlings (Marshall et al. 1995).

Trend: NMFS has concluded this ESU is not in danger of extinction, nor likely to become endangered in the foreseeable future. However, if negative trends continue, NMFS will reevaluate the status of this ESU.

Snake River Fall-Run ESU

Status: The Snake River Fall-Run ESU was listed as a threatened species on April 22, 1992 (57 FR 14653). The listed ESU includes all natural populations of fall-run chinook salmon in the mainstem Snake River and any of the following sub-basins: Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River.

Critical Habitat: Critical habitat was designated for the Snake River Fall-Run ESU on December 28, 1993. Critical habitat for the listed ESU is designated to include river reaches presently or historically accessible (except reaches above impassable natural falls, and Dworshak and Hells

Canyon Dams) to Snake River fall chinook salmon in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) and including all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake Rivers; the Snake River, all river reaches from the confluence of the Columbia River, upstream to Hells Canyon Dam; the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 13,679 square miles in Idaho, Oregon, and Washington.

Factors Affecting ESU: Almost all historical Snake River fall-run chinook salmon spawning habitat in the Snake River Basin was blocked by the Hells Canyon Dam complex; other habitat blockages have also occurred in Columbia River tributaries. Hydroelectric development on the mainstem Columbia and Snake Rivers continues to affect juvenile and adult migration. Remaining habitat has been reduced by inundation in the mainstem Snake and Columbia Rivers, and the ESU's range has also been affected by agricultural water withdrawals, grazing, and vegetation management. The continued straying by non-native hatchery fish into natural production areas is an additional source of risk to the Snake River chinook salmon.

Trend: Historically, the Snake River populations dominated production in this ESU; total abundance is estimated to have been about 72,000 in the 1930s and 1940s, and it was probably substantially higher before that. Long-term trends in abundance are downward in the Snake River. Short-term trends in remaining populations are upward. NMFS concluded that the ESU is likely to become an endangered species within in the foreseeable future throughout all or a significant portion of its range.

Snake River Spring-and Summer-Run ESU

ESU Status: The Snake River Spring- and Summer-Run ESU was listed as a threatened species on April 22, 1992. The ESU includes all natural populations of spring/summer-run chinook salmon in the mainstem Snake River and any of the following sub-basins: Tucannon River, Grande Ronde River, Imnaha River, and Salmon River.

Critical habitat: Critical habitat was designated for this ESU on December 28, 1993 and revised October 25, 1999. Critical habitat is designated to include river reaches presently or historically accessible (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams) to Snake River spring/summer chinook salmon in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) and including all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake Rivers; all Snake

River reaches from the confluence of the Columbia River upstream to Hells Canyon Dam. Clearwater River and tributaries are not designated critical habitat because the area was for decades inaccessible to chinook salmon due blockage by the former Lewiston Dam. Non-indigenous chinook were stocked above the Lewiston Dam, and present-day runs in the Clearwater River above Lolo Cree are believed to be dominated by offspring of non-indigenous fish. Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 22,390 square miles in Idaho, Oregon and Washington.

Factors Affecting ESU: Like other chinook ESUs, habitat problems are common in the range of this ESU. Spawning and rearing habitat are affected by agriculture, including water withdrawals, timber harvest, grazing, mining, and riparian vegetation management. Mainstem Columbia River and Snake River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat. Also, naturally spawning chinook salmon of hatchery origin have been increasing, and there is concern about possible genetic and/or life-history consequences to the sustainability of natural populations from hatchery releases.

Trend: Matthews and Waples (1991) concluded that in some years during the late 1800s, the Snake River produced in excess of 1.5 million adult spring/summer chinook salmon. By the 1950s the abundance of spring/summer chinook had declined to an annual average of 125,000 adults.

Steelhead Life History and Ecology

Steelhead (*Oncorhynchus mykiss*) exhibit one of the most complex suite of life history traits of any salmonid species. Steelhead may exhibit anadromy (meaning that they migrate as juveniles from fresh water to the ocean, and then return to spawn in fresh water) or freshwater residency (meaning that they reside their entire life in fresh water). Resident forms are often referred to as "rainbow" or "redband" trout, while anadromous life forms are termed "steelhead." Few detailed studies have been conducted regarding the relationship between resident and anadromous O. mykiss and as a result, the relationship between these two life forms is poorly understood. Recently however, the scientific name for the biological species that includes both steelhead and rainbow trout was changed from Salmo gairdneri to O. mykiss. This change reflects the premise that all trouts from western North America share a common lineage with Pacific salmon.

Steelhead typically migrate to marine waters after spending 2 years in fresh water. They then reside in marine waters for typically 2 or 3 years prior to returning to their natal stream to spawn as 4 or 5 year-olds. Unlike Pacific salmon, steelhead are iteroparous, meaning that they are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying; most that do so are females. Steelhead adults typically spawn between December and June (Bell 1990). Depending on water temperature, steelhead eggs may incubate in "redds" (nesting gravels) for 1.5 to 4 months before hatching as "alevins" (a larval life stage dependent on food stored in a yolk sac). Following yolk sac absorption, alevins emerge

from the gravel as young juveniles or "fry" and begin actively feeding. Juveniles rear in fresh water from 1 to 4 years, then migrate to the ocean as "smolts."

Biologically, steelhead can be divided into two reproductive ecotypes, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration. These two ecotypes are termed "stream maturing" and "ocean maturing." Stream maturing steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn. Ocean maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (e.g., summer and winter steelhead).

Two major genetic groups or "subspecies" of steelhead occur on the west coast of the United States: a coastal group and an inland group, separated in the Fraser and Columbia River Basins by the Cascade crest approximately (Huzyk and Tsuyuki 1974; Allendorf 1975; Utter and Allendorf 1977; Okazaki 1984; Parkinson 1984; Schreck et al. 1986; Reisenbichler et al. 1992). Behnke (1992) proposed to classify the coastal subspecies as *O. m. irideus* and the inland subspecies as *O. m. gairdneri*. These genetic groupings apply to both anadromous and nonanadromous forms of *O. mykiss*. Both coastal and inland steelhead occur in Washington and Oregon. California is thought to have only coastal steelhead while Idaho has only inland steelhead.

Historically, steelhead were distributed throughout the North Pacific Ocean from the Kamchatka Peninsula in Asia to the northern Baja Peninsula. Presently, the species distribution extends from the Kamchatka Peninsula, east and south along the Pacific coast of North America, to at least Malibu Creek in southern California. There are infrequent anecdotal reports of steelhead continuing to occur as far south as the Santa Margarita River in San Diego County (McEwan and Jackson 1996). Historically, steelhead likely inhabited most coastal streams in Washington, Oregon, and California as well as many inland streams in these states and Idaho. However, over 23 indigenous, naturally-reproducing stocks of steelhead are believed to have been extirpated, and many more are thought to be in decline in numerous coastal and inland streams in Washington, Oregon, Idaho, and California. Forty-three stocks have been identified by Nehlsen et al. (1991) as being at moderate or high risk of extinction.

Few detailed studies have explored the relationship between resident and anadromous O. mykiss residing in the same location. Genetic studies generally show that, in the same geographic area, resident and anadromous life forms are more similar to each other than either is to the same form from a different geographic area. Recently, Leider et al. (1995) found that results from comparisons of rainbow trout in the Elwha and Cedar Rivers and Washington steelhead indicate that the two forms are not reproductively isolated. Further, Leider et al. (1995) also concluded that, based on preliminary analyses of data from the Yakima and Big White Salmon Rivers, resident trout would be genetically indistinguishable from steelhead. Based on these studies, it appears that resident and anadromous O. mykiss from the same geographic area may share a

common gene pool, at least over evolutionary time periods.

Genetic information indicates that resident fish should generally be considered part of the steelhead ESUs. However, little data regarding resident rainbow trout abundance during its west coast steelhead status review was received, making status determinations with respect to resident rainbow trout problematic. Because available information did not clearly define the relationship between resident rainbow trout and steelhead, NMFS did not list resident rainbow trout.

ESU Determinations

Based on the best available scientific and commercial information, including the biological effects of human activities, NMFS identified 15 ESUs that included steelhead populations from Washington, Oregon, Idaho, and California. Genetic data were the primary evidence considered for the reproductive isolation criterion, supplemented by inferences about barriers to migration created by natural geographic features and human-induced changes resulting from artificial propagation and harvest. Factors considered in evaluating ecological or genetic diversity include data pertaining to the physical environment, ocean conditions/upwelling, vegetation, estuarine and freshwater fish distributions, river entry, and spawning timing. In addition, NMFS has listed only anadromous life forms of O. mykiss due to uncertainties regarding the relationship between resident rainbow trout and steelhead. Of the 15 ESUs found along the West Coast, the four ESUs found within the NFHCP are: 1) Lower Columbia River, 2) Middle Columbia River Basin, 3) Upper Columbia River Basin, and 4) Snake River Basin.

Status of Steelhead ESUs

Analyses of steelhead abundance indicate that across the species' range, the majority of naturally-reproducing steelhead stocks have exhibited declining long-term trends in abundance. The severity of declines in abundance tends to vary by geographic region. Based on historical and recent abundance estimates, southern stocks of coastal steelhead appear to have declined significantly, with widespread stock extirpations. Northern coastal steelhead stocks tend to be relatively more stable with larger overall population sizes. However, stocks in these areas continue to exhibit downward abundance trends as well. A lack of accurate run size and trend data make abundance estimates difficult in some areas.

Lower Columbia River ESU

This ESU is composed of winter steelhead and summer steelhead.

Status: The Lower Columbia River steelhead ESU was listed as a threatened species on March 19, 1998. The ESU includes all naturally spawned populations of steelhead (and their progeny) in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington

(inclusive) and the Willamette and Hood Rivers, Oregon (inclusive). Excluded are steelhead in the upper Willamette River Basin above Willamette Falls and steelhead from the Little and Big White Salmon Rivers in Washington.

Critical Habitat: Critical habitat for this ESU was designated on February 16, 2000. Critical habitat is designated to include all river reaches accessible to listed steelhead in Columbia River tributaries between the Cowlitz and Wind Rivers in Washington and the Willamette and Hood Rivers in Oregon, inclusive. Also included are areas above Mayfield Dam, in the Cowlitz River, where listed fish transported and released, adjacent riparian zones, as well as river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to the Hood River in Oregon. Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 5,017 square miles in Oregon and Washington.

Factors Affecting ESU: All sub-basins are affected (to varying degrees) by habitat degradation. Major habitat problems are primarily related to blockages, forest practices, urbanization in the Portland and Vancouver areas, and agriculture in floodplains and low-gradient tributaries. Substantial chinook salmon spawning habitat has been blocked (or passage substantially impaired) in the Cowlitz (Mayfield Dam 1963, RKm 84), Lewis (Merwin Dam 1931, RKm 31), Clackamas (North Fork Dam 1958, RKm 50), Hood (Powerdale Dam 1929, RKm 7), and Sandy (Marmot Dam 1912, RKm 48; Bull Run River dams early 1900s) Rivers (WDF et al. 1993; Kostow 1995).

Trend: No estimates of historical (pre-1960s) abundance specific to this ESU are available. Total run size for the major stocks in the lower Columbia River (below Bonneville Dam, including the upper Willamette ESU) for the early 1980s can be calculated from estimates in Light (1987) as approximately 150,000 winter steelhead and 80,000 summer steelhead. Light (1987) estimated that 75 percent of the total run (summer and winter steelhead combined) was of hatchery origin. Recent 5-year average natural escapements for streams with adequate data range from less than 100 to 1,100. Total recent run size for major streams in this ESU was greater than 16,000, but this total includes only the few sub-basins for which estimates are available.

Of the 18 stocks for which adequate adult escapement trend data exists, 11 have been declining and 7 increasing, with a range from 24 percent annual decline to 48 percent annual increase. Eight of these trends (5 negative, 3 positive) were significantly different from zero. Most of the data series for this ESU begin only in the late 1970s to the mid-1980s. Thus, they may be heavily influenced by short-term climate effects. Some of the Washington trends (notably those for the Cowlitz and Kalama River Sub-basins) have been influenced (positively or negatively) by the 1980 eruption of Mount Saint Helens. For Washington streams, these trends are for the late run "wild" component of winter steelhead populations; Oregon data included all stock components. Most of

the Oregon trends are based on angler catch, and so may not reflect trends in underlying population abundance.

Hatchery fish are widespread, and many stray to spawn naturally throughout the region. Most of the hatchery stocks used originated primarily from stocks within the ESU, but many are not native to local river sub-basins. The WDFW has provided information supporting substantial temporal separation between hatchery and natural winter steelhead in this ESU; however, some Washington stocks (notably Kalama River winter and summer steelhead) appear to have substantial hatchery contribution to natural spawning. ODFW estimates of hatchery composition indicate a range from about 30 percent (Sandy River and Tanner Creek winter steelhead) to 80 percent (Hood River summer steelhead) hatchery fish in spawning escapements. Estimates for Hood River winter steelhead range from 0 percent (ODFW 1995b) to greater than 40 percent (ODFW 1995a).

NMFS concludes that the Lower Columbia River steelhead ESU is not presently in danger of extinction, but is likely to become endangered in the foreseeable future. The majority of stocks within this ESU for which data exist have been declining in the recent past, but some have been increasing strongly. However, the strongest upward trends are either non-native stocks (Lower Willamette River and Clackamas River summer steelhead) or stocks that are recovering from major habitat disruption and are still at low abundance (mainstem and North Fork Toutle River). NMFS is very concerned about the pervasive opportunity for genetic introgression from hatchery stocks within the ESU and about the status of summer steelhead in this ESU. Concerns about hatchery influence are especially strong for summer steelhead and Oregon winter steelhead stocks, where there appears to be substantial overlap in spawning between hatchery and natural fish.

Middle Columbia River ESU

All steelhead in the Columbia River Basin upstream from The Dalles Dam are summer-run, inland steelhead (Schrenk et al. 1986; Reisenbichler et al. 1992; Chapman et al., 1994). Life history information for steelhead of this ESU indicates that most middle Columbia River steelhead smolt at 2 years and spend 1 to 2 years in salt water (i.e., 1-ocean and 2-ocean fish, respectively) prior to re-entering fresh water, where they may remain up to a year prior to spawning (Howell et al. 1985; BPA 1992).

Status: The Middle Columbia River Basin ESU was listed as a threatened species on March 25, 1999. The ESU includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington. Excluded are steelhead from the Snake River Basin.

Critical Habitat: Critical habitat for this ESU was designated on February 16, 2000. It is designated to include all river reaches accessible to listed steelhead in Columbia River tributaries (except the Snake River) between Mosier Creek in Oregon and the Yakima River in Washington

(inclusive). Also included are adjacent riparian zones, as well as river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to the Yakima River in Washington. Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 26,739 square miles in Oregon and Washington.

Factors Affecting ESU: Habitat problems are common in the range of this ESU. There are no large blockages to spawning areas for steelhead. Spawning and rearing habitat are affected by agriculture including water withdrawals, grazing, and riparian vegetation management. Mainstem Columbia River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat.

Trend: Estimates of historical (pre-1960s) abundance indicate that the total historical run size for this ESU might have been in excess of 300,000. Total run sizes for the major stocks in the upper Columbia River (above Bonneville Dam, including the Upper Columbia River, Snake River Basin, and parts of the Southwest Washington and Lower Columbia River ESUs) for the early 1980s were estimated by Light (1987) as approximately 4,000 winter steelhead and 210,000 summer steelhead. Based on dam counts for this period, the Middle Columbia River ESU represented the majority of this total run and was estimated just below 200,000. Light (1987) estimated that 80 percent of the total Columbia River Basin run (summer and winter steelhead combined) above Bonneville Dam was of hatchery origin.

Of the major sub-basins, the Yakima, Umatilla, and Deschutes Rivers show upward overall trends, although all tributary counts in the Deschutes River are downward and the Yakima River is recovering from extremely low abundance in the early 1980s. The John Day River probably represents the largest native, natural spawning stock in the ESU, and combined spawner surveys for the John Day River have been declining at a rate of about 15 percent per year since 1985. However, estimates of total run size for the ESU based on differences in counts at dams show an overall increase in steelhead abundance, with a relatively stable naturally-produced component.

NMFS concludes that the Middle Columbia steelhead ESU is not presently in danger of extinction, but has reached no conclusion regarding its likelihood of becoming endangered in the foreseeable future. NMFS remains concerned about the status of this ESU. There is particular concern about Yakima River stocks and winter steelhead stocks. Total steelhead abundance in the ESU appears to have been increasing recently, but the majority of natural stocks for which NMFS has data within this ESU have been declining, including those in the John Day River, which is the largest producer of native, natural steelhead. NMFS is very concerned about the pervasive opportunity for genetic introgression from hatchery stocks within the ESU. There is widespread production of hatchery steelhead within this ESU, but are largely based on within basin stocks.

Estimated proportion of hatchery fish on spawning grounds ranges from low (Yakima River, Walla Walla River, John Day River) to moderate (Umatilla River, Deschutes River).

Snake River ESU

Snake River Basin steelhead are summer steelhead, as are most inland steelhead, and comprise 2 groups, A-run and B-run, based on migration timing, ocean-age, and adult size. Snake River Basin steelhead enter fresh water from June to October and spawn in the following spring from March to May. A-run steelhead are thought to be predominately l-ocean, while B-run steelhead are thought to be 2-ocean (IDFG 1994). Snake River Basin steelhead usually smolt at age 2 or 3 years (Whitt 1954; BPA 1992; Hassemer 1992).

The steelhead population from Dworshak National Fish Hatchery (NFH) is the most divergent single population of inland steelhead based on genetic traits. Steelhead returning to Dworshak NFH are considered to have a distinctive appearance and are the one steelhead population that is consistently referred to as B-run. Little specific information is available regarding this population's native habitat in the North Fork Clearwater River, which is currently unavailable to anadromous fish due to blockage by Dworshak Dam.

Status: The Snake River Basin ESU was listed as a threatened species on August 18, 1997. The ESU includes all naturally spawned populations of steelhead (and their progeny) in streams in the Snake River Basin of southeast Washington, northeast Oregon, and Idaho.

Critical Habitat: Critical habitat for this ESU was designated on February 16, 2000. It is designated to include all river reaches accessible to listed steelhead in the Snake River and its tributaries in Idaho, Oregon, and Washington. Also included are adjacent riparian zones, as well as river reaches and estuarine areas in the Columbia River from a straight line connecting the west end of the Clatsop jetty (south jetty, Oregon side) and the west end of the Peacock jetty (north jetty, Washington side) upstream to the confluence with the Snake River. Excluded are tribal lands and areas above specific dams identified or above longstanding, naturally impassable barriers (i.e., Napias Creek Falls and other natural waterfalls in existence for at least several hundred years). Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 29,282 square miles in Idaho, Oregon, and Washington.

Factors Affecting ESU: Like other anadromous fish ESUs, habitat problems are common in the range of this ESU. Spawning and rearing habitat are affected by agriculture, including water withdrawals, timber harvest, grazing, mining, and riparian vegetation and streambank management. Mainstem Columbia River, Snake River, and North Fork Clearwater River hydroelectric developments have resulted in major disruptions of migration corridors and affected flow regimes and estuarine habitat. Also, naturally spawning steelhead of hatchery origin have

been increasing, and there is concern about possible genetic and/or life-history consequences to the sustainability of natural populations from hatchery releases.

Trend: No estimates of historical (pre-1960s) abundance specific to this ESU are available. Light (1987) estimated that 80 percent of the total Columbia River Basin run (summer and winter steelhead combined) above Bonneville Dam was of hatchery origin. Although there is little information for most stocks within this ESU, there are recent run-size and/or escapement estimates for several stocks. Escapement above Lower Granite Dam for 1990-1994 was approximately 71,000, with a natural component of 9,400 (7,000 A-run and 2,400 B-run).

The aggregate trend in abundance for this ESU (indexed at Lower Granite Dam) has been upward since 1975, although natural escapement has been declining during the same period. Adult abundance trend information is available for several individual stocks from a variety of sources, including spawner surveys, dam counts, and angler catch. Of thirteen stock indices (excluding Lower Granite Dam counts), nine have been declining and four increasing, with a range from 30 percent annual decline to a 4 percent annual increase. The U.S. v. Oregon Technical Advisory Committee found that A-run steelhead densities were closer to rated capacities than were B-run steelhead; it noted that "percent carrying capacity indicates that all surveyed areas are underseeded" (CRFMP TAC 1991).

Given the relatively low natural run sizes to individual streams for which estimates are available, the declines in natural returns at Lower Granite Dam and in parr density estimates, and the widespread presence of hatchery fish, NMFS concludes that the majority of natural steelhead populations in this ESU are probably not self-sustaining.

While total run size (hatchery and natural) has increased since the mid-1970s, there has been a severe recent decline in natural run size. The majority of natural stocks for which adequate data exists within this ESU have been declining. Parr densities in natural production areas have been substantially below estimated capacity in recent years. Downward trends and low parr densities indicate a particularly severe problem for B-run steelhead, the loss of which would substantially reduce life-history diversity within this ESU. NMFS is very concerned about the pervasive opportunity for genetic introgression from hatchery stocks within the ESU. There is widespread production of hatchery steelhead within this ESU. The total Snake River steelhead run at Lower Granite Dam is estimated to average 86 percent hatchery fish in recent years. NMFS concludes that the Snake River Basin steelhead ESU is not presently in danger of extinction, but is likely to become endangered in the foreseeable future.

Coho Salmon Life History and Ecology

Coho salmon are anadromous salmonids historically distributed throughout the North Pacific Ocean from central California to Point Hope, AK, through the Aleutian Islands, and from the

Anadyr River, Russia, south to Hokkaido, Japan. Historically, this species probably inhabited most coastal streams in Washington, Oregon, and central and northern California. Some populations, now considered extinct, are believed to have migrated hundreds of miles inland to spawn in tributaries of the upper Columbia River in Washington, and the Snake River in Idaho.

In contrast to the life history patterns of other anadromous salmonids, coho salmon generally exhibit a relatively simple, 3-year life cycle. Adults typically begin their freshwater spawning migration in the late summer and fall, spawn by mid-winter, then die. Run and spawn timing of adult coho salmon varies between and within coastal and Columbia River Basin populations. Depending on temperature, eggs incubate in gravel redds excavated by spawning females for 1.5 to 4 months before hatching as yolk sac alevins. Following yolk sac absorption, alevins emerge from the gravel as young juveniles or fry and begin actively feeding. Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as smolts in the spring. Coho salmon typically spend two growing seasons in the ocean before returning to their natal stream to spawn as 3 year-olds. Some precocious males, called jacks, return to spawn after only 6 months at sea.

During this century, indigenous, naturally-reproducing populations of coho salmon are believed to have been extirpated in nearly all Columbia River tributaries and to be in decline in numerous coastal streams in Washington, Oregon, and California. At least 33 populations have been identified by agencies and conservation groups as being at moderate or high risk of extinction.

Homing fidelity in coho salmon is generally strong, with low levels of straying (about 1 percent) estimated for most natural populations. On the other hand, coho salmon habitat typically includes small tributaries that experience relatively frequent, temporary blockages, and there are a number of examples in which coho salmon have rapidly recolonized vacant habitat that had only recently become accessible to anadromous fish. Because ESU determinations focus on units that are strongly isolated over evolutionarily important time frames, local spawning populations of coho salmon are unlikely to meet the criterion of reproductive isolation. However, groups of local populations among tributaries within a river drainage may experience substantial, long-term isolation from other such groups. Major stock groupings include: California coast, Oregon coast, Lower Columbia River, and Puget Sound area.

Several types of physical and biological evidence were considered in evaluating the contribution of coho salmon from southern British Columbia, Washington, Oregon, and California to the ecological/genetic diversity of the biological species throughout its range.

Coho salmon life-history traits show some regional variation in river entry and spawning timing, age at maturity, and marine CWT recovery patterns. River entry and spawning timing patterns of coho salmon are considerably variable in time and space, but some regional patterns exist. Puget Sound coho salmon typically enter the rivers in October, but some sub-basins have very early and late runs. Along the Washington coast, river entry generally occurs in October, with a few

exceptionally late or early runs. Historically, Columbia River coho salmon entered fresh water from August through December, while Oregon coho salmon enter rivers in October. Coho salmon in southern Oregon and northern California also enter rivers in September or October. River entry is much later south of the Klamath River Basin, occurring in November and December in sub-basins south of the Klamath River to the Mattole River, CA, and from mid-December to mid-February in rivers farther south.

Spawning timing shows less variation than river entry, but it has similar patterns. Along most of the Washington and Oregon coasts and in Puget Sound, coho salmon spawn in November and December, with exceptionally early and late runs occurring along the Washington coast, in the Columbia River, and in Puget Sound. Spawning in southern Oregon and northern California also occurs in December, but south of the Mattole River it occurs most frequently in January. Coho salmon adults in the three-state area overwhelmingly (>95 percent) spawn at age 3, spending just over a year in fresh water and a year and a half in the ocean (Sandercock 1991). In contrast, many coho salmon adults from southeast Alaska spend over 2 years in fresh water and return to spawn at age 4. It is not known exactly where the transition occurs between these two age structures, but limited information suggests that an increasing proportion of 2 year-old smolts is seen in coho salmon as one approaches the north end of Vancouver Island from the south.

The life-history trait showing the clearest differentiation coastwide is the pattern of ocean distribution inferred from marine recoveries of hatchery fish carrying CWTs. These data, from the Pacific States Marine Fisheries Commission's regional Mark Information System, show that marked coho salmon from southern Oregon and northern populations from the Washington coast, Puget Sound, and British Columbia have much more northern recovery patterns than those from either the Columbia River or the Oregon coast, although distinctive patterns within Washington and British Columbia are not as obvious as those for groups farther south.

The effects of artificial propagation and other human activities can be relevant to Act listing determinations in two ways. First, such activities can genetically change natural populations so much that they no longer represent an evolutionarily significant component of the biological species (Waples 1991). For example, in 1991, NMFS concluded that, as a result of massive and prolonged effects of artificial propagation, harvest, and habitat degradation, the agency could not identify natural populations of coho salmon in the lower Columbia River that qualified for Act consideration. Second, risks to the viability and genetic integrity of native salmon populations posed by human activities may contribute to their threatened or endangered status (Goodman 1990, Hard et al. 1992). The severity of these effects on natural populations depends both on the nature of the effects (e.g., harvest rate, gear size, or type of hatchery practice) and their magnitude (e.g., duration of a hatchery program and number and life-history stage of hatchery fish involved). Several of these factors may be important to Act considerations of coho salmon.

Columbia River outplanting records show a pattern of extensive use of Columbia River and Oregon coast coho salmon, and some Puget Sound stocks. The Clackamas River has also been extensively outplanted with early-running Columbia River stocks and was outplanted with coho salmon from the Oregon coast in 1967.

ESU Determinations

Based on the best available biological and commercial information, including the biological effects of human activities, NMFS has identified six ESUs that include coho salmon populations from southern British Columbia, Washington, Oregon, and California. Of the six ESUs, only one, the Lower Columbia River/southwest Washington Coast is found within the NFHCP. Genetic data were the primary evidence considered for the reproductive isolation criterion, supplemented by inferences about barriers to migration created by natural geographic features and human-induced changes resulting from artificial propagation and harvest. Factors considered to be most informative in evaluating ecological/genetic diversity include data pertaining to the physical environment, ocean conditions/upwelling, vegetation, estuarine and freshwater fish distributions, river entry and spawning timing, and marine CWT recoveries.

Status of the Coho Salmon ESUs

The only coho salmon ESU found within the NFHCP area is the Lower Columbia River/Southwest Washington coast ESU.

Lower Columbia River/Southwest Washington coast ESU

Status: The Lower Columbia River/Southwest Washington coast ESU was listed as a candidate species in July 1995.

Critical Habitat: Since this ESU is listed only as a candidate species, there has been no designation of critical habitat.

Factors Affecting ESU: Habitat degradation (Logging and associated road building, agricultural activities, urbanization, stream channelization, dams, wetland loss, water withdrawals and unscreened diversions for irrigation, and mining), overfishing, inadequate regulatory mechanisms, negative effects of artificial propagation programs, drought and adverse ocean conditions over the last two decades are believed to be factors contributing to the species' decline.

Long-term trends in rainfall and marine productivity associated with atmospheric conditions in the North Pacific Ocean may have a major influence on coho salmon production. The effects of extended drought on water supplies and water temperatures are a major concern. Poor ocean conditions have played a prominent role in the decline of coho salmon populations in Washington, Oregon, and California.

Trend: Although several tributaries in the upper Columbia River Basin, including the Snake River, once supported coho salmon runs, NMFS is not aware of any native coho salmon production in the upper basin at the present time.

The number of naturally-reproducing fish within the lower Columbia River/southwest Washington coast ESU is fairly large, but uncertainty exists about the relationship of the present natural populations to the historic ESU. It is not presently possible, with the limited information available, to identify with certainty native, naturally reproducing populations in lower Columbia River tributaries or along the Washington coast. Although an Act listing is not presently warranted, there is sufficient concern regarding the overall health of this ESU, especially in light of evidence that some native, naturally reproducing fish may exist. Therefore, NMFS added the lower Columbia River/southwest Washington coast ESU to the Candidate List.

Many of the coho salmon populations which are not in decline have a large hatchery-produced component that could hinder the ability of natural populations to sustain themselves in the long-term.

Chum Salmon Life History and Ecology

Chum salmon belong to the family *Salmonidae* and are one of eight species of Pacific salmonids in the genus *Oncorhynchus*. Chum salmon are semelparous (spawn only once then die), spawn primarily in fresh water, and apparently exhibit obligatory anadromy, as there are no recorded landlocked or naturalized freshwater populations (Randall et al. 1987). The species is best known for the enormous canine-like fangs and striking body color (a calico pattern, with the anterior two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) of spawning males. Females are less flamboyantly colored and lack the extreme dentition of the males.

The species has the widest natural geographic and spawning distribution of any Pacific salmonid, primarily because its range extends farther along the shores of the Arctic Ocean than that of the other salmonids (Groot and Margolis 1991). Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east, around the rim of the North Pacific Ocean, to Monterey Bay in southern California. The species' range in the Arctic Ocean extends from the Laptev Sea in Russia to the Mackenzie River in Canada (Bakkala 1970; Fredin et al. 1977). Historically, chum salmon were distributed throughout the coastal regions of western Canada and the United States, as far south as Monterey, California. Presently, major spawning populations are found only as far south as Tillamook Bay on the northern Oregon coast.

Chum salmon may historically have been the most abundant of all salmonids. Neave (1961) estimated that, prior to the 1940s, chum salmon contributed almost 50 percent of the total

biomass of all salmonids in the Pacific Ocean. Chum salmon also grow to be among the largest of Pacific salmon, second only to chinook salmon in adult size, with individuals reported up to 108.9 cm in length and 20.8 kg in weight (Pacific Fisherman 1928). Average size for the species is around 3.6 to 6.8 kg (Salo 1991).

Chum salmon usually spawn in coastal areas, and juveniles outmigrate to seawater almost immediately after emerging from the gravel that covers their redds (Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, coho salmon, and most types of chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine and marine conditions. Another behavioral difference between chum salmon and most species that rear extensively in fresh water is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Age at maturity appears to follow a latitudinal trend in which a greater number of older fish occur in the northern portion of the species' range. Age at maturity has been investigated in many studies, and in both Asia and North America, it appears that most chum salmon (95 percent) mature between 3 and 5 years of age, with 60 to 90 percent of the fish maturing at 4 years of age. However, a higher proportion of 5 year-old fish occurs in the north, and a higher proportion of 3 year-old fish occurs in the south (southern British Columbia, Washington, Oregon) (Gilbert 1922; Marr 1943; Pritchard 1943; Kobayashi 1961; Oakley 1966; Sano 1966).

Chum salmon may depend less on freshwater habitats than some other Pacific salmonids, but their requirements for successful spawning and rearing, such as cold, clean water and relatively sediment-free spawning gravel, are similar to other Pacific salmon. Chum salmon usually spawn in the lower reaches of rivers. Redds are usually dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. In some areas (particularly in Alaska and northern Asia), they typically spawn where upwelled groundwater percolates through the redds (Bakkala 1970; Salo 1991). After hatching, juvenile chum salmon spend a very limited amount of time in fresh water and typically migrate to estuarine and marine areas soon after emergence.

Chum salmon are believed to spawn primarily in the lower reaches of rivers because they usually show little persistence in surmounting river blockages and falls. However, in some systems, such as the Skagit River, Washington, chum salmon routinely migrate over long distances upstream (at least 170 km in the Skagit River) (Hendrick 1996). The species swims a much greater distance in the Yukon River, Alaska, and the Amur River, between China and Russia, where chum salmon migrate more than 2,500 km inland. However, both rivers have low gradients and are without

extensive falls or other blockages to migration. In the Columbia River Basin, there are reports that chum salmon may historically have spawned in the Umatilla and Walla Walla Rivers, more than 500 km from the sea (Nehlsen et al. 1991). However, these fish would have had to pass Celilo Falls, a web of rapids and cascades, which presumably were passable by chum salmon only at high water flows.

During the spawning migration, adult chum salmon enter natal river systems from June to March, depending on characteristics of the population or geographic location. Groups of fish entering a river system at particular times or seasons are often called "runs", and run timing has long been used by the fishing community to distinguish anadromous populations of salmon, steelhead, and sea-run cutthroat trout. In Washington, a variety of seasonal runs are recognized, including summer, fall, and winter populations. Fall-run fish predominate, but summer runs are found in Hood Canal, the Strait of Juan de Fuca, and in southern Puget Sound (Washington Department of Fisheries (WDF) et al. 1993). Only two rivers have fish returning so late in the season that the fish are designated as winter-run fish, and both of these are in southern Puget Sound.

ESU Determinations

The chum salmon ESU determinations represent a synthesis of a large amount of diverse information. In general, the geographic boundaries for ESUs are supported by several lines of evidence that show similar patterns. In some cases environmental changes occur over a transition zone rather than abruptly. In addition, as ESU boundaries are based on biological and environmental information, they do not necessarily conform to state or national boundaries, such as the U.S./Canada border.

Based on a review of the best available scientific and commercial information, the BRT identified four chum salmon ESUs in the Pacific Northwest. Each ESU include multiple spawning populations of chum salmon, and most ESUs extend over a considerable geographic area. The ESUs include: 1) Puget Sound/Strait of Georgia ESU, 2) Hood Canal Summer-Run ESU, 3) Pacific Coast ESU, and 4) Columbia River ESU. The only ESU found within the NFHCP area is the Columbia River ESU.

Status of Chum Salmon

Columbia River ESU

Status: The Columbia River chum salmon ESU was listed as a threatened species on March 25, 1999. The ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon.

Critical Habitat: Critical habitat was designated for Columbia River chum salmon on February 16, 2000. It includes all river reaches accessible to listed chum salmon (including estuarine areas

and tributaries) in the Columbia River downstream from Bonneville Dam, excluding Oregon tributaries upstream of Milton Creek at river km 144 near the town of St. Helens. Also included are adjacent riparian zones. Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river sub-basins containing spawning and rearing habitat for this ESU comprise approximately 4,426 square miles in Oregon and Washington.

NMFS has not proposed critical habitat in marine areas. If additional information becomes available that supports the inclusion of such areas, NMFS may revise critical habitat.

Factors Affecting ESU: The present depressed condition of many populations is the result of long-standing, human-induced factors (e.g., habitat degradation, water diversions, harvest, and artificial propagation) that serve to exacerbate the adverse effects of natural factors (e.g., competition and predation) or environmental variability from such factors as drought and poor ocean conditions.

Among habitat losses documented by NMFS (1996), the following are those with 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, habitat simplification); 3) mining (especially gravel removal, dredging, pollution); and 4) urbanization (stream channelization, increased runoff, pollution, and habitat simplification).

Hydropower development is probably less significant for chum salmon (due to chum salmon's use of lower river areas for spawning). However, many spill dams and other small hydropower facilities were constructed in lower river areas, and Bonneville Dam presumably continues to impede recovery of upriver populations. Substantial habitat loss in the Columbia River estuary and associated areas presumably was an important factor in the decline and also represents a significant continuing risk for this ESU.

The Columbia River historically contained large runs of chum salmon that supported a substantial commercial fishery with a harvest of more than 500,000 chum salmon in some years in the first half of the 1900s. There are presently neither recreational nor directed commercial fisheries for chum salmon in the Columbia River, although some chum salmon are taken incidentally in the gill-net fisheries for coho and chinook salmon and there has been minor recreational harvest in some tributaries (WDF et al. 1993).

Because of the short time chum salmon generally spend relative to other salmonids in streams and rivers before migrating downstream, the survival of early life history stages depends more on the health and ecological integrity of estuaries and near-shore environments than it does for most

other Pacific salmon. Habitat loss in the estuarine or near-shore marine environment is difficult to quantify since there are few historical studies that include baseline information and since these studies encompass a variety of classification methods and several time intervals to measure change; however, documentation exists that these environments have changed considerably (Levings and Thom 1994).

Trend: Historically, chum salmon were abundant in the lower reaches of the Columbia River and may have spawned as far upstream as the Walla Walla River. Today only remnant chum salmon populations exist, all in the lower Columbia River, and of uncertain stocking history. The Columbia River supported a substantial chum salmon commercial fishery in the first half of the 20th century with harvests of more than 500,000 chum salmon in some years. There are presently neither recreational nor directed commercial fisheries for chum salmon in the Columbia River, although some chum salmon are taken incidentally in the gill-net fisheries for coho and chinook salmon, and there has been minor recreational harvest in some tributaries. Although current abundance is probably less than 1 percent of historical levels, and much of the original genetic diversity has presumably been lost, the total spawning run of chum salmon to the Columbia River has been relatively stable since the run collapsed in mid 1950s. Total natural escapement for the ESU is probably at least 1500-2000 fish per year. Taking all factors into consideration, NMFS concluded that chum salmon in this ESU are not presently in danger of extinction but are likely to become endangered in the foreseeable future.

ENVIRONMENTAL BASELINE

Regulations implementing section 7 of the Act (50 CFR §402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area which have already undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. In this opinion, such actions include, but are not limited to, previous timber harvest and road building on covered lands, and other land management activities such as the adoption of the Northwest Forest Plan (USDA et al. 1994a,b) and the PACFISH and INFISH programs (see Federal Land Management section below).

The section 7 implementing regulations also define the "action area," which includes all areas to be affected directly or indirectly by the Federal action, not merely the immediate area involved in the action (50 CFR §402). Although activities that would be covered by the proposed permit are restricted to Plum Creek lands (i.e., the 1.6 million acre NFHCP covered lands), the effects of the proposed action on the covered species may extend beyond this area. For this consultation, we therefore define the action area to include the 16.5 million acre planning area. The action area consists of 15 sub-basins, referred to in the DEIS and FEIS as "planning area basins", where bull

trout and other covered species are known to occur. These sub-basins are depicted in Map 1.3-1 in the FEIS (page 35) and include ten sub-basins in Montana, one in Idaho, and four in Washington. The NFHCP action area also includes a few "outlier" Plum Creek parcels that occur in other sub-basins outside but near the 15 planning area sub-basins.

The NFHCP did not independently establish these sub-basins (i.e, planning area basins) but, in most cases, simply adopted planning area boundaries from existing bull trout conservation processes other than the NFHCP. In Montana, the Montana Bull Trout Restoration Team identified Restoration Conservation Areas (RCAs) based on existing or potential bull trout metapopulations. The sub-basins for Montana in the NFHCP are nearly equivalent to these RCAs. In Idaho, Key Bull Trout sub-basins identified in the Governor's Bull Trout Conservation Plan were used as the NFHCP's planning area basins where they contain Plum Creek lands. In Washington, a rationale similar to the Montana approach was used to identify NFHCP planning area basins.

Another, but similar, approach is used in this biological opinion. The Environmental Baseline discussions for the covered species below are grouped on the basis of major river sub-basins. These sub-basins constitute the 4th-field in the hydrologic unit code (HUC) system utilized by the U.S. Geological Survey for classifying watersheds. The HUC approach is adopted for this biological opinion because it is a standard watershed classification system, and because most source information relied upon for the Environmental Baseline discussion utilizes the HUC system. Furthermore, the 4th-field HUC (sub-basin) has been selected as the primary classification level for the opinion because a sub-basin typically contains most or all of the bull trout's typical life history (although information is often provided down to the 6th-field HUC i.e., the creek or sub-watershed level). Note, however, that there may be differences between the HUC system at the sub-basin level and the "planning area basin" approach used in the NFHCP. However, these differences are relatively minor because the 4th-field HUC (sub-basin) and the NFHCP's planning area basins are closely equivalent geographically, except where otherwise noted. Thus, use of the two systems in this opinion and the NFHCP, respectively, should not confuse the reader, or be interpreted as constituting a significant difference in the Services' or Plum Creek's respective analysis of the effects of the proposed NFHCP.

Baseline Common to all Sub-Basins Within the Action Area

Plum Creek Lands

To manage bull trout and other covered species on covered lands within the NFHCP (i.e., the 1.6 million acres of Plum Creek lands), Plum Creek has prioritized the watershed units on its lands based on bull trout biology. Covered species management, conservation, and restoration activities under the NFHCP would have highest priority in Tier 1 watersheds, with conservation measures in Tier 2 watersheds being second priority. Tier 1 watersheds (depicted in Map 2.2-1 of the FEIS,

page 45) are those containing streams known to be important for bull trout spawning and juvenile rearing. Tier 2 lands are Plum Creek lands that occur outside of Tier 1 watersheds (i.e., all other covered lands). Some areas within Tier 2 lands are known or suspected to provide migratory, foraging, and over-wintering habitat for adult and sub-adult bull trout. Tier 2 areas also provide the majority of available habitat (on Plum Creek lands) for other native salmonids, including westslope cutthroat trout, steelhead trout, redband trout, chinook salmon, pygmy whitefish, and mountain whitefish.

The covered lands (i.e., Plum Creek lands) contain over 5,000 miles of perennial and intermittent streams. Of this, 190 miles are rivers and large streams likely to be fish-bearing and 1,400 miles are intermittent and perennial streams known to be fish-bearing; however, 260 miles of perennial and 3,200 miles of intermittent streams are known to be non-fish-bearing (DEIS/NFHCP 1999). The covered lands also contains 312 miles of streams known to support bull trout. Of this, 175 miles (56 percent) are in Tier 1 watersheds (those known to support bull trout spawning and rearing) and 137 miles (44 percent) are on Tier 2 lands (all other covered lands) and are primarily Key Migratory Rivers (Plum Creek 1999a). Overall, Tier 1 watersheds comprise 18 percent of the covered lands (300,500 acres), while Tier 2 lands comprise 82 percent (1,277,635 acres). Of the 300,500 acres of Tier 1 lands, 272,624 acres (91 percent) are in Montana, 13,365 acres (4 percent) are in Idaho, and 14,516 acres (5 percent) are in Washington. Tier 1 acreages within each watershed sub-basin are summarized in Table 2.3-1 of the FEIS (page 49). Of the 74 Tier 1 watersheds on covered lands within the NFHCP area, 65 are in Montana, 7 are in Idaho, and two are in Washington. Appendix C in the DEIS/NFHCP (1999) lists the individual Tier 1 watersheds within each watershed sub-basin.

Water quality in most rivers, streams, and lakes on covered lands in the NFHCP area meet state water quality standards (DEIS/NFHCP 1999). However, 8 percent to 12 percent of stream miles are water quality limited due to temperature or nutrient conditions; sediment, siltation, or turbidity conditions; or flow impairments. Parts of eleven of the plan's watershed sub-basins have water quality conditions that may threaten bull trout (the three Kootenai River sub-basins, three Clark Fork River sub-basins, Flathead River basin, Blackfoot River sub-basin, Bitterroot River sub-basin, Little North Fork Clearwater River sub-basin, and Ahtanum Creek sub-basin) (FWS 1998b).

For purposes of evaluating vegetation impacts, the DEIS/NFHCP (1999) divides covered lands in the NFHCP area into the Interior Columbia River Basin and Western Washington portions. The Interior Columbia River Basin portion contains an estimated 62,000 acres of riparian area along its rivers and streams, of which approximately 49,000 acres (3 percent of the covered lands in the NFHCP area) are forested (Plum Creek 1999a). Of this, approximately 16,000 acres (1 percent of the covered lands in the NFHCP area) are legally "harvestable." The 68,000-acre Western Washington portion of the covered lands in the NFHCP area contains an estimated 2,000 acres of forested riparian area.

Federal Land Management

Nearly 10.3 million acres of Federal lands lie within the action area, representing about 60 percent of total action area acreage. The USFS manages approximately 92 percent of these lands. The National Park Service, Bureau of Land Management (BLM), and FWS manage the remainder. Table 2.2-1 in the FEIS (page 47) summarizes Federal land ownership by action area sub-basin. Other Federal landowners and managers present within the action area but which do not represent significant acreages include the U.S. Army Corps of Engineers, Department of Defense, and Bureau of Reclamation. Federal land management within the action area is significantly affected by the Northwest Forest Plan, Inland Native Fish Strategy (INFISH), and Pacific Anadromous Fish Strategy (PACFISH).

The Northwest Forest Plan (USDA, USDI, USDC, and EPA 1993)directs Federal land management activities within the range of the spotted owl. In 1994, an aquatic conservation strategy (ACS, USDA and USDI 1994) was added to the Northwest Forest Plan. Under the ACS, a project cannot have a negative effect in the long-term on riparian-dependent resources which could cause further degradation of the habitat. Each project or management action must maintain or restore the physical and biological processes required by the riparian-dependent resources within the watershed. The purpose of the ACS is to restore and maintain the ecological health of watersheds within the geographic area affected by the Northwest Forest Plan through four components–riparian reserves, key watersheds, watershed analysis, and watershed restoration. This plan is an attempt to protect all fish species (and other aquatic organisms) at the watershed scale by protecting and restoring ecosystem function and processes.

The ACS of the Northwest Forest Plan utilizes a set of standards or prescriptions designed to focus proposed or existing projects such that actions that do not maintain existing conditions or lead to improved conditions in the long-term would not meet the ACS. The components of the ACS include riparian reserve widths that cover five categories of streams, wetlands, and lakes and ponds. Key watersheds identified under the ACS are to provide refugia or high quality habitat for aquatic fish species such as at-risk anadromous salmonids, bull trout, and resident fish species. Watershed analyses is required in key watersheds and riparian reserves to determine how a proposed land management action would meet ACS objectives, thus ensuring that proposed projects protect the structure and function of fish-bearing and nonfish-bearing streams. Lastly, a water restoration program would be employed that would examine potential opportunities to control or prevent road-related runoff and sediment production, rejuvenate condition of riparian vegetation, and restore instream habitat complexity. The ACS is designed to be proactive and not rely on the outcome of mitigation actions from a project that could put at risk riparian-dependent aquatic resources. Instead, the risk to the aquatic and riparian habitat has been shifted in that planned mitigation should not be used as a substitute for preventing habitat degradation.

The INFISH (Interim Strategy for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada, USDA and USDI 1995a) and PACFISH (Interim Strategy for Managing Anadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California, USDA and USDI 1995b) programs provide programmatic direction for management of lands administered by the USFS and BLM. They are interim strategies intended to provide protection against extinction or further endangerment of fish stocks and to maintain management options until long-term conservation programs are completed through the Interior Columbia Basin Ecosystem Management Project (ICBEMP).

In addition, management on Federal lands must comply with the Service's biological opinion on the effects on bull trout of continued implementation of existing USFS and BLM program activities. Activities administered by the USFS are carried out under the direction of Land and Resource Management Plans (LRMPs) and BLM activities are administered under the direction of Resource Management Plans or Management Framework Plans. The USFS and BLM have amended existing LRMPs and Resource Management Plans, respectively, in accordance with PACFISH and INFISH within the geographic range of the Columbia River bull trout Distinct Population Segment. For details on these aquatic conservation strategies, refer to INFISH (USDA and USDI 1995a), PACFISH (USDA and USDI 1995b), and FWS (1998a).

The USFS and BLM have added PACFISH and INFISH aquatic conservation strategies to their LRMPs and Resource Management Plans to provide direction and standards for a large variety of projects and activities, including forest management, recreation, range management, mining, watershed restoration, fish and wildlife habitat management, fire and fuels management, land exchanges and acquisitions, and other special uses. Individual National Forests and BLM Districts with anadromous fish have modified their LRMPs and Resource Management Plans to include PACFISH strategies either through amendment (USFS) or instruction memorandum (BLM). Where PACFISH was not already in place, the USFS amended its LRMPs in accordance with INFISH. The BLM has produced instruction memorandums to apply INFISH direction to all bull trout watersheds within its lands. Under the Endangered Species Act, these agencies also must consult with the FWS on site-specific actions conducted under the direction of their LRMPs/Resource Management Plans where such actions may affect listed species. Ultimately, the USFS and BLM intend to modify and implement PACFISH/INFISH guidance with science-based, ecosystem management strategies formulated by the ICBEMP. The emphasis in each of these programs is on coordination with state, tribal, and local governments and key interested and affected parties, with the goal of maintaining and restoring a network of well-connected high-quality habitats that support a diverse assemblage of native species.

Assessment of the Interior Columbia River Basin (ICRB) by the ICBEMP has identified aquatic strongholds and areas of high fish community integrity. This and other information will be used to develop aquatic conservation and restoration strategies that focus on watersheds with higher fish

densities and populations that are likely to be more resilient than those in a depressed condition. Such strategies will include protection of high integrity areas and restoration of areas with lower integrity. Although still evolving, the ICBEMP aquatic conservation strategy is expected to include fish riparian management objectives and management standards that would provide consistent management guidance across Federal administrative units. The objectives and standards would be replaced, as appropriate, through Federal ecosystem analysis at the watershed scale. The ICBEMP (Quigley and Arbelbide 1997) assumes that federally managed land would function as habitat anchors in the maintenance of fish habitat and water quality. Through implementation of ICBEMP, Federal lands are expected to carry the major burden of conservation and recovery of native salmonid habitats.

More than 90 percent of remaining bull trout and westslope cutthroat trout subwatersheds with known or predicted strong populations of these species are on USFS and BLM administered lands. These lands will be vital to ultimate recovery of these species. Federal lands are often concentrated in the headwater areas of watersheds, upstream of the lower-gradient reaches that were historically important for salmonid production. In other cases, Federal lands are distributed in a checkerboard fashion (for example, with Plum Creek lands), resulting in fragmented landscapes and a highly variable Federal ability to protect and restore watershed functions and salmonid habitat across land management boundaries (62 FR 24596).

On March 1, 1999, the USFS adopted an interim rule establishing an 18-month moratorium on new road construction in unroaded areas in most National Forests. While the suspension is in effect, the USFS will develop a long-term road policy for the National Forest Transportation System. The goal will be to minimize environmental damage, guide decisions on identifying non-essential roads, recommend roads to be eliminated or maintained to reduce environmental damage, and assess roads that need to be reconstructed and maintained so they are safe and can sustain public use. The USFS's water quality protection strategy relies on Forest Plan standards and guidelines that specify BMPs that meet or exceed state standards. This includes meeting or exceeding requirements of various forest practices acts and streamside protection laws.

State Land Management/Bull Trout Policies

There are 310,108 acres of state lands within the NFHCP action area, representing approximately 2 percent of action area acreage. Of this total, 212,281 acres (68 percent) are in Montana, 6 acres (less than 1 percent) are in Idaho, and 97,821 acres (31.5 percent) are in Washington.

As important as state lands are to certain fish and aquatic communities, improvements in aquatic conditions are not expected to be systemic on state lands throughout the action area (Quigley and Arbelbide 1997). This conclusion was reached during ICBEMP analyses for the following reasons: 1) the goals of the state natural resource agencies often are not specifically aimed at restoring aquatic ecosystems and biodiversity, but instead are aimed at meeting social needs while

disrupting ecological processes and structures as little as possible; 2) as one moves from broad and uniform application of forest practice rules, which are themselves not fully protective of riparian function, to rangelands and settlement areas, the outcomes of regulations and laws are variable, localized, and often vague; and 3) adequate information about species at sites that will be affected by management activities is generally lacking, especially in terms of the biological condition and presence of rare species. Thus, while each state within the action area has bull trout protection and aquatic improvement policies and associated goals, as described below, achievement of those goals through adherence to state requirements remains uncertain and it may be difficult for such policies to protect and restore riparian and aquatic resources through time.

In Montana, a Bull Trout Roundtable was convened by the Governor in 1993 to review bull trout status and to discuss options to maintain and restore the species in the state. A Bull Trout Restoration Team consisting of representatives from federal and state agencies, Native American tribes, the private timber industry, and environmental groups was subsequently formed to develop a Restoration Plan for bull trout in Montana. The Bull Trout Restoration Team appointed a scientific group of technical experts, the Montana Bull Trout Scientific Group (MBTSG), to develop the tenets of a plan to halt the decline of bull trout in Montana. The Montana Bull Trout Restoration Plan was recently released in June, 2000.

The Idaho Bull Trout Conservation Plan (IBTCP), completed in 1996, is directed at maintaining or restoring complex interacting bull trout populations throughout their native range in Idaho. The goals of the IBTCP are to: 1) maintain existing critical bull trout habitat; 2) improve the status, abundance, and habitat of bull trout; 3) achieve stable or increasing bull trout populations over a range of watersheds; and 4) achieve bull trout conservation goals while providing economic viability for Idaho's industries. The IBTCP uses basin and watershed advisory groups to address problems in water quality limited stream segments and to provide locally developed watershed-specific plans to maintain or increase bull trout populations.

The Washington Forest Practices Act (Revised Code of Washington 76.09, Washington Administrative Code 222-08) and its implementing forest practices rules and regulations are the state's principal means of regulating activities on state and private forest lands in Washington. Administered and enforced by the Washington Department of Natural Resources (WDNR), the forest practices rules and regulations address most issues of concern on forested lands, including harvest practices, regeneration, road construction, and the protection of other public resources such as water quality, fisheries, and wildlife. All harvest activities on state and private forest lands require a forest practices notification of approval from WDNR. Issuance of this approval depends on compliance with the Forest Practices Act and its regulations. Most or all provisions within the forest practices rules and regulations ultimately influence fish and wildlife habitat by regulating how and when certain activities may take place on private forest lands. Washington's forest practice regulations are among the most stringent in the nation.

Included in the Washington Forest Practices Act is a provision for voluntarily initiating watershed analysis. Watershed analysis is a systematic procedure to assess local processes within a watershed and provide information for developing management guidelines that protect and restore aquatic and riparian habitat. A key component of watershed analysis is monitoring to assess the effectiveness of prescriptions developed using the procedure. A detailed description of recommended watershed analysis methods is presented in the Washington Forest Practices Board Manual: Standard Methodology for Conducting Watershed Analysis, Version 4.0 (WFPB 1997).

Another feature of the forest land management system in the State of Washington is the Timber, Fish, and Wildlife (TFW) Agreement. The TFW was developed in 1987 by four caucuses: Native American Indian tribes, state agencies, the private timber industry, and environmental groups. The TFW created a process for cooperative management of public and private natural resources at the local, regional, and statewide levels, based on adaptive management and technical information. Since its inception, TFW participants have contributed to the continuous improvement of Best Management Practices (BMPs) around the state using information gathered through cooperative research and monitoring projects. More than $15 million of state, tribal, and private funds have been spent on these projects. The products of these efforts are a variety of management tools, including a cumulative effects assessment and watershed analyses that are being used to comprehensively evaluate and revise forest practice rules and regulations.

To respond to the numerous Federal listings under the Act of salmon and Clean Water Act listings of water quality limited streams, the TFW caucuses, along with the FWS, National Marine Fisheries Service (NMFS), and Environmental Protection Agency (EPA), joined to draft the Forests and Fish Report (FFP). The FFP provides recommendations for rules, statutes, and programs designed to develop biologically sound and economically practical solutions that improve and protect riparian habitat on non-federal forest lands in Washington. The goals of the report are to: 1) provide compliance with the Act for aquatic and riparian-dependent species on non-federal forest lands; 2) restore and maintain riparian habitat on non-federal forest lands in order to support a harvestable supply of fish; 3) meet the requirements of the Clean Water Act for water quality on non-federal forest lands; and 4) keep the timber industry economically viable in the State of Washington. The FFP will be implemented through authorizing legislation passed by the 1999 Washington Legislature (ESHB 2091). ESHB 2091 directs that protection for salmonids using prescriptions outlined in the FFP will be implemented immediately through emergency rule making, followed by permanent rule making required to be promulgated by June 2001.

In 1997, the Washington State Department of Natural Resources (WDNR) completed a multi-species HCP across their managed lands within the range of the spotted owl. However, the WDNR HCP addresses only species listed under the Act as of January 30, 1997, and does not include a riparian-protection strategy or a comprehensive road management plan. Therefore, it is relatively ineffectual in addressing aquatic conditions in the state of Washington. Current WDNR policies direct staff to retain larger buffers along streams and be more protective of natural

resources on behalf of their fiduciary trust responsibilities; however, there are no guarantees that these actions will continue.

Baseline Conditions for Covered Species in the Action Area

On NFHCP lands within the action area, bull trout occur in three states, Washington, Idaho, and Montana. In Washington these areas include the Lower Columbia River area (Lewis, Cowlitz, and Kalama River sub-basins) and the Mid-Columbia River area (Ahtanum and Tieton river drainages in the Yakima Sub-basin). In Idaho these lands include the Snake River area (Lochsa River sub-basin) and in Montana the upper Columbia River area (Kootenai, Flathead, Clark Fork, Blackfoot, Bitterroot, and Swan River sub-basins). Within the action area, bull trout are most widely distributed in Montana, specifically the Swan, Blackfoot, Kootenai, and Clark Fork River sub-basins. Bull trout populations are present in the other major drainages of the action area, but they are generally limited to a few headwater streams. Refer to the FEIS (Map 4.6-2, page 221) which shows bull trout distribution in action area sub-basins in Montana, Idaho, and Washington.

Baseline discussions below for covered species are grouped within each state by major river sub-basins which are generally 4th-field hydrologic unit codes (HUCs) in the U.S. Geological Survey's system for classifying watersheds. More detailed information and data on baseline conditions by individual covered species and sub-basin, including at the finer scale of the 6th-field HUC sub-watershed level, can be found in Appendix A. Baseline information from Appendix A, mostly for native trout and salmon covered in the NFHCP, is summarized below, narratively and in tables. Individual tables related to each sub-basin discussion list 9 important habitat indicators pertinent to all covered species and indicate the Services' qualitative rating for each habitat indicator based on the baseline information presented in Appendix A.

Montana

Upper Kootenai River Sub-basin

Plum Creek lands in the Upper Kootenai River sub-basin consist of a few sections in the southwest portion of the sub-basin just west of Koocanusa Reservoir. These lands total 7,030 acres and are in a checkerboard pattern with USFS lands. No Tier 1 watersheds occur in the Upper Kootenai River sub-basin, either on Plum Creek lands or on lands under other ownership. Tier 2 lands, however, total 664,643 acres under Federal ownership (83 percent of the drainage), and 7,030 acres under Plum Creek ownership (1 percent of the drainage). Several miles of Key Migratory Rivers occur in the Upper Kootenai River drainage, none of which, however, occur on Plum Creek lands. Perennial streams on Plum Creek lands in the Upper Kootenai total 7 miles. A total of 149 miles of roads occur on Plum Creek lands in the Upper Kootenai and another 4 miles are proposed (DEIS/NFHCP 1999).

This sub-basin was created by the construction of Libby Dam in 1972 and constitutes the Kootenai drainage upstream of Libby Dam, including the 90 mile long Koocanusa Reservoir. Libby Dam is an upstream migratory barrier to fish; thus, no bull trout or other fish species have been known to migrate upstream past the dam since its construction (MBTSG 1996a). However, migratory bull trout are known to inhabit Koocanusa reservoir and to migrate from the reservoir into tributary drainages to spawn; the juvenile fish rear for several years before moving back downstream to the river or reservoir, where sub-adults rear for several more years prior to maturity.

The three primary concerns of the in the upper Kootenai area are forestry practices, cooperation with Canada, and illegal fish introductions MBTSG (1996a). Extensive road construction to support logging operations exists throughout the sub-basin. Risks to covered species are high because of the existing road system, mixed land ownership, forestry practices on private lands, and the lingering effects of past activities. The latent effects from past activities on habitat include increased sediment in streams, increased peak flows, thermal modifications, loss of instream woody debris, channel instability, and increased access for anglers and poachers.

Illegal harvest of bull trout is a threat because poachers target concentrations of large bull trout in Grave Creek, the only known substantial bull trout spawning and rearing habitat located in the U.S. portion of the sub-basin (Long 1997). Grave Creek is designated as a Water Quality Limited Segment (WQSL) due to sediment derived from agriculture and silviculture. In addition, bull trout and likely other native fish outmigrating from Grave Creek into Glen Lake irrigation ditch are lost from the upper Kootenai River subpopulation (MBTSG 1996a). Another risk factor for native fish habitat is rural residential development, which is increasing along tributaries in the upper Kootenai drainage (MBTSG 1996a); this is because large tracts of private land exist along the stream channels throughout this area.

The status and trend of bull trout in the Upper Kootenai River sub-basin are unknown; however, recent redd surveys suggest a stable population (MBTSG 1996a). WCT stocks are strong or predicted strong in 15 subwatersheds; depressed or predicted depressed in 159 subwatersheds; and absent or predicted absent in the remaining 18 subwatersheds (USDI 1999a). No information was found on the status or presence of RBT in the sub-basin.

Table 2. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Upper Kootenai River Sub-basin, Montana.

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature		|-------|	
2. Fine sediment			|-------|
3. Large woody debris		|-------|	
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage		|-------|	
8. Refugia		|-------|	
9. Road density			|-------|

Explanation of Baseline Ratings

1. **Water temperature. Good** - water temperatures do not exceed 12 °C in bull trout streams, and 16-18 °C in salmon and steelhead streams in the majority of watersheds in the basin; **Fair** - water temperatures occasionally exceed 12 °C in bull trout streams, and 16-18°C in salmon and steelhead streams, but potential use by permit species is not limited by temperature; **Poor** - summer water temperatures regularly exceed 12 °C in bull trout streams, and 16-18 °C in salmon and steelhead streams, and potential use by permit species is limited or precluded by temperature.

2. **Fine sediment. Good** - fine sediment (<6.3 mm) volume in spawning gravels does not exceed 25-35% in the majority of locations, and spawning activity is well-distributed among potential sites; **Fair** - fine sediment in spawning gravels exceeds 35% in some localized drainages, but elsewhere, spawning activity is well-distributed among potential sites; **Poor** - fine sediment in spawning gravels exceeds 25-35% in the majority of locations, and spawning activity does not occur in many potential sites.

3. **Large woody debris. Good** - existing and future LWD supply within expected norms in most locations; **Fair** - existing or future LWD supply below expected norms in many locations, but pool frequency and channel morphology is not substantially altered; **Poor** - existing LWD is well-below expected norms in most locations, pool frequency or channel morphology is altered, and improvement from future supply is not expected for several decades or more.

4. **Stream flow. Good** - hydrograph not substantially altered by diversions, impoundments, or increased peak flows, and streams are usable all year-round; **Fair** - alterations in the hydrograph reduce the amount of habitat available, but with few exceptions, streams are usable all year; **Poor** - alterations in the hydrograph eliminate usable habitat over a widespread area, and one or more salmonid life stages is precluded from using altered areas.

5. **Water quality. Good** - water quality meets or exceeds state standards, and levels of pollutants such organic enrichment, turbidity, and contaminants do not affect fish habitat use or survival in the majority of areas; **Fair** - most water quality

parameters are near state standards, but localized problems may occur, and fish habitat use or survival may be locally impaired; **Poor** - one or more water quality parameters precludes or severely limits fish habitat use or survival over a large portion of a basin.

6. **Channel morphology. Good** - common indicators such as width:depth ratio, sinuosity, gradient and bank stability are within expected norms in most locations; **Fair** - common indicators are outside expected norms in a few locations, and alterations (e.g. straightening, riprap, bank trampling) occasionally occur in localized areas; **Poor** - common indicators are typically outside expected norms, and mainstem channels show signs of instability, and alterations are frequent.

7. **Fish passage. Good** - artificial barriers are few or none, and where barriers exist, fish are precluded from only a small amount of area, or from areas that have little or no production potential; **Fair** - artificial barriers preclude or limit use of up to several watersheds in a basin, but the majority of watersheds in a basin that are potentially used by fish are accessible; **Poor** - either numerous barriers exist in tributaries, or large portions of a basin are inaccessible.

8. **Refugia. Good** - areas that are mostly undeveloped are well-distributed in a basin, and key habitat components are available such as side channels or mainstem pools are intact; **Fair** - key habitat components and areas that are mostly undeveloped occur in a few locations; **Poor** - a basin has widespread development, and key habitat components are likely to be limiting factors.

9. **Road density. - Good** - generally less than 1 road mile per square mile, and little effect of roads on riparian areas, stream hydrograph, or sediment delivery; **Fair** - 1 to 2.4 road miles per square mile, and only localized effects of roads on riparian areas, stream hydrographs, or sediment delivery; **Poor** - greater than 2.4 road miles per square mile, and effects of roads are likely to be a limiting factor.

Middle Kootenai River Sub-basin

Plum Creek lands in the Middle Kootenai River sub-basin consist of 328,597 acres distributed primarily throughout the central and eastern portions of the watershed. Some of these lands are in a checkerboard pattern with USFS lands, while other portions are in relatively uniform Plum Creek ownership. Tier 1 watersheds in the Middle Kootenai drainage total 145,303 acres (approximately 16 percent of the drainage), of which 12,149 acres (approximately 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 764,788 acres (84 percent of the drainage), of which 315,902 acres (35 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Middle Kootenai River drainage total 87 miles; 34 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Middle Kootenai total 257 miles. Grazing leases on Plum Creek lands in this drainage total 114,650 acres along 283 miles of streams, all of which are on Tier 2 lands. A total of 3,562 miles of roads occur on Plum Creek lands in the Middle Kootenai and another 179 miles are proposed (DEIS/NFHCP 1999).

This sub-basin consists of the 29 mile reach and its tributaries between Libby Dam downstream to Kootenai Falls. Libby Dam is an upstream passage barrier to native salmonids from the middle and lower Kootenai drainages, and restricts this migratory population to 25 miles of river. Libby Dam also reduces high spring flows, making upstream passage over Kootenai Falls impossible. Libby Dam has altered temperatures, flow regimes, and sediment loads in the Kootenai River (MBTSG 1996b).

The Fisher River is the largest tributary to the Middle Kootenai River and may have been an important bull trout stream historically. The entire length of the Fisher River and the confluence of all the Fisher River's tributaries are on private lands owned primarily by Plum Creek. These private lands, including Plum Creek's, extend upslope for 1 to 4 miles along the entire valley corridor. All of these lands have been roaded and harvested on at least one occasion. The two largest tributaries to the Fisher (Wolf Creek and Pleasant Valley Fisher River) are situated in wide valley bottoms owned by Plum Creek and a few private individuals.

The Fisher River has also been extensively channelized. The channelization of Fisher River and Wolf Creek and subsequent maintenance activities has resulted in significant impacts to the aquatic habitats in this portion of the Middle Kootenai drainage. Timber harvest, extensive road construction, railroad construction, cattle grazing, and channel realignments have been major impacts in this portion of the Fisher River. These factors and past management practices have resulted in increased erosion and damage to riparian vegetation in the Fisher River drainage (May 1971 as cited in Kootenai National Forest, 1999). Poor aquatic habitats resulting from past construction and land management activities is apparently limiting bull trout populations in the Fisher River. Sediment pollution and increases in water temperatures were caused by the destruction of riparian vegetation. This environmental damage and extensive modifications to the river and creek channels are the most probable factors adversely affecting bull trout populations and other native fish in the Fisher River and Wolf Creek drainages.

The dominant land use in the Middle Kootenai River sub-basin is timber harvest. Extensive road construction to support logging operations exists throughout the watershed. The Montana Bull Trout Scientific Group (MBTSG 1996b) reported that past forestry practices (road construction, log skidding, riparian harvest, clearcutting, and terracing) were major contributing causes to the decline of bull trout in the sub-basin. However, mining and recreation occur in other tributaries to the Fisher River, and 4 to 7 miles of these streams is characterized by channel instability, increased sediment loading, channel migration, and bank cutting. Snowshoe Creek, Libby Creek, and Big Cherry Creeks are water quality impaired because of past mining activities (MDHES 1994). Potential pollution from mine-tailing seepage and magnified peak flow events are also possible events that could negatively impact native fish and their habitat.

The population abundance of bull trout in this sub-basin is low, although the actual status is unknown. Forestry practices rank as the highest risk followed by dam operations (MBTSG 1996b). At this time there is not sufficient data on bull trout population trend; however, redd counts appear to be up from recent surveys. Most WCT stocks in the sub-basin are considered depressed or predicted depressed and none are strong or predicted strong (USDI 1999a). RBT are present in a very few watersheds in this sub-basin and exist as remnant, isolated populations Muhlfeld (1999). There is a high risk that watershed disturbances could progressively isolate RBT

populations into smaller and smaller habitat patches increasing their risk of extirpation.

Table 3. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Middle Kootenai River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature			|-------|
2. Fine sediment			|-------|
3. Large woody debris			|-------|
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology			|-------|
7. Fish passage		|-------|	
8. Refugia		|-------|	
9. Road density			|-------|

Lower Kootenai River Sub-basin

Plum Creek lands in the Lower Kootenai River sub-basin consist of 32,232 acres distributed in a checkerboard fashion in the southern half of the sub-basin. Tier 1 watersheds in the Lower Kootenai drainage total 104,739 acres (approximately 16 percent of the drainage), of which 4,854 acres (approximately 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 544,869 acres (83 percent of the drainage), of which 28,363 acres (4 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Lower Kootenai River drainage total 35 miles; 4 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Lower Kootenai total 49 miles. There are no grazing leases on Plum Creek lands in this drainage. A total of 427 miles of roads occur on Plum Creek lands in the Lower Kootenai and another 19 miles are proposed (DEIS/NFHCP 1999).

This sub-basin consists of the Kootenai River drainage from Kootenai Falls downstream into Idaho. The dominant land use in the Lower Kootenai River watershed is timber harvest which is supported by an extensive road system. Seven miles of stream in the Lower Kootenai are water

quality impaired as a result of silviculture activities (MDHES 1994). As a result of salvage logging, which began in the watershed in 1996, the number of acres of timber sold and clearcut increased substantially over the previous 3 years (Kootenai National Forest 1997).

Several risks to covered species exist in the lower Kootenai River drainage. Forestry practices remain a significant threat. The effects on the habitat of past such activities are still evident and include increased sedimentation, increased peak flows, thermal modifications, loss of instream woody debris, and channel instability. Another current and ongoing factor in this area is Libby Dam, whose operations have altered discharge patterns undoubtedly decreased production of resident native fish populations. A major risk to bull trout populations is illegally introduced species (MBTSG 1996c) like brook trout and lake trout introductions. The quality of covered species habitat in several tributaries in the area has been compromised as a result of past human disturbances, including catastrophic fire, mining, salvage logging, water diversion, road construction, and poaching.

Currently, O'Brien Creek is considered the most important bull trout spawning and rearing tributary in the lower Kootenai subpopulation in Montana (MBTSG 1996c). Lower main and South Fork Callahan creeks are also important for bull trout even though spawning redds have not been observed. The abundance of bull trout in the sub-basin is small and status and trend are unknown. The FWS does not consider this population at risk of stochastic extirpation however (FWS 1998b).

Stocks of WCT are known to occur in three stream reaches in the Lower Kootenai River watershed, but remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in two subwatersheds and depressed or predicted depressed in the remaining 31 (USDI 1999a). RBT are native to the Lower Kootenai River and the small, isolated remnant populations may represent the only known sources of refounding the historic distribution of pure RBT in Montana.

Table 4.	Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Lower Kootenai River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)		
ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature		|-------|	
2. Fine sediment			|-------|
3. Large woody debris		|-------|	
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage		|-------|	
8. Refugia		|-------|	
9. Road density			|-------|

Flathead River Basin/Flathead Lake

Plum Creek lands in the NFHCP's Flathead River basin consist of 102,980 acres situated in two general locations–west and northwest of Flathead Lake and just north of Whitefish Lake. Tier 1 watersheds in the Flathead River basin total 157,670 acres (approximately 6 percent of the drainage), of which 11,439 acres (less than 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 2,424,512 acres (94 percent of the drainage), of which 90,965 acres (4 percent of the drainage) are owned by Plum Creek. No Key Migratory Rivers occur in the Flathead, on either Plum Creek or other lands. Perennial streams on Plum Creek lands in the Flathead total 88 miles. Grazing leases on Plum Creek lands in the Flathead total 46,757 acres along 105 stream miles. Of these, 3,263 acres and 7 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 1,288 miles of roads occur on Plum Creek lands in the Flathead and another 15 miles are proposed (DEIS/NFHCP 1999).

There are three major sub-basins within the Flathead River basin: 1) the sub-basin including the North and Middle Forks of the Flathead River, Flathead Lake, the lower Flathead River, and the Stillwater and Whitefish Rivers (both of which flow directly into Flathead Lake); 2) the sub-basin including Swan Lake and the Swan River system upstream from Swan Lake; and 3) the sub-basin including Hungry Horse Reservoir and the South Fork of the Flathead River. In this assessment,

the Swan River sub-basin is addressed separately below and the South Fork Flathead River sub-basin is not addressed because it is outside the action area.

Past forest practices in the Flathead River basin (e.g., road construction, log skidding, riparian tree harvest, clearcutting, and splash dams) are considered a significant factor in the decline of covered species in the basin, especially bull trout (MBTSG 1995a). Although forest practices have improved, past effects still impact bull trout because existing roads still cause erosion and sedimentation and increase water yields to streams. Other activities in the Flathead basin have also impacted aquatic habitats in the past and may do so in the future, including mining, road construction, railroad operation, residential development, and dam operations. The MTDEQ (1994) lists 17 streams in the Flathead River sub-basin as being water-quality impaired as the result of forestry practices and 16 streams impaired by agricultural practices; additional impairments result from other land-use practices (USDI 1999a). Many of these streams are water-quality impaired by more than one activity.

Currently, migratory bull trout reside in Flathead Lake and spawn primarily in the North Fork Flathead tributaries and Middle Fork Flathead tributaries (Fraley and Shepard 1989; MBTSG 1995a). Since 1991, the Flathead Lake bull trout subpopulation has declined drastically, as well as the abundance of WCT. MFWP estimated the total number of adult bull trout in Flathead Lake in 1982 at 12,980 fish, and since 1992 (the last 8 years) this average has dropped to 2,426 fish (MFWP internal memo 1998). Evidence suggests that lake trout introductions and the resulting high numbers of lake trout resulting from a change in the lake's food web, are responsible. Such introductions have been implicated in contributing to the decline of bull trout and westslope cutthroat trout in the basin. The Flathead Lake population of bull trout is considered depressed, but currently not at risk of stochastic extirpation (FWS 1998b).

WCT stocks are strong or predicted strong in 55 subwatersheds, depressed or predicted depressed in 220 subwatersheds, and absent or predicted absent in the remaining 37 subwatersheds that collectively constitute the Flathead River sub-basin (USDI 1999a). Whirling disease poses a threat to WCT in the basin, as well as predation by normative predatory fishes such as lake trout.

Table 5. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Flathead River/Flathead Lake Basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature		|-------|	
2. Fine sediment			|-------|
3. Large woody debris		|-------|	
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage		|-------|	
8. Refugia		|-------|	
9. Road density			|-------|

Swan Lake/Swan River Sub-basin

Plum Creek lands in the NFHCP's Swan River sub-basin consist of 471,926 acres situated in the southern half of the sub-basin. Tier 1 watersheds in the Swan River sub-basin total 176,187 acres (approximately 38 percent of the drainage), of which 36,178 acres (8 percent of the drainage) are Plum Creek lands. Tier 2 lands total 295,739 acres (62 percent of the drainage), of which 46,417 acres (10 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Swan River sub-basin total 45 miles; 10 miles of these occur on Plum Creek lands. Perennial streams on Plum Creek lands in the Swan River sub-basin total 139 miles. Grazing leases on Plum Creek lands in the Swan River sub-basin total 6,654 acres along 20 stream miles. Of these, 339 acres along 2 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 822 miles of roads occur on Plum Creek lands in the Swan and another 79 miles are proposed (DEIS/NFHCP 1999).

The Swan River flows north from its headwaters in the Swan and Mission mountains for 35 miles to Swan Lake, which is the largest lake in the drainage. The Swan River then flows out of Swan Lake for 14 miles before entering Flathead Lake. About 45 percent of the Swan River drainage is on USFS lands, much of which is mid to upper elevations. Roughly 20 percent is in Plum Creek ownership, 10 percent is state lands, and 25 percent is in other private ownership.

Extensive logging and road building has occurred throughout the Swan river sub-basin. However, because of the geomorphology and geology of the drainage, it is difficult to assess the effects of forestry on native salmonids in this sub-basin (MBTSG 1996d). Some research has been not been able to demonstrate a relationship between bull trout distribution and management history (Watson and Hillman 1997), whereas other investigations have reported that Swan River tributaries draining large areas of roadless land are disproportionately important for the persistence and recovery of bull trout and WCT (Frissell et al. 1995).

Introduced fish species that currently inhabit the Swan drainage pose a major risk to bull trout. Brook trout, which are abundant in the sub-basin are a major threat because they hybridize extensively with bull trout in certain territories and directly compete with bull trout for resources. The greatest threat to bull trout and perhaps native WCT in the Swan River sub-basin is illegal introduction of lake trout, which are present in high numbers immediately downstream in Flathead Lake (MBTSG 1996d) and have recently been caught in Swan Lake. Northern pike also occur in Swan Lake where they prey on juvenile bull trout and juvenile and adult WCT and present a risk

Migratory bull trout continue to be the dominant life form in the Swan River sub-basin. Currently, the Swan River likely supports the largest numbers of migratory bull trout remaining in Montana (MBTSG 1996d). A significant positive population trend was found for Swan River bull trout (Rieman and Meyers 1997) and presently, the FWS considers this population of bull trout as increasing and the trend is upward. This population has the only legal harvest of bull trout allowed in Montana at present.

WCT stocks are depressed or predicted depressed in the 29 subwatersheds that constitute the Swan River sub-basin (USDI 1999a). The factors affecting WCT in the Swan River sub-basin are essentially the same as the factors affecting bull trout. In addition, whirling disease has been detected in trout in the Swan River (Gustafson 1996 as cited in USDI 1999a) and poses a potential threat to WCT

Table 6. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Swan River Sub-basin. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|-------|		
2. Fine sediment		|-------|	
3. Large woody debris		|-------|	
4. Stream flow	|-------|		
5. Water quality		|-------|	
6. Channel morphology	|-------|		
7. Fish passage		|-------|	
8. Refugia		|-------|	
9. Road density			|-------|

Upper Clark Fork River Sub-basin

Plum Creek lands in the Upper Clark Fork River sub-basin consist of 2,367,280 acres situated along the northern edge of the. Tier 1 watersheds in the Upper Clark Fork total 92,906 acres (approximately 4 percent of the drainage), of which 10,578 acres (less than 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 2,274,374 acres (96 percent of the drainage), of which 94,270 acres (4 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Upper Clark Fork total 46 miles; 2 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Flathead total 89 miles. Grazing leases on Plum Creek lands in the Upper Clark Fork total 71,073 acres along 144 stream miles. Of these, 3,587 acres along 8 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 1,347 miles of roads occur on Plum Creek lands in the Upper Clark Fork and another 122 miles are proposed (DEIS/NFHCP 1999).

The Clark Fork River basin is divided into 3 sub-basins in terms of the mainstem river: 1) Upper Clark Fork (upstream of Milltown Dam); 2) Middle Clark Fork (Milltown Dam downstream to Thompson Falls Dam); and 3) Lower Clark Fork including Cabinet Gorge Reservoir (Noxon Dam downstream to Cabinet Gorge Dam) and Noxon Rapids Reservoir (Thompson Falls downstream to Noxon Dam). The upper segment of the Clark Fork River (above Milltown Dam) is about 119 miles long.

Numerous water quality problems occur in the Upper Clark Fork River as a result of a century of mining and it continues to pollute 349 miles of streams in the area (MDHES 1994). The sub-basin tributaries are heavily polluted with toxic metals and other chemicals. Dewatering for irrigation, warm irrigation return flows, and a lack of riparian vegetation to shade the water have led to warm temperatures in the sub-basin and thermal passage barriers for native salmonids (MBTSG 1995b). Intensive grazing has also had a substantial impact on fisheries. Grazing is a very high risk to restoration of bull trout in the upper Clark Fork (MBTSG 1995b).

Currently, with the exception of Rock Creek, bull trout are rare in the Upper Clark Fork drainage and were likely eliminated from in the mainstem and headwaters due to mine operations (Berg and Priest 1995, MBTSG 1995a). The status and trend of the Upper Clark Fork River bull trout subpopulation is unknown (FWS 1998b), although redd counts from four index streams indicated an increasing trend (Maxell 1996). In general, current populations of bull trout in the Upper Clark Fork River sub-basin are highly depressed with the exception of the Rock Creek drainage, where bull trout are more common in the upper portion of this tributary.

Stocks of genetically pure WCT occupy 224 miles in the Upper Clark Fork River sub-basin. WCT stocks are strong or predicted strong in 10 subwatersheds; depressed or predicted depressed in 39 subwatersheds; and absent or predicted absent in the remaining 18 subwatersheds that collectively constitute the Upper Clark Fork River sub-basin (USDI 1999a).

Table 7. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Upper Clark Fork River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature			|-------|
2. Fine sediment			|-------|
3. Large woody debris			|-------|
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology			|-------|
7. Fish passage			|-------|
8. Refugia		|-------|	
9. Road density		|-------|	

Middle Clark Fork River Sub-basin

Plum Creek lands in the Middle Clark Fork River sub-basin consist of 3,198,753 acres scattered about the northern, western, and southern portions of the sub-basin. Tier 1 watersheds in the Middle Clark Fork total 468,837 acres (approximately 15 percent of the drainage), of which 45,369 acres (approximately 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 2,729,956 acres (85 percent of the drainage), of which 377,121 acres (12 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Middle Clark Fork total 245 miles; 34 of these occur on Plum Creek lands. Perennial streams on Plum Creek lands in the Middle Clark Fork total 360 miles. Grazing leases on Plum Creek lands in the middle Clark Fork total 307,017 acres along 760 stream miles. Of these, 20,223 acres along 81 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 15,284 miles of roads occur on Plum Creek lands in the Middle Clark Fork and another 288 miles are proposed (DEIS/NFHCP 1999).

The middle segment of the Clark Fork River mainstem extends from Thompson Falls Dam upstream 120 miles to Milltown Dam near Bonner. Milltown Dam on the mainstem Clark Fork, prevents fish passage upstream to the Upper Clark Fork drainage and the Blackfoot River. The middle Clark Fork River includes 2 major tributaries, the lower Flathead River and the Bitterroot (addressed as a separate sub-basin, see below).

Covered species in the Middle Clark Fork are adversely affected by mining, grazing, and agricultural impacts on water quality and quantity, and introduced species. The Middle Clark Fork River segment is water quality impaired because of mining (153 miles), forestry (238 miles), dams, and agricultural impacts (MDHES 1994).

Bull trout are rare in the mainstem Clark Fork River between Milltown dam and the confluence of the Flathead River. Although there is little evidence available, limited data suggest that migratory bull trout are declining and rare at the present time in the Middle Clark Fork (MBTSG 1996e). The actual status and trend are unknown. Extreme habitat fragmentation (has resulted in numerous resident bull trout populations of moderate to low density (MBTSG 1996e). The most serious threat to bull trout restoration in the middle Clark Fork River is fragmentation of bull trout into isolated units caused by fish passage barriers at hydroelectric dams, culverts, and irrigation diversions.

In the Middle Clark Fork River sub-basin, stocks of genetically pure WCT occupy 105 miles. WCT stocks are strong or predicted strong in 11 subwatersheds; depressed or predicted depressed in 55 subwatersheds; and absent or predicted absent in the remaining one sub-watershed (USDI 1999a). Similar to bull trout, major land-use activities in the Clark Fork River sub-basin that may adversely affect WCT include dams, forestry practices, mining, livestock

grazing and other agricultural practices, and urbanization. In addition, whirling disease which has been found in the sub-basin and may negatively affect WCT.

Table 8. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Middle Clark Fork River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature			|-------|
2. Fine sediment			|-------|
3. Large woody debris		|-------|	
4. Stream flow		|-------|	
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage			|-------|
8. Refugia		|-------|	
9. Road density		|-------|	

Lower Clark Fork River Sub-basin

Plum Creek lands in the Lower Clark Fork River sub-basin consist of 716,525 acres. Tier 1 watersheds in the Lower Clark Fork sub-basin total 68,008 acres (approximately 9 percent of the drainage), of which 1,912 acres (less than 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 648,517 acres (91 percent of the drainage), of which 739 acres (less than 1 percent of the drainage) are owned by Plum Creek. No Key Migratory Rivers or grazing leases occur on Plum Creek lands in the Lower Clark Fork, though 23 miles of Key Migratory Rivers occur on other lands in the sub-basin. Perennial streams on Plum Creek lands in the Lower Clark Fork total 89 miles. A total of 27 miles of roads occur on Plum Creek lands in the Lower Clark Fork while another 2 miles are proposed (DEIS/NFHCP 1999).

Today, three hydroelectric dams occur within the Lower Clark Fork River mainstem segment and each one is a fish passage barrier. Prior to hydroelectric development in the Lower Clark Fork River drainage, migratory bull trout from the Clark Fork River and from Lake Pend Oreille had access to tributary streams both within the Lower Clark Fork River drainage and upstream of Thompson Falls Dam. When the dams blocked access the migratory corridor shifted from larger

migratory bull trout populations to smaller more isolated migratory and resident populations, and in turn, the likelihood of extinction increased.

Fragmentation of the historic migratory population is considered to be the highest risk to restoration (MBTSG 1996f). Fragmentation has resulted in smaller, more discrete population units with less tributary accessibility. The migratory component of these smaller units is at a high threat of extirpation due to their limited abundance and available range. Forestry practices in the Lower Clark Fork have affected primary spawning streams and future logging activity is expected. The past effects of forestry, including road construction, continues to be a source of impaired water quality in tributaries in this subpopulation (MDHES 1994).

Bull trout populations in the Lower Clark Fork River are considered depressed and the trend is unknown, although little current status information is available (FWS 1998b). Recent surveys indicate that there are very few bull trout in the reservoirs and these fish are in a very fragile situation and susceptible to further population declines (MBTSG 1996f).

Stocks of genetically pure WCT occupy 249 miles in the sub-basin and the majority (>80 percent) are depressed or predicted depressed (UDSI 1999a). Dams, forestry practices, mining, livestock grazing and other agricultural practices, and urbanization have contributed to the decline of native salmonids in the Lower Clark Fork River.

Table 9. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Lower Clark Fork River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature			|-------|
2. Fine sediment			|-------|
3. Large woody debris		|-------|	
4. Stream flow		|-------|	
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage			|-------|
8. Refugia		|-------|	
9. Road density		|-------|	

Blackfoot River Sub-basin

Plum Creek lands in the Blackfoot River sub-basin consist of 1,479,429 acres. These are scattered throughout the sub-basin but are mostly situated in the central portion and western edge. Tier 1 watersheds in the Blackfoot River planning area sub-basin total 659,696 acres (approximately 45 percent of the drainage), of which 124,049 acres (about 8 percent of the drainage) are Plum Creek lands. Tier 2 lands total 819,733 acres (55 percent of the drainage), of which 166,578 acres (11 percent of the drainage) are owned by Plum Creek. One hundred seventy two miles of Key Migratory Rivers occur in the Blackfoot, of which 16 miles are on Plum Creek lands. Perennial streams on Plum Creek lands in the Blackfoot total 278 miles. Grazing leases on Plum Creek lands in the Blackfoot total 163,278 acres along 405 stream miles. Of these, 42,701 acres and 94 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 3,116 miles of roads occur on Plum Creek lands in the Flathead and another 301 miles are proposed (DEIS/NFHCP 1999).

The Blackfoot River flows from its headwaters approximately 133 miles to its confluence with the Clark Fork River near Bonner, Montana (Moore et al. 1991). Mining has had extensive impacts on aquatic ecosystems in the Blackfoot River drainage over the past century. Many mines exist in the western and southern portions of the sub-basin (MBTSG 1995c). Toxic mining wastes moving downstream from the headwaters and degraded habitat in tributaries are considered leading causes that reduced the viability of the fishery in the Blackfoot river drainage. Most of the upper sub-basin's large tributaries and mainstem waters have been contaminated at one time or another by mine tailings, waste piles, or mine effluent. Fish populations in the upper Blackfoot continue to be impacted by heavy metal contamination.

In the Blackfoot River drainage, wide-spread canopy removal, alterations to riparian vegetation, and warm water irrigation returns have significantly warmed the historic temperature regime of the Blackfoot (MBTSG 1995c; Pierce et al. 1997). Probable causes of elevated temperatures are grazing in riparian zones, logging, and irrigation return flows (MBTSG 1995c). Extensive logging has occurred in many Blackfoot drainages such that the effects include increased sediment in streams, increased peak flows, thermal modifications, loss of instream woody debris, and channel instability (MBTSG 1995c). Chronic dewatering has been found in 82.4 miles of 18 streams within the Blackfoot. Irrigation diversions are a high threat to the restoration of migratory bull trout in some Blackfoot waters. Impacts to water quality as a result of agricultural practices have also been observed in the Blackfoot River drainage. These practices have been identified as a primary source of non-point pollutants, delivering nitrates, phosphates, sediment, and elevated stream temperatures to the middle Blackfoot River (MFWP 1997).

The Blackfoot River is one of the few drainages in Montana where fluvial bull trout are still the dominant life history form; both adfluvial and resident bull trout also occur in the drainage. (Hillman and Chapman 1997; Pierce et al. 1997; Swanberg and Burns 1997). The abundance of these fish varies by reach in that from the mouth of the Blackfoot to the North Fork of the

Blackfoot River, bull trout are considered uncommon; rare from the North Fork Blackfoot River to Poorman Creek; unverified from Poorman Creek to the Landers Fork; and rare from the Landers Fork to the headwaters (MBTSG 1995c). Mining and introduced species are two predominant risks to bull trout restoration in the Blackfoot drainage (MBTSG 1995c). Overall, the status of the population is depressed and the trend unknown (FWS 1998b).

In the Blackfoot River sub-basin, stocks of genetically pure WCT occupy 255 miles. WCT stocks are strong or predicted strong in five subwatersheds; depressed or predicted depressed in 77 subwatersheds; and absent or predicted absent in the remaining 10 subwatersheds (USDI 1999a). Little is known about the status and trend WCT populations in the Blackfoot River; however, ongoing fish population studies may eventually lead to this information. Whirling disease has been detected in the Blackfoot River watershed (Gustafson 1996 as cited in USDI 1999a) and is a threat to WCT.

Table 10. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Blackfoot River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature			|-------|
2. Fine sediment			|-------|
3. Large woody debris			|-------|
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage			|-------|
8. Refugia		|-------|	
9. Road density			|-------|

Bitterroot River Sub-basin

Plum Creek lands in the Bitterroot River sub-basin consist of 1,822,548 acres situated at the extreme northern end of the sub-basin. Tier 1 watersheds in the Bitterroot sub-basin total 106,286 acres (approximately 5 percent of the drainage), of which 19,220 acres (approximately 1 percent of the drainage) are on Plum Creek lands. Tier 2 lands total 1,716,262 acres (95 percent of the

drainage), of which 61,379 acres (3 percent of the drainage) are owned by Plum Creek. No Key Migratory Rivers occur in the Bitterroot sub-basin, either on Plum Creek or other lands. Perennial streams on Plum Creek lands in the Bitterroot total 101 miles. Grazing leases on Plum Creek lands in this sub-basin total 42,050 acres along 132 stream miles. Of these, 10,043 acres and 33 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 1,181 miles of roads occur on Plum Creek lands in the Flathead and another 94 miles are proposed (DEIS/NFHCP 1999).

The Bitterroot River, a major tributary to the Clark Fork River, originates in the Sapphire and Bitterroot Mountains. The East and West Forks of the Bitterroot join near the town of Connor and from there the mainstem flows north approximately 85 miles, entering the Clark Fork River near Missoula, Montana.

Diversion dam barriers and effects of past and potential future forestry practices are high risks to survival of covered species. Development in the Bitterroot Valley has altered stream and riparian habitats, resulting in streambank modification and destabilization, increased nutrient loads, and increased water temperature problems (MBTSG 1995d). Intensive livestock grazing, has adversely affected water quality and fisheries habitat in large areas of the Bitterroot River drainage.

Currently, bull trout appear to be absent from the Bitterroot mainstem, or nearly so, and are rare, in upper tributaries. Some migratory bull trout still exist, but very low in numbers. Resident bull trout are the most common life history form and tend to live in higher elevation streams within USFS lands (Clancy 1993; MBTSG 1995c; Clancy 1996). Bull trout in the Bitterroot River drainage now consist of numerous (perhaps 25 or more) resident subpopulations in headwater streams that are no longer connected to the Bitterroot mainstem (MBTSG 1995d; Clancy 1996).

The two highest risks to bull trout recovery in the Bitterroot system are the presence of introduced fish and dewatering of streams, although severe overgrazing in stream bottoms is also considered very high risk to bull trout restoration (MBTSG 1995d). Original connections between the Bitterroot mainstem and its tributaries have been severed by habitat degradation, dewatering, and other passage barriers. Brown trout are common in the Bitterroot River and the lower end of tributary streams, and brook trout are common throughout many tributaries. The mainstem Bitterroot and the lower reaches of many of its tributaries are chronically dewatered during the irrigation season by five major diversions and numerous small canals (Clancy 1993; MBTSG 1995d; Clancy 1996).

Stocks of genetically pure WCT occupy 353 miles. WCT stocks are strong or predicted strong in 10 subwatersheds; depressed or predicted depressed in 86 subwatersheds; and absent or predicted absent in the remaining two subwatersheds (USDI 1999a). WCT are also adversely affected by poor habitat conditions in the same manner as bull trout.

Table 11. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Bitterroot River Sub-basin, Montana. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature			|-------|
2. Fine sediment		|-------|	
3. Large woody debris		|-------|	
4. Stream flow			|-------|
5. Water quality			|-------|
6. Channel morphology		|-------|	
7. Fish passage			|-------|
8. Refugia			|-------|
9. Road density		|-------|	

Idaho

Lochsa River Sub-basin

Plum Creek lands in Idaho are all located in the Lochsa River sub-basin, a tributary to the Middle Fork Clearwater River. Tier 1 watersheds in the overall drainage total 82,912 acres (approximately 11 percent of the drainage), of which 13,365 acres (2 percent of the drainage) are Plum Creek lands. Tier 2 lands total 674,010 acres (89 percent of the drainage), of which 26,896 acres (4 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Lochsa drainage total 42 miles; 11 miles of these are on Plum Creek lands. A total of 539 miles of roads occur on Plum Creek lands in the Lochsa and another 47 miles are proposed.

The status of bull trout in the Lochsa River sub-basin varies depending on location within the drainage, land management history, and biotic and abiotic conditions. Bull trout spawning and early rearing have been observed only in the upper Lochsa. Columbia Basin Ecosystem Management Project (ICBEMP) described bull trout populations in the Lochsa sub-basin as "strong" or "depressed," depending on the sub-watershed. (USDA and USDI 1997).

Bull trout are distributed throughout much of the Lochsa sub-basin; however, bull trout spawning and early rearing occur only in the upper Lochsa, while, in the lower Lochsa and the Lochsa

mainstem, only adult and subadult bull trout occur. Bull trout status is considered "strong" in only two creeks in the upper Lochsa (Squaw and Beaver creeks), and are absent from or are considered "depressed" in all other watersheds in the sub-basin. This is attributable to several natural and manmade factors but land management activities, including logging and road building, resulting in elevated water temperatures and sediment levels are probably the primary responsible factors. Westslope cutthroat trout are widely distributed in the Lochsa River sub-basin but in varying densities. Generally, WCT numbers are higher in the upper portions of the sub-basin than the lower portions. This distribution is similar to bull trout distribution in the Lochsa and is probably temperature related (pers. comm., Pat Murphy, Clearwater National Forest).

Anadromous fish species in the Lochsa River sub-basin include unlisted spring/summer chinook salmon, and listed Snake River steelhead. Listed Snake River fall chinook salmon are present downstream in the Clearwater River, but they are seldom found upstream of Lolo Creek, and they are not known to be present in the Lochsa River. The Lochsa 4th field HUC is designated Critical Habitat for steelhead. Plum Creek lands in the Lochsa River sub-basin consist of 40,424 acres located in a checkerboard ownership pattern at the headwaters. Principal drainages in the sub-basin that include Plum Creek lands are the upper Lochsa River, and Brushy Fork, Papoose, Crooked Fork, Colt Killed, and Walton creeks. The Lochsa River sub-basin is primarily forest land owned by the USFS and private timber companies. About half of the area is designated Wilderness. There are few commercial activities in the sub-basin besides and timber production.

Fish habitat on most of the lands managed for timber are in fair to good condition, and the unroaded lands are generally in good to excellent condition. Many streams would be rated as "properly functioning" for the majority of habitat indicators in the FWS and NMFS matrix, with the exception of LWD and sediment. The biggest problems in the sub-basin are elevated sediment from roads in steep or granitic watersheds, elevated water temperature, and localized reductions in LWD. Granitic areas have naturally high rates of erosion, and they are sensitive to ground-disturbance and hydrologic effects of roads. Debris flows triggered by failures of road fills are numerous in certain watersheds from rain-on-snow events. Summer air temperatures are hot, creating a natural tendency for high stream temperatures. A high percentage of the managed timber lands have been clear-cut, on both Federal and non-Federal lands, and removal of LWD from streams was a common practice in the recent past. The majority of riparian areas on Plum Creek land have been harvested in recent decades, and few riparian harvest opportunities remain.

Two kinds of rainbow trout occur in Idaho's Lochsa River sub-basin–the anadromous steelhead form and a resident form. The FWS considers the resident form to be redband trout and this is the form that is covered by the NFHCP (i.e., is a "covered species"). Steelhead are widely distributed in the Lochsa River sub-basin, and have been observed in virtually all accessible areas where suitable spawning or rearing habitat is found in the sub-basin. Snorkel counts of steelhead smolts in the Lochsa River from 1982 to1998 reported by the Clearwater National Forest generally show population size fluctuating at low densities, with no clear trend. Recent re-introduction efforts of

non-indigenous spring chinook salmon by the Nez Perce Tribe has apparently been successful, since recent redd counts in several Lochsa River tributaries are much higher than counts during 1992-1996. Streams with the highest productivity of chinook salmon and steelhead in the Project Area include Colt Killed Creek and Brushy Fork Creeks. Outside the NFHCP covered lands, high densities of steelhead are found in Deadman, Pete King, and Hungery Creeks. Steep terrain, passage barriers, and coarse streambed material limit the potential availability of spawning areas for steelhead and chinook in many parts of the Lochsa River sub-basin.

Table 12 . Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Lochsa River Sub-basin, Idaho. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature		|-------|	
2. Fine sediment			|----------|
3. Large woody debris			|----------|
4. Stream flow	|-------|		
5. Water quality	|-------|		
6. Channel morphology		|-------|	
7. Fish passage	|-------|		
8. Refugia		|-------|	
9. Road density		|-------|	

Washington

Yakima River Basin

The principal drainages with Plum Creek ownership in the Yakima River Basin include North and South Forks of Foundation Creek; North, Middle, South Forks of Ahtanum Creek and Reservation Creek in the Ahtanum Creek sub-basin; and the Tieton River, Oak Creek, and Cowiche Creek in the Naches River sub-basin. Plum Creek owns approximately 10,000 acres the Ahtanum Creek drainage, 10,000 acres in the Tieton River drainage, and several hundred acres in Cowiche and Oak Creeks. The land is in a checkerboard pattern in the Tieton and Cowiche drainages, and by the Washington Department of Natural Resources and the Yakama Indian

Nation in Ahtanum and Oak Creek drainages. Land use in the vicinity of Plum Creek property is principally forestry and grazing. These sub-basins with Plum Creek property are described below.

Irrigation withdrawals have a dominant effect on fish habitat throughout the Yakima River Basin. Pre-irrigation system maps show that the channel system in the Basin was much more complex with myriad side channels and dense riparian vegetation. Reservoirs now regulate most of the winter and spring runoff, reducing the frequency of overbank flows, and reducing natural recharge of the flood plain that historically sustained summer flows and moderated water temperatures. Certain reaches in both the upper and lower Yakima River do not comply with Washington State Department of Ecology (WDOE) standards for temperature, fecal coliform, sediment, and pesticide residue violations, and have been placed on the Section 303(d) list of the Clean Water Act. Turbidity and phosphorus have also been detected at concentrations that may affect aquatic life. The National Water Quality Assessment Program conducted a survey in 1990, which indicated that the ecological health in the lower Yakima River and some tributaries was impaired.

Ahtanum Creek and Tributaries

Plum Creek owns approximately 10,000 acres the Ahtanum Creek drainage. The land is in a checkerboard pattern with adjacent lands owned principally by the Washington Department of Natural Resources and the Yakama Indian Nation. Land use in the vicinity of Plum Creek property is principally forestry, grazing, and recreation, and irrigated cropland is the dominant use along the mainstem Yakima River valley. Anadromous fish ESUs present today in the Yakima basin include Upper Columbia River fall-run chinook salmon, Mid-Columbia River spring chinook salmon and Mid-Columbia River steelhead. The Yakima basin is designated critical habitat for threatened Mid-Columbia River Steelhead. Plum Creek lands are located primarily in portions of the Foundation Creek watershed, the North, Middle, and South Forks of Ahtanum Creek, and a small amount of acreage in Reservation Creek. If passage barriers were removed, the North and Middle Forks of Ahtanum Creek and several other tributary streams could probably support anadromous fish, although sedimentation and reduced vegetative cover from cattle grazing, logging, and roads in riparian areas have caused habitat degradation. The watershed would probably be rated as "functioning at risk" or "not properly functioning" in the bull trout FWS matrix and NMFS matrix because of sediment and riparian connectivity. The WDFW bull trout stock assessment, and the Ahtanum Watershed Analysis, discuss numerous problems such as overgrazing, off-road vehicle traffic use, intensive agriculture use along shorelines, development of shorelines and floodplains, excessive timber harvest in the upper watersheds and excessive road densities.

Ahtanum Creek bull trout are now isolated from fish in the lower Yakima River due to thermal barriers and total dewatering of the lower Ahtanum Creek at 19.7 river miles at the Wapato Irrigation Diversion by water withdrawals (WDFW 1998). Ahtanum Creek bull trout have been identified as a distinct stock based on their geographic location by WDFW (WDFW 1998).

Mainly resident sized bull trout are known to occur in the Middle and North Forks of Ahtanum Creeks. Recent spawning surveys indicate that the numbers of bull trout appear very low in the system. Where non-native rainbow trout have been introduced, hybridization with westslope cutthroat trout is widespread (Behnke and Zarn 1976; Rieman and Apperson 1989). Therefore, the true distribution and status of the original genotypes is questionable. However, it is likely that westslope cutthroat trout continue to exist in isolated populations within the Ahtanum Creek sub-basin.

The largest factor affecting covered species in the Ahtanum Creek sub-basin are impassable diversion dams, unscreened ditches, and agricultural irrigation that causes total dewatering of the mainstem Ahtanum Creek below RM 20 from July 10 to mid-October. Anadromous fish numbers are depressed as a result of these problems. Impassable diversion dams and low flows severely limit the potential use of Ahtanum Creek by anadromous fish. There is only a narrow window for fish to enter the stream in the fall, and to migrate elsewhere before the stream is de-watered in mid-July. Steelhead and coho salmon can potentially use Ahtanum Creek for spawning, but chinook salmon are largely precluded from using more than the lower three miles of Ahtanum Creek because of dewatering. The StreamNet fish distribution database indicates that steelhead use the mainstem of Ahtanum Creek, and the North, South and Middle Forks. The Ahtanum Watershed Analysis states that anadromous fish are precluded from using the North Fork Ahtanum Creek due to passage barriers.

Table 13. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Ahtanum Creek Sub-basin, Washington. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|----------|		
2. Fine sediment		|----------|	
3. Large woody debris			|-------|
4. Stream flow			|-------|
5. Water quality		|-------|	
6. Channel morphology			|-------|
7. Fish passage			|-------|
8. Refugia		|-------|	
9. Road density			|-------|

Naches River and Tributaries

The Naches River is a tributary to the Yakima River, where Plum Creek owns lands in several tributaries. Plum Creek lands are located in primarily along the middle portions of the Tieton River, below Rimrock Dam, and in the upper portions of the Oak Creek and South Fork Oak Creek watersheds, which drain into the lower Tieton River.

The Tieton Watershed encompasses approximately 115,296 acres of which 10, 067 acres are owned by Plum Creek Timber Company. The U.S. Forest owns approximately 64 percent of the watershed below Rimrock Dam, and more than 90 percent above Rimrock Dam. A few hundred acres drain into the upper portions of the North and South Forks of Cowiche Creek. The principal land uses in these watersheds are forestry and recreation. Most of the private lands have been intensively harvested. Flows in the Tieton River are controlled by upstream releases from Rimrock Dam, which is impassable by anadromous fish. The current flow regime is managed to protect downstream spring chinook spawning while providing irrigation water to the Yakima Valley. The resultant flows are opposite or "flip flopped" from original flows. Runoff water is held in Rimrock Lake while most irrigation flows are released from the other upper Yakima Reservoirs. In late summer, flows are stored in the upper Yakima reservoirs and released from Rimrock Lake. The change in reservoir releases helps to protect spring chinook redds in the Tieton River, but virtually eliminates spawning by other anadromous fish in the Tieton River.

Fish habitat conditions in the Tieton River drainage below Rimrock Dam are generally functioning at risk, or not properly functioning, because of riparian disturbance from timber harvest, roads, past grazing, and water management. Eighty percent of the watershed below Rimrock Dam has been harvested with ground based systems, leaving Oak Creek with low LWD recruitment potential. State Highway 12 closely parallels nearly the entire mainstem Tieton River, reducing floodplain connectivity and off-channel habitat. Oak Creek has the highest road density in the Tieton River drainage. Roads within the riparian area in the floodplain of S. Fork Oak Creek and the mainstem Oak Creek are a causing riparian degradation, however some of the USFS roads in Oak Creek are going to be relocated or closed.

The Naches River bull trout subpopulation resides in the lower Yakima River system and consists of the Naches River mainstem and its tributaries (Little Naches, American River, lower Bumping River, Rattlesnake Creek, and lower Tieton River, excluding the watersheds above Rimrock and Bumping Dams. According to the 1998 WDFW bull trout stock assessment, bull trout in the Naches River, originated from native fluvial/resident forms. The smaller resident bull trout inhabit smaller headwater tributaries and larger fluvial fish inhabit mainstem systems and spawn in the smaller tributaries. More recently, fluvial and adfluvial sized bull trout have been seen spawning lower in the mainstems of rivers (pers. comm., Judy De La Vergne, FWS). Bull trout abundance

is low in the Naches River subpopulation. In the Tieton River most of the bull trout use occurs in the upper watershed. The watershed above Rimrock Dam is the location of the Rimrock Lake subpopulation of bull trout, which originated from a native fluvial/resident life history form that occurred in the Tieton River. Adult bull trout are found on occasion in the lower Tieton River but no spawning has been documented.

Anadromous fish ESUs present today in the Naches River basin include Upper Columbia River fall-run chinook salmon, Mid-Columbia River spring chinook salmon and Mid-Columbia River steelhead. All streams in the Naches River sub-basin accessible to anadromous fish are designated critical habitat for threatened Mid-Columbia River Steelhead.

Steelhead in the Naches sub-basin is considered depressed by WDFW (1992). The Naches River system produced approximately 10 percent of the smolts found in the Yakima in 1990, representing 40 percent of the Yakima River steelhead returns (USFS 1999). Little is known about the distribution of steelhead in the Naches River sub-basin. Natural production of spring chinook salmon in the Naches River has grown, on average by 7 percent since 1958. Fall chinook currently spawn in the lower Yakima River from Sunnyside Dam to the mouth, and in Marion Drain, but are not present in the Naches River sub-basin. Summer chinook and coho salmon have been extirpated from the Yakima River basin for several decades.

Table 14. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Naches River Sub-basin, Washington. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|-------|		
2. Fine sediment		|-------|	
3. Large woody debris			|-------|
4. Stream flow			|-------|
5. Water quality	|-------|		
6. Channel morphology		|-------|	
7. Fish passage			|-------|
8. Refugia		|-------|	
9. Road density			|-------|

Lewis River Sub-basin

The Lewis River watershed includes two large drainages, the North Fork and East Fork, that converge 3.5 miles from the Columbia River. The Lewis River watershed drains an area of about 1,050 square miles. The majority of the drainage is forested, and timber harvest, recreation, and residential development are the principal uses. The mainstem of the river (North Fork) has three major dams that do not do not have facilities designed for passing fish, either upstream or downstream. Upstream fish passage is completely blocked by the Merwin Dam, 20 miles from the mouth. The majority of Plum Creek lands in the Lewis River sub-basin are above Merwin dam. Plum Creek owns several large contiguous areas that drain into Swift Creek Reservoir, a few scattered sections that drain into Yale and Merwin Lakes, scattered parcels on the north side of the Lewis River that drain into the Lewis River, below Merwin Dam

The sub-basin can be viewed as having two distinct parts, above and below Merwin Dam, with different characteristics and problems. In the sub-basin above Merwin Dam, 45 percent of the land is Federal land, owned mostly by the USFS. Forestry, and recreation and scattered residential development, and are the dominant land uses. A large portion of the North Fork Lewis River basin is undeveloped except for roads which average 4.48 miles/square mile above Merwin Dam. Fire effects, timber harvest/management activities, road construction, and effects of dams were identified as key factors causing fish habitat degradation above the dam. Fish habitat characteristics such as reduced quantity and future supply of LWD, pool frequency, stream temperatures, habitat fragmentation from loss of fish passage, innundation of fish habitat by the reservoirs, and fine sediment are impaired in upper portions of the sub-basin. Approximately 30 square miles of the upper basin was denuded by the 1980 eruption of Mt. Saint Helens.

Below Merwin Dam, the majority of lands are private, and road densities average 4.96 miles/square mile. The lower 12 miles of the North Fork Lewis River flows through a wide valley where riprap and dikes have been used extensively for flood protection. The dominant land uses below Merwin Dam are crop production and forestry, and to a lesser extent, recreation, and residential development. Stream Flows in the North Fork Lewis River are regulated by the Merwin Dam. Water temperature in the mainstem of the North Fork is moderated by releases from Merwin dam and is generally cool. Flow regimes are timed to protect native fall chinook, but they virtually eliminate spawning by other anadromous fish that could otherwise use the mainstem. Freshwater habitat characteristics and functions impaired below Merwin Dam include a scarcity of LWD, loss of riparian functions, elevated water temperatures quality, flow alterations, and loss of off-channel habitats related to diking and hardening of stream channels.

Covered species present above Merwin Dam include the listed Columbia River bull trout DPS, rainbow trout, and coastal cutthroat trout. Westslope cutthroat trout have been introduced into

the watershed. All three reservoirs (Merwin, Yale, and Swift) have populations of bull trout, and resident, fluvial, and adfluvial populations exist. The bull trout stock is native and maintained by wild production. Stock status is "Depressed" due to chronically low abundance. Rainbow trout of unknown origin have been observed in the Lewis River watershed, but the distribution and abundance is poorly documented in the Lewis River sub-basin. The overall status of the Lewis River coastal cutthroat trout stocks are unknown, but likely to be depressed.

Covered species below Merwin Dam include resident and anadromous forms of coastal cutthroat trout and rainbow trout, and listed Lower Columbia River steelhead, Lower Columbia River chinook salmon, and Columbia River chum salmon, and unlisted Lower Columbia River/Southwest Washington coho salmon. The Lewis River sub-basin, below Merwin Dam, is designated critical habitat for Lower Columbia River steelhead, Lower Columbia River chinook salmon, and Columbia River chum salmon. The main habitat limiting factor for anadromous fish in the Lewis river is the system of dams that block passage to 80 percent of the historic habitat. A large tributary, Cedar Creek, provides the majority of spawning and rearing habitat remaining in the Lewis River system for steelhead and coho. The mainstem of the North Fork, provides a highly productive spawning area for fall chinook. Nearly all of the spring chinook spawning in Lewis River occurs in a 4-mile reach extending downstream from Merwin Dam. Fall chinook spawn in the 4 mile reach below Merwin Dam, and in the East Fork Lewis River. Since the early 1900's, natural fall chinook populations have been stable or increasing in the Lewis River, without significant hatchery influence. Steelhead spawning now occurs in the East Fork, and throughout most of Cedar Creek and throughout most of the East Fork Lewis River drainage. Steelhead are identified as depressed by the WDFW. Historically, the Lewis River system had abundant wild coho, but numbers are now likely depressed, and dependent on hatchery production. A few returning fish successfully use natural habitat in Cedar Creek. Chum salmon spawn in the lower reaches of both the mainstem North Fork and East Fork Lewis River, but are in very low numbers. About 45 juvenile chum were captured during seining operations in 1998.

Table 15. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Lewis River Sub-basin, above Merwin Dam, Washington. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|-------|		
2. Fine sediment **			|-------|
3. Large woody debris **			|-------|
4. Stream flow **	|-------|		
5. Water quality	|-------|		
6. Channel morphology **	|-------|		
7. Fish passage			|-------|
8. Refugia	|-------|		
9. Road density		|-------|	

** Only free-flowing stream channels were rated for these factors, reservoirs were excluded.

Table16. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Lewis River Sub-basin, below Merwin Dam, Washington. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|-------|		
2. Fine sediment **	|-------|		
3. Large woody debris **			|-------|
4. Stream flow **			|-------|
5. Water quality	|-------|		
6. Channel morphology **			|-------|
7. Fish passage	|-------|		
8. Refugia	|-------|		
9. Road density		|-------|	

** Only free-flowing stream channels were rated for these factors, reservoirs were excluded.

Kalama River Sub-basin

Plum Creek owns roughly 4,000 acres of land on the mountain range that separates the headwaters of the Kalama and South Fork Toutle river basins. About 80 percent of this acreage drains into the Fossil Creek and North Fork watersheds in the Kalama River sub-basin. Plum Creek also owns roughly1,800 acres of land in the middle reaches of the Kalama River, mostly in and between the Jacks and Arnold creek drainages. Many of the tributaries to the Kalama River have steep gradients, with only the lower portions of the streams accessible to anadromous fish. The lower Kalama Falls, at river mile 10, blocked most anadromous passage other than summer steelhead, until it was laddered in 1936 and then improved in the 1950s. A concrete barrier dam and fish ladder at the falls now traps most returning fish. Presently, adult anadromous coastal cutthroat, steelhead and excess spring chinook are collected at the trap and passed above the lower falls by the WDFW. At river mile 35, Kalama Falls blocks all further fish passage.

Ninety-six percent of the Kalama River sub-basin is private land managed for commercial timber. Federal lands are less than 2 percent of the drainage. Most of the watershed was logged from the 1960s through the early 1980s, and this activity damaged or eliminated fish habitat throughout the sub-basin. Past logging occurred in riparian zones, and most of instream LWD debris was removed. Current timber harvest levels are minimal because of limited availability of mature timber. There is a general lack of LWD throughout the Kalama sub-basin, and most is in log jams. The potential for future LWD recruitment will be low for most of the next century because nearly 88 percent of the riparian habitat is early seral stages. Road density is high, and averages 5.75 miles/square mile. Much of the sub-basin was affected by the 1980 eruption of Mount Saint Helens. Mudflows from St Helens traveled down many of the Kalama basin's drainages, leaving unconsolidated volcanic deposits in river valleys and slopes. The potential for mass wasting is extremely high in the upper portions of the Kalama River sub-basin due to thick volcanic deposits and steep slopes. February 1996 rain events triggered at least 39 new slides in the Kalama River basin. Excess fine sediment occurs in most of Arnold Creek, and several other tributaries, and spawning areas are embedded in portions of the mainstem. Coarse gravel deposits have accumulated at the mouths of the Kalama River and many tributaries, creating passage impediments. The lower mainstem Kalama has good quality, deep pools and good pool to riffle ratios, while the quality and availability of pools vary in the tributaries. Substrate conditions in the mainstem Kalama below the lower falls are believed to contain patches of fair to good spawning gravels. Water quality in the lower 10 miles of the Kalama River is considered impaired (303 d listed) due to elevated water temperature. Extensive floodplain development, channelization and diking has occurred in the lower 2 miles of the Kalama River sub-basin.

Covered species present in the sub-basin include listed bull trout, rainbow and coastal cutthroat trout, listed Lower Columbia River steelhead, Lower Columbia River chinook, and Columbia

River chum salmon, and unlisted Lower Columbia River coho salmon. All accessible reaches of the Kalama River sub-basin are designated critical habitat for all three anadromous fish species. Coastal rainbow and cutthroat trout are the most common fish found in streams in the Kalama. McBride and Merrill Lakes support high use recreational fisheries and support native cutthroat, brown, and brook trout.

A single bull trout was noted above Kalama Falls in1998 during a doing hook and line fish survey. Suitable temperatures for bull trout exist in the north and east forks of Fossil Creek due to the influence of springs, however elevated water temperatures have been observed in the mainstem of Fossil Creek. The Kalama River spring chinook stock status was also considered healthy based on escapement trends. Spawning occurs in the mainstem Kalama River from river mile 5 to the trap at river mile 10. The Kalama River fall chinook stock is considered healthy based on escapement trend, however, the wild component of this stock is unknown. Spawning occurs in the mainstem Kalama from river mile 2 to the trap at river mile 10. The Kalama River coho stock status is depressed based on chronically low production Limited amounts of natural spawning occur in tributaries such as Hatchery, Spencer, and Cedar creeks. Most historic steelhead spawning occurred below river mile 10, but now occurs up to the Kalama Falls. Potential steelhead spawning areas are limited by steep channel gradient. The Kalama River summer steelhead stock is depressed, while the winter stock is considered healthy. The status and occurrence of chum salmon in the sub-basin is unknown.

Table 17. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Kalama River Sub-basin, Washington. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|----------|		
2. Fine sediment		|----------|	
3. Large woody debris			|-------|
4. Stream flow	|-------|		
5. Water quality	|----------|		
6. Channel morphology	|-------|		
7. Fish passage	|-------|		
8. Refugia		|-------|	
9. Road density			|--------|

Cowlitz River Sub-basin

The headwaters of the Cowlitz River originate from Mt. Rainier National Park and the Goat Rocks Wilderness. Headwater areas are mountainous forests, and the upper tributaries are typically steep, confined channels. Approximately 8 percent of the upper Cowlitz watershed is private land with most of that land in an early successional stage, in the form of forest, pasture, and rangelands. Land use in the Cowlitz River drainage, above Mayfield Dam, is principally forestry, agriculture, recreation and rural development. Road densities vary widely in Cowlitz River watersheds, ranging from nearly 0 - 5 miles/sq. mile. High densities occur in the vicinity of Plum Creek lands in the Tilton and South Fork Toutle River basins. Two large reservoirs have been constructed in the middle portion of the sub-basin. The dams for the reservoirs have a large effect on fish habitat and fish distribution, through their effects on flow regimes, passage barriers, and innundation of more than 30 miles of stream channel. The lower reservoir is created by the Mayfield Dam, which is an impassable barrier for upstream fish migration, but fish can pass downstream over the dam. Roughly 15 miles upstream, the Mossyrock Dam forms Riffe Lake, and it is impassable for both upstream and downstream fish migration. Riffe Lake is operated for flood control and hydropower, with large fluctuations in water levels during the year.

Plum Creek owns slightly more than 15,000 acres in the Cowlitz River sub-basin. Roughly one-half of the Plum Creek lands in the Cowlitz River sub-basin drain into the Tilton River and Mayfield Lake. The remainder of parcels drain into Riffe Lake or the Cowlitz River above Riffe Lake, and a few hundred acres drain into the South Fork Toutle River. Approximately half the watershed that drains into Riffe Lake is in a grass/pole and small tree structural stage. Most of the grass/pole stage occurs on private or State lands, and most of the small tree stage occurs on National Forest land. There are six Inventoried Roadless Areas on Federal lands above Riffe Lake, covering more than 30,000 acres. Below Riffe Lake, the area inundated by Mayfield Lake eliminated miles of formerly productive habitat, and now favors predators of juvenile salmonids. Extensive timber harvest, high road densities, and numerous stream-adjacent roads in the Tilton River watershed create impaired riparian function and water quality, and increased peak flows, inputs of fine sediments, and channel instability. Over-winter survival in the Tilton River watershed is impaired by elevated peak flows and a lack of pools and off-channel habitat for refuge. Juvenile rearing success of covered species is reduced because of predation within the reservoir. Increased peak flows and lack of LWD, have led to scouring of spawning gravels in many areas of the Tilton watershed.

Plum Creek lands have little or no effect on covered species or fish habitat below Mayfield Dam, due to the moderating effect of the dam on water quality and stream flow. The quality and temperature of the water released from Mayfield Dam is generally good, and the reservoir also traps much of the sediment load. In the Cowlitz River below the confluence with the Toutle

River, the channel has been almost completely armored and diked, and most of the floodplain has been filled with deposits from the eruption of Mount St. Helens. In the South Fork Toutle River, massive debris avalanche and mudflows from the eruption of Mt. Saint Helens buried the mainstem and portions of the lower reaches of many tributary streams. Fine sediments from the eruption largely have been flushed from the system, however elevated temperatures are a problem from stream widening and loss of riparian vegetation. Almost all of the South Fork Toutle has low existing and potential LWD, with grass/forb - small tree stands covering approximately 50 to 79 percent of the riparian corridors.

Covered species present in the sub-basin include listed bull trout, "rainbow" and coastal cutthroat trout, listed Lower Columbia River steelhead, Lower Columbia River chinook, and Columbia River chum salmon, and unlisted Lower Columbia River coho salmon. Other fish species include German brown trout, mountain whitefish, and sculpin and brook trout. All accessible reaches of the Cowlitz River sub-basin, and streams above the Mayfield Dam, where listed anadromous fish are trucked and released, are designated critical habitat for all three anadromous fish species. Nearly all natural production of listed anadromous fish occurs downstream from the Mayfield Dam, with a small number of adults surviving to spawn in the Tilton River. Smolts produced from anadromous fish released in the Tilton River are capable of downstream migration, and contribute to the listed ESUs, while offspring of anadromous fish released in and above Riffe Lake cannot move downstream. Bull trout are not known to occur above Mayfield dam, but survey data is limited and suitable habitat likely exists, based on stream temperatures. Listed spring chinook, coho and steelhead are released above Mayfield Dam, including the Tilton River, and tributaries to the Cowlitz River, upstream from Riffe Lake. Off-spring of anadromous fish released above the dam, in streams where smolts are capable of downstream migration, are considered part of the listed ESUs. Anadromous fish stocked above the reservoir are managed as a sport fishery, and are sustained by hatchery production. Anadromous forms of cutthroat trout have been excluded from areas above the Mayfield Dam for 40 years. Only fluvial and/or resident populations are currently evident, and the stock is depressed. The presence of introduced westslope cutthroat trout, brook trout, and rainbow trout is factor negatively affecting these populations. The distribution and status of coastal rainbow trout in this sub-basin is not well-documented. "Rainbow" trout have been observed in the Cowlitz River and tributaries above Riffe Lake. "Rainbow" trout of unknown origin were once stocked in the basin, and some remnant populations remain. Mountain whitefish occur in the Cowlitz River sub-basin, but the status and distribution is unknown.

Table 18. Ratings of Baseline Environmental Habitat Indicators for Covered Species in the Cowlitz River Sub-basin, above Mayfield Dam, Washington. (Refer to Table 2 for explanation of Baseline Ratings.)

ENVIRONMENTAL INDICATOR	ENVIRONMENTAL BASELINE		
	Good	Fair	Poor
1. Water temperature	|----------|		
2. Fine sediment		|----------|	
3. Large woody debris			|-------|
4. Stream flow		|-------|	
5. Water quality	|-------|		
6. Channel morphology **		|----------|	
7. Fish passage **	|-------|		
8. Refugia		|-------|	
9. Road density			|-------|

** excluding reservoirs

EFFECTS OF THE ACTION

"Effects of the action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. Direct effects are the immediate effects of the proposed action on the species or its habitat. Indirect effects are those caused by the proposed action and are later in time, but are still reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consultation.

As previously mentioned, for purposes of consultation under section 7 of the Act, the "action area" is defined by 50 CFR 402.02 to mean "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." Although the specific actions which might potentially affect the covered species are restricted to Plum Creek's lands (i.e., the 1.6 million acre covered lands in the NFHCP area), the effects of the action on these species may extend beyond this area. For purposes of this consultation, therefore, the Services defines the action area to include the 16.5 million acre planning area which consists of 15 planning area sub-basins where bull trout are known to occur, and sub-basins in Idaho and Washington,

outside the planning area, where covered activities may affect designated critical habitat or listed species downstream. The action area in Idaho includes the Lochsa River sub-basin, and the mainstem Clearwater River below the confluence with the Lochsa River, and in Washington, includes the Yakima, Cowlitz, Kalama, and Lewis river sub-basins. The planning area sub-basins are depicted in Map 1.3-1 in the FEIS (page 35) and include ten in Montana, one in Idaho, and four in Washington. The NFHCP planning area also includes a few "outlier" Plum Creek parcels that occur outside the planning area sub-basins in the Cowlitz, Kalama, and Lewis River sub-basins.

Introduction/Background

The planning area sub-basins are comprised of many individual watersheds that are classified as either Tier 1 or Tier 2. Certain mainstem rivers that are migratory corridors for covered species are classified as and Key Migratory Rivers (see Description of the Proposed Action section). Of the 74 Tier 1 watersheds affected by the NFHCP, 65 are in Montana, seven are in Idaho, and two are in Washington (see Appendix C in the DEIS/NFHCP 1999). All remaining watersheds are considered Tier 2 lands. Individual Tier 1 and Tier 2 watersheds will be affected differently by the proposed action because of differences in geology; topography; the types of timber, road, grazing, and land uses they will experience; land ownership patterns; and their significance to native fish conservation. Because there is a lack of detailed information on native fish populations, habitats, and baseline habitat conditions for every watershed, it is not possible to address how proposed NFHCP implementation would change baseline conditions at the individual "creek" scale (i.e., the 6th-field HUC in the USGS's watershed classification system). Therefore, a programmatic and qualitative approach to determining the effects of the NFHCP on baseline conditions is taken in this analysis, in lieu of analyzing effects at the finer scale of the individual subpopulation level. The Services will ensure the amount of improvement in habitat quality is sufficient to allow for species recovery through the NFHCP monitoring and adaptive management commitments.

In this biological opinion, where site-specific information is limited or unavailable, the Services assume that in managed landscapes where local populations of native fish are known to be extirpated or suppressed, baseline conditions for most watersheds are probably functioning at some level of risk or at unacceptable risk. This premise is supported status reviews, petitions for listing additional fish species, and inventory and survey data available throughout the planning area, and cited in this opinion, that indicate widespread habitat degradation and declines in native salmonid populations. Further, the watershed baseline descriptions above in the Environmental Baseline Section for nearly all of the covered species clearly show that many major watersheds in the action area have been heavily impacted by various land management activities to the extent most populations face some degree of threat or risk. In turn, this precarious status of bull trout has prompted all 3 state resource agencies to develop bull trout restoration plans.

The mitigation and minimization measures in the proposed NFHCP are intended to improve baseline habitat conditions for the plan's covered species. These measures may accomplish this either directly, indirectly, and/or cumulatively. The actual effects of implementing the proposed NFHCP and the actual level of protection for native fish and their habitats cannot be determined precisely, but can be inferred. Just as there are highly variable baseline conditions across watersheds in the action area, so too it is likely that the rate and direction of changing baseline conditions in the action as a result of the NFHCP will be variable. The numerous watersheds in the action area will be affected differently by the proposed action because of differences in geology, topography, land cover and types of timber management and road management. Nonetheless, the Services anticipate that over the permit period the proposed NFHCP will halt or reverse downward trends in baseline habitat conditions on Plum Creek lands. Refer to the baseline discussion in Appendix A for more information about specifics of watersheds and sub-basins. Overall, the Services anticipate that the NFHCP will ensure a net improvement in habitat quality of the action area and will contribute to recovery of the federally listed covered species and the conservation of the unlisted covered species through a combination of fixing legacy problems, maturation of areas harvested in the past, and active prevention and reduction of future impacts through road, grazing, land use, and timber harvest prescriptions. However, the Services do not expect that habitat conditions will be fully restored to proper function in all project area streams during the life of the permit, because recovery of many impaired riparian and channel processes will require more than the 30-year permit life, and the checker board land ownership pattern limits the ability of any individual land owner to singularly restore watershed processes.

Riparian prescriptions are expected to provide riparian vegetation that maintains water temperatures similar to those found in unharvested stands, and supplies normative LWD recruitment once riparian stands reach maturity. Reductions in road-related sediment are generally expected to trigger increased transport of sediment out of impaired streams, and to accelerate progress toward properly functioning hydrology and sediment transport. Grazing prescriptions are expected to restore channel morphology and riparian functions in areas where stream-side grazing has altered riparian areas. Land use commitments will help maintain gains made from the NFHCP in the event of a land sale or exchange. Through these effects, the NFHCP is expected to contribute to restoration of physical and ecological processes on which fish depend, and aid in the recovery of the federally listed species and the conservation of the unlisted species covered in the NFHCP.

Habitat Approach to Effects Analysis

Analysis of the effects of the proposed action (issuance of an ITP to Plum Creek) in this biological opinion is habitat-based–that is, the opinion will analyze the likely effects of the NFHCP on salmonid habitat in the covered lands in the NFHCP area. The most significant effects of the NFHCP on listed species are through its influence on riparian processes and characteristics, forest

hydrology, connectivity, and hydrologic and geomorphic responses of stream systems. Effects of the NFHCP on fish populations are more subtle, and difficult to predict. Therefore, effects of the NFHCP on fish populations are considered in this opinion as consequences of habitat effects. To conduct this analysis, the best scientific and commercial data available was used to characterize potential changes to water quality conditions–including channel condition, hydrology, stream temperature, large woody debris, sediment, and physical barriers to migration–as well as the general condition of the watersheds that support populations of the covered species. An underlying assumption of this analytical approach is that the covered species will experience demographic changes (that is, changes in vital rates, population size, and distribution) commensurate with changes in these habitat-related variables, and that positive changes in the habitat variables will result in positive population trends. Thus habitat variables described above are used as surrogates or indices of covered species population trends for purposes of this analysis. This approach is consistent with the approach used in the project DEIS and FEIS, and follows the analysis procedures used by NMFS to make a jeopardy determination, which is described in the Appendix D.

The relationship between changes in habitat quantity, quality, and connectivity and the status and trends of fish and wildlife populations has been the subject of extensive scientific research and publication, and the assumptions underlying the habitat approach in this Opinion are consistent with this extensive scientific background. For more extensive discussion of and data supporting the relationship between changes in habitat variables and the status and trends of fish and wildlife populations, readers are referred to the work of Fiedler and Jain (1992), Gentry (1986), Gilpin and Soule (1986), Nicholson (1954), Odum (1971,1989), and Soule (1986,1987). For detailed discussions of the relationship between habitat variables and the status and trends of fish populations, readers are referred to the work of the Forest Ecosystem Management Assessment Team (USDA, USDI, USDC, and EPA 1993), Gregory and Bisson (1997). Hicks et al. (1991), Murphy (1995), National Research Council (1996), Nehlsen et al. (1991), Spence et al. (1996), MBTSG (1998), and any of the numerous additional references contained in this rich body of literature.

The relationship between habitat and populations is embodied in the concept of carrying capacity. The concept of carrying capacity recognizes that a specific area of land or water can support a finite population of a particular species because food and other resources in that area are finite (Odum 1971). By extension, increasing the carrying capacity of an area (that is, increasing the quality or quantity of resources available to a population within that area) increases the number of individuals the area can sustain over time. By the same reasoning, decreasing the carrying capacity of an area (that is, decreasing the quality or quantity of resources available to a population) decreases the number of individuals the area can support over time. Restoring habitat that has been previously destroyed or degraded can increase the size of a population the habitat can support; conversely, habitat destruction and alteration can reduce the size of a population the

habitat can support. In either case, there is a corresponding, but non-linear relationship between changes in the quality and quantity of resources available to a species in an area and the number of individuals that area can support.

The approach used in this Opinion is intended to determine whether the proposed action is likely to either restore properly functioning stream and riparian processes where they are impaired by Plum Creek activities, or contribute to restoration or maintenance of properly functioning conditions where they are impaired by factors beyond Plum Creek's control. Ultimately, the Opinion is intended to determine whether implementation of the proposed NFHCP is likely to decrease the size, number, dynamics, or distribution of covered species populations in the action area in ways that would appreciably reduce the likelihood of their survival and recovery in the wild and whether the action might destroy or adversely modify critical habitat, for those species where critical habitat has been designated.

To accomplish this, this analysis examines specific habitat characteristics of the NFHCP's planning area sub-basins that are essential to supporting populations of the covered species. These characteristics have been derived from a synthesis of published reviews on the status and trends of native fish species in or near the action area, and must be present to ensure that watersheds function properly for native fish populations. They include water quality, water quantity, channel conditions, physical barriers to fish migration, and specific habitat variables such as stream temperature, sediment, LWD, and refugia (USDA Forest Service et al. 1993, Gregory and Bisson 1997, Murphy 1995). These characteristics, or variables, have been developed primarily from information on the habitat needs of bull trout, but will be treated as equally relevant to the other native fish species considered in this biological opinion. Although the presence of these variables does not assure the presence of bull trout, bull trout populations are not likely to survive in a stream if these variables are absent or highly degraded.

To facilitate an understanding of the likely effects of the proposed action, an overview of the general effects of forest, road, and range management activities on native fish habitats is presented in Appendix B. The overview is a synthesis of information from the literature and other sources that discusses how these practices have changed important fish habitat indicators or parameters identical to those that were rated by the Services' in the Environmental Baseline section above (see the tables for each sub-basin). The Services' used the information in the overview to help assess potential effects of the NFHCP on covered species.

The following section addresses <u>specific</u> effects of these forest, road, and range management actions proposed under the NFHCP on those individual habitat parameters most important to the covered species, particularly bull trout. The analysis also addresses how the proposed NFHCP would apply specific conservation measures to offset potential adverse impacts of Plum Creek's management activities on the covered species. In addition, the analysis examines the results and

likely effects of the NFHCP's Adaptive Management program in addressing biological uncertainty in the plan (e.g., changing status of the covered species through time, the effectiveness of the plans' conservation measures, etc.). Included in this analysis are summaries of the proposed habitat prescriptions and other components of the proposed NFHCP. Cumulative effects are described last.

Specific Effects of Forest, Road, and Range Management Activities on Fish Habitat Under the Proposed NFHCP

Forest management encompasses a broad range of actions associated with managing commercial timber harvest, including road construction and maintenance. General categories of activities associated with timber harvest and road management include actual harvest activities (cutting, felling, limbing, yarding, loading, and hauling); construction of landings; road construction, use, maintenance, and decommissioning; site preparation; use of forest chemicals; slash and residual treatment; planting; fire and erosion control; and precommercial thinning and pruning.

This analysis will address the NFHCP's proposed timber harvest prescriptions within or near the riparian zone of various stream categories and evaluate how such harvest would affect the variables associated with properly functioning aquatic habitat. In general, the effects of timber harvest on riparian functions for fish can include increased summer and decreased winter water temperatures resulting from removal of shading and insulating vegetation; reduced LWD recruitment caused by removal of streamside vegetation; reduced pool quality, habitat complexity, channel stability, and bank stability due to vegetation removal and bank erosion; and reduced substrate quality caused by increased sediment delivery.

The NFHCP is aimed at protecting and conserving all native salmonids. However, the plan's conservation program is based on bull trout biology because bull trout are well-distributed across the covered lands in the NFHCP area and because the conservation needs of bull trout are generally more specialized that those for other native salmonids covered in the NFHCP. In addition, potential habitat for anadromous covered species on Plum Creek land is found only in a few locations. Site-specific prescriptions were developed for anadromous fish in areas potentially used by salmon and steelhead, when information was available on habitat condition. Otherwise, NFHCP conservation measures contribute to improved habitat quality in watersheds where anadromous fish are found.

The NFHCP provides a broad, habitat-based approach to native fish conservation within covered lands in the NFHCP area. This means the plan identifies important habitat components and focuses on improving or preventing further degradation of those components. It also means the plan's monitoring and adaptive management program focuses on tracking habitat conditions on covered lands in the NFHCP area rather than actual fish numbers in determining the success of the

plan. The NFHCP identifies three areas within the covered lands in the NFHCP area to which varying conservation measures will be applied: 1) Tier 1 watersheds; 2) Tier 2 lands; and 3) Key Migratory Rivers. These are defined in the Project Description section and are summarized in the Environmental Baseline section for each action area sub-basin. The NFHCP also focuses on four characteristics of aquatic habitats considered important to salmonids–cold, clean, complex, and connected water (i.e., "the four C's"). These habitat characteristics serve as the basis for the NFHCP's biological goals and its 56 conservation commitments. The discussion of NFHCP effects, below, is arranged by these four habitat characteristics: temperature, sediment, LWD, and water quality and quantity.

Stream Temperature

Forest/Silvicultural Management

The NFHCP is expected to reduce water temperatures through increased canopy cover as a result of riparian management commitments; improvement in bank stability and riparian habitat through range management prescriptions; restoration of badly degraded riparian areas through legacy management actions; and reduction in sediment delivery through road improvement and land use planning commitments. Implementation of the NFHCP could result in a 1 °F reduction in stream temperature and a 0-44 percent increase in shade (DEIS/NFHCP 1999). Riparian harvest deferrals (see next section on Sedimentation as well) and development of special prescriptions for watersheds with native fish assemblages could also reduce water temperatures. Actual changes in water temperature resulting from the above practices are currently unknown, except for changes associated with canopy cover which have been estimated through forest simulation models.

Under the NFHCP, Plum Creek may log in only 20 percent of all riparian lands in the first decade and where any such logging takes place, Plum Creek would implement the NFHCP's riparian management prescriptions. In the remaining years of the plan, Plum Creek would enter no more than an additional 20 percent in the second 10 years, and no more than an additional 20 percent in the third 10 years, for a total of 60 percent. Thus, over the lifetime of the NFHCP Plum Creek would not enter for timber harvest a total of 40 percent of its riparian lands, while the remainder would be entered only under the guidance of the plan's minimization and mitigation program.

To minimize the effects of timber harvest on stream temperatures, the proposed NFHCP uses existing state rules for streamside management zones (SMZ's) as a base conservation level, and then supplements these rules with additional conservation measures in certain specific places and situations. SMZs are the equivalent of riparian buffer areas, which are usually established to protect canopy cover over streams, recruit large woody debris, preserve bank stability, reduce sediment delivery, and maintain nutrient input. Riparian buffer areas have been accepted as a means to minimize and mitigate adverse effects from timber harvest in aquatic communities

(Murphy 1995, Thomas et al. 1993, Spence et al. 1996). Generally, riparian harvest prescriptions under the NFHCP would reduce canopy cover in mature stands harvested during the permit period, and increase canopy cover in younger stands. However, overall canopy closure is expected to be greater at the end of the permit period than at present. This is because, due to the prescriptions, much of existing canopy cover will be retained in harvested stands, while canopy cover in unharvested stands will increase significantly over the permit period. The increases would be similar in fish-bearing and non-fish-bearing streams, and would be slightly, but not measurably, greater in Tier 1 watersheds than on Tier 2 lands.

The NFHCP will comply with state forest practice rules as a base conservation level for all native fish covered in the NFHCP. The rules for each state are summarized in Appendices RP-1 and RP-2 in the DEIS/NFHCP (1999). In addition, the NFHCP would provide for additional conservation measures that Plum Creek would implement to protect stream temperature, as well as other essential fish habitat features. These additional conservation commitments are designed to leave more trees in key locations that maximize benefits. Plum Creek has determined that these benefits can best be realized by: 1) defining channel migration zones (CMZs); and 2) implementing specific harvest prescriptions in CMZs based on CMZ type and sensitivity classes (i.e. sensitivity to timber harvest). Three types of CMZs have been defined and are summarized in Table 19.

The CMZ prescriptions described in Table 19 do not cover all fish-bearing streams, only those with defined CMZs. Streams that are not likely to migrate because they are confined by high valley walls or high banks are addressed separately. For high sensitivity streams without CMZs (defined as streams exhibiting a forced pool riffle/bed morphology) in Tier 1 watersheds, the NFHCP requires 1) no-harvest within 25 feet of the ordinary high water mark (OHWM); and 2) full implementation of applicable state rules. All other perennial fish-bearing streams on covered lands in the NFHCP area not covered by previous prescriptions (including all Tier 2 streams without CMZs) will have the full protection of state SMZ rules only. The NFHCP does provide additional conservation guidance, however: 1) retention of trees whose root systems are integrated into the streambank; 2) retention of trees that lean toward the stream; and 3) directionally fell trees away from the stream.

Table 19. Harvest Prescriptions for Streamside Management Zones under the NFHCP. Under the NFHCP, the highest sensitivity Channel Migration Zones (CMZs) will receive the greatest protection and moderate sensitivity CMZs less harvest restrictions. Three harvest prescriptions are adopted based on this convention.

1. High Sensitivity CMZs in Tier 1 Watersheds

- No harvest for the full width of the CMZ.
- Yarding corridors are prohibited unless needed to minimize road construction.
- On the terrace slope adjacent to the CMZ boundary upslope for 50 feet, harvest is allowed to an average 22 foot spacing (88 tpa) or less of trees larger than 8" dbh; no more than 50 percent of trees greater than 8" dbh can be harvested; leave trees must represent size and species of preharvest trees; no harvest where the terrace slope is within 25 feet of the OHWM except where a stream segment is less than 10 foot bankful width and further than 500 feet from its confluence with a larger stream; and the terrace slope prescription need not extend beyond the top of the terrace slope.
- Tracked or wheeled equipment will be excluded (except for road construction) except in winter with adequate snow and frozen ground or very dry conditions in the absence of riparian vegetation, and equipment does not cause soil displacement or rutting, and vegetation integrity of the CMZ is conserved, and equipment is operated no closer than 50 feet from the OHWM of an active channel in Montana or Eastern Washington, or 75 feet in Idaho.
- **Limited harvest rule:** Harvest is allowed to an average 22 foot spacing or less of trees larger than 8 inches diameter breast height (DBH), which corresponds to 88 trees per acre. No more than 50 percent of trees greater than 8 inches DBH may be harvested. Trees retained must be representative of the size of trees in the pre-harvest stand.
  Limited harvest provisions: 1) concentrate trees closer to the stream (no more than 30 percent of the harvest trees have been removed from the first 25 feet from the streamside zone; 2) trees retained will be lineally distributed along the stream segment; 3) trees leaning toward the stream will be favored for retention; and 4) within a harvest unit or across the harvest unit, trees will be retained in compensation for trees lost due to a road paralleling an adjacent stream segment, or compensation can be through road abandonment.

2. Moderate Sensitivity CMZs in Tier 1 Watersheds

In the CMZ:

- No harvest for 25 feet from OHWM.
- Yarding corridors are prohibited unless needed to minimize road construction.
- For remainder of the CMZ, apply limited harvest rule and provisions; harvest is allowed to an average 22 foot spacing (88 tpa) or less of trees larger than 8" dbh; no more than 50 percent of trees greater than 8" dbh can be harvested; leave trees must represent size and species of preharvest trees, and favor retaining trees next to relic channels.
- Tracked or wheeled equipment will be excluded (except for road construction) except in winter with adequate snow and frozen ground or very dry conditions in the absence of riparian vegetation, and equipment does not cause soil displacement or rutting, and vegetation integrity of the CMZ is conserved, and equipment is operated no closer than 50 feet from the OHWM of an active channel in Montana or Eastern Washington, or 75 feet in Idaho.

On the Terrace Slope Outside the CMZ upslope 50 feet:

- Harvest is allowed to an average 22 foot spacing (88 tpa) or less of trees larger than 8" dbh; no more than 50 percent of trees greater than 8" dbh can be harvested; leave trees must represent size and species of preharvest trees; leave trees must represent size and species of preharvest trees; no-harvest where the terrace slope in within 25 feet of the OHWM except where a stream segment is less than 10 foot bankful width and further than 500 feet from its confluence with a larger stream; and the terrace slope prescription need not extend beyond the top of the terrace slope.

3. High and Moderate Sensitivity CMZs in Tier 2 Watersheds

In the CMZ:

- Apply limited harvest rule; harvest is allowed to an average 22 foot spacing (88 tpa) or less of trees larger than 8" dbh; no more than 50 percent of trees greater than 8" dbh can be harvested; leave trees must represent size and species of preharvest trees, and favor retaining trees next to relic channels.
- Tracked or wheeled equipment will be excluded (except for road construction) except in winter with adequate snow and frozen ground or very dry conditions in the absence of riparian vegetation, and equipment does not cause soil displacement or rutting, and vegetation integrity of the CMZ is conserved, and equipment is operated no closer than 50 feet from the OHWM of an active channel in Montana or Eastern Washington, or 75 feet in Idaho.

On the Terrace Slope from Outside the CMZ Upslope for 50 feet:

- Harvest is allowed to an average 22 foot spacing (88 tpa) or less of trees larger than 8" dbh; no more than 50 percent of trees greater than 8" dbh can be harvested; leave trees must represent size and species of preharvest trees, leave trees must represent size and species of preharvest trees; and the terrace slope prescription need not extend beyond the top of the terrace slope.

The NFHCP has also incorporated the concept of Thermal Management Zones (TMZs) for small headwater streams that may not be fish-bearing but which flow into fish bearing streams (i.e., are "connected" to fish bearing streams). The States of Idaho and Washington allow canopy removal in these types of streams but the NFHCP augments these state regulations with the measures described in Table 20.

Table 20.	Prescriptions that apply to headwater streams not likely to have fish, or have few fish, but are both perennial and connected by surface flow to a stream that may support fish. Applies to Class II perennial streams in Idaho and perennial non-fish-bearing streams in Washington. Applies to intermittent streams connected by surface flow associated with unstable features.

Perennial, connected headwater streams:

- A 50-foot SMZ from the OHWM will be applied:
    - Within the SMZ, equipment will be excluded
    - Retention of at least 35 TPA (35 foot spacing) > 8" dbh
    - Retention of all sub-merchantable trees and brush except in yarding corridors
    - Retention of trees in closer proximity to the stream will be favored

Thermal management zone:

- When a headwater tributary contributes >20 percent of flow to a fish-bearing stream, the lowermost 500 feet of the tributary headwater stream above the confluence will have the a thermal management zone within the 50-foot SMZ:
    - Apply limited harvest rule 88 tpa > 8"dbh
    - Assure applicable state rule is met.
    - Apply rule for "other perennial fish-bearing stream."

Intermittent (or seasonal), connected streams:

- Retain sub-merchantable conifers, hardwoods, and brush when harvesting timber

The effects of the NFHCP on microclimate variables in riparian areas adjacent to streams is uncertain. 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. If ground water adjacent to the stream channel increases significantly, it could cause increases to instream water temperatures because of interchange of water flow between the channel and adjacent riparian groundwater areas.

The NFHCP acknowledges that management actions in the riparian-upland interface may influence riparian function, stream conditions, and fish habitat. To reduce the risk of impacts to fish habitat while preserving forest management activities, the NFHCP establishes another management concept: the Interface Caution Area (ICA), which is an area immediately outside an SMZ where the NFHCP provides protection in addition to state SMZ requirements. The ICA requirements are described in Table 21.

The NFHCP's ICAs will add an additional element of management caution in areas next to riparian zone boundaries (i.e., where riparian buffer areas meet upland areas). This is expected to reduce the risk of altering interior microclimate conditions within SMZs as a result of conditions adjacent to the SMZ, i.e., potential changes in wind velocity, light penetration, air temperature and humidity, and other factors would be reduced, which could help maintain stream conditions for native fish. However, the degree to which ICAs will reduce this risk is currently not known or highly predictable.

Table 21.	Interface Caution Area (ICA) requirements applied wherever timber harvest occurs adjacent to streams that are perennial and connected east of the Cascades crest (in Class I streams in Montana, Class I streams and Class II streams that are perennial and connected in Idaho, and fish-bearing and non-fish bearing connected perennial streams in Washington).

ICA Prescription:

- Width of the ICA will be at least 150 feet horizontal distance from the OHWM as an average by Planning Area basin calculated annually.
- The ICA will not extend beyond the hydrologic divide or nearest road to the stream, unless the road has been abandoned.
- The minimum ICA width will be 100 feet slope distance from the outside edge of the CMZ, unless limited by the hydrologic divide or nearest road.
- **ICA requirements:**
  - Constructed skid trails will be prohibited within an ICA except unless required. If required, it will be fully reclaimed.
  - Mechanical site preparation and slash treatment with tractors is prohibited where ground slope is >20 percent; piling and spot scarification may be performed by excavator only on slopes >20 percent.
  - Broadcast burning is prohibited.
  - Roads will be prohibited within ICAs except where necessary to cross a stream
  - supplemental tree retention (feathering) will be provided adjacent to the SMZ for 50' to a minimum amount where the adjacent post-harvest stand would not meet the following canopy levels: 1) 60 tpa > 20' tall, 2) 30 tpa > 10" dbh, or 3) a prorated combination of the above.
  - Clear cutting will be avoided provisionally (clearcuts will be limited to no more than 5 percent of total ICA area annually, determined by Planning Area Basin.

- When ICA is at the minimum width, field measurement will be employed to ensure compliance.

- **Additional conservation guidance**:
  - Skid trail design should minimize soil and vegetation disturbance; directional skidding away from the SMZ will be used when feasible.
  - Skidding equipment will be confined to skid trails or corridors and dispersed skidding will be avoided unless over snow.
  - Spacing between skid trails should be maximized.
  - ICAs will extend to include unstable areas whenever possible.
  - Road abandonment will be prioritized when next to streams or in conjunction with a harvest project ICA.

The NFHCP would also provide for: 1) deferral of riparian harvest along fish-bearing streams in three sensitive watersheds in Idaho and two sensitive watersheds in Montana until the year 2010 (i.e., Placid Creek, tributary to Clearwater River, Blackfoot River sub-basin, Montana; Big Rock Creek, tributary to Thompson River, Middle Clark Fork sub-basin, Montana; Rock Creek, tributary to Crooked Fork, Lochsa sub-basin, Idaho; and Spruce Creek and Twin Creek, tributaries to Brushy Fork, Lochsa sub-basin, Idaho), which would contribute to increased canopy cover and improved riparian function; and 2) collaborative watershed analysis and development of special prescriptions for six watersheds in Montana and two in Washington containing unique "Native Fish Assemblages (see conservation commitment AM4 in the NFHCP).

Deferral of riparian harvest in these watersheds will provide an opportunity to improve riparian conditions and functions that have been impacted from past management actions. The NFHCP mitigation measures that will be conducted in these areas will likely maintain those conditions in the future throughout the permit period.

Based on mathematical modeling of the effects of canopy closure on stream temperature, Plum Creek estimates that NFHCP riparian harvest prescriptions in Tier 1 watersheds will reduce average stream temperature in the covered lands in the NFHCP area by about 1 °F (Plum Creek Timber Company 1999). This is expected as a result of state regulations, which will likely prevent riparian harvest in many younger stands within the covered lands in the NFHCP area throughout the permit period, and as a result of the NFHCP commitments described above–e.g., the thermal buffers created by SMZs, CMZs, and ICAs. The Services have reviewed this data and agree that Tier 1 prescriptions will likely have some positive effect. The effectiveness of the NFHCP's conservation measures in meeting the needs of the covered species on Tier 2 lands is less certain, however. On Tier 2 lands, which would receive fewer and less focused protections than Tier 1 watersheds, there is a potential that important habitats or sensitive life history stages could be overlooked or more seriously affected by timber harvest than currently expected. However, while the effectiveness of the NFHCP's Tier 2 prescriptions is currently uncertain, the NFHCP's

monitoring and adaptive management commitments should allow Plum Creek and the Services to ensure that the covered species' habitat needs on Tier 2 lands are adequately addressed. This is because: 1) Plum Creek has agreed under the NFHCP to conduct additional surveys of its Tier 2 lands to better determine species status on those lands; and 2) Plum Creek will monitor implementation of its conservation measures on Tier 2 lands to ensure biological goals of the plan are met for all covered species occurring there.

Summary of Stream Temperature Effects of NFHCP Forest/Silvicultural Commitments

Thermal effects of the NFHCP were evaluated by modeled estimates of shade and canopy closure. Trends in modeled stream temperature were more a result of riparian vegetation existing in early seral stages on the majority of covered lands, than from effects of riparian prescriptions. Computer modeling of riparian growth and harvest showed that average canopy closure would increase, and average stream temperatures would decrease, with or without NFHCP prescriptions. NFHCP prescriptions would increase canopy closure to a greater extent and more rapidly than without the NFHCP. Additional inference was drawn from a discussion of harvest deferrals and possible microclimate effects of the ICA prescriptions that have thermal effects besides those considered in the riparian growth model. The harvest deferrals would allow canopy closure to reach a point where the effects of past riparian harvest on stream temperature have dissipated to near pre-harvest conditions, before additional harvest would occur. Although elevated temperatures are widespread in the project area, a few areas such as the Lochsa River, were selected for harvest deferrals because: 1) Plum Creek owned enough of a land base to have a measurable effect on temperature through deferred harvest; and 2) the selected areas are known to be important centers of production for some of the listed species. The thermal effects of the ICAs could not be quantified, but their role in moderation of stream temperature effects from timber harvest is through maintenance of microclimate in the valley bottoms, from the additional buffer width. Overall, the conservation commitments for timber harvest are likely to contribute to restoration of normative stream temperatures where they are now elevated from past harvest, and the commitments will reduce the likelihood that future riparian harvest will have more than ephemeral temperature effects.

The magnitude of changes in stream temperatures in any given area are unknown but are likely to promote improved habitat functions for covered species in most instances. If project monitoring or other information indicates that harvest prescriptions are not protecting or restoring stream temperatures, then the adaptive management pathway will be used to identify alternative practices that are more effective. Also, the exact relationships involved–e.g., between microclimate variables adjacent to streams and resulting aquatic habitat quality, and between conditions at the riparian/upland interface and interior riparian conditions–is unclear. The Services are concerned about the future importance of microclimate considerations and believe the use of adaptive management will be critical in minimizing these concerns.

Range Management

Grazing can cause increased stream temperature through reduction of shading from riparian vegetation, and through an increased width:depth ratio that occurs as a result of bank trampling and slumping when cows are concentrated along stream banks. Current grazing management on Plum Creek lands does not require allotment management plans or specific practices to prevent riparian and stream degradation. The NFHCP establishes riparian objectives, BMPs, and monitoring that will restore channel morphology and riparian vegetation damaged by past, and on-going grazing. At present, a total of 764,560 acres of Plum Creek lands are covered by grazing allotments or leases in the covered lands in the NFHCP area. Of this, 588,779 acres are currently under active leases and 175,781 acres are vacant (see Table 6 below). In 1998, Plum Creek had 106 active leases representing an estimated 10,000 cows or more on its property, most of which (98 percent) was in Montana. Grazing is not a large factor affecting anadromous fish covered by the NFHCP. Plum Creek grazing allotments occur only in portions of the Yakima River sub-basin, and there are no Plum Creek allotments in Idaho and the remainder of Washington lands covered by the NFHCP.

Plum Creek's white paper on livestock grazing on Plum Creek land (Plum Creek Timber Company 1998) shows the status and acres of grazed lands in Tier 1 watersheds within the covered lands in the NFHCP area. Tier 1 watersheds that have active and significant leases have been identified by Plum Creek in this white paper. These include Belmont Creek, Cottonwood Creek, Upper Lolo Creek, and North Fork Blackfoot River. Large and currently vacant leases include Big Rock and Fishtrap creeks in the Thompson River drainage in Montana, and Ahtanum Creek in central Washington.

Table 22. Active and vacant grazing leases in Tier 1 watersheds and Tier 2 lands (Plum Creek Timber Company 1998).

Lease Status	Tier 1 Watershed Area Leased (acres)	Tier 2 Land Area Leased (acres)	Total Area Leased (acres)
Active	56,319	532,460	588,779
Vacant	31,279	144,502	175,781
Total	87,598	676,962	764,560

Four sub-basins in Montana contain 91 percent of currently leased grazing lands in Tier 2 lands within the covered lands in the NFHCP area. Tier 2 lands with large amounts of land presently leased for grazing include the Blackfoot River (113,000 acres), Middle Clark Fork River (210,000

acres), Middle Kootenai River (96,000 acres), and Upper Clark Fork River (65,000 acres). A list of grazed acres on Tier 2 lands can be found in Plum Creek's white paper on livestock grazing on Plum Creek land (Plum Creek Timber Company 1998).

Plum Creek does not have extensive survey information on these grazed lands, except in a few cases in which where Plum Creek has compiled information quantifying impacts to streams that may be attributable to grazing. Consequently, information about the conditions of riparian zones where grazing occurs generally is lacking. However, Plum Creek has calculated the mileage of streams within the covered lands in the NFHCP area that are critical to bull trout and that are within active and inactive grazing leases (see Table 23 below). About 1,928 miles of streams flow through grazing lands within the covered lands in the NFHCP area, of which 265 miles (14 percent) occur in Tier 1 watersheds and 40 miles are along Key Migratory Rivers. Active grazing leases presently include 21.3 miles of bull trout spawning/ rearing streams, 12 miles of migration/foraging streams, and 19.9 miles of Key Migratory rivers. Vacant leases encompass another 25.9 miles of spawning/rearing streams and 19.7 miles of Key Migratory Rivers.

Table 23. Miles of bull trout spawning, migration, and foraging streams on Plum Creek land within active and inactive grazing leases in the NFHCP area (Plum Creek Timber Company 1998).

Lease Status	Bull Trout Spawning/Rearing Streams (miles)	Bull Trout Migration and Foraging (miles)	Key Bull Trout Migratory Rivers (miles)
Active	21.3	12	19.9
Vacant	25.9	2.5	19.7
Total	47.2	14.5	39.6

The total length of all streams (by various gradient classes) affected by grazing leases (active and vacant) is shown in Table 24. The gradient ranges follow those outlined by Light et al. (1998). Lower gradient streams tend to be the ones most impacted by livestock grazing (Sugden 1994).

Table 24.	Miles of stream within suitable grazing lands on Plum Creek ownership in the Tier 1 watersheds and Tier 2 lands distributed by stream gradient (Plum Creek Timber Company 1998).						
Gradient Class	Tier 1 Streams		Tier II Streams		Total		
	Perennial	Interm.	Perennial	Interm.	Perennial	Interm.	Total
0 percent-1.5 percent	8.5	5.8	79	53.1	87.6	58.9	146.5
1.5-3 percent	17.5	13	90.2	98.9	107.7	111.9	219.6
3 percent-6 percent	24.8	18.8	116.5	150.9	141.3	169.7	311
>6 percent	45.1	131.3	223.3	849.5	268.4	982.3	1250.7
Total	95.9	168.9	509	1152.4	605	1322.8	1927.8

The NFHCP acknowledges that grazing practices on Plum Creek's lands, if not implemented properly, could impact fish habitat and water quality. To help regulate grazing management on its lands, in 1995 Plum Creek developed grazing Best Management Practices (BMPs) as a tool for managers to use to protect water quality and stream and riparian habitat. These grazing BMPs were the foundation for the NFHCP's conservation commitments for management of Plum Creek's grazing lands. Following review by a range expert from the University of Montana (Ehrhart 1998), these BMPs were incorporated into NFHCP commitments, in addition to other measures.

As a part of grazing BMP implementation, for each grazing lease that contains a stream that flows more than 6 months per year and is connected by surface flow to another stream, lake, or other body of water, a designated Plum Creek lease administrator will visit the site late in the grazing season at least once annually to ensure compliance and to make a determination of whether positive trends are being achieved, using Environmental Trend Indicators. The grazing BMPs may be modified over the course of time under NFHCP adaptive management.

The assessment below reviews the potential effects of grazing on stream temperature and the NFHCP's range management measures intended to address temperature effects. The NFHCP's range commitments are summarized below:

- Grazing BMPs will be implemented on all grazing leases and may be improved in response to changing scientific information.

- Grazing exclosures will be constructed in priority watersheds (Tier 1 watersheds and Key Migratory Rivers) in areas of highest concern to salmonid conservation. Cattle will not be grazed in areas that, and continue to have, severe riparian impacts due to livestock grazing.

- Long-term effectiveness of grazing BMPs will be evaluated through a rigorous scientific study (CAMP 4), and research results will be used to refine the BMPs through the plan's Adaptive Management program.

- Vacated grazing leases will not be renewed until all riparian areas meet environmental trend indicators and the area is suitable for grazing.

- Rancher training will be provided so that lessees understand how to implement BMPs and achieve riparian protection goals.

Plum Creek's Grazing BMPs have trend indicators to provide a benchmark of grazing conditions. Methods to measure changes in riparian vegetation conditions along all streams within grazing allotments are shown below in Table 25. Regular opportunities for monitoring and improving degraded vegetation would be summarized in annual range management plans and practiced by lessees.

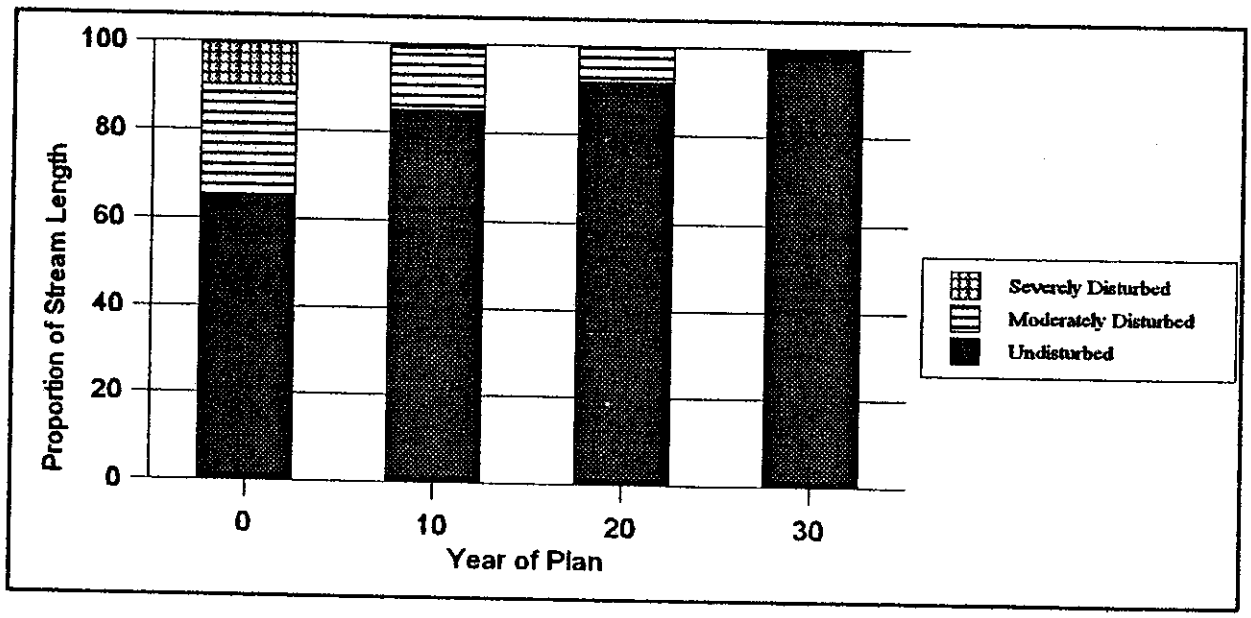
Table 25. Environmental trend indicator for grazing BMPs under the NFHCP (Plum Creek NFHCP and FEIS).	
Environmental Trend Indicator	Description
Streambank Stability	Livestock-caused bank disturbance will affect no more than 10 percent of the streambanks. Measured as the number of feet altered by livestock divided by 100 feet of measured bank.
Riparian Compaction	Less than 10 percent of riparian soils will be affected by hoof displacement/compaction. Visual estimation on 1/10 th acre plot.
Grass Utilization	Riparian grasses, sedges, and rushes may be utilized no less than 8 inches in height, unless unattainable, and upland grasses utilized no less than 4 inches.
Shrub Utilization	No more than 25 percent of the current year's shrub growth can be damaged/utilized by livestock. Visually estimated based on comparison of illustrations of various levels of utilization provided to lease holders.
Visual Appearance	Must look good. Subjectively rated by lease administrator.
Tree Regeneration	Less than 10 percent of seedlings and other trees can have physical damage caused by livestock, and compaction by livestock cannot inhibit tree regeneration. Visual estimation on 1/10 th acre plot.
Shrub Regeneration	At sites where shrubs can grow, they must be present along streams and in riparian areas, with all age classes represented. Presence, size classes, and numbers will be measured..
Weeds	Note presence and species (no specific numeric value).

The Services anticipate that the combined effects of these measures, especially the BMPs, the construction of grazing exclosures around negatively impacted riparian habitats, and the review of vacated leases will restore all grazed stream reaches on Plum Creek lands to a properly functioning condition within the 30-year permit period (see Figure 1). Reduction in livestock use of riparian areas should allow for areas that have been impacted by livestock in the past to recover and to provide effective riparian habitat, and, in addition, will likely prevent the further degradation of areas that have been relatively unaffected to date. The effects of the NFHCP's measures could include significantly increased stream shading in site-specific areas where opportunities for improvement exist.

In addition, the NFHCP's commitment to evaluate the status of vacated leases before renewal of grazing leases will be important. If riparian conditions are unacceptable and riparian function does not meet environmental trend indicators, lease renewal may be deferred; the benefits in such cases

would be similar to those of fenced riparian exclosures. If riparian vegetation is severely impacted, leases may never be renewed. Indeed, the estimate of riparian habitat recovery from grazing shown in Figure1 may be conservative, since it included only the NFHCP's range management commitments, not its legacy and restoration commitments (i.e., its riparian vegetation restoration measures), which are likely to accelerate riparian habitat recovery still more. The NFHCP will attempt to eliminate essentially all stream reaches severely impacted by livestock year 15 of the permit.

Figure 1. Proportion of stream length affected by grazing disturbance by decade on NFHCP covered lands (Adapted from DEIS/NFHCP 1999).



In the Services's view, the effects of restoring riparian vegetation by appropriate grazing 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 because of grazing impacts.

The magnitude of potential temperature decreases from the above practices is unknown, but is likely to be greatest in sub-basins within the action area with large amounts of Key Migratory Rivers and grazed stream miles. These sub-basins include three in Montana (the Middle Kootenai River, Blackfoot River, and Middle Clark Fork River), and one in Washington (Ahtanum Creek).

Under the NFHCP, evaluation of the effects of grazing on stream temperature and health within the covered lands in the NFHCP area through time, and evaluation of the effects on stream temperature of the NFHCP's grazing mitigation program will occur through several processes: 1)

assessment of the status of vacated grazing leases before renewing them; 2) annual reporting by each leaseholder, which would be used by Plum Creek to determine the success of the grazing strategy at maintaining or improving riparian conditions, and to make changes in the next year's annual grazing plan, if needed; and 3) the plan's proposed adaptive management program, which would evaluate the long-term effectiveness of Plum Creek's grazing BMPs and would provide for opportunities to amend the plan's grazing prescriptions. Thus, needed adjustments to livestock management on individual allotments can be made on an annual basis, while adjustments to grazing practices across the covered lands in the NFHCP area can be made as needed through the plan's monitoring and adaptive management program.

Summary of Stream Temperature Effects of NFHCP Range Commitments

Grazing commitments in the NFHCP are likely to result in large improvements in riparian areas and streams that are presently degraded by Plum Creek grazing activities. Under the NFHCP, Plum Creek will establish greater control of grazing activities, and require ranchers to take specific actions to reduce or eliminate riparian grazing impacts. As a result, stream temperatures, elevated from grazing effects, are likely to be reduced as riparian vegetation and channel morphology are re-established. The NFHCP grazing commitments will potentially have a widespread effect on stream temperatures in Montana, and a localized effect on stream temperatures in Washington, in Ahtanum Creek. Improvements in stream temperature for bull trout and resident species could be substantial due to widespread problems from riparian grazing in Montana. Improvements in stream temperature for anadromous fish are expected to be less dramatic because grazing only occurs in a limited portion of the Yakima River sub-basin, primarily in Ahtanum Creek, where irrigation diversions and reservoir management de-water many stream channels for portions of the year. Overall, the Services believe these factors will lead to a grazing program on Plum Creek lands that would be compatible with conservation of the covered species, and that improved riparian habitat conditions are likely to reduce stream temperatures impaired by grazing allotments.

Adaptive Management

As indicated above, the Services are uncertain whether the NFHCP's proposed riparian prescriptions for timber harvest and grazing are adequate to maintain suitable stream temperatures for all life stages of native salmonids in all portions of the NFHCP project area, particularly for bull trout. Consequently, the Services must rely on opportunities provided by the NFHCP's monitoring and adaptive management programs in the face of these uncertainties. One of the NFHCP' studies (CAMP 3) is intended to address whether the NFHCP riparian prescriptions would effectively minimize water temperature increases at both the reach and watershed scales. This project is summarized below (more detailed information can be found in the NFHCP and FEIS).

The primary purpose of this study addresses the question to what degree does streamside harvesting affect summer stream temperatures. Stream temperatures will be measured for one summer before, and after, streamside harvesting. The proposed hypothesis for this project is "reach-scale temperature change less than 1 °C following streamside timber harvesting" with the alternative hypothesis being "a statistically significant reach-scale temperature increase of 1 °C or more following streamside timber harvesting (alpha=0.1). Temperature measured is the maximum weekly average temperature. If monitoring shows that the null hypothesis should be rejected (i.e.,the alternative hypothesis is accepted), then a trigger is tripped, meaning an evaluation will be done to determine whether a change in the conservation measure is warranted.

A description of the experimental design, types of data collected, site selection criteria, and statistical tests used for the study can be found in the FEIS and will not be repeated here. Data collected would be used to evaluate the biological significance of observed temperature changes, identify causal factors for the change, and direct modifications of NFHCP prescriptions or actions if needed. At minimum, four types of information would be gathered: 1) reach-scale stream temperatures changes associated with timber harvest per NFHCP prescriptions before and after treatment; 2) watershed-scale temperature changes; 3) biological data relative to the importance of documented temperature increases (fish habitat utilization); and 4) vegetative and physical habitat changes associated with NFHCP treatments, which would help evaluate observed temperature changes and direct NFHCP modifications. The results of this work may or may not trigger changes to the NFHCP. If results show statistical differences between treatment and control (i.e., increase in stream temperature for a given gradient/width class), such information would trigger a decision process which could lead to revision of the plan's riparian prescriptions. If results do not indicate statistical significance, the riparian prescriptions, in all likelihood, would be functioning appropriately to protect stream temperatures for native fish.

As with all the NFHCP's adaptive management projects, there would be close association and involvement by the Services in evaluating the effectiveness of the riparian habitat prescriptions to minimize stream temperature increases. Prior to initiation of the CAMP 3 project, the Services would be able to review the project design and provide input. Furthermore, CAMP 3 contains mandatory reporting and milestone requirements, so the Services would be able to participate at key points in project planning and administration, including the interpretation of results. The Services would also participate in the adaptive management decision process should it be invoked. Plum Creek and the Services would then consult on whether new or modified management actions are needed in order to meet or to continue to meet the plan's biological goals.

Adaptive management findings may play an important role in the effectiveness of the NFHCP for restoration or maintenance of normative stream temperatures. Elevated water temperatures are a factor limiting all covered species in at least some portions of NFHCP covered lands. The majority of sub-basins in Montana and the Lochsa River and nearly all the sub-basins in Washington have elevated water temperatures. The Services are confident that the temperature

model used to evaluate riparian prescriptions accurately predicts average temperatures that represent a cross-section of sites, however, the model was not used to predict effects at the watershed scale. The temperature studies will provide information to refine riparian prescriptions and predictive models, if necessary. The Services cannot anticipate any particular changes to riparian prescriptions at this time, however, the study may result in either a mandatory or voluntary change in riparian prescriptions, depending on the findings. Any such change would increase the likelihood that normative temperatures would be restored or maintained.

Sedimentation

Most of the NFHCP commitments influence erosion or sediment delivery. The NFHCP activities with the largest effect on sediment are those related to roads, grazing, and ground disturbing activities in riparian areas. Other NFHCP commitments such as upland practices, ICAs, harvest deferrals, contribute to sediment reduction, but do not have the dramatic effect of roads or grazing. Effects of the covered activities are discussed below for each of the NFHCP commitment categories, following a summary of research conducted by Plum Creek on road-related sediment.

Roads are essential for Plum Creek to manage their timberlands for commercial forestry. However, existing forest roads are also a major contributing factor to impacts to native fish within the covered lands in the NFHCP area. Plum Creek has investigated the sediment-related problems of roads and developed an approach it believes would minimize and mitigate to the maximum extent practicable the sources of road impacts to native fish and their habitat, while allowing efficient forest management to continue. The NFHCP's proposed mitigation plan for road related impacts is the subject of the following analysis.

Background Studies on Sediment from Roads

Plum Creek conducted a watershed analysis of three watersheds in the Thompson River drainage (Boiling Springs, Beatrice, and Murr creeks) in western Montana following the Watershed Analysis Manual for the State of Washington (Washington Forest Practices Board 1995). Sugden et al. (1998), and McGreer et al. (1998) found that sediment produced from roads in the three drainages were 70, 98, and 34 percent, respectively, over background amounts of sediment. When erosion was recalculated for these drainages with NFHCP BMPs, the average reduction in sediment from roads was 39 percent, which is still 48, 50 and 15 percent above background rates, respectively for the three drainages. The study suggests that road BMPs can substantially reduce the amount of sediment delivered to streams, however, the effects on fish habitat depend on the ability of a watershed to transport the excess sediment out of the system. With sediment delivery to stream remaining at nearly 50 percent over background in some watersheds, conditions could remain functioning at risk for most native salmonids. Bull trout habitat conditions are considered at risk where surface fines are greater than 12 percent in spawning areas and/or where embeddedness exceeds 20 percent in rearing areas due to surface fines. Salmon and steelhead spawning gravels are considered at risk when embeddedness exceeds 20 to 30 percent.

McGreer et al. (1998) suggested that sources of sediment delivery in the above Thompson River watershed analysis can be identified and therefore treated individually. A total of 23, 36, and 38 road segments in Boiling Springs, Beatrice, and Murr creeks, respectively, were found to deliver sediment to streams. Of these road segments a small number of discreet locations were found to deliver the majority of sediment to the streams. For example, 16 road segments in Beatrice Creek contributed 54 percent of the total sediment volume; similarly 8 locations in Murr Creek contributed 46 percent of the total volume, whereas nine locations delivered 76 percent of the total sediment volume in Boiling Springs Creek. Nonetheless, it is difficult to determine whether individual treatment will significantly reduce sediment delivery, over what time frame such reductions might occur, and whether associated reductions are enough to make a difference in improving habitat function for native fish. One could surmise that these reductions will benefit fish; however, this presumes that bedload transport of the stream channel is functioning properly and that transport efficiency will eventually reach a balance in the system, assuming it is left undisturbed. Also, contrary to some scientific evidence (Weaver and Fraley 1991b; Rhodes et al. 1994; Waters 1995), it assumes that small amounts of sediment delivered annually from roads would not maintain excessively degraded conditions for native fish, which have evolved to cope with lower natural background sediment levels and periodic natural sediment delivery events.

In the Goat Creek watershed in the Swan River valley in western Montana, road construction and timber harvest began in the 1950s at lower elevations. Plum Creek conducted a watershed analysis in the Goat Creek sub-basin, which estimated that roads delivered 39.3 tons per year from 18 delivery locations, of which 72 percent comes from the road tread and 28 percent from cutslopes and fillslopes (Watson et al. 1997). This amount of road erosion was estimated to contribute 11 percent above the estimated background level. In a nearby drainage where roads were first built in the 1970s, a similar finding was observed for the Piper Creek watershed, where erosion rates were estimated to be 24 percent above background. In both the Goat Creek and Piper Creek watersheds, the majority of sediment was determined to come from a minority of stream crossings. On Goat Creek, five stream crossings contributed 70 percent of the total sediment delivered by roads to the watershed. Overall for both watersheds, less than 5 percent of road mileage was considered to actually deliver sediment to streams (Watson et al. 1997).

The Goat Creek/Piper Creek watershed analysis indicated that the main triggering mechanism for road-related problems usually involved one or more of the following: 1) road construction that removed trees or locally increased slope gradient (e.g. sidecast material, cutslopes) along streams with steep slopes; 2) road locations within snow avalanche/debris flow paths; 3) road drainage addition/concentration from culverts, waterbars, dips, etc. onto steep slopes; and 4) road construction that is not full benched (i.e., roads constructed with material placed or sidecast on the fillslope (Watson et al. 1997). In both watersheds it was observed that some area roads may intercept a significant amount of shallow groundwater. Although in all these situations no sediment contribution to the creeks was noted, the potential for this to occur was acknowledged, particularly in areas where the ground morrain intersects with the residual slope hillslope (Watson et al. 1997).

Watson et al. (1997) reported of a number of opportunities to reduce sediment loading in Goat and Piper creeks. Specific locations of areas contributing sediment to the streams were mapped and prioritized. For example, of particular concern in the Goat Creek watershed is a log stringer bridge over a small tributary where the bridge is partially washed out and several yards of fill material are perched above the stream. It was recommended in the report that this problem be voluntarily addressed as a high-priority sediment source. Under the NFHCP, road problems such as this, identified through watershed analyses or road inventories, would be addressed in a timely manner.

Similarly to the Goat and Piper creeks analysis, the results of the Thompson River watershed analysis (Sugden et al. 1998) identified resource sensitive areas in each watershed regardless of ownership and the natural and management-related triggering mechanisms. In some areas stream crossings and road segments (parallel to streams) were not up to current BMP standards. Under the NFHCP, Plum Creek would bring these areas up to current standards and maintain them in that condition within the covered lands in the NFHCP area. Plum Creek would identify areas defined as "hot spots" and prioritize as first priority. In areas where streambanks were unstable and deficient for LWD recruitment because of past management actions (e.g., harvest within the riparian zone), Plum Creek would avoid harvest within the CMZ and attempt to recruit new trees into the riparian system, primarily by promoting conifer regrowth in these areas. For example, in Beatrice Creek, because the road parallels particular channel segments, all LWD recruitment must come from the south side of the stream; consequently, Plum Creek would design future harvest prescriptions on the south side of Beatrice Creek to promote future LWD recruitment.

Effects of NFHCP on Sediment from Roads

The majority of roads in the NFHCP covered lands were constructed prior to development of BMPs (Sugden and Light 1998). Thus, on much of the road network on Plum Creek lands, road drainage is inadequate, and fine sediment is directed into streams, resulting in accumulation of sediment in stream channels. Based on published scientific literature, and studies conducted by Plum Creek on their roads, Plum Creek identified a set of BMPs to reduce sediment delivery to streams from roads.

The road BMPs include: 1) upgrading old roads; 2) construction of new roads following NFHCP standards; 3) abandoning surplus roads; and 4) treatment of locations that are potentially high risk sources of sediment input (i.e., "hot spots"). Implementation of the road BMPs are projected to reduce sediment delivery from roads by roughly 30-50 percent by the end of the 30-year permit period. In general, sediment delivery would be reduced through the addition of road drainage features that direct road surface runoff away from stream channels or into filtration areas. Old roads not expected to be used in the future would be abandoned, and new road construction would be conducted in accordance with NFHCP prescriptions. Appendix C summarizes the NFHCP's road and upland sediment reduction commitments. More detail on these mitigation measures is provided in the DEIS/NFHCP (1999).

As previously discussed, existing roads, particularly those constructed before establishment of state BMPs, are the single greatest source of sediment input within the NFHCP area. Under the NFHCP, Plum Creek would upgrade old roads to state forest BMPs within 10 to15 years. Road upgrades in high priority watersheds would be competed by 2010, with the remaining road upgrades competed by 2015. High priority watersheds are defined as those with native fish assemblages, watersheds impaired due to fine sediment delivery, or the watersheds consisting of granitic geologies.

Under the NFHCP, total sediment delivery from existing roads to all watersheds within the covered lands in the NFHCP area over the 30-year planning period is anticipated to be 379,000 tons, with 88,000 tons of that total delivered to Tier 1 streams (many being high priority watersheds) and 291,000 tons delivered to streams within Tier 2 lands (DEIS/NFHCP 1999). These figures are based on results of modeling exercises in 11 watershed analyses, which included sediment erosion studies and were completed across the various geologies within the covered lands in the NFHCP area (McGreer et al. 1998). However, it is estimated that upgrading existing old roads over a 10 to 15-year period as described above would drop the annual sediment delivery rate from about 24,000 tons per year to about 9,000 tons per year by 2015 and thereafter. In Tier 1 watersheds the annual drop would be about 340 tons per year and 770 tons per year for streams in Tier 2 lands. The net sediment reduction as a result of upgrading old roads under the NFHCP's BMPs versus the status quo (state BMPs only) is estimated at 167,000 tons, or a 29 percent decrease in total sediment delivery (DEIS/NFHCP 1999).

Assuming that Plum Creek would construct approximately 1,300 miles of new road using the NFHCP's BMPs, approximately 9,040 tons of sediment would be delivered to streams over the covered lands in the NFHCP area during the 30-year permit period (DEIS/NFHCP 1999). Adding this to the total estimated sediment delivery from Plum Creek's existing road network, implementation of the NFHCP would yield a total of about 388,040 tons of sediment to covered lands in the NFHCP area watersheds during the 30-year permit period (379,000 + 9,040 = 388,040). The highest potential of new road construction to deliver sediment to streams occurs in the first years following construction (Ketcheson and Megahan 1996). Assuming the NFHCP's BMPs are implemented for new road construction, analysis in the DEIS/NFHCP (1999) estimated 2,400 tons less sediment per year would be delivered to covered lands in the NFHCP area streams than if state BMP measures were only complied with.

In Montana 17,203 miles of existing roads occur on Plum Creek NFHCP lands and it is anticipated another 1,139 miles will be constructed. In the Lochsa River sub-basin in Idaho 539 miles of roads occur and 47 more miles are expected to be built on Plum Creek land. Plum Creek's NFHCP lands in Washington have 803 miles of existing roads with an additional 31 more miles to be constructed during the permit term (FEIS, Table 4.6-3, page 217). Adverse effects on native fish habitat from sediment delivery from new road construction would likely be highest in

those sub-basins where road densities are high and where most of the new roads are expected to be built. High road densities exist in all NFHCP sub-basins where anadromous fish occur.

The sub-basins having the highest existing road densities and highest proposed new road miles are all in Montana: 1) Middle Kootenai River with 3,562 miles of road and 179 miles proposed; 2) Blackfoot River with 3,116 miles of roads and 301 proposed, and 3) Middle Clark Fork River with 5,284 miles of roads and 288 proposed. The highest amounts of sediment delivery in the NFHCP area would likely occur in these 3 sub-basins. The precise amounts of sediment delivered to these sub-basins is largely unquantifiable. However, elevated sediment production and delivery would probably occur 1 to 2 years following new road construction; would likely be staggered over the 30-year permit period, and presumably be localized to those watershed areas where stream crossings are frequent or the road location is near streams. Should one of these watersheds exhibit sediment problems due to new road construction by Plum Creek, the FWS can work with Plum Creek on ways to stop the erosion. If the FWS and Plum Creek cannot agree on any options, the FWS has the ability to revoke the permit for the watershed area of concern.

The predicted reductions in sediment delivery could result in significant improvement in habitat conditions for native fish. However, the magnitude of improvement may not be sufficient to benefit native fish where baseline conditions are already highly degraded. Even small amounts of fine sediment delivered annually to a highly embedded stream can be enough to maintain degraded baseline conditions, which would not then benefit native fish (Rhodes et al. 1994). Consequently, in watersheds where sediment is currently a significant problem, relatively large sediment reductions may not translate into large beneficial effects because the degraded baseline might be maintained by only small amounts of sediment additions. Furthermore, even relatively small shifts in fine sediment in spawning habitat can cause major changes in bull trout survival at the egg-fry stages (Weaver and Fraley 1991b).

Although substantial reductions in sediment delivery from roads are anticipated, the effect of the NFHCP on reduction of sediment in stream channels is unknown, because the response is likely to vary from stream to stream. Where sediment delivery to streams remains well-above the natural background rates, after BMPs are applied, a stream may still not have the capacity to transport the excess sediment out of the system in most years. Consequently, the recovery time can be very long and in some cases (Rhodes et al. 1994), a watershed may not recover at all in spite of effective sediment control measures. Restoration of properly functioning sediment regimes may require more than the anticipated reduction from the NFHCP. In such instances, applying additional sediment reducing measures, as well as not engaging in any sediment producing activities, such as construction of new roads, whatsoever.

It is well established that forested roads generate erosion, and even in the presence of old roads that have been treated with BMPs and closed to traffic, sediment from these roads cannot be turned off all at once. Erosion in the watershed can continue for several years, possibly decades.

Closing and upgrading existing roads and constructing new roads to higher standards in a damaged watershed may not be adequate to recover the watershed and associated fish habitat in time to allow a local population of a sensitive species, such as bull trout, to recover. Although some mechanisms of increased road surface erosion and hydrologic change can be minimized by BMPs, some mechanisms are inherent to watershed and site conditions (e.g., slope steepness, stream network density, and geologic instability) and are not readily controllable by BMPs or improved road design (USDA, USDI, USDC, and EPA 1993; Furniss et al. 1991; Packer 1967).

Because of the high landslide risk to covered species, Plum Creek has a commitment in the NFHCP to treat the Papoose Creek watershed (tributary to the Lochsa River, Idaho) to prepare an analysis of landslides and landslide risks on NFHCP covered lands and produce a detailed management plan to reduce landslides by the end of 2001. This analysis and planning process will identify the characteristics of existing landslides based on review of current and historic aerial photographs along with field reconnaissance and follow protocol outlined in the Washington Watershed Analysis Methodology (WFPB 1997). Landslide location and character will be documented and the likely cause of the landslide (e.g., stream crossing failure, wood in fills, harvest/burn related, concentrated road drainage, natural, etc.). Additionally, as part of this analysis, a stream crossing inventory will be completed to evaluate potential for culvert failure. This inventory will include an examination of culvert capacities in relation to predicted flood flows (i.e., probability of failure) as well as the fill volume at risk of failure (i.e., and index of environmental consequence). Based on this analysis, potentially unstable features on NFHCP covered lands in the watershed will be mapped. This will provide a basis for determining need for geotechnical review of any new roads and help to identify, surplus roads, hot spots, and road abandonment opportunities. Based on the analysis above, a detailed restoration action plan will be prepared by Plum Creek and submitted to the Services for input by the end of 2001. Additionally, this plan will specify watershed-specific road construction and harvesting criteria and be implemented by the end of 2003.

Under the NFHCP, Plum Creek would be required to upgrade old roads, used enhanced BMPs to construct new roads, and conduct necessary maintenance to ensure BMP effectiveness throughout the covered lands in the NFHCP area. According to the NFHCP, application and implementation of BMPs for roads may reduce sediment input by 33 percent over existing state regulations during the 30-year permit period. Because these measures would occur sooner on existing forest roads that are the primary sediment problem areas, the majority of net sediment delivery reduction is expected to occur in the first half of the permit period. Additionally, it seems reasonable that the enhanced BMP measures would be implemented throughout the covered lands in the NFHCP area, as Plum Creek has exhibited very high compliance in implementing voluntary state BMPs according to state audits (McGreer et al. 1998; Fortunate et al. 1998). Nonetheless, despite the state audits indicating BMPs are likely to be implemented and likely to reduce sediment delivery (Fortunate et al. 1998), there remains uncertainty about whether BMP practices control sediment input adequately to protect aquatic resources (Furniss et al. 1991).

Generally, recent assessments of road BMPs in various states in the Pacific Northwest indicate that these measures can help protect water quality (Murphy 1995). In Idaho, BMPs were evaluated to determine whether they were effective in preventing sediment pollution in streams (Hoelscher et al. 1993). In this audit there was a high compliance rate (92 percent), but where BMPs were not implemented, sediment pollution occurred in 75 percent of the cases, suggesting that enforcement was highly important. McGreer et al. (1998) examined BMP audits in Idaho, Montana, and Washington and concluded that unacceptable quantities of road surface sediments were added to streams because states do not always provide operators with sufficient guidance to ensure adequate control of erosion and sediment delivery. In Montana, road BMP effectiveness is uncertain because there has been little monitoring conducted to determine BMP performance, specifically as it relates to changes in fish habitat characteristics.

Plum Creek's commitments to upgrade its 20,000 miles of existing road network over the 30-year permit period by implementing enhanced BMPs should reduce existing sediment delivery by some level in most, if not all, watersheds in the covered lands in the NFHCP area, though they would not eliminate road-related sedimentation. However, it is uncertain whether Plum Creek's projected sediment reductions are accurate because of the inherent problems and assumptions associated with predictive modeling for sedimentation. Furthermore, as explained above, it is uncertain whether anticipated sediment reductions will be adequate in all watersheds to protect covered species and their habitats, particularly where background levels of sediment loading have been and continue to be greatly exceeded. Without site specific watershed analyses for all watersheds, the degree of the improvement or magnitude of change across the covered lands in the NFHCP area cannot be ascertained, and, in turn, the degree of improvement in covered species habitats is uncertain. However, the Services anticipate that the NFHCP's monitoring and Adaptive Management program would provide for significant opportunities to address these uncertainties (see Adaptive Management section below).

Road Density

Plum Creek's current transportation system involves about 20,000 miles of roads in the covered lands in the NFHCP area. Plum Creek would construct another 1,300 miles of new roads during the 30-year permit period. Road density overall in the action area is 6.9 miles per square mile. Within Tier 1 and Tier 2 watersheds, road density is 7.1 miles per square mile and 6.8 miles per square mile, respectively. In Montana and Idaho, the road system contains at least one stream crossing per mile of road, and two stream crossings per mile of road in Washington. The majority of roads occur in Tier 2 watersheds of geology with low to moderate erosion potential.

New roads within the covered lands in the NFHCP area will modify the natural hillslope drainage network and likely accelerate erosion processes, which may already be highly altered since most watersheds in managed landscapes have extensive road systems. These changes can alter or exacerbate the physical processes in nearby streams, leading to changes in streamflow regimes,

sediment transport and storage, channel bed and bank configurations, substrate composition, and stability of slopes adjacent to the streams (MBTSG 1998; Furniss et al. 1991). These changes can potentially have significant effects for native fish in the action area, particularly in watersheds where fish are already stressed due to degraded habitat conditions.

McGreer et al. (1998) suggested that a cause-and-effect relationship of road impacts should not be attributed to road density because the impacts of roads on streams is predominantly dependent upon road location, design, construction, and maintenance practices. The Services acknowledge that studies of these factors have shown that a cause-and-effect relationship exists only between road surface drainage characteristics and sediment delivery. Nevertheless, other studies besides have documented aquatic habitat or fish density changes associated with road density or indices of road density (Trombulak and Frissell 1999). Eaglin and Hubert (1993) showed a positive correlation with numbers of culverts and stream crossings and amount of fine sediment in stream channels, and a negative correlation with fish density and numbers of culverts on the Medicine Bow National Forest, Wyoming. Macro invertebrate diversity has also been demonstrated to be negatively correlated with an index of road density (McGurk and Fong 1995). Lee et al. (1998) concluded the best indicator of management intensity was predicted road density, and that overlaying road density on the location of key salmonid populations showed that the strongest populations occurred with areas of lowest road densities. Their analysis illustrates how past land management often focused on mid-elevation forested areas that historically may have supported some of the most productive fisheries.

According to Baxter et al. (1999), in the Swan River sub-basin in Montana changes in bull trout redd densities over time were negatively correlated with road densities, and the protection of critical spawning tributary catchments from additional road building and associated land use disturbance will likely be necessary to maintain viable bull trout populations in the Swan River sub-basin.

It is likely that construction of 1,300 miles of new roads on Plum Creek lands will result in additional impacts to covered species and their habitats. These impacts would be localized to the watersheds and local populations where the roads are built. Despite the estimates of increased sediment loads described above, the exact magnitude of sediment impacts resulting from new road construction under the NFHCP is difficult to discern and quantify because the locations of the new roads are not known at this time. For example, even though the NFHCP will attempt to minimize stream crossings, new roads will require fill to be used for the construction of additional stream crossings. How much of this fill will enter the stream and what its fate will be in terms of impacts on the aquatic system is difficult to predict. Further, culverts will be installed and sized for 50-year flood events in Montana and in the majority of locations in Idaho (Washington requires 100-year culverts). Fifty year culverts may not be adequate for larger events or even single, isolated rain-on-snow storm events, which are frequent nowadays, particularly in heavily managed landscapes. Culverts of this size may be incapable of handling very large woody debris.

The largest "key pieces" are needed to form logjams and store large amounts of sediment in stepped-bed, high gradient streams, which slow and moderate sediment transport to downstream fish bearing streams (Swanston 1991). The largest woody debris can, however, block culverts and cause them to fail and deliver pulses of fine sediment to downstream streams. The effects of these added road miles and roadside ditches may substantially increase the drainage network on project lands. These roads may further cause compaction of forest soils, resulting in increased surface runoff which may contribute to increase stream peak flows. During normal high flow events, the added stream power may help mobilize coarse bedload, and depending on magnitude and timing, could cause potential physical displacement and/or direct mortality of bull trout and salmon eggs and juveniles.

With respect to the potential risk of impacts of roads under the NFHCP, no construction of new forest roads would be the only known way to ensure that no new or additional impacts to covered species would occur, particularly in currently unroaded watersheds or drainage areas. Many adverse effects of roads cannot be fully minimized or successfully mitigated (Furniss et al. 1991). Increasing road densities is likely to result in increased frequency of debris avalanches, which can cause massive sediment entry into fish bearing streams, as well as other impacts that result, directly or indirectly, from significant land disturbances for which there is no natural analog and which alter watershed processes and functions via numerable pathways. Although roads can have very different effects on water resources depending on location and construction, all else being equal, higher total road densities are worse for aquatic system functioning and native fish than lower total road densities.

Existing Roads

Impacts from roads built prior to state BMPs will continue for the first 10 years of the NFHCP until upgrades are completed in Tier 1 watersheds, and for 15 years for the remainder on NFHCP covered lands. Existing roads in poor locations, or with improper design may have unavoidable effects no matter how well they are repaired or maintained . Many older roads on covered lands in the NFHCP area have drainage control and maintenance problems, which may continue to cause excessive erosion and sedimentation. Even after the completion of upgrades, some level of impact will continue to occur since BMPs do not eliminate or mitigate erosion and sedimentation from all road surfaces.

In many locations, restoration of properly functioning conditions, where sediment delivery is balanced with three transport capacity of the watershed might require, that many miles of roads o be "put to bed," by pulling culverts, resloping road beds, pulling fill, and replanting. Under the NFHCP, existing roads should be relocated out of floodplains where feasible, following recommendations by Reeves and Sedell (1992), and new roads will avoid these areas. Treatment and upgrade of old roads and abandonment of old roads under the NFHCP will be one of the most effective means of reducing road-related adverse effects to streams caused by sedimentation.

The sooner these treatments can be implemented the earlier watershed functions can be restored and the sooner benefits to covered species can occur. The Services believe there could be substantial benefits to native fish from these treatments in areas where the reduction in sediment delivery and changes in timing of delivery reach a threshold where the watersheds can transport the sediment our of the system. Where this balance may be reached is indeterminate at this time.

Lee et al. (1997) stated that "the effects associated with roads reach beyond their direct contribution to disruption of hydrologic function and increased sediment delivery to streams." In other words, roads also provide access to people, and the activities that accompany access magnify the negative effects on aquatic systems beyond those due solely to the roads themselves. Activities associated with roads other than timber harvest include fishing, recreation, livestock grazing, agriculture, and others. Roads also provide avenues for stocking non-native fish (e.g., with brook trout and lake trout). Fishing, poaching, and stocking of non-natives are three significant avenues for adverse effects to bull trout that result from roads. It is not just "road practices" but the roads themselves that are often the problem. The NFHCP addresses concerns about poaching and public access primarily through road closures and working with local state resource agencies to identify and rectify public access resource problems. Under the NFHCP, the extent of these problems and the impacts to covered species is anticipated by the Services to be minor and localized. However, the actual impacts from these actions are indeterminate for this analysis.

Abandonment of Surplus Roads

Regular road use can cause chronic sediment inputs to streams nearly as great as road construction. Heavily trafficked roads can cause up to 130 times more sediment production than abandoned roads (Reid and Dunne 1984), and even unused roads can cause sediment. However, vegetative cover that becomes established on abandoned roads, either naturally or by design, can significantly reduce on-site erosion (Burroughs and King 1989).

The proposed NFHCP commits to abandon all surplus roads concurrently with the upgrade of adjacent road systems. The DEIS/NFHCP reported estimates of between 500 and 1,500 miles of road would be abandoned within the first 15 years of the permit (DEIS/NFHCP 1999). 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, although it is not known precisely which roads will be identified as surplus and subsequently abandoned. 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).

The DEIS/NFHCP (1999) disclosed that approximately 1,000 miles of roads would be abandoned, that the reduction in sediment delivery through surplus road abandonment would be about 8,900 tons of sediment and that, by year 15 of the plan, sediment delivery would be reduced by approximately by 450 tons per year. This estimate is based on several assumptions regarding the function of geology, road age, erosion rates, estimated area disturbed, and estimated miles of roads anticipated to be abandoned. Although the accuracy of this prediction is difficult to determine, and the actual benefit to the NFHCP's covered species is therefore difficult to predict. Old roads generally do not meet erosion control standards and are known in some cases to be chronic sources of sediment input to streams. Furthermore, if the roads to be abandoned are definitive sediment sources, the likelihood of benefit is higher than abandoning roads that are not impacting the local hydrology. Since road location is a key factor of sediment delivery, surplus roads located near stream courses that are abandoned increase the probability of significant sediment reductions. In a given watershed, sediment delivery reduced by road abandonment may be exceeded by sediment increases from new road construction, or the opposite might occur, depending on the relative location of road abandonment and new road construction, and on factors discussed above. The roads identified for abandonment will not be determined until road inspections have been completed.

Adaptive Management

The Services expect that the NFHCP's road BMPs and road abandonment commitments are likely to reduce sediment delivery to a level below existing conditions. It is difficult, however, to determine precisely what levels of sediment reduction will occur and where or when sediment delivery will be reduced. Furthermore, the effectiveness of these various sediment reduction measures needs to be validated in terms of improving the habitat baseline conditions for fish. Several sediment models to date have attempted to measure the contributions of sediment from forested roads, but nearly all these models have weaknesses due to the variability of the landscape, lack of precise site-specific information on erosion rates, and the assumptions inherent with all predictive modeling approaches (Elliot et al. 1999). However, they can serve as tools to help elucidate road-related sediment problems along with other scientific and geologic information.

New road construction will continue on NFHCP covered lands over the 30-year term of the permit. Plum Creek has estimated that approximately 1,300 miles of new roads, the majority of which will branch off from existing system roads, will be constructed, bringing the total to an estimated 21,300 miles on the 1.6 million acres of NFHCP covered lands. In general terms, this amounts to an average density of 8 miles per square mile after new road construction is completed, which is expected in the first 10 to15 years of the permit. Sub-basins where new road-building potential is highest include the Middle Kootenai River, Blackfoot River, and Upper and Middle Clark Fork Rivers, all in Montana (DEIS/NFHCP1999). Because new road construction is perhaps the forest activity posing the greatest risk of producing sediment, the first few years of

the permit period following road construction will be the period when most sediment will be produced, because the majority of sediment from new roads occurs within the first 2 years following construction.

As shown above, sediment from roads, has contributed substantially to natural background levels. Based on Plum Creek's analysis of 11 watersheds in the project action area, it predicts that sediment delivery will be reduced from 137 percent above background levels to 77 percent after NFHCP implementation. It remains unknown whether implementation of the BMPs will sufficiently mitigate or minimize the effects of NFHCP activities to restore or maintain properly functioning sediment regimes, and whether habitat changes that occur would allow for recovery of all covered species in all portions of the action area. This uncertainty arises because most watersheds have mixed land ownership, where Plum Creek may not be able to singularly change habitat conditions if they entirely eliminated sediment delivery from roads, and because the effects of the road BMPs depend on sediment budgets and hydrologic conditions unique to each watershed.. Consequently, the Services need assurances provided by the adaptive management commitments that as more scientific information is collected on the effectiveness of road BMPs relative to fish habitat improvement, the NFHCP' commitments and measures can be modified accordingly.

Given the uncertainty of the effectiveness of enhanced BMPs for erosion control from roads, Plum Creek has incorporated an Adaptive Management strategy to test whether these measures are adequate for conservation of covered species and their habitats. The proposed NFHCP includes a CAMP 1 to evaluate road BMP effectiveness; to determine the direction and magnitude of sediment delivery trends at the project, watershed, and landscape scales; and to determine whether the direction and magnitude of trend is sufficient to provide for properly functioning fish habitat over time (DEIS/NFHCP1999). This investigation will focus on two major facets: 1) sediment reduction from existing roads; and 2) sediment delivery to instream fish habitat. Study areas will be selected to represent all geologic, geomorphic, and climatic settings present in all watersheds throughout the covered lands in the NFHCP area.

The Adaptive Management approach would evaluate whether predicted sediment reduction levels are being achieved and should also determine what BMPs provide the greatest sediment reduction benefits. Under provisions of the NFHCP, the Services will assist in design of these studies and will have the ability to determine whether or not the plan's BMP measures meet the needs of the covered species and whether or not the BMPs need to be changed to provide more aggressive road treatments. Plum Creek would then adapt the NFHCP's measures to achieve the expected net sediment reduction. This effort allows the Services a higher level of assurance that BMPs are likely to be successful and are likely to help recover and conserve native fish by improving overall baseline conditions for sediment on covered lands in the NFHCP area.

Forest/Silvicultural Management

The NFHCP contains riparian timber harvest prescriptions and other silvicultural provisions also designed, like the road BMPs, to contribute to reduced sediment delivery to streams. These provisions aim at preventing and minimizing soil disturbance that might otherwise result from timber harvest activities. The beneficial effects or extent of sediment reduction associated with these mitigation actions cannot be quantified, but can be inferred qualitatively.

Although Plum Creek uses tractors on tracks and other heavy equipment that can cause compaction, the proposed NFHCP does not allow equipment in the CMZ or inner gorges, which are the sites at most risk of surface erosion during forest management activities. Also, within ICAs east of the Cascade crest, the following activities are prohibited: 1) constructed skid trails; 2) mechanical site preparation and slash treatment with tractors; and 3) broadcast burning. West of the Cascades within ICAs, clearcutting would be avoided and skid trails must be designed to minimize soil and vegetation disturbance.

Plum Creek is required by Idaho and Washington state law to regenerate harvested forest lands within specified time frames. Montana BMPs encourage "rapid" reforestation of harvested areas to re-establish protective vegetation to avoid erosion, but Montana does not require tree planting. Plum Creek's Environmental Principles, and NFHCP commitments, sets a policy of reforestation of all harvested areas within 2 years in the westside forests of the Cascade Region, and within 5 years on the east slopes of the Cascades and in the Rocky Mountain Region. Reforestation occurs through natural or artificial regeneration. Plum Creek is currently moving away from clearcutting as a timber harvest method and moving toward selective logging which does not remove enough trees to require regeneration or provides favorable conditions for natural regeneration. However, Plum Creek still plants over 2 million seedlings annually within the covered lands in the NFHCP area to ensure adequate stocking where natural regeneration success is less likely, and to supplement naturally occurring tree establishment and species diversity. Planting is done by hand, although machine planting has been used on a limited basis in the past and may be used again in the future.

Planting of certain tree species and planting and scalping adjacent to streams, especially when mechanical equipment is used, may have an effect on native fish, positive or negative. Potential risk to fish habitat from soil disturbance while planting trees is low. Clearing of vegetation just prior to planting (known as scalping) is typically done by hand. A tree-planting hoe is used to expose a 12-inch square of ground in which the seedling is planted. In Montana, trees are never planted closer than 50 feet to any stream, unless it is a restoration project not associated with timber harvest. In Idaho, planting may occur up to the edge of intermittent streams if an area has been clearcut (clearcutting comprised only two percent of the acres harvested by Plum Creek in 1998). In Washington, seedlings are routinely planted up to the edge of intermittent and non-fish-bearing perennial streams using hand-scalping techniques.

Tractor scalping occurs in Montana and Idaho to a limited extent. Under the NFHCP, however, tractor scalping will not likely occur in riparian zones because of the 50-foot buffer requirement, which would preclude equipment operation. In Washington, tractor scalping is used less than 20 percent of the time near streams, and is not permitted closer than 30 feet to an intermittent stream, 50 feet to a non-fish bearing stream, and 100 feet to fish-bearing streams in western Washington and 50 feet in eastern Washington. This technique consists of lightly scattering rather than piling slash, and results in some incidental, minor soil exposure away from the stream. Tree planting near the edge of streams would likely occur only in Montana and only as part of a restoration project, but planting next to Idaho and Washington streams is not prohibited and could occur. Machine scarification is likely in cases where sites targeted for restoration projects are heavily occupied by exotic grasses.

Tree species selected for planting vary according to geographic location and environmental and growing conditions. The decision of which trees to plant may depend on what species are more commercially valuable, disease resistant, and the seral stage existing on the site. Important species planted east of the Cascades include ponderosa pine, Douglas fir, western larch, lodgepole pine, western white pine, and Engelmann spruce. Important species planted west of the Cascades include Douglas fir, noble fir, and western hemlock. The resultant fully-stocked stands of improved, native tree species contribute to ecological function in riparian and upland areas on NFHCP covered lands.

In Idaho, state law requires planting to a minimum stocking level that varies by site but on poorer sites is about 150 tpa, which must be accomplished within 3 years of harvest. In Washington the reforestation rule requires 150 tpa. As previously mentioned, there is no state law for tree planting in Montana. Plum Creek typically plants trees that are 6 to 12 inches tall, at a rate of 300 to 500 tpa depending on tree size, site, geographic location, and other factors. Plum Creek typically thins planted sites down to 200 tpa within 20 years (150 tpa on poor sites). Plum Creek considers 88 tpa a fully stocked stand when trees are commercially mature.

It is unlikely that tree planting, which is done mostly by hand and not near the edge of streams (with the exception of restoration activities), would adversely affect any of the covered species. At most, any effect due to soil disturbance and sediment delivery to streams would be very minor and localized. Furthermore, Plum Creek would likely correct any potential erosion problems resulting from tree planting problems since it is in their interests to protect soil productivity for future timber production and it would comply with their Environmental Principles commitments. If needed, Plum Creek prepares sites for forest regeneration within 1 year following harvest or up to 3 years after harvest if surveys show natural regeneration expectations were not met. Such preparation provides better assurances that sites will be fully stocked with healthy trees and desirable species.

Only about five percent or less of the total acres harvested by Plum Creek are mechanically site-prepped (DEIS/NFHCP 1999). Plum Creek uses the technique (via tractor scalping) primarily on some lands in Washington. Tractor scalping causes some incidental, minor exposure of soil as slash is scattered, but never closer than 25 feet to a stream. A tractor can be used to prepare sites with slopes of up to 25 percent, while special backhoe equipment can be used on sites with steeper slopes (up to 45 percent), if needed. Existing state regulations and forest practices acts are designed to provide some stream and streamside protection by governing or excluding mechanical site preparation activities in riparian buffers. The proposed NFHCP builds on these existing regulations and practices through equipment exclusion prescriptions in riparian buffers and special site preparation provisions in ICAs located between riparian and upland habitat types. The NFHCP does not allow equipment in the CMZ except under very limited circumstances. The NFHCP also restricts mechanical piling in the site preparation process within the SMZs in Montana and CMZs generally. Additionally, there are restrictions on slash piling within ICAs.

During the fall, Plum Creek conducts controlled burns of some debris and brush piles remaining from previous harvest and site preparation activities. The timing of burns reduces the potential for wildfire to ignite or spread through the site. Large roadside piles are usually contained within a fire line and piles in the forest are confined to the pile location because burnable debris surrounding the pile is moved to the pile location. Prescribed burning is not allowed within inner gorges or CMZs. Broadcast burning is seldom used and is prohibited in riparian areas. The NFHCP prohibits broadcast burning outside of the riparian areas in the ICAs. Fire lines may be constructed around broadcast burns if needed and are usually done mechanically, following BMP requirements. Erosion following fires can range from extensive to minimal, depending on severity and areal extent (Robichaud and Waldrop 1994). The most severe fires can affect extensive landscapes and cause nutrient loss and create water-repellent soil conditions (Elliot et al. 1999).

On Plum Creek lands, during or after site preparation activities, there is a risk that erosion and associated sediment delivery could occur into nearby streams, or that a slash burn could escape and cause damage to streamside vegetation, or that actions to control an escaped slash burn could cause negative impacts. However, the probability that these events would have significant impacts overall is low because of state regulations and NFHCP conditions that result in avoidance of such circumstances, as well as the Plum Creek's limiting these actions in recent years. For example, only two percent of the acres harvested on Plum Creek lands in 1998 were clearcuts and only half or less of this area was broadcast burned. Furthermore, prescribed fire is generally a good tool to prepare sites for regeneration, reducing fuel loads, and for returning sites to a more natural condition (Elliot et al. 1999).

For nearly all forest management activities (site preparation, timber harvest, yarding, road building, etc.) the potential for hillslope erosion increases with increasing gradient. Logging operations on steep terrain (generally greater than 35 percent) is done by cable systems, skyline,

or helicopter to reduce the potential effects on slope stability (Elliot et al. 1999). On less steep slopes (less than 35 percent), wheeled or tracked forwarders or skidders use designated skid trails to drag logs to a landing. Under Montana BMPs, tractor or wheeled skidding on unstable, wet, or easily compacted soils and slopes that exceed 40 percent should be avoided. Under the proposed NFHCP, Plum Creek would comply with this BMP in Montana and similar state BMPs on remaining covered lands in the NFHCP area lands.

Harvest Deferrals

Under the NFHCP, Plum Creek will defer harvest for 10 years in select watersheds that have been heavily impacted by past harvest and where native fish are potentially at risk. The riparian areas in these watersheds (listed below) would therefore be given time to restore riparian habitat and function prior to re-entry for harvest. After year 10 of the NFHCP, streamside harvest would comply with the NFHCP prescriptions. This time period would ensure riparian stand development and provide an added level of protection. These watersheds include:

- Rock Creek (tributary to Crooked Fork, Lochsa Sub-basin, Idaho)
- Spruce Creek (tributary to Brush Fork, Lochsa Sub-basin, Idaho)
- Placid Creek (tributary to Placid Creek, Blackfoot Sub-basin, Montana)
- Twin Creek (tributary to Brushy Fork, Lochsa Sub-basin, Idaho)
- Big Rock Creek (tributary to Thompson River, Middle Clark Fork Sub-basin, Montana

Over the 10-year harvest deferral period, baseline conditions for sediment delivery to these streams, as well as stream temperature, should improve with restoration and maturation of riparian vegetation. The extent of the sediment reduction depends on many factors, including but not limited to, current levels of sedimentation, particularly in spawning and rearing areas. The more this habitat function is degraded, the more time it will likely take for sediment to reach an appropriate functioning level for spawning and rearing. Bull trout are particularly sensitive because they occur higher in the watershed than species such as salmon and steelhead. Headwater streams respond quickly to changes in chronic because the small streams have limited energy to transport the sediment, and the distance from the sediment source to the stream is short. Response time is longer for the larger streams used by salmon and steelhead, where there is generally a higher amount of energy available for sediment transport, but the sediment regimes reflect broader conditions in a watershed that change over the course of decades. Because these fish evolved with natural background levels of coarse and fine sediments, one could presume that attaining background sediment levels would provide the greatest assurance that depressed fish populations would recover from past adverse effects. The further the departure from background sediment levels, the less probable the rate of recovery for bull trout or native fish in these watersheds.

Baseline conditions in the action area are a reflection of past management actions as well as natural events such as fire and floods. Under its "Changed Circumstances" provisions, the NFHCP addresses the potential effects of some natural events that are reasonably foreseeable to occur on the covered lands in the NFHCP area, such as forest fires, flooding, and landslides. Plum Creek has incorporated in the NFHCP a planning procedure for addressing the effects of such events, and thereby has provided a certain level of conservation certainty. These actions could reduce potential future sediment inputs that might otherwise go unaddressed for long period of time. Plum Creek would put into place a site-specific plan to identify and reduce or eliminate ongoing impacts from the event.

The amount of erosion from wildfires depends on the severity of the fire, soil erodibility, slope steepness, and precipitation after the fire (McNabb and Swanson 1990). The exposure of mineral soil surfaces left after the fire because of the lack of protective vegetative cover and forest litter is a principle factor. Over time, increased likelihood of soil mass wasting after plant roots have decayed in the soil can lead to further soil losses, which can reach upwards of 25 percent of all forest sediment losses and persist for several decades (McNabb and Swanson 1990).

Forest fires of various intensities are expected to occur on the covered lands in the NFHCP area at some unpredicted interval during the permit term. The most typical fire event would be a low to moderate burn between 300 and 5,000 contiguous acres, whereas high intensity burns are less frequent, are more environmentally damaging, and can destroy large contiguous stands of trees over thousands of acres (DEIS/NFHCP 1999).

A changed circumstance due to a forest fire as defined in the proposed NFHCP is a stand replacement fire between 300 and 5,000 contiguous acres, or a fire that directly affects between 25 and 50 percent of the action area stream length within a given fourth order watershed. "Stand replacement" is of sufficient intensity to kill 90 percent or more of the trees (i.e., a fire that would necessarily result in the need to establish a new stand). In the event of such a fire, Plum Creek would conduct an impact assessment on the effect of the fire on the proposed NFHCP biological goals and objectives. Further, Plum Creek would develop and implement a rehabilitation plan that includes actions such as seeding erodible slopes, expeditious tree planting, restricting ground-based equipment around streams, and enhanced skid trail and road drainage where hydrophobic soils have been created due to the fire. In addition to this plan, Plum Creek would disclose fire salvage timber harvest plans to the Services.

Native Fish Assemblages

Under the NFHCP, watershed analyses would be conducted and additional conservation prescriptions would be developed and implemented (such as accelerated road upgrades or enhanced retention of riparian vegetation) to increase conservation of the covered species in eight designated watersheds with significant "native fish assemblages." These watershed-specific

prescriptions would be submitted to the affected Services for agreement. These actions will be initiated within 1 year of permit issuance and complete within 10 years.

This NFHCP commitment would contribute to site (watershed) specific restoration and retention of riparian function beyond the general categories of commitments applicable across the proposed NFHCP's covered lands. This approach corresponds with the concept that successful conservation of bull trout, and other native species of fish, depends in large part on identifying core areas with strong populations that represent the range of the species, and maintaining the populations and habitat within those areas (Rieman and McIntyre 1993; MBTSG 1998; Frissell et al. 1993). A similar approach was not taken specifically for anadromous fish because they are not as widespread on NFHCP lands, and they typically occur downstream from Plum Creek property, in larger rivers where effects of irrigation, channelization and other factors in the watershed overshadow the effects of Plum Creek activities.

These watersheds were selected based on the following factors: 1) sub-basin size and bull trout presence; 2) bull trout population fitness; and 3) genetic integrity and population richness of other covered species. Watersheds designated as containing native fish assemblages are as follows: 1) Elk Creek (Swan River planning area sub-basin, Montana); 2) Fishtrap Creek above Jungle Creek (Middle Clark Fork planning area sub-basin, Montana); 3) Keeler Creek (Lower Kootenai River planning area sub-basin, Montana); 4) North Fork Blackfoot River (Blackfoot River planning area sub-basin, Montana); 5) Quartz Creek (Middle Kootenai River planning area sub-basin, Montana); 6) Vermillion River (Lower Clark Fork River planning area sub-basin, Montana); 7) Pine Creek (Lewis River planning area sub-basin, Washington); and 8) Ahtanum Creek (Ahtanum Creek planning area sub-basin, Washington).

Three of the watersheds were selected for higher priority completion based upon likelihood of management activity. These are Fishtrap Creek, Pine Creek, and Ahtanum Creek. These will be complete with prescriptions developed in conjunction with or prior to the first 5-year reporting period. Additionally, road upgrades for all watersheds will commence immediately upon permit issuance, in advance of analysis, and will be complete by the end of the fifth year of the NFHCP

Riparian Prescriptions

The amount of sediment deposition in a stream depends on the availability of sediment from sediment sources, and the rate the sediment is delivered to the stream. Generally, the amount of sediment created from timber harvest activities is related to the amount of bare and compacted soils 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). Activities such as skidding and yarding can compact soils and cause considerable disturbance to soils as a result of machinery used, especially at landings. Poorly designed landings and skid trail systems can be persistent sediment sources. Skidding generally causes more ground disturbance than cable

or helicopter yarding. However, cable yarding on steep slopes also may result in soil disturbance because the ends of trees may drag on the ground, leaving scars of exposed soil. Soil disturbance can be reduced by using designated skid trails and compaction reduced by skidding either during the dry season or when the ground is frozen.

When fine and coarse sediments reach a stream they move downstream through the stream system by different routes. Fine sediment moves through the system rapidly and is deposited in slack-water areas. Bedload or coarse sediment moves during high flow events and gets deposited as "wedges" behind structural features such as large woody debris and at channel bends (Murphy 1995; Swanston 1991). Over time all sediment is redistributed, sorted and redeposited to form pools and riffles behind obstructions and at points of reduced gradient.

The effects of logging on hillslopes or in or near riparian areas changes the sediment delivery, routing, and storage equilibrium (Murphy 1995). The loss of periodic pulses of large woody debris into the stream causes a loss of structural channel features that reduce storage and accelerate routing of bedload sediment downstream (Everest et al. 1987). This, in turn, causes aggradation in downstream reaches which become wider, shallower, and more prone to bank erosion and avulsion. The result of the channel changes is degraded fish habitat and declines in the local populations of native fish.

Plum Creek's proposal to provide for aquatic integrity for covered species is to supplement state forest management requirements (see DEIS/NFHCP, Table 3.3-2) through a variety of riparian management commitments. Two important commitments indicated above that will likely result in reduced sediment delivery to streams include the timber harvest deferral and "native fish assemblage" provisions.

The effectiveness of vegetation in filtering sediment depends on slope steepness and density of obstructions (i.e. woody debris and ground vegetation) (Murphy 1995). In general, the steeper the slope, the wider the vegetation buffer should be to filter sediment. The NFHCP's Channel Migration Zones (CMZs) to be applied east of the Cascade Mountain crest, and associated riparian prescriptions mentioned above resulting in vegetative buffers adjacent to streams, would likely contribute to reduced sediment level and delivery conditions over time, particularly where riparian baseline conditions are highly degraded. The extent of this reduction and actual benefits to native fish is unknown, because of natural variability and the multiple effects of logging on streams (Murphy 1995). However, it is reasonable to infer that the NFHCP's CMZ (see Table 3 above) and "Native Fish Assemblage" provisions would buffer the effects of sediment delivery to some significant degree; although, in the case of CMZs, the degree of benefit would depend on the strictness of the prescriptions (e.g., whether a CMZ is considered "high" or "moderate" sensitivity). Also unknown is the impact CMZ prescriptions will have on sediment transport and storage once sediment reaches the stream. This function is related to a large degree on the ability of the CMZ to provide adequate amounts of LWD at properly time intervals. In the most sensitive

CMZs, where entry would be prohibited or highly restricted, and particularly where baseline conditions for sediment are poor, it is likely that sediment input would be reduced and sediment transport and storage would be protected or improved.

One area where CMZ prescriptions may not be adequate in controlling sediment or providing other important functions for native fish habitat is small headwater streams. This is because of the exclusion from the CMZ prescription of the no-harvest rule for stream segments less than 10 feet full bank width and greater than 500 feet from the confluence with a larger stream. This applies to the area outside of the CMZ on the terrace slope within 25 feet of the ordinary high water mark. Due to the exclusion, timber harvest would be allowed in this zone. This is a concern because the effects of riparian vegetation in stabilizing banks, contributing LWD, and providing shade are relatively more important for the integrity of small channels than for larger channels (Kondolf et al. 1996). Furthermore, small channels, fish-bearing or non-fish bearing, ephemeral or perennial, are vitally important to downstream habitats because they carry water, sediment, nutrients, and woody debris from upper parts of the watershed, which in turn, determines the quality of downstream habitats (Chamberlin et al. 1991). In addition, bull trout and cutthroat trout in particular often utilize smaller tributaries for spawning and rearing, and these two species often occur further upstream that other salmonids (MFWP 1982). Resident bull trout are known to utilize headwater streams for spawning and rearing (Thomas and Hvenegaard 1997; Goetz 1997; Cross and Everest 1997). Fraley and Shepard (1989) found that in the Flathead Lake and River system adult adfluvial bull trout spawned in third order streams; however, juvenile bull trout moved upstream to grow in reaches not used by adult spawners. In a major study of mountain streams in the North Fork Flathead River system in western Montana, MFWP showed that nearly all second order streams (lowest average wetted width measured equaled 5.5 feet) surveyed contained significant populations of westslope cutthroat trout and to a lesser extent bull trout (MFWP 1982).

Small streams are responsible for a high proportion of native fish production, are also more easily altered by forest management activities, and account for the majority of total aggregate stream length available to native fish in most watersheds and can account for 50 percent to 70 percent of the channel network (Chamberlin et al. 1991). Decomposition of root masses after harvest of riparian trees can lead to decreased channel stability, lateral channel migration during flood events, and reductions in the quantity and quality of cover for native fish (undercut banks and deep pools) (MBTSG 1998). Impacts of logging can be reduced if buffer zones are left around small headwater streams that themselves do not support salmonids (Cummins et al. 1994 as cited in Spence et al. 1996). Steep headwater drainages are often trigger points for landslides and minimizing road construction and logging around these channels can prevent mass soil movements that propagate downstream to the detriment of native fish (Spence et al. 1996). Note that buffers of any width may be ineffective at stopping sediment that moves through them in gullies and small stream channels (Duncan et al. 1987).

Fish-bearing and non-fish bearing small streams that are less than 10 feet bankful width can be very important to maintaining properly functioning habitat conditions for native fish inhabiting these streams or inhabiting downstream reaches of larger streams. It also seems apparent that these smaller channels are more sensitive to streamside perturbations within or adjacent to riparian zones and that maintaining their integrity is essential to protection of water quality and fish habitat. Small channel segments of 10 feet bankful or less would seem to warrant a high level of protection regardless of its segment location relative to its confluence with a downstream larger stream. Therefore, the CMZ prescription as described in the proposed NFHCP may not be sufficient to provide all riparian functions in small streams. A certain amount of sediment filtering will occur along small streams from vegetation provided by NFHCP prescriptions, but other riparian functions provided by stream-side trees, and LWD may be compromised.

Interface Caution Areas (ICAs)

As mentioned above, the NFHCP would place specific conditions within ICAs. Generally, ground-disturbing activities that could increase the risk of sediment delivery would be moved farther away from the SMZs and streams. An ICA is defined as: 1) an area that averages at least 150 feet horizontal distance from the ordinary high water mark (calculated by planning area sub-basin relative to total streamside miles harvested) and 2) an area not less than 100 feet slope distance from the outside of the CMZ. ICA commitments include the following: 1) constructed skid trails are generally prohibited, but if required because of site specifics they will be fully reclaimed within the same operating season; 2) site preparation and slash treatment with tractors is prohibited if the slope is greater than 20 percent; 3) broadcast burning is prohibited; 4) roads will be prohibited, unless a stream crossing requirement is unavoidable; and 5) additional tree retention (feathering) will be provided adjacent to the streamside management zone (i.e., at least 60 trees larger than 20 feet tall per acre, 30 or more of which are 10-inch DBH).

ICAs also provide an incentive-based approach to minimize road construction where it could have the greatest risk—close to the stream (Reeves and Sedell 1992), and provide incentives for considering surplus road designations. As a result, road abandonment would be placed where it would do the most good for aquatic habitats.

The establishment of ICAs on covered lands in the NFHCP area reflects the approach the MBTSG (1998) recommended to minimize potential effects of land management activities on bull trout core and nodal areas, including, but not limited to, the effects of sedimentation. ICA commitments are likely to minimize sediment delivery from certain activities, but they will not eliminate all sediment sources. However, the riparian harvest commitments that restrict or exclude equipment operation in CMZs and ICAs, together with other ICA requirements and conditions listed above, could reduce soil disturbance and sediment delivery to streams beyond the requirements of existing state regulations (DEIS/NFHCP 1999).

Range Management

As previously mentioned, livestock grazing can degrade aquatic habitat by removing riparian vegetation, destabilizing streambanks, widening stream channels, promoting incised channels, lowering water tables, reducing pool frequency, increasing soil erosion, and altering water quality, and include increasing sediment delivery to spawning and rearing habitats (MBTSG 1998; Elmore and Beschta 1987).

The goal of the NFHCP's grazing management prescriptions is to restore all grazed stream reaches to a properly functioning condition within the 30-year permit period (DEIS/NFHCP 1999). About 25 percent of the riparian areas in Plum Creek's grazing allotments are moderately disturbed and about 10 percent are severely disturbed (DEIS/NFHCP 1999). Plum Creek's five grazing management commitments, including their grazing BMPs (Plum Creek 1995), have the potential to beneficially affect streams within the covered lands of the NFHCP by reducing sediment delivery by the end of the 30-year permit period (DEIS/NFHCP 1999).

The NFHCP proposal includes commitments to educate grazing leaseholders concerning the NFHCP program and their responsibilities under the program, including requirements for lessees to implement grazing BMPs, environmental trend indicators for riparian vegetation conditions along all streams, monitoring of riparian conditions, and reporting the results of efforts to improve degraded riparian areas. The level and timing of utilization are two of the most important grazing strategy considerations, particularly for those areas with critical fisheries habitats (Platts 1991). Also, grazing strategies should be site specific, as no single strategy can be applied across the range of habitat variability (Ehrhart and Hanson 1998; Platts 1991, 1989).

The extent of sloughing and erosion of streambanks caused by trampling of livestock depends on soil texture and geologic parent material, as well as the stocking rate and duration of access to the stream reach. Generally, higher stocking rates cause increase sediment production and the longer livestock have access to a stream reach, the more likely accelerated streambank deterioration will occur (Mosley et al. 1997). One NFHCP environmental trend indicator intended to reduce sediment delivery would confine livestock-caused bank disturbance (by hoof displacement or compaction) to no more than 10 percent of streambanks within grazing leases. This standard should maintain or improve streambank conditions significantly, 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.

Fencing to exclude grazing can result in rapid improvements in riparian areas and has been proven successful (Platts 1991; Ehrhart 1998; Ehrhart and Hansen 1997). Complete exclusion would be the most effective way to improve degraded areas (Platts and Wagstaff 1984; Keller and Burnham 1982). In heavily degraded riparian areas, at least as an initial action in restoring riparian function,

cattle should be excluded by fencing until such time that riparian vegetation functions (shading, LWD, sediment and nutrient control, leaf litter inputs, and bank stabilization) are restored (Elmore and Beschta 1987; Spence et al. 1996). Further, once recovery has been achieved, implementing seasonal and stocking intensity restrictions with appropriate monitoring and adaptive management, should allow maintenance of riparian functions while grazing continues. Under the NFHCP, cattle would be excluded by fencing along Tier 1 streams and Key Migratory Rivers that have previously been severely impacted or overgrazed by livestock. Thus, the Services anticipate that the NFHCP would provide significant improvements in aquatic habitats that are vitally important to bull trout and other covered species.

Trees, shrubs, forbs, and grasses are key to maintaining streambank stability and to preventing erosion and accompanying sedimentation. Trees and shrubs, because of their large, deep root systems protect streambanks from water erosion and contribute substantially to stability (Platts 1991). Ehrhart and Hansen (1997) generalized that all trees and shrubs should be considered to have deep, binding root masses, but herbaceous species that are annual plants generally do not have binding root masses. However, perennial plants vary in effectiveness in providing streambank stability, since deep-rooted sedges that are rhizomatous are excellent bank stabilizers while rhizomatous species like Kentucky bluegrass (*Poa pratensis)* have only shallow root systems and are poor bank stabilizers. It is clear that vegetation with a deep, binding root mass will increase the ability to resist erosion of streambanks. Ehrhart and Hansen (1997) reported that in all situations, the density and vigor of any plant species, or group of species, growing on a streambank will influence the stability of that bank.

Under the NFHCP, Plum Creek will restrict the amount of browsing and grass utilization in the riparian zone in order to maintain and protect the abundance and vigor of the plant community. Browsing at some level of use can adversely affect shrubs (Platts 1986; Kovalchik and Elmore 1992); however, light or moderate browsing may have little or no effect or may even stimulate growth (Skovlin 1984). Plum Creek will restrict browse utilization of riparian shrubs to less than 25 percent of the current year's shrub growth each year. However, this utilization applies to livestock use only and does not consider wildlife use, which could be significant on individual sites, so total browse utilization could exceed 25 percent in some cases.

Another environmental trend indicator in Plum Creek's grazing BMPs considers shrub and tree regeneration. In riparian zones with shrubs, all age classes of shrubs must be represented; further, compaction cannot inhibit tree regeneration and livestock-caused damage tree to seedlings cannot exceed 10 percent. To ensure these requirements are met, the condition of shrubs and trees will be regularly measured and will be reported to the Services annually.

Height of riparian vegetation affects sediment entrapment, velocity of moving water, pollutant filtering, and streambank stability; therefore the height of grazed herbaceous grasses or forbs is an important criterion to consider in grazing strategies (Mosley et al. 1997; Ehrhart 1998). Stubble

height influences the erosive power of the stream and slows the velocity of water, which then loses its capacity to carry sediments resulting in sediment deposition, which in turn affects channel bar formation, pool formation, streambank integrity as well as other channel-forming features (Ehrhart 1998). The results of several studies that have examined various stubble heights that maintain various functions such as sediment retention/entrapment and streambank stability, have indicated a range of heights from 0.5 to 12 inches depending on site conditions and plant species (Mosley et al. 1997). With regard to sediment however, some research has shown that shorter stubble heights (.5 to 4 inches) trap sediment better than taller vegetation, however, taller vegetation (8 to12 inches) is better at retaining the deposited sediment over time (Ehrhart 1998).

The NFHCP contains a grass utilization, (includes grasses, sedges, and rushes) an environmental trend indicator of 8 inches stubble height in riparian areas (along streambanks). According to Ehrhart (1998), this conforms to or exceeds the guidance in the literature. However, this standard relates only to grasses and not sedges or rushes which may perform the same functions as grasses and be more prevalent (Ehrhart 1998). Where 8 inch stubble heights cannot be achieved, the specific allotment indicator defaults to a maximum 50 percent utilization. At no time will stubble heights be less than 4 inches. Some flexibility (i.e., in modifying this standard) may therefore be needed in certain allotments to adjust to specific site conditions, site sensitivity, desired future conditions, season of use, and habitat conditions of covered species that may be present.

Livestock grazing strategies to increase forage, encourage more favorable plant species, and to decrease soil erosion have been developed which should aid in protection of fisheries and allow continued livestock grazing (Platts 1991). Limiting pasture size allows greater control of grazing effects because cattle can be moved to other pastures as forage utilization targets are met. Seasonal grazing adjustments allow the rancher to maximize benefits while minimizing adverse effects (Kovalchik and Elmore 1991; Platts 1984). Implementation of and adherence to a proper management plan, incorporating these and other approaches to reducing adverse effects resulting from grazing, is critical to overall success (Platts 1984).

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 unacceptable riparian conditions, benefits would probably be similar to riparian exclosures and riparian vegetation would be expected to respond relatively rapidly. In cases where impacts are particularly severe, such as severe bank erosion and sedimentation, leases may not be renewed at all until recovery occurs. The threat of sediment impacts from grazing on streams could be greatly reduced in those cases where habitat degradation is most severe.

The NFHCP includes other grazing management commitments that would advance the body of knowledge of modern grazing practices through training, monitoring, and learning, e.g., CAMP 4. These actions may have long-term institutional benefits in reducing grazing impacts on riparian areas for both Plum Creek lands and grazing practices generally.

Many of Plum Creek's proposed grazing BMPs such as offsite water development, salting away from streams, and rotating pastures, have already been proven successful at reducing livestock impacts and helping to control sediment delivery to streams (Ehrhart 1998). Further, 4 years of experience with Plum Creek's grazing BMPs indicate that riparian conditions would likely improve (DEIS/NFHCP 1999). Nevertheless, there remains some uncertainty about the degree to which the overall grazing management system would lead to improved conditions over time. In part, this would depend on Plum Creek's rigor in lease administration and lease-level monitoring of trends. For streams where exclosures are determined to be necessary, Plum Creek will begin fencing in year 1 of the NFHCP and progress will be reported annually. Success of the grazing program may also vary depending on individual sites and grazing strategy. Some lease holders will undoubtedly achieve greater results than others because of their personal commitment or other factors (however, lease holders who do not comply with the Plum Creek grazing commitments would be phased out as the leases expire). Overall, the Services expect that the NFHCP' grazing commitments will result in improved habitat conditions within the covered lands in the NFHCP area because of: 1) lease holder education; 2) the requirement for application of grazing BMPs; 3) development of appropriate grazing exclosures; 4) individual allotment and grazing strategy effectiveness reviews, which will feed into the Adaptive Management process; and 5) the potential for leases in particularly troublesome areas where BMPs have not achieved desired results to be vacated.

Although continued grazing operations on Plum Creek may still contribute to some habitat degradation, grazing can be compatible with healthy riparian systems if conducted appropriately (Elmore and Beschta 1987; Platts 1984). Thus, the Services anticipate that the NFHCP's grazing program would significantly minimize such degradation, and the number of stream reaches classified as moderately or severely disturbed is likely to be reduced to zero. It is not certain how quickly the removal of excessive disturbance would actually convert to improvements in aquatic habitats or in fish populations where they may have been affected by degraded habitat. Therefore, the NFHCP also includes Adaptive Management measures that would establish meaningful success metrics and a feedback loop process for improving range management methods if needed to meet NFHCP biological goals. Grazing under the NFHCP does not occur in Idaho or in most of the western Washington streams, therefore, changes from grazing commitments will only affect streams in Montana and portions of the Yakima River basin.

Adaptive Management

Under the NFHCP, Plum Creek would commit to obtaining scientifically-based information on the trends in riparian conditions and fish habitat relative to the performance and effectiveness of grazing BMPs. This would be conducted under the plan's monitoring and Adaptive Management commitments, particularly CAMP 4. Under CAMP 4, a network of long-term monitoring plots intended to elucidate differences between various grazing treatments and their controls will be conducted on the most sensitive stream reaches. Data from the stream reaches will be collected at

year 2 of the plan and every 5 years thereafter. The exact study design would be developed in cooperation with the Services and other experts.

The effectiveness of grazing BMPs has two dimensions, one at the site level and another at the watershed scale. The effects of specific BMPs can be highly variable due to differences in climate and hydrologic conditions (Mosley et al. 1997). There can also be variability due to differences in BMP implementation and maintenance. Therefore, an Adaptive Management program designed to test grazing BMPs must account for the full spectrum of forest riparian environments and varying implementation efforts across all the cattle allotments of interest to native fish protection. In addition, it is important to determine whether BMPs are successful at the watershed level because at this level BMPs can have a profound effect on water quality throughout the downstream portions of the drainage (Mosley et al. 1997).

The Services believe the NFHCP's grazing BMPs–including its Adaptive Management commitments–will likely reduce and minimize current grazing impacts along riparian areas in Tier 1 watersheds and on Tier 2 lands. The precise degree or extent (at the individual site or watershed scale)of these improvements will have on fish habitat over the 30-year life of the permit is dependent to a large extent on how severely degraded existing conditions were to begin with, the time necessary to recover properly functioning riparian conditions, and the rigor with which the commitments are implemented. In any case, studying the effectiveness of the NFHCP's grazing BMPs through its Adaptive Management program will be crucial to determining how well the BMPs perform and to making the adjustments necessary to maximize their performance.

Legacy and Restoration Commitments

Legacy and Restoration Commitments includes two provisions that could reduce sediment input by some unquantifiable amount to important stream habitats for native fish within the covered lands of the NFHCP: 1) Key Migratory River provisions and 2) instream habitat restoration provisions.

Some rivers that serve as actual or potential migratory pathways and overwintering areas for covered species such as fluvial bull trout and anadromous fish may have degraded habitat conditions resulting from previous human activities. Plum Creek has identified 124 river miles of known or potential migratory river segments on Plum Creek lands. These are designated "Key Migratory Rivers" for the purposes of the NFHCP and are river systems that have undergone extensive alterations since the early 1900s. The NFHCP requires riparian habitat conditions of key migratory river segments be assessed by year 7 of the NFHCP, that a draft restoration plan be submitted to the Services by year 8, that Plum Creek implement whatever restoration actions are agreed to by Plum Creek and the Services, and that subsequent monitoring be implemented to determine the effectiveness of the restoration actions.

Although the exact degree to which restoration efforts on Key Migratory Rivers under the NFHCP will be implemented is dependent on the results of the assessments, and the results of any such efforts will not be known until monitoring efforts have been implemented, any restoration of degraded riparian habitats can be expected to contribute to water quality improvements by minimizing sediment input from streambank erosion. Furthermore, the Services anticipate, given Plum Creek's commitment to the NFHCP's biological goals, and future Services's involvement in restoration decisions, that restoration of Key Migratory Rivers will yield substantial benefits to aquatic habitats and covered species. Under the NFHCP's engineered habitat restoration provisions, Plum Creek would cooperate with other entities (e.g., state fish and wildlife agencies) as opportunities arise to implement active habitat restoration projects within covered lands of the NFHCP area. Restoration actions that include enhancement of native riparian vegetation, as done by Plum Creek in 1998 in the Thompson River drainage in Montana (Parker 1998), could improve streambank stability as well as shade. Reducing the presence of exotic weeds and grasses and promoting native willow shrubs provides increased root mass on streambanks by providing the proper rooting depth, rooting character, and surface protection to reduce the streambank erosion potential (Rosgen 1996).

As a result of implementing legacy restoration projects, sediment delivery would be expected to decline in some degree over the long-term. For example, repairs of old landslides that have been a chronic source of excessive sediment supply to a key migratory river would be expected to reduce sediment delivery substantially. Also, sediment transport would be expected to improve in these key migratory systems and result in better habitat conditions, assuming the restoration projects are effective and other human factors do not negate the potential benefits during the term of the permit.

Land-use Planning Measures

Plum Creek buys and sells land as part of its timber management business. The act of buying or selling property will not, of itself, affect sediment delivery to streams. However, if Plum Creek sells land the potential exists for adverse effects to the covered species resulting from a subsequent landowner's activities. Consequently, the NFHCP allows land sales to be conducted in a variety of ways depending on the habitat sensitivity of the land involved–including dedicated conservation dispositions, private holdings with conservation easements, private holdings with restricted use provisions, and unrestricted sales. These commitments are designed to reduce the potential for adverse effects, especially with respect to sedimentation, that exists when lands initially held by Plum Creek and subject to the NFHCP's restrictions pass out of Plum Creek ownership and control. For example, under the plan Plum Creek would commit to a category of disposition of NFHCP covered lands that would require that any lands with high public (e.g., habitat) values be disposed of to a state or federal agency or a not-for-profit entity, such as the Nature Conservancy, created or organized agencies) for the bona fide purpose of holding or managing lands for the promotion of conservation.

Summary of NFHCP Effects on Sediment

Sediment reductions from the NFHCP would occur primarily through road closures and upgrades, and improved grazing practices. Additional reductions would occur through harvest prescriptions, and indirect benefits from adaptive management and land use commitments. An average reduction in cumulative sediment delivery from roads and other covered activities, over the 30-year life of the permit, is estimated to be roughly 30 -50 percent. Sediment delivery after NFHCP practices are implemented will remain around over background levels by an average of 77 percent. In many NFHCP watersheds, sediment is a primary factor limiting spawning and rearing success, and sediment reductions from the NFHCP are expected to facilitate recovery of degraded streams, and should maintain proper function (with regard to sediment) where it currently exists. Greater amounts of sediment reduction from Plum Creek activities are possible through additional road closures or additional BMPs such as graveling road surfaces. However, the patterns of mixed land ownership make it unlikely that Plum Creek can singularly restore degraded watersheds from road BMPs, regardless of the amount of sediment reduction they achieve. Adaptive management and road sediment delivery analyses may play a key role in determining the amount of sediment reductions needed in a given watershed to restore proper function, and it will provide the Services an opportunity to make limited adjustments in BMPs if they are warranted.

Large Woody Debris

Forest/Silvicultural Management

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.

The NFHCP is expected to increase habitat complexity habitat by improving LWD loading, bank stability, channel protection, canopy cover, sediment loading, and the hydrologic regime over existing conditions. The silvicultural prescriptions are expected to leave more wood standing closer to the streams located on NFHCP covered lands. Tree harvest would be limited or precluded throughout the riparian areas and on adjacent hillslopes, and as described in the DEIS/NFHCP (1999) retention trees managed in riparian zones would maintain trees in areas where they would contribute to aquatic habitat. The NFHCP will add no cut zones, extend state buffers farther from the streams, and require that at least 50 percent of the larger trees [greater than 8 inches average diameter at breast height (dbh)] be maintained. In general terms, an overall increase in LWD available instream and for recruitment on covered lands would contribute to improving baseline conditions for covered species.

The NFHCP developed forest management prescriptions for riparian and adjacent upslope area to enhance aquatic habitat throughout covered lands in the NFHCP project area. There are five categories of commitments identified in the NFHCP; State Regulations, Channel Migration Zones (CMZ), Other Streams that Support Fish, Headwater Streams, and Riparian-Upslope Interface. The management prescriptions are based on the sensitivity of the stream channels to LWD, the sensitivity of areas of the floodplain called the CMZ, locating the Thermal Management Zone (TMZ), and the Interface Caution Area (ICA). While the identification of channel and CMZ sensitivity is expected to reduce generalities and place more site specific prescriptions, extrapolation and use of information from one watershed to another may have unknown effects in untested watersheds or sub-basins. While the designation of channel types and associated riparian management prescriptions is based to some extent on channel widths, channel gradients, and LWD sensitivity, the specific effects of riparian harvest adjacent to these channel type designations on NFHCP covered lands are generally unknown. Testing the actual channel sensitivity to LWD is expected to occur through the adaptive management process in the NFHCP and is expected to reduce potential effects to current and future recruitment of LWD in these channel types.

Smaller channels formed of bedrock and boulder/cobble reaches exhibit dam pools or plunge pools formed by LWD and in particular, key pieces of LWD, which exist within the spawning distribution of covered species such as bull trout, and form important rearing habitat for steelhead and salmon. Though models may show some channels that have low sensitivity to LWD they may not be showing the sensitivity to large key pieces of LWD. As well, Overton et al. (1995) discusses that users of LWD counts need to be cautious because of the high range of natural variability and sampling error that exists. While the NFHCP models use LWD counts based on sizes of wood that are ~4 inches (10 cm) dbh and greater, they may not be capturing inclusions in the data related to larger key pieces of wood, natural variability, and sampling error. For example, spawning bull trout will use streams up to 15 percent gradient when no barrier exists, as evident in Washington and some Montana streams. Typically spawning gravels are trapped behind large key pieces of wood in these higher gradient streams, which maintain primary pool features over time, due to their large size and entrapment within smaller confined channels. Modeling LWD for certain channel types may point out larger numbers of smaller sizes of wood, important for native salmonid cover, but may not show the smaller numbers of larger key pieces of wood important for pool formation and entrapment of spawning gravels, particularly in some higher gradient confined reaches important for bull trout spawning. Adaptive management and watershed analysis is expected to minimize effects to LWD caused by the extrapolation of data (see Adaptive Management discussion below). Commitments in the NFHCP will add new information to models that were used to determine the channel types and the CMZ's in the NFHCP and it is expected that the information gathered will result in updated models and prescriptions which will minimize effects to LWD and habitat complexity.

LWD input resulting from the implementation of the NFHCP riparian prescriptions would range from 36-166 pieces per 1,000 feet of stream, spanning the natural average observed on the NFHCP covered lands (DEIS/NFHCP 1999). The average number of in-channel LWD, from unmanaged stands throughout the action area, is estimated to be 78 pieces per 1,000 feet of stream channel (DEIS/NFHCP 1999). While under the existing conditions (no NFHCP), the cumulative number of LWD after 30 years is expected to range from 33-93 pieces per 1,000 feet of stream for 10-foot wide streams, and 30-78 pieces for 30-foot wide streams. Based on modeling done by Plum Creek, the NFHCP is expected to provide 48-107 pieces of LWD per 1,000 feet of stream for 10-foot wide streams, and 36-93 pieces for 30-foot wide streams. Thus the NFHCP could provide more LWD over time than without the NFHCP, especially to channel types that are sensitive to LWD inputs or channels with reaches used by native salmonids as identified by Plum Creek in Technical Report #7 (DEIS/NFHCP 1999).

Implementation of the NFHCP is expected to increase LWD levels over existing management conditions in high sensitivity streams by 25-55 percent along small streams and by 25-75 percent along larger streams and in general in moderate sensitivity streams by 25-75 percent, depending on the riparian stand types, over the 30-year permit period. Levels of LWD in low sensitivity streams are expected to remain similar over the 30-year permit period. The NFHCP contains the CMZ, TMZ ,and ICA management areas and is expected to increase the probability that projected LWD levels would be maintained. However, the ability of this area to affect current and future levels of LWD is unknown and effects will vary among watersheds and subwatersheds. The NFHCP will also implement Land Use Conservation Areas (LUCAs) on land titles that are going to be sold by Plum Creek which will add to the maintenance and future recruitment of LWD on forested lands.

Actual and potential LWD levels and complex habitat such as pools and spawning habitat formed from LWD jams, could decrease on NFHCP covered lands due to riparian harvest or when more wood exits a system than is recruited. To minimize chances that this will occur the under the NFHCP, only 20 percent of the riparian areas will be harvested within the first 10 years of the project, with an additional 20 percent harvested in the second 10 years, followed by another 20 percent in the final 10 years will be harvested. Thus, Plum Creek will not harvest timber in 90 percent of the riparian areas on NFHCP covered lands within the first 5 years and will not harvest timber in 80 percent riparian areas on NFHCP covered lands within the first 10 years. Out of the 80 percent riparian areas not being harvested within the first 10 years, 65 percent is not harvestable due to state forest practice standards and the remaining 15 percent are voluntary commitments (DEIS/NFHCP 1999). In summary, a total of 60 percent of the riparian areas within NFHCP covered lands will be harvested using the NFHCP riparian management prescriptions. Still, depending on the watershed or sub-watershed baseline conditions, whether it is a Tier 1 or Tier 2 watershed, the level of harvest, and the capabilities of individual stands to produce LWD, the NFHCP may or may not maintain the levels of LWD necessary for salmonid habitat specific to the individual watershed or sub-watershed. Other commitments and provisions such as watershed

analysis, engineered fish habitat restoration, and adaptive management in the NFHCP will provide more knowledge about specific areas lacking LWD and are expected to help maintain levels of LWD necessary to provide for complex habitat essential to salmonid survival (see the baseline discussion in Appendix A for individual sub-basin conditions, particularly where fifth and sixth field watershed baseline assessments suggest that LWD levels are not functioning appropriately).

Riparian prescriptions developed to minimize and mitigate effects of timber harvest on aquatic habitat, including LWD, are expected to be implemented across riparian areas on NFHCP covered lands (see Table 3, 4,and 5 Stream Temperature section above). The state riparian buffers are the base conservation levels for the NFHCP with the CMZ and the TMZ adding additional protection to maintain and enhance habitat complexity. The NFHCP defines CMZ's based on their sensitivity to timber harvest and has particular prescriptions based on that sensitivity. The NFHCP defines TMZ's for small headwater streams that may not be fish bearing but are connected to fish bearing streams. The only existing requirements for management in riparian zones are the state required buffers. The additional protection outside of the state buffers, is expected to leave more trees in key locations to maximize benefits to aquatic habitat. One of the intents of these measures is to maintain and enhance LWD recruitment and pool development. A model used by Plum Creek and discussed under the NFHCP indicated that 2/3 of the LWD can be recruited into the stream channel from within 25 feet of the channel margin on NFHCP covered lands, over the term of the permit (DEIS/NFHCP 1999). Adaptive management (see Adaptive Management below) is expected to reduce the potential for general prescriptions which can negatively effect numbers of LWD at a more local level. By using adaptive management and testing the model which is used for determining the riparian prescriptions in the NFHCP, especially the numbers of trees per acre and the use of different sideslopes in the model, it is expected that prescriptions may be developed to better meet the watershed or sub-basin needs for LWD.

There are concerns that the different protection levels in the NFHCP, given to Tier 2 watersheds or areas of migratory habitat, may not be enough to minimize effects to LWD levels and habitat complexity. New information is revealing that larger mainstems of river systems may be important spawning and rearing habitat for bull trout, especially as populations become larger. Several examples in Washington State can be noted for multiple years, where there are increasing occurrences of spawning bull trout overlapping with chinook and sockeye salmon spawning areas or are spawning in larger systems not generally used before as index reaches in spawning surveys. The spawning of bull trout is occurring in larger mainstem rivers generally 5th-field and 6th-field HUCs and is noted in the middle and upper reaches of mainstem tributary rivers to the Wenatchee, Twisp, Methow, and Skykomish Rivers (pers. comm., J. DeLaVergne, FWS, 2000). It is expected that adaptive management and the development of baseline conditions with watershed analysis will provide new information for incorporating appropriate riparian prescriptions specific to such areas, which will reduce effects and disturbance to future levels of LWD important for these areas (see Adaptive Management below).

Where uplands are adjacent to the riparian management zones the NFHCP will implement the Interface Caution Area or ICA (see Table 21 under Stream Temperature above). This is an additional commitment used to maintain and enhance aquatic habitat complexity and in addition to state required riparian buffers; this is an area where caution is applied adjacent to riparian areas. This provision in the NFHCP is expected to reduce the risk of altering microclimate and the potential for mass wasting and soil erosion that could alter LWD levels. Such things as limiting mechanical site preparation and broadcast burning, road limitations, designating skid trails, clearcut limitations, tree retention, and road abandonment in the ICA are expected to minimize compaction, vegetation disturbances, and maintain root strength, all which have associated effects to the hydrologic regime and disturbances to levels of LWD. It is expected that the ICA will benefit aquatic habit t complexity but to what extent is unknown. Implementation and effectiveness monitoring and associated adaptive management is expected to strengthen effectiveness of the commitments in the ICA's. Past hydrologic effects associated with soil and vegetation disturbances from previous forest management can last decades. There may be areas discovered through adaptive management or watershed analysis, on NFHCP covered lands, that exhibit compaction in upland areas because of past harvest. Effects from such areas should be minimal because it is expected that these areas can be included within a particular ICA to avoid potential mass wasting, increased compaction, and a reduction in soil disturbance that can eventually lead to reduced vegetative growth and changes in LWD levels.

Headwater reaches of streams are known to be the upper extent or initiation points of debris slides and torrents which will recruit LWD to streams and transport it through the watershed. Potentially prime native salmonid spawning and rearing habitat is often located within the headwater reaches of stream systems. The Services are concerned that NFHCP forest prescriptions within the headwater areas may not be protective enough to maintain complex habitat particularly because the NFHCP allows harvest of some trees on slopes adjacent to CMZs. However, as described above it is expected through monitoring and adaptive management, that the incorporation of new information in the development of more site specific harvest prescriptions will reduce effects on current and future recruitment of LWD in these headwater stream channels (see Adaptive Management below).

In summary, silvicultural prescriptions developed under the NFHCP are expected to leave more wood standing closer to the streams on NFHCP covered lands. Tree harvest would be limited or precluded throughout the riparian areas and on adjacent hillslopes, and as described in the DEIS/NFHCP (1999) retention trees managed in riparian zones would maintain trees in areas where they would contribute to aquatic habitat. The NFHCP will add no cut zones, extend state buffers farther from the streams, and require that at least 50 percent of the larger trees (greater than 8 inches average diameter at breast height or (dbh) be maintained.

Road Management

In terms of habitat complexity roads can adversely affect hydrologic regimes, channel morphology, and upslope and riparian vegetation which leads to changes in LWD. Mass wasting, debris slides or torrents, and erosion can directly and indirectly affect LWD by altering LWD levels in the floodplain and channel and reducing current and future recruitment of LWD through vegetation changes. Upgrading old roads, construction of new roads with enhanced BMP's, abandoning surplus roads, and treatment of high risk or "hot spot" sources of sediment, programs identified in the NFHCP to improve sediment delivery to the stream network, are also expected to address effects of road development on LWD recruitment. In watersheds with high road densities (see baseline discussion in Appendix A for watersheds not functioning appropriately for road density), old roads and new road locations may have some of the greatest effects on LWD recruitment. Because of their location and condition, and because of the cumulative effects of increased road mileage in poorly functioning watersheds, the potential for mass wasting and erosion to effect LWD is great. The NFHCP will upgrade old roads within 10 to 15 years, completing high priority watersheds (Tier 1 watersheds) or Native Fish Assemblages (NFAs) within 10 years with all upgrades completed on NFHCP covered lands within 15 years which will minimize potential mass wasting. NFHCP commitments such as not building roads in ICAs on slopes adjacent to CMZs and within inner gorges, slash filter windrows, grass seeding and mulching, surfacing with rock, and providing appropriate cross drains, etc. will minimize potential for mass wasting. The NFHCP will track road conditions and it is expected that a schedule of treatments may be able to be developed using this as a tool. This will reduce the potential for mass wasting from overlapping new construction, upgrading, and abandonment of roads, particularly, adjacent to native salmonid spawning habitat and in watersheds with degraded baselines. Monitoring and adaptive management is expected to provide information about increased levels of sediment or mass wasting due to multiple road projects within watersheds or sub-basins. The overall commitments to upgrade 20,000 miles of existing roads over the 30-year permit period with enhanced BMP's should reduce sediment delivery and mass wasting potential, when combined with such commitments as upgrading culverts, keeping roads outside of the ICAs, and treating hot spots.

Road density on average, on NFHCP covered lands, is approximately 7. 0 miles per square mile with 1 crossing per mile of road in Montana and Idaho and 2 crossings per mile of road in Washington. The effect of building 1,300 miles of new road on top of this is negative for native salmonids, as such, ICBEMP (USDA 1997) discusses that 1.0 mile of road per square mile begins to show a decline in the abundance of bull trout. Whether this negative relationship is related to LWD levels or sedimentation is not known. However, because culverts and bridges are often too small to pass LWD, increasing their potential to plug, fill, and cause mass wasting, protection of roads by the removal of LWD is not uncommon during storm events. Effects from this mass wasting would cause negative changes in levels of current and potential LWD and riparian vegetation. Changes can also occur to channel morphology and the hydrologic regime, which will

alter water levels and cause changes in the species of riparian vegetation. Depending on specific watershed baseline conditions there may be more or less of a threat to salmonid species from changes in LWD levels due to road densities. In some watersheds which already have very high concentrations of roads, and in particular those watersheds where current levels of LWD is already at low levels and future recruitment is minimal, it is expected that the adaptive management process will focus on methods to restore LWD processes and reduce effects of increased road mileage.

Range Management

Livestock grazing can reduce habitat complexity in terms of LWD, by removing riparian vegetation, lowering water tables, causing unstable streambanks and incised channels, and widening channels and reducing pools. Considered collectively, Plum Creek grazing allotments equate to one of the largest ranches in the State of Montana (DEIS/NFHCP). Current grazing management on Plum Creek lands does not require allotment management plans or specific practices to prevent riparian and stream degradation. The NFHCP establishes riparian objectives, BMPs, and monitoring that will restore channel morphology and riparian vegetation damaged by past, and on-going grazing. Approximately 25 percent of the areas in Plum Creek's allotments are moderately disturbed and about 10 percent are severely disturbed (DEIS/NFHCP 1999). However, Plum Creek does not have extensive survey information on these grazed lands and information is lacking about conditions of riparian areas on grazed lands. Grazing is not a large factor affecting anadromous fish covered by the NFHCP. Plum Creek grazing allotments occur only in portions of the Yakima River basin, and there are no Plum Creek allotments in Idaho and the remainder of Washington lands covered by the NFHCP.

Environmental Trend Indicators (ETIs) will be used to monitor gazing allotments (see Table 25 under Stream Temperature above). The provision of benchmarks for grazing conditions will enhance effectiveness of best management practices designed for grazing. The NFHCP still restricts damage to tree seedlings to less than 10 percent to reduce impacts on LWD. The NFHCP will restrict the amount of browsing and grass utilization in the riparian zone and browsing on shrubs will be restricted to less than 25 percent of the current year's growth each year to reduce impacts to riparian vegetation. Grass utilization under the NFHCP includes an eight-inch stubble height in riparian areas an indicator to monitor, where stubble heights of a 4-inch minimum would not be exceeded. The NFHCP will monitor streambank stability and riparian compaction so that no more than ten percent bank disturbances or ten percent of riparian area soils are affected by hoofprints and compaction, to reduce the potential of negative effects on riparian vegetation and streambank stability. Other commitments such as BMPs, enclosures, rancher training, effectiveness monitoring and adaptive management, and the status of vacated leases are expected to help restore and maintain levels of LWD within gazing allotments. Because of the commitment to evaluate the status of vacated leases before allowing release of livestock for grazing, effects to LWD are expected to be reduced and levels of future and current LWD are expected to increase

over the time of the permit. Long-term monitoring of ETIs and adaptive management should reduce negative effects, improve allotment conditions, and is expected to adapt conservation measures to grazing allotments which generally depends on watershed or sub-basin specific information.

It is important to note that in Ahtanum Creek in Washington, a collaborative management approach is being developed between Plum Creek, Washington State Department of Natural Resources, and other land owners to develop a multi-watershed grazing strategy that will enhance aquatic and wildlife habitats. Currently, cattle graze heavily across land ownership's in Ahtanum Creek. The Ahtanum watershed is also in one of the Native Fish Assemblages under the NFHCP and it is expected that a grazing plan for this watershed, developed with specific information through the collaborative process, will enhance riparian vegetation and LWD. This information and management plan, developed by the collaborative management approach, can be used for adaptive management and may be used in other allotments across NFHCP covered lands.

In summary, grazing commitments in the NFHCP are likely to result in large improvements in riparian areas and streams that are presently degraded by Plum Creek grazing activities. Under the NFHCP, Plum Creek will establish greater control of grazing activities, and require ranchers to take specific actions to reduce or eliminate riparian grazing impacts. As a result, LWD levels, degraded from grazing effects, are likely to increase as riparian vegetation and channel morphology are re-established. The NFHCP grazing commitments will potentially have a widespread effect on future LWD recruitment levels in Montana, and a localized effect on stream temperatures in Washington, in Ahtanum Creek. Improvements in LWD levels for bull trout and resident species could be substantial due to widespread problems from riparian grazing in Montana. Improvements in LWD levels for anadromous fish are expected to be less dramatic because grazing only occurs in a limited portion of the Yakima River basin, primarily in Ahtanum Creek sub-basin, where irrigation diversions and reservoir management de-water many stream channels for portions of the year. Overall, the Services believe these factors will lead to a grazing program on Plum Creek lands that would be compatible with conservation of the covered species, and that aquatic improved riparian habitat conditions are likely to improve future LWD recruitment impaired by improve within grazing allotments.

Legacy and Restoration Commitments

Under the NFHCP, two of the Legacy and Restoration commitments, riparian vegetation restoration and engineered habitat restoration, will be very beneficial in the long-term for LWD development. They will be implemented to reduce effects on aquatic habitat complexity that exist on Plum Creek land, from past land management by multiple land owners, or "Legacy Impacts". "Legacy Impacts" are described as lingering effects of past activities (DEIS/NFHCP 1999). Monitoring and surveys initiated will help to plan watershed restoration projects that will positively effect habitat complexity by increasing current and potential LWD levels. Under the

NFHCP and by the seventh year of the plan, Key Migratory River segments will be inventoried and a draft restoration plan submitted to the Services by the eighth year. Without knowing exactly what restoration will occur, effects of the restoration are unknown. However, in the long-term the trend will generally be expected to be positive towards restoration of complex aquatic habitat for salmonid species. It would be expected that current LWD be maintained and that future LWD would be enhanced to maintain natural LWD processes.

Adaptive Management

The NFHCP proposes a study (CAMP 2; see FEIS 2000 for details) on the effects of the proposed NFHCP riparian management actions on woody debris loads and fish habitat diversity. The results of this study will be used to provide early indications of any needed changes to the riparian management commitments by validating assumptions used to forecast LWD loads, and collecting data to determine if LWD recruitment potential is improving on NFHCP lands through time. Under this project, some very important questions will be tested. For example, in terms of forecasting LWD loads, research will be done on the following: 1) whether treefall angle is independent of hillslope angle; 2) if trees leaning towards streams have a significant influence on post-harvest recruitment rates; 3) whether stream width and channel gradient has significant influence on LWD depletion rates; and 4) how well forest growth model does in forecasting LWD loads from different silvicultural treatments. Another component of research will investigate whether riparian stands on NFHCP covered lands show improving trends of LWD recruitment and canopy closure by examining relative tree density and average diameter of the largest trees and canopy cover over sampling plots.

In addition to the above research questions, under the CAMP 2, Plum Creek will also address the influence of LWD upon the amount and quality of fish habitat affected by channel type. This will be done by examining the relationships between LWD load, pool spacing, and residual pool depth across different stream channel types. The results of this effort will not be used to determine if an adaptive management trigger is tripped, but to determine a causal linkage and biological relevance in terms of finding whether different channel types have inherently different sensitivities to LWD gain or loss. For example, if a strong relationship is found between LWD and pools in a step-pool channel type, and its known that fish density increases with pools in this channel type, then through a cooperative management response an increase in the riparian commitment may be warranted and proposed for step-pool channels.

In general, adaptive management under the NFHCP will address the Services' uncertainties regarding NFHCP's LWD conservation commitments discussed above. In turn, if a trigger is tripped which indicates the commitment is falling short of meeting the NFHCP biological goals, then the Services and Plum Creek will work together through the adaptive management pathway and implementation framework to reach a mutual solution.

Water Quantity and Quality

This section discusses specific effects of the proposed NFHCP on water quantity and those aspects of water quality that were not discussed in previous sections of this document. The reader is referred to foregoing text for specific discussions on the effects of NFHCP measures associated with forest, road, range, and adaptive management on water temperature and sedimentation, and the subsequent effects of changes in these important water quality constituents on fish habitat. The effects of NFHCP measures on channel morphology as influenced by hydrologic function, and subsequent influences on instream and riparian habitat, are discussed in a later section in this document.

Forest/Silvicultural, Road, and Range Management

The potential for risk to covered species from hydrologic changes associated with implementing the NFHCP on 1.6 million acres of covered lands and streams is likely to be low. The NFHCP includes commitments that should serve to reduce the risk of peak-flow and low-flow hydrologic changes and adverse effects on aquatic habitat. These commitments are discussed in the following text and include, among others, minimizing the use of clearcutting as a harvest prescription; buffering streams and channel migration zones; "feathering" harvesting around stream buffers into upland areas; reducing the delivery efficiency of roads through road upgrading, drainage improvements, and abandoning surplus roads; and implementing hydrologic-related grazing, fish passage, and adaptive management commitments.

The potential for hydrologic-related risk to covered species in the16.5-million-acre action area from implementing the NFHCP also is low. The NFHCP covered lands encompass only a small portion of the entire action area. The USFS manages most lands within the action area, as well as Tier 1 watersheds. Plum Creek owns, on average, no more than 10 to 15 percent of the lands in each of the 15 planning area sub-basins (DEIS/NFHCP 1999)

The abandonment by Plum Creek of as many as 1,000 miles of surplus roads not required for long-term forest management in the NFHCP covered area and the management of remaining and newly constructed roads in the covered area to reduce hydrologic connectivity to streams through added road drainage should contribute to proper hydrologic function. One of the NFHCP commitments prohibits new road construction within riparian-upland ICAs and provides incentives for abandoning existing roads within ICAs. This commitment also provides an incentive to abandon those roads closer to streams, which would benefit water quantity and quality.

The scientific literature indicates variable responses of peak flows related to road densities in the Pacific Northwest. Jones and Grant (1996) identified increases in small peak flows (runoff events of 2 years or less), but this was not identified for larger peak flows (Thomas and Megahan 1998). King and Tennyson (1984) investigated road construction effects on peak flows in six watersheds

in the Rockies and did not find any significant effect on flood flows. It is likely that the NFHCP commitments to disconnect road-runoff from perennial stream channels and to close surplus roads as described above will be adequate to reduce potential risks to covered species associated with peak flows.

Road management prescriptions would interact to reduce the flow of surface runoff that is delivered to streams during precipitation events. During new road construction, this would be accomplished through the use of existing regulations and enhanced BMPs, placement of turnouts to disperse road runoff and prevent sudden and artificial pulses in stream flow, more frequent drains and ditch relief culverts, especially those close to stream channels, and conveying water from seeps and springs to the forest floor as close as possible on the other side of the road. Plum Creek commits to an enhanced BMP of installing culverts during new road construction that would be designed to accommodate at least 50-year flood flows, which would reduce the risk of catastrophic failure.

Any unnatural flow alterations in watersheds also would be reduced by upgrading old roads, treating hot spots, abandoning surplus roads, and intensively maintaining roads that slope or drain directly to streams. The treatment of hot spots would be given high priority and is especially important for quickly reducing existing, high-risk hydrologic hazards. These prescriptions would prevent unnaturally high spikes or pulses in stream flows that can potentially impact channel and bank integrity, instream habitat, and seasonally sensitive life stages of salmonids and benthic invertebrates.

Because more than 95 percent of Plum Creek harvesting in the Rocky Mountains and 80 percent in the eastern Cascades is by partial cutting, the potential for hydrologic risk from the covered activity of clearcutting is low. The effects of partial cutting in upland and riparian areas on the hydrology of streams was assessed by conducting five watershed-scale hydrologic investigations in the NFHCP area. Analysis of two Tier 1 watersheds in the Swan River sub-basin (Watson et al. 1996) and one Tier 1 watershed and two Tier 2 watersheds in the Thompson River drainage (Sugden et al. 1998) did not detect a timber harvest-related effect on watershed hydrology or fish habitat. The watersheds included the Goat Creek and Piper Creek watersheds in the Swan River sub-basin; and the Beatrice Creek, Boiling Springs Creek, and Murr Creek watersheds in the Thompson River drainage. These studies suggest that partial cutting practiced by Plum Creek does not cause measurable peak flow increases or low flow changes. The watershed-scale investigations showed no substantive changes in peak flows through removal of forest cover, and the Thompson River drainage showed similar or decreased peak flows compared to historical conditions (Sugden et al. 1998). Based on these findings, upland and riparian timber harvests on NFHCP covered lands under the NFHCP would likely not measurably alter or adversely affect peak or low streamflows. These analyses also suggested the present day practice of suppressing fires has sometimes resulted in greater canopy cover than occurred historically.

Because of the timber types available, the maximum potential extent of clearcutting over the permit period would be 25 percent of NFHCP covered lands (DEIS/NFHCP 1999). However, this extent of clearcutting would be unlikely. Based on Plum Creek's track record and their current estimates, Plum Creek expects to clearcut no more than about 3 percent of their lands east of the Cascade mountain range crest during the permit period. For example, in 1998 Plum Creek clearcut less than one-tenth of 1 percent of their total ownership east of the Cascade Crest. At this rate, Plum Creek would clearcut approximately 3 percent of the NFHCP covered lands over 30 years (DEIS/NFHCP 1999).

In 1998, 1.5 percent of NFHCP covered lands west of the Cascade Crest were harvested by clearcutting. Another 1.5 percent were harvested using other methods (for example, commercial thinning, selection harvest and light salvage). Over the next 20 years, NFHCP covered lands west of the Cascades will largely be in a re-growth phase, where substantial hydrologic recovery will occur. During this 20-year period, Plum Creek harvest levels will be at similar levels to 1998, with most harvest coming from commercial thinning (DEIS/NFHCP 1999). After 20 years, more clearcut harvesting will occur as intermediate stands mature. While substantial hydrologic recovery will be occurring over the permit period, watershed hydrology will also be influenced by adjacent lands. In western Washington, Federal lands encompass 68 percent of the Lewis River sub-basin, and 13 percent of lands in the North Riffe sub-basin. All of these Federal lands are managed under the Northwest Forest Plan and are experiencing substantial reductions in harvesting.

Plum Creek will monitor the amount of clearcutting in the NFHCP covered area and annually report to the Services the fraction of harvested acres, including those outside of ICAs, that utilized clearcutting as a harvest prescription. Plum Creek has committed in the NFHCP to limit clearcuts to less than 5 percent of the total harvest in the ICAs. Should new information become available, or trends in clearcutting on NFHCP covered lands change, the Services can bring this to the attention of Plum Creek through the adaptive management process. The NFHCP includes sufficient adaptive management flexibility such that where a proposed approach is not as effective as necessary to conserve covered species, management can be modified as necessary. This reporting would allow the Services to judge whether levels of clearcutting may affect the ability to meet biological goals in the future. The Services could also determine if Plum Creek practices have jeopardized the existence of one or more covered species, and thereby mandate either changing management, or permit suspension or revocation.

Retention of more riparian vegetation would likely increase the infiltration rate of overland flows into the ground. This may enhance stream flows during low flow periods by increasing the amount of water stored in stream banks, which is released as stream levels drop. Greater infiltration and reduced surface runoff, combined with increased surface roughness from vegetation retained in channel migration zones, may also slightly reduce unnaturally high peak flows or spikes in runoff that may occur. Also, limiting or eliminating harvest in channel migration zones (CMZs) would

minimize or avoid potential effects on groundwater and water that flows through the gravels under the stream (hyporheic zones) that influence macroinvertebrate (insect) populations and food for fish.

Grazing controls under the NFHCP would help stabilize stream banks and decrease stream width relative to depth, which should locally improve channel functions, such as depth of water, particularly during low flows. Perhaps one of the greatest potential benefits of the grazing controls is the commitment to riparian assessment and restoration where existing ecological functions are undesirable. In addition, the NFHCP proposes to develop a management plan to reduce or eliminate impacts on native fish caused by irrigation diversions. Plum Creek has committed to working with water rights holders to design appropriate alternatives to existing diversions that could, for example, improve low flows during critical upstream migrations in the summer and fall.

The NFHCP contains a changed circumstances commitment that requires site-specific plans to deal with the possible adverse effects on covered species of events that can be reasonably anticipated if they, in fact, occur. A hydrological changed circumstance that could affect covered species includes flooding at calculated recurrence intervals of 25 and 50 years. Should floods of such magnitude occur, Plum Creek and the Services would work together to determine if impacts have occurred, and develop plans to address those impacts.

Importantly, the benefits to water resources and hydrology resulting from implementing conservation measures included in the NFHCP lie in the commitments themselves, and in the rate at which those commitments are implemented. The NFHCP commitments would be implemented, in large part, within the first half of the proposed 30-year permit period, allowing multiple generations of bull trout and other native fish to benefit from the effects of the conservation measures.

Most streams, rivers, and lakes in the NFHCP area have water quality that currently meets state standards. There are 42 reaches of 303(d) listed streams in the NFHCP area, all in Montana, that have been assigned a TMDL priority of high, moderate, or low. Reaches of certain drainages in six of the 15 NFHCP action area sub-basins have impaired water quality conditions that may threaten some subpopulations of bull trout (FWS 1998a).

Water quality can be affected by land management and timber harvest related activities that require using heavy machinery within or near stream channels. These activities have the potential to introduce petroleum derivatives and other contaminants into streams. Fuel spills can result in a range of adverse effects to fish, depending on the magnitude and potential dilution factors. Fish and invertebrates may be lethally or sublethally affected by contact with petroleum-related spills for periods of up to several years (Hamilton et al. 1979 in U.S. Department of the Interior 1997). These potential effects can be avoided or minimized by restricting the use of mechanized

equipment in or near stream channels, checking the equipment daily for leaks, and requiring a hazardous materials spill kit on site. A spill contingency plan outlining the procedures to follow if a fuel or hydraulic fluid discharge occurs will further minimize the potential for adverse effects.

The SMZ law in Montana prohibits the operation of wheeled or tracked vehicles for the purpose of commercial timber harvest within SMZs (i.e., at least 50 feet slope distance from the ordinary high water mark; associated wetlands and slopes greater than 35 percent extend this distance) of streams that flow for six months annually or contribute surface flow to another water body, except on established roads. The Idaho Forest Practices Act prohibits ground-based equipment in the Stream Protection Zone (i.e., 75 feet from the ordinary high water mark for streams used by fish for spawning, rearing, or migration; 30 feet from the ordinary high water mark for streams with "few fish" or where fish presence is unknown), except at approaches to stream crossings. Emergency rules relative to timber harvest in Washington are effective March 20, 2000, through June 6, 2001. These rules, contained in the Forests and Fish Report, complement the existing Forest Practice Rules and establish a 30-foot equipment limitation zone for type 4 and 5 waters (perennial and seasonal non-fish bearing streams; rules prohibit equipment except for the purposes of crossing streams and establishing yarding corridors), and exclude mechanized equipment within WMZs for type 1, 2, and 3 streams (fish bearing) except by written permission from the Forest Practices Board.

The above requirements are likely to prevent the introduction of equipment-related contaminants into streams that could adversely affect covered species in Montana relative to timber harvest activities. For Idaho and Washington, the situation is less clear. Although Idaho stream crossings are required to be removed immediately after use and streamside vegetation maintained to the degree possible, the number of stream crossings and scope of equipment operations at the crossings is not specifically limited. The situation is essentially the same for type 4 and 5 streams in Washington. The Forest Practices Board review process for waiving equipment prohibitions relative to type 1-3 waters in Washington could conceivably, but not necessarily, limit equipment entries into those WMZs. Plum Creek's internal policy regarding water quality, stated in one of their 11 Environmental Principles, specifies that activities meet or exceed state and federal standards by employing BMPs, including riparian buffers, to protect water quality and aquatic resources. This internal scrutiny is likely to complement the implementation of state standards to limit the likelihood of equipment-related introduction of pollutants into waters flowing through NFHCP covered lands.

Application of pesticides and fertilizers is not proposed to be covered under the incidental take permit issued to Plum Creek. However, state regulations prohibit the introduction of hazardous or toxic materials in a manner that pollutes waterways. Runoff from pesticide applications has been identified as a serious water quality concern with potential to affect bull trout (MBTSG 1998; 63 FR 31647), and the potential to likely affect other covered species as well. Fairchild et al. (1999) found that Atlantic salmon runs were negatively impacted after aerial applications of insecticides

to control spruce budworm. Norris et al. (1991) summarized data on the entry and fate in forest waters, bioaccumulation, and toxicity to aquatic species of 10 herbicides, 5 chemical insecticides, and 2 biological insecticides. They noted the potential for acute, chronic, and indirect effects on various life stages of resident and anadromous salmonids and aquatic insects, depending on factors such as movement, persistence, and fate of the chemical in the environment and the dose-response relationships between the chemical and organism.

Plum Creek's adhering to state regulations and following internal company policies to meet or exceed state standards will reduce, but not entirely eliminate, the likelihood that activities involving hazardous or toxic materials will inadvertently result in adverse effects to covered species. State forest practice rules and BMPs prohibit handling, storing, applying, or disposing of hazardous or toxic materials, including pesticides, fertilizers, and petroleum products, in a manner that pollutes streams lakes, or wetlands, or that may cause damage or injury to humans, land, animals, or plants. Licensed applicators are required to follow label instructions prepared by the EPA for the chemical being applied. State rules also prohibit storing, mixing, or rinsing hazardous substances below the high-water mark of water bodies or where they might enter state waters (DEIS/NFHCP 1999). In addition, Plum Creek's NFHCP contains a commitment to implement, in consultation with the Services, habitat improvement actions in response to events such as wildfire, landslides, floods, etc. that may not be directly related to land management activities. This commitment would also apply to a situation where an unforeseen event or changed circumstance related to management activities, such as a chemical spill or improper pesticide application, occurs. The goal of such a response would be minimization of effects and restoration of the affected waterway.

Many roads are located adjacent to streams or their drainage structures are routed to streams. Application of chemicals to forest road surfaces to control airborne dust caused by traffic poses a risk of stream contamination either through direct or indirect contact. Although there is little information on the migration of chemicals from road surfaces or their toxic effects on fish, there is evidence that oil-based, dust-control agents can cause reduced production (survival and growth) of cutthroat trout when exposed intermittently or for short periods. Moreover, inorganic salts such as magnesium chloride have the least potential for impact and should be used instead on roads associated with important fish-producing streams (undated Completion Report by Daniel Woodward, Fish and Wildlife Service, Columbia National Fishery Research Laboratory, Jackson, Wyoming). Fish, in general, can withstand high salt concentrations, with cutthroat trout withstanding concentrations up to 400 parts per million (ppm) magnesium chloride salt. However, these high concentrations are very unlikely to occur in dust abatement applications. In general, it is recommended that use of these compounds be restricted to 25 feet away from water bodies in order to prevent chloride moving through the soil and encountering groundwater, mainly to protect riparian vegetation.

Plum Creek applies dust abatement measures to approximately 200 miles of forest roads per year. These measures typically include application of water and/or magnesium chloride, which comes premixed. The actual effects of applying magnesium chloride are unknown, but based on the best available information it appears the risk of toxicity or harm to fish from Plum Creek's dust abatement activities is not likely to cause negative impacts, if any.

In addition to effects on riparian vegetation, stream channels, and streambanks, livestock grazing can negatively affect water quality through the introduction of animal wastes, which contain nutrients and fecal coliform bacteria (MBTSG 1998; Platts and Raleigh [1984] in Clary and Webster [1989]). NFHCP strategies to improve riparian habitat by implementing grazing management plans that include fencing, grazing rotations, and limiting cattle access to riparian areas, as well as potential reductions in the number of grazing leases, should result in a reduction of cattle and associated wastes on NFHCP covered lands and streams. Considering the 600,000 to 765,000 acres of NFHCP covered lands that may be actively grazed at the outset of the NFHCP, the cumulative effect of such reductions could be considerable, but unquantifiable, benefit to water quality and covered species.

Point source water discharges resulting from activities on some NFHCP covered lands are limited to forest products manufacturing sites in Columbia Falls, Kalispell, Fortine, and Pablo, Montana. Discharges from these manufacturing plants are regulated under State water quality discharge permits. Practices followed at these facilities include avoidance of direct discharge of process waters to surface waters, the containment and reuse of process water, possibly some periodic but limited discharge of stormwater, and a Spill Prevention Control and Countermeasure Plan, where required (DEIS/NFHCP 1999). Monitoring will continue to occur to ensure that any discharges from these sites conform to specified limits. Accordingly, normal operations should not result in introductions to waterways that would influence water quality to the point of adversely affecting covered species. However, as in the example described above, any unforeseen event or changed circumstance related to Plum Creek management activities would engage the Services and Plum Creek in a collaborative effort to minimize such effects and restore the affected habitat.

Some of the proposed covered activities on NFHCP covered lands either do not result in a product that degrades water quality or are located on sites well removed from water bodies. Examples are Plum Creek's confined forest nursery and seed orchard facilities in Montana and Washington, sites of miscellaneous forest and land product sales (e.g., decorative stone, gravel, Christmas trees, sawdust, and wood chips), and electronic facility sites on mountain tops. Other covered activities such as commercial outfitting (hunting and fishing) and recreation uses (e.g., mountain bike rides on designated, maintained trails) are so localized or small in scale that any water quality impact would likely not result in substantive, adverse effects on covered species. Activities such as forest fire suppression may result in temporary, localized degradation of water quality.

In summary, alteration of watersheds through forestry actions such as timber harvest and road building can potentially change hydrologic regimes and alter water quality. However, the NFHCP is designed to reduce such risks to watershed hydrology by minimizing impacts of roads and promoting increased efforts to avoid roads significantly altering water flows, by reducing risk of clearcutting across watersheds, by increasing buffer widths and densities near streams, and by implementing various other hydrologic-related measures associated with livestock grazing, fish passage, and adaptive management. The NFHCP commitments governing new road construction, upgrade of old roads, and abandonment of surplus roads would reduce the hydrologic connectivity of roads with streams and reduce sediment supply, both of which should improve watershed hydrologic conditions and bedload movement. Risk of major vegetation removal (widespread clearcutting) is low, and road density will not increase significantly, if at all, so the likelihood of significant hydrologic effects from implementing the NFHCP is low. The effectiveness of these measures will be evaluated through Plum Creek studies and the use of outside information. If these measures are insufficient, Plum Creek will either adapt management or risk losing the regulatory assurances of the permit.

Channel Morphology

While minimizing sediment input to stream channels and increases to stream temperature may be achieved in the short term in many areas by implementing BMPs and conservation commitments, and limiting harvest/adding protection within the CMZs and ICAs, measures that stabilize channel morphology will take longer. Properly functioning stream channel conditions necessary to support stable native fish populations in systems where moderate to high levels of habitat degradation have already occurred, can only be realized if cumulative factors that have led to this condition are reduced appreciably. Restoring stream channels to a state of dynamic equilibrium will require conservation commitments and adaptive management flexibility that will minimize deleterious effects to stream health. The rigorous implementation of the NFHCP could result in the rejuvenation of connectivity between fragmented habitats and minimize the susceptibility of stream channels to continued perturbations.

As mentioned previously, sediment, insufficient large woody debris, extreme high and low flows, streambank erosion, insufficient riparian or streamside vegetation, disconnected off-channel areas, unstable substrate, incised channels, increased microclimates, and soil temperature extremes (anchor ice), are all factors that adversely affect channel morphology. Plum Creek has identified within the NFHCP specific habitat objectives that are expected to minimize impacts to channel morphology and provide an improving trend to channel stability and complexity.

For example, better grazing practices and more careful use of ground tree-skidding equipment can reduce soil compaction, which allows more rainfall to infiltrate and become groundwater instead of creating runoff and delivering more sediment to surface water systems (streams), as well as minimize streambank erosion from livestock trampling. Changes in the aquatic and riparian

ecosystems can pose risks to key links in hydrologic cycles. Some of the more apparent changes can include soil and vegetation disturbance and compaction that can alter relationships among water infiltration, soil moisture storage, groundwater recharge, evapotranspiration, surface runoff, and stream flows. These alterations can affect water quantity and hydrologic regimes, which can in turn degrade aquatic and riparian habitat for resident and anadromous native salmonids (ICBEMP 1997a). Hydrologic effects associated with soil and vegetation disturbance from past forest land management practices can last 3 to 4 decades or more, depending on vegetation characteristics and the intensity and extent of harvest.

BMPs and conservation commitments that minimize hydrologic effects and return hydrologic regimes to natural patterns will be critical if stable channel conditions are to be attained in aquatic systems throughout the NFHCP covered lands. BMPs and conservation commitments that provide for LWD recruitment, riparian vegetation, bank stabilization, and canopy cover, are expected to provide tangible components necessary for stable channels. However, if unnatural flow regimes with high peak flows and low summertime flows continue or occur as a result of implementing the NFHCP, these benefits would be diminished. Hydrologic changes that will result from timber harvest, road building, and other activities related to Plum Creek forest management and conservation commitments are unknown.

Sugden and Light (1998) and Light et al. (1998) assessed the effectiveness of BMP and forest practices regulations in protecting native fish resources and identified opportunities to augment current BMPs and regulations where needed to further reduce the risk to native fish habitat.

Plum Creek has committed to more than 20 of the conservation commitments that would have the potential to reduce sediment delivery and benefit soil productivity. As a result, sediment delivery and mass wasting improvements generally would occur across the NFHCP covered lands, particularly in those areas currently affected by forestry, grazing, and roads (see Table 4.6-3 in the FEIS, page 217).

Riparian Management

Vegetation resources in the NFHCP covered lands should be minimally affected by implementation of the NFHCP as riparian prescriptions in the proposed NFHCP would affect less than 1 percent of riparian areas in the action area and less than 10 percent of the NFHCP covered lands. Existing state riparian regulations currently preclude harvest along an estimated 65 percent (3,300 miles) of NFHCP covered lands streams. Many of the streamside forest stands of these stream miles were harvested before riparian harvest regulations; their canopy cover, woody debris recruitment potential, and other riparian functions will improve throughout the life of the plan because of natural riparian stand development.

The protection of channel morphology is of great concern in headwater streams as riparian prescriptions for these areas speak primarily to maintaining water temperatures close to natural conditions when these areas contribute more than 20 percent of the flow to fish-bearing streams. While these areas have limited harvest prescriptions of 35 trees per acre in place, there is concern that this lower level of retention, depending on the level of harvest on the hillslope or upland areas, will not offer enough protection to channel morphology due to increased flows and less potential large woody debris recruitment. As stated above, headwater stream reaches (both perennial and connected) are common initiation sites of debris slides and debris flows (Dietrich and Dunne 1978; Grant et al. 1990; Selby 1993). Headwater reaches are also known to provide critical spawning and rearing habitat for remnant bull trout populations. As well, sediment that is produced from scour in headwater areas from harvest related activities, aggregates in lower channel reaches (Cross and Everest 1995). Given the concern over the importance of protecting headwater areas, the Services feel that monitoring and adaptive management will be necessary to address these concerns.

Conservation commitments identified in the NFHCP to protect channel conditions include the identification and protection of CMZs with variable levels of entry depending on the streams ranking (refer to specific prescriptions in the Sediment section above). With this limited amount of entry, the Services anticipates that timber harvest within these areas (excluding headwater areas), should have minimal impacts to instream and off-channel habitat LWD recruitment.

These prescription recognizes the importance of LWD as the main element creating the pool-riffle/plane-bed habitat complex. The intent of the conservation measure is to protect recruitment of LWD to ensure maintenance of pool development and relies on the premise that over 2/3 of the available LWD that could be recruited into the channel over the permit period originates within 25 feet of the channel margin (Light et al. 1998).

All other perennial fish-bearing streams, that are not covered by previous prescriptions and include all Tier 2 streams without CMZs, will have the full protection of state SMZ rules only. Under the NFHCP, additional conservation guidance is offered however: 1) retain trees whose root systems are integrated into the streambank; 2) favor retention of trees that lean toward the stream; and 3) directional fall trees away from the stream. There is however, concern that this reduced level of riparian protection, as well, may inhibit LWD recruitment and hinder channel stability. Monitoring and adaptive management flexibility may be necessary to address these concerns.

Upland forest management commitments and additional commitments in areas adjacent to riparian areas could also result in significant effects on vegetation resources. These and other vegetation-related conservation commitments include provisions for riparian tree retention and buffers in fish-bearing and non-fish-bearing streams, upland and riparian ICA's, riparian harvest deferrals in sensitive fish-bearing watersheds, commitments to minimize clearcutting in upland areas,

rangeland protection and riparian restoration, and development of setbacks from sensitive aquatic sites. ICAs may not include roads and becomes the incentive for identifying and designating a road as surplus. Therefore, the incentive is to focus road abandonment close to streams where it also does the most good.

Overall, the retention of more riparian vegetation would likely increase the infiltration rate of overland flows into the ground. This may enhance stream flows during low flow periods by increasing the amount of water stored in stream banks, which is released as stream levels drop. Greater infiltration and reduced surface runoff, combined with increased surface roughness from vegetation retained in channel migration zones, may also slightly reduce unnaturally high peak flows or spikes in runoff so current flow regimes better match historic peaks and flow regimes. Also, limiting or eliminating harvest in CMZs could minimize or avoid potential effects on groundwater and water that flows through the gravels under the stream (hyporheic zones) that influence macroinvertebrate (insect) populations and food for fish.

In addition to protecting riparian and interface areas that subsequently improve channel morphology, Plum Creek recognizes the opportunity to improve riparian function in others areas and proposes the implementation of a comprehensive strategy. While the harvest prescriptions in the NFHCP focus on minimizing the impacts related to riparian harvest, it is important to view these harvest prescriptions in the context of the package of other NFHCP measures that also focus on riparian function recovery. For example: the upgrade of old roads, hot spot treatment, and surplus road abandonment efforts on Plum Creek's extensive road system will manage sediment reduction at its primary source rather than relying wholly on streamside zones as a sediment filter. Also, the area occupied by roads within riparian areas will be reduced.

Range management commitments through the implementation of grazing BMPs, combined with judicious use of fenced exclosures, should minimize current grazing impacts and allow for recovery of fish habitat in impacted streams. These commitments should result in a positive trend in riparian function restoration to 1,928 miles of stream, which is 38 percent of NFHCP covered lands stream miles.

Riparian vegetation restoration in impacted areas along 124 miles of Key Migratory Rivers should accelerate fish habitat recovery in the larger valley bottom areas that have had a greater diversity of legacy impacts from past management activities. For severely impacted stream reaches where riparian restoration (intervention) would greatly accelerate recovery, restoration plans will be implemented within the first 15 years of the NFHCP.

As opportunities arise, Plum Creek will cooperate in engineered stream habitat restoration projects. Where implemented, Plum Creek will have to be highly confident the instream structure would address the limiting factor for native fish in that particular stream. Engineered habitat

restoration could include: Addition of large woody debris, placement of boulders, bank stabilization techniques, rock turning barbs, wood cabled to bank, erosion control matting.

Range Management

Grazing controls under the NFHCP would help stabilize stream banks and decrease stream width relative to depth, which should locally improve channel functions, such as depth of water, particularly during low flows. Perhaps one of the greatest potential benefits of the NFHCP is the commitment to riparian assessment and restoration where existing ecological functions are undesirable.

The NFHCP would target specific situations where vegetation resources that influence Covered species' habitat are most vulnerable to Plum Creek's land management activities. The NFHCP includes a comprehensive monitoring and adaptive management program to ensure that livestock management commitments are benefitting native salmonid habitat.

These include grazing BMPs, which have environmental trend indicators for riparian vegetation conditions along all streams within grazing allotments. Regular opportunities for monitoring and improving degraded vegetation would be summarized in annual range management plans and practiced by lessees. Along Tier 1 streams and Key Migratory Rivers severely impacted by livestock, cattle would be excluded by fencing. The combined effects of grazing management prescriptions would be to restore all grazed stream reaches to a properly functioning condition within the 30-year permit period (Figure 1 in this Opinion).

The Services expect that effects from continued livestock grazing would be greatest in areas that have already been heavily impacted by past grazing and forest activities, if conservation commitments are out of compliance. Cattle grazing within riparian areas can have extensive detrimental impacts to streambank stability and channel morphology when improperly managed and is expected to be a high risk to bull trout and other native fish habitat if conservation commitments are not met. The Services expect that effects from grazing will be minimal and of low risk to bull trout and other native fish when the conservation commitments are in full compliance.

A total of 1,928 miles of stream flow through grazing lands on NFHCP covered lands. Of the total, 265 miles (14 percent) occur within Tier 1 watersheds. Also, 40 miles of streams designated under the NFHCP as Key Migratory Rivers (35 percent of the total) flow through grazing lands.

Plum Creek has identified four primary components for grazing BMPs:

1. Environmental Trend Indicators (ETI) to be achieved on Plum Creek property over time (see Table NFHCP4-1 in the FEIS, page 107). These indicators are also used to establish

whether a positive trend toward improvement is being obtained as a result of implementing the leaseholder requirements.

2. Leaseholder development of an annual Range Management Plan (RMP) describing the management system that will be implemented during a grazing season. This system must be designed to achieve the ETIs or result in an improving trend toward attainment of the ETIs. A toolbox of individual practices is provided that the leaseholder can include in the RMP. Some of these BMPs are mandatory (such as salting away from streams and maintaining existing fencing) and some are optional (such as constructing new fencing). Because of the site-specific nature of environmental conditions and sensitivities on each grazing lease, a simplistic set of mandatory BMPs is not workable. This system has built-in flexibility that gives leaseholders latitude to implement a system that will achieve the desired outcome.

3. Monitoring stream and riparian conditions at several sensitive locations on the allotment at least twice each grazing season. Monitoring involves a simple form and photo-points submitted to Plum Creek by the leaseholder. A copy of a simple monitoring form based upon the rancher's observations that may be used by the rancher is included as a part the Grazing BMPs. Or the rancher may use more complex monitoring approaches that are available. Leaseholder self-monitoring information will be verified in a site visit by a Plum Creek lease administrator who will also evaluate trends in ETIs.

4. Preparation of an end of year report by the leaseholder that describes what worked well during the grazing season and what did not with regard to environmental compliance, and includes a list of things needing to be modified in the next year's RMP. If adequate progress is not made in attaining the ETIs, or improving conditions over time, Plum Creek may require specific practices be implemented, or terminate the lease.

The intent of environmental indicators is to provide a benchmark by which the Services can ensure that Plum Creek is meeting its corporate environmental objectives such as clean water and healthy fisheries. For the vast majority of cases, the indicators proposed in the NFHCP will maintain or improve conditions over time. Adaptive management research, as developed under Plum Creek's NFHCP and other outside research, will be the basis for refining these indicators.

Road Management

Road construction can adversely affect surface water quantity and hydrologic regimes. However, there is uncertainty regarding the effects of forest roads on the magnitude and timing of peak flows (Jones and Grant 1996; Thomas and Megahan 1998). The comparatively impermeable surfaces of roads and associated cutbanks and ditches can result in less water infiltration and more

surface runoff. In addition, roadcuts can intercept subsurface flow and direct it to stream channels (ICBEMP 1997a, b).

Road management prescriptions proposed in the NFHCP would interact to reduce the flow of surface runoff that is delivered to streams during precipitation events. During new road construction, this would be accomplished through the use of existing regulations and enhanced BMPs, placement of turnouts to disperse road runoff and prevent sudden and artificial pulses in stream flow, more frequent drains and ditch relief culverts, especially those close to stream channels, and conveying water from seeps and springs to the forest floor as close as possible on the other side of the road. Plum Creek commits to an enhanced BMP of installing culverts during new road construction that would be designed to accommodate at least 50-year flood flows in Idaho and Montana and, by state regulation, 100-year flood flows in Washington, which would reduce the risk of catastrophic failure. Flow alteration in watersheds would also be reduced while upgrading old roads, and treating hot spots, abandoning surplus roads, and intensively maintaining roads that slope or drain directly to streams. The treatment of hot spots would be given high priority and is especially important for quickly reducing existing, high-risk hydrologic hazards. These prescriptions would prevent unnaturally high spikes or pulses in stream flows that can potentially impact channel and bank integrity, instream habitat, and seasonally sensitive life stages of salmonids and benthic invertebrates.

Although road miles would increase by 8 percent under the proposed NFHCP, older roads would be upgraded or abandoned at a 2:1 ratio to new roads constructed. Because older roads may not have been designed to integrate hydrological functions to the degree that would be implemented in new road construction, the net effect should be a benefit to hydrological functions in the NFHCP covered lands.

The NFHCP strategy to address slope stability builds upon basic state regulations and, where necessary, supplements them with additional practices. Throughout the NFHCP covered lands, the principal slope stability concerns are found in what are described as "inner gorge landforms." These are areas where streams have downcut into unconsolidated material (often glacial till) and created extremely steep (greater than 70 percent) slopes as a result. Because of their proximity to streams, these are high-risk areas that warrant careful consideration when locating new roads. The NFHCP New Road Construction includes commitments of "enhanced" BMP standards for dealing with inner gorge landforms.

To address road stability risks associated with old legacy roads, the NFHCP through Road Condition Inspections will identify where perched road fills exist and other areas where existing roads have a stability concern. Once identified, they will be addressed through Hot Spot Treatments.

Of the 12 enhanced BMPs for new roads, seven address BMPs that were identified in the 1998 Montana BMP Audit as most often out-of-compliance (Fortunate et al. 1998). These include providing adequate road surface drainage, routing road drainage through adequate filtration zones, directing road drainage away from stream crossing sites, stabilizing erodible fills, properly sizing crossing structures, and avoiding high hazard areas. The enhanced BMPs will provide the necessary specificity to ensure that these "problem BMPs" are fully addressed on new roads.

Under the NFHCP, the reduction in sediment delivery to streams from the existing road system is expected to exceed the increase in sediment delivery to streams from new road construction. To ensure that a net reduction in sediment delivery occurs from the outset of the NFHCP, a "pay-as-you-go" provision is included. The 2:1 ratio between upgrading/abandonment and new road construction is based on a desire to ensure that sediment reductions exceed any increases in sediment delivery throughout the first decade of the NFHCP in each action area sub-basin.

Prioritizing roads for their potential impact on fish would assure the most significant conservation benefits would be achieved first. Inspections would emphasize watersheds known to support bull trout, but would not be limited to those watersheds. Watersheds supporting other listed fish or with water quality limitations would receive priority treatment as appropriate.

Plum Creek will upgrade old roads for which the company has or shares management responsibility to "enhanced" BMP standards. This means that old roads will not only be upgraded to meet existing state rules and BMPs but will exceed them by implementing certain enhancements. Two priority categories are established for the purpose of focusing conservation: All roads in "high priority" watersheds will be upgraded by the end of 2010. All roads in the remainder of the NFHCP covered lands will be upgraded by the end of 2015.

Forest/Silvicultural Management

Timber harvest and associated road construction can alter the hydrologic processes that determine stream flow. Generally the removal of vegetation can increase the amount of water that infiltrates the soil, and ultimately reaches the stream, by reducing the water losses from evapotranspiration (Spence et al. 1996). Logging can change the total annual water yield, increase the magnitude of peak flows, alter the timing of peak flows, and increase or decrease the magnitude of summer low flows.

In general, the higher the level of disturbance in headwater areas, the greater the risks of impacts to watershed hydrology during high flow events. Relationships between silvicultural treatments such as uneven-aged or selective harvest techniques affecting only portions of a watershed, and impacts to soil water storage and hydrologic functions in a watershed, are less clear. Alterations to watershed hydrologic processes can be prevented or minimized by establishing conservation measures that identify and minimize cumulative watershed affects.

Currently, over 90 percent of the timber harvest in the NFHCP covered lands is by partial cutting, an alternative to clearcutting. The effects of partial cutting in upland and riparian areas on the hydrology of streams was assessed by conducting five watershed-scale hydrologic investigations in the NFHCP covered lands (Plum Creek 1996a, 1998d). The watersheds included the Goat Creek and Piper Creek watersheds in the Swan River sub-basin; and the Beatrice Creek, Boiling Springs Creek, and Murr Creek watersheds in the Thompson River sub-basin. These and other studies suggest that partial cutting practiced by Plum Creek does not cause measurable peak flow increases or low flow changes. The watershed-scale investigations showed no substantive changes in peak flows through removal of forest cover, and the Thompson River sub-basin showed similar or decreased peak flows compared to historical conditions (Plum Creek 1996a, 1998d). Based on these findings, upland and riparian timber harvests in the NFHCP covered lands under the NFHCP would likely not measurably alter or adversely affect peak or low streamflows.

Generally, vegetation structure within the NFHCP covered lands would be more diverse and less intensively harvested , the dynamic mosaic of patch patterns and seral stages would be similar to existing conditions, but riparian areas and corridors would be less disturbed or manipulated, and where forest management activities occur in the landscape, the NFHCP's ICAs would moderate changes to forest structure by prescribing minimum tree retention, regeneration stocking requirements, and a number of other conservation guidelines. These would influence disturbances and transitions outside riparian management zones to be less intense and less abrupt. Finally, the reduced likelihood of clearcutting in upland areas under the NFHCP would contribute to a relatively more natural vegetative condition.

Prescriptions associated with the NFHCP would likely contribute to the maintenance of naturally occurring flow regimes in NFHCP covered lands drainages. Under the NFHCP, the combination of reduced activity in the riparian zone, more intensive road management practices aimed at reducing effects on water flow, management of irrigation diversions, avoiding extensive clearcutting in upland forest areas, grazing management, and implementation of Plum Creek's Environmental Principles should provide some increased protection of water resources and hydrology.

Conservation commitments primarily focused on the reduction of sediment to streams, bank stabilization, normative flow regimes, and increasing canopy cover to stream channels will potentially have the greatest influence on channel morphology. Stream reaches that are currently in dynamic equilibrium are expected to maintain adequate habitat for all native species. Those stream reaches where habitat complexity and channel morphology have been compromised are expected to move back towards dynamic equilibrium over the period of the permit. It however is likely that stream habitat complexity and channel morphology will be further degraded if compliance with conservation commitments are not met and if adaptive management tools are not utilized.

Adaptive Management

As indicated previously, the Services are uncertain whether all of the proposed NFHCP riparian habitat prescriptions will provide adequate protection necessary to promote stable channel conditions. Consequently, the Services must rely on opportunities in monitoring and adaptive management in the face of these uncertainties. Several proposed core adaptive management projects in the NFHCP are intended to address, among other uncertainties, the specific problem of whether the riparian prescriptions will effectively protect LWD loads and habitat diversity as well as monitor long-term trends in physical stream channel attributes as a result of implementing grazing BMPs. More detailed information of the proposals can be found in the NFHCP.

The results of this work may or may not trigger changes to the NFHCP. If the results show statistical differences between treatment and control, it will initiate a decision process to step through which could lead to revision or creation of riparian prescription or grazing BMP enhancement based on causal factors. If results do not indicate statistical significance, the riparian prescriptions, in all likelihood, are functioning appropriately to protect channel conditions and complexity for native fish.

As with all the adaptive management projects, there will be close association and involvement by the Services regarding the evaluation of the effectiveness of the riparian habitat prescriptions to protect channel morphology. The Services will be provided specific project information prior to initiation of the project. The Services will be able to review the project design and provide input. Furthermore, there is a mandatory reporting period and sequence which is years 2, 4, 10, 15, 20, 25, and 30. The Services will have the option of participating at key milestones throughout project planning and administration, such as interpretation of the results. The Services' involvement will also occur early in the adaptive management decision process should it be invoked. Plum Creek and the Services will consult on whether new or modified management actions are needed relative to achieving the biological goal.

Passage Barriers

As a result of past management impacts in the action area, habitat connectivity has been disrupted more frequently and rapidly than what naturally occurred on unmanaged landscapes, resulting in threats to covered species. Under the NFHCP, Plum Creek would identify and remove human-caused barriers to habitat connectivity (such as at some road stream crossings) at an accelerated rate such that all barriers would be removed by year 15 of the permit. Habitat connectivity would be restored as completely as possible for a managed landscape condition.

Plum Creek examined a sample of culverts for potential fish passage problems and found 24 percent of those sampled were fish passage barriers and an additional 19 percent may have been (DEIS/NFHCP 1999). This sample occurred in a small portion of the NFHCP project lands, and

was not intended to represent an accurate sample of stream crossings across the NFHCP project lands. 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 and prioritize repairing fish passage barriers at culverts.

Due to potential fish passage issues, designing culverts has become more refined and now often considers the swimming capabilities of fish as discussed above. Most work on culvert design comes from information related to salmon species and a few trout species (Bell 1991; Thompson 1972; Furniss et al. 1991). However, some of this information has been applied to covered species in the absence of better information. In general, when considering swimming capabilities of fish, the value to be used in culvert design will be the lowest maximum average water velocity for the weakest-swimming fish requiring fish passage, and in many cases this will be determined by the requirement to safely pass juvenile fish (Bell 1991).

The length of culvert and its relation to how long a fish can maintain a certain speed is a major design consideration. In general, flow velocity increases in discharge and culvert slope, and decreases with increases in culvert wall roughness and culvert size (Tillinger and Stein 1996). Minimum depth of flow in a culvert is also a design consideration as well as the maximum vertical jump height. New culverts proposed on forest roads should not be designed with a vertical jump, and at existing perched culverts, attempts should be made to reduce the vertical jump as much as possible, preferably to less than 6 inches for adult resident trout. Designing culverts that will pass fish effectively requires knowledge of the fish species that are present in the system, how small the moving fish will be, and what time of the year fish passage would be occurring.

Retrofitting existing culverts for fish passage can incorporate design features that attempt to meet fish passage criteria. Resting pools can be provided at the inlet and outlet of the culvert. The depth of the tailwater can be increased to provide deeper, slower flow within the culvert and/or to repair a perched culvert. Baffles or other devices can be installed in a culvert to keep flow velocities within the culvert to that of the natural channel. Also, depth of flow within the culvert may be adjusted by installations of structures or using other methods to provide more depth for certain size fish of interest, if known; if design fish's height is unknown, the minimum flow depth should be 6 inches.

Under the NFHCP fish passage problems caused by impassable road culverts would be corrected by either replacing them or modifying them to restore fish passage. Culverts in Montana will be sized to carry a 50-year peak flood and Plum Creek foresters/biologists will determine if existing culverts are fish passage barriers based on measurements at specific sites which will be used to answer a set of "pass/fail" questions. Essentially, these questions are the criteria with which Plum Creek will determine if a culvert is a fish passage barrier to any covered species (see Appendix R-6 in the NFHCP).

Plum Creek's assessment criteria to determine adequacy of fish passage at culverts considers most of the fish passage design considerations mentioned above and in the literature. These include the following: 1) culvert slope in relation to the streambed's natural gradient; 2) culvert outlet perched above the water level on the downstream side; 3) adequate resting pool at the outlet end of the culvert; 4) adequate minimum thalweg depth in the culvert ; 5) culvert length; 6) culvert type; and 7) average water velocity above and below the culvert. The specific assessment criteria in which Plum Creek will determine adequacy of fish passage approximates design criteria metrics mentioned in the literature. For example, the maximum water velocity used in the assessment is 6 feet-per-second (fps) and the minimum water depth is 4 inches, which should be adequate for adult migrating bull trout and WCT during May and June in western Montana. The general guide for fish passage, depending on culvert length, is 4 fps, and goes lower as culvert lengths increase. Minimum water depth for adult migrating bull trout and WCT in May and June is 6 inches and in July and August for the juvenile run of bull trout is 4 inches. Plum Creek's minimum thalweg depth in the culvert is 4 inches. If the conclusion of determining whether a culvert is a fish passage barrier is difficult and requires more detailed measurements, the information will be provided to a Plum Creek fish biologist for final determination.

The Services anticipate that under the NFHCP, new culvert installations will provide for adequate seasonal fish passage of covered species per the Montana road BMPs and fish passage design considerations discussed above. Furthermore, Plum Creek will upgrade old roads to these BMP standards and where fish passage barriers are identified, treat these culverts as "hot spots" to receive priority management on an accelerated schedule. Abandonment of surplus roads under the NFHCP may involve removal of culverts that could be causing existing passage problems. It is likely that over the permit period there could be substantial benefits to covered species as a result of fixing passage problems at culverts and reconnecting habitat. The actual benefits that will occur are difficult to ascertain. However, an inventory of the passage problems identified through the road condition inspections (RCI) should help describe the extent of the problem (as indicated in Plum Creek's 1998 survey), and in turn, as these problems are fixed, indicate the potential benefit to covered species.

Barriers to fish passage are expected to improve under the NFHCP through a commitment to find and remove passage barriers at irrigation and stock-watering diversions. 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. Plum Creek would develop a management plan that includes irrigation diversion BMPs and a cooperative action plan to be implemented with water-right holders. Benefits to covered species from this commitment could extend beyond the 30-year planning period. This commitment presumes that fish passage problems at diversions will be addressed successfully in terms of remedies for upstream passage barriers and in terms of downstream passage entrainment problems at diversion headgates. It also presumes that effective upstream fish passage devices may have to be installed at certain sites and

effective fish screens may have to be installed. The inventory of diversion sites and management plans are expected to be complete by the third year of implementation of the NFHCP.

Addressing the irrigation and stock-watering water diversion problems on the NFHCP project lands should improve habitat connectivity which has been identified as a significant factor affecting bull trout and other salmonids (Rieman and McIntyre 1993; Brown 1992a) by isolating subpopulations and exposing them to greater risks of extinction (Rieman and McIntyre 1993; Lee et al. 1997). 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 sub-basins in the action area (see Table 4.6-10 in the FEIS, page 253). 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 which could improve the overall baseline conditions throughout the action area. The actual benefits of this effort under the NFHCP are difficult to precisely ascertain at this time. However, even at a small scale, if fish passage problems are identified and improvements are made at water diversions, as anticipated, benefits to the local populations of native fish are likely.

Refugia

The proposed NFHCP addresses the functioning of refugia for covered species through the habitat objectives that support the Four C's (cold, clean, complex and connected) indicative of proper functioning stream habitat for native salmonids. The NFHCP conservation measures are directed at either protecting existing habitat or more importantly restoring or improving proper structure and function of degraded habitats. A main tenet of the NFHCP is to minimize habitat disturbance from forest, road and grazing management activities to the maximum extent practicable while attempting to halt and reverse downward trends in highly disturbed areas, but with greater focus and emphasis on key watersheds (i.e.,Tier 1 watersheds). However, most conservation commitments (51 out of 56) are independent of Tier-designation and will be applied to all Plum Creek covered lands.

The NFHCP employs several conservation commitments and programmatic approaches intended to accelerate additional habitat protection for covered species. These commitments directly and indirectly address the concerns about the functioning of refugia habitats on covered lands by facilitating movements and migration patterns, protecting the most valuable habitats for native salmonids, and improving habitat conditions for covered species. For example, direct actions will be taken to provide adequate fish passage at culverts that are blocking fish migration. Where specific site conditions of barriers to fish passage are identified, these will be given prioritization for treatment under the R-6 commitment, Hot Spot Treatments. Indirectly, habitat improvements

can be expected to occur from upgrade of old roads, especially in high priority watersheds. Watersheds considered impaired due to fine sediment delivery will be identified and old roads supplying sediment will be upgraded by appropriate means (e.g., installation of ditch relief pipes, relocation of roads paralleling streams; providing slash filter windrows in areas close to streams) under the commitment to upgrade old roads. Improvement in habitat conditions can improve degraded refuge habitat, and/or improve transition areas for access to refuge habitat. Grazing BMPs are also likely to result in habitat improvements and access to refuge habitats.

Native fish assemblages, as indicated above, are key watersheds that contain a unique collection of native fish species. There are eight of these areas identified under the NFHCP. These areas likely contain existing refugia supported by appropriately functioning riparian habitat, water quality, streamflow, and stream channel conditions because they contain productive populations of covered species and the greatest variety of those species. The proposed NFHCP would provide specialized management in these watersheds designed to protect them as core areas of native fish integrity within a larger connected river sub-basin. Through various analyses watershed sensitive areas on NFHCP lands would be identified and a particular prescriptive approach applied. Further, limiting factors for native fish populations in the watershed would be identified and followed up with unique conservation measures tailored to address the actual cause of the limiting factors with the intent of reducing further risks to these populations.

Effects on fish passage resulting from water diversions was discussed above (see Passage Barriers). In addition to impediments to migration and dispersal movement, water diversions for irrigation or livestock watering can cause changes in sediment transport and storage, stream flow and temperature regime, and surface water levels (Spence et al. 1996). Plum Creek's commitment to develop a management plan to manage impacts caused by irrigation diversions that occur on their lands is likely to improve covered species instream dispersal movements and movements among streams, including annual migrations from headwater streams to mainstem rivers. Fish passage improvements could allow access to additional rearing and spawning areas as well as refuge habitats. Any improvements assume that all impacts of the irrigation diversion are addressed. Improvements may include screening of the irrigation ditch at the headgate, furnishing adequate bypass flows, and providing unrestricted upstream and downstream passage at the diversion dam. Improvements need to consider upstream and downstream limitations. For example, it would not be beneficial to provide upstream passage for adult spawners if downstream juvenile fish are attracted into an unscreened irrigation ditch or are stranded in pools due to low bypass flows.

The application of the NFHCP commitments and conservation measures are likely to complement federal land management actions to protect and/or recover covered species. Application of the conservation measures and commitments on a large landscape-scale level may result in additional secure habitats for covered species. If upstream passage for migrating adult bull trout or WCT on lower elevation Plum Creek lands is secured, and assuming spawning areas are protected on

adjacent federal ownership, production of these covered species would be expected to increase. Assuming this scenario, or similar conservation benefits, is occurring across all the action area sub-basins as intended, covered species would be expected to benefit at a regional level. Complementary habitat protection/enhancement measures, combined with the augmented conservation provided to all species that utilize Tier 1 watersheds and/or native fish assemblages could result in a network of secure refugia habitat throughout the action area.

Provision of refugia habitat is dependent on the combined success of the NFHCPs conservation measures. For some commitments and conservation measures there is more confidence regarding effectiveness, and where there is less confidence (i.e., more uncertainty), adaptive management studies have been incorporated into the NFHCP so that changes can be made if necessary to ensure conservation measures can produce the desired effect. Further, the Services have the ability under the NFHCP to designate up to twelve additional Tier 1 watersheds where additional conservation for any covered specie is deemed necessary. Having the ability to change the conservation action is an important component of the NFHCP because incremental conservation improvements will successively add to the effectiveness of the NFHCP. The extent of securing and providing refuge habitat for covered species on a landscape-scale will be expressed as a product of this cumulative effectiveness.

Timber-Related and Non-Timber Resource-Related Activities

Plum Creek manages its lands in Montana, Idaho, and Washington primarily to grow, harvest, and sell commercial timber. However, a small amount of land is managed for purposes other than commercial timber production. Other commercial forest management activities include seed and seedling production (forest nurseries), forest products manufacturing, miscellaneous forest products, tree planting, site preparation, prescribed burning, stand maintenance, and other actions. Non-timber resource uses are those such as commercial outfitting, recreational activities, landscape stone collection, gravel quarrying for roads, and siting of electronic facilities. Plum Creek has included these activities in the NFHCP so that they are covered under the NFHCP's associated incidental take permit. However, some of these activities are also regulated under federal, state, and local regulations and BMPs.

Potential effects on covered species of those NFHCP activities associated with forest management and those that are non-timber resource activities are addressed below. Impacts due to habitat loss and/or alteration in riparian zones from forest, road, and grazing management activities are described above.

Forest Fire Suppression Activities.

Forest fire suppression is a covered activity under the proposed NFHCP. State government has primary responsibility for fire suppression; however, Plum Creek does undertake fire suppression

activities fire as needed (DEIS/NFHCP1999). Further, there may be agreements between state governments and the USFS for primary fire control and management in specific areas. Plum Creek complies with currently accepted standard techniques and tools for fighting fires. As a first response, Plum Creek will attempt to control a wildfire on their lands, but if the fire becomes too large, the state or local fire fighting agency with jurisdiction would assume control.

Forest fire suppression can result in adverse effects directly, indirectly, and cumulatively on native fish and fish habitats. Habitat features important to native fish that can be affected by fire include sediment levels, stream temperature, chemical contaminants, water regime, riparian/ floodplain processes, and displacement. The risk of adverse impacts to native fish may result from fire camp operations, fireline construction, water drafting, application of fire retardants, foams and surfactants, fire rehabilitation, and possibly other, as yet unidentified, related actions. These activities include application of chemical fire retardants (potentially toxic to fish); construction of fire lines by hand or machinery around perimeters (resulting in sediment delivery resulting from scraping a line to mineral soil); complete removal of understory and overstory vegetation (canopy cover removal in riparian areas affecting stream temperature); fire camps with potentially hundreds of people (riparian impacts if next to streams with native fish); water drafting from streams (may directly impact native fish if present in areas where water is being drafted); construction of temporary dams for drafting water into pumps/hoses (fish may be present in area); and helibases or helispots where Jet-A fuel is stored (may pose a risk to fish from a fuel spill if near a stream).

It is likely that during the 30-year permit period wildfires will occur on occasion within the NFHCP covered lands, and adverse impacts to native fish and their habitats could occur as a result of fire suppression activities to control these wildfires. The actual impacts from these actions is unpredictable and largely indeterminable, except in the general sense described above. It is expected that large wildfires, which are the most destructive would be infrequent, and smaller wildfires wold be localized and less destructive. Plum Creek has indicated it would suppress any wildfire as quickly as possible while trying to maintain the integrity of riparian areas. Some actions that could minimize the risk of adverse impacts during fire suppression includes: 1) fire camps and helipads will not be located within riparian areas; 2) portable and tanker truck pumps will be screened to protect pumps from debris and minimize potential entrainment; 3) burned areas on Plum Creek lands will be replanted; 4) fire line construction, if done by the USFS or a responsible state agency, would be governed by state BMPs and state forest practice regulations.

Gravel Quarrying for Roads

Plum Creek surfaces some of its roads with gravel to improve road conditions and reduce the potential for road-related erosion (DEIS/NFHCP1999). Gravel quarrying for roads is a covered activity under the proposed NFHCP. Concerns about potential impacts to native fish as a result of this activity relates primarily to potential for sediment delivery from quarries. The location of the

quarries in relation to stream channels and erosion control at the quarries would be important factors in this determination.

Gravel is normally obtained from gravel pits on Plum Creek lands. Small pits range in size from one to three acres and these constitute over 90 percent of Plum Creek's quarry pits. These are usually located adjacent to roads in specialized locations where the subsurface rocky material has desirable characteristics. Larger gravel pits greater than five acres are developed at high-quality rock sources that have characteristics desirable for crushing. Plum Creek estimates that 250 to 500 gravel pits are located within the NFHCP covered lands on and that 25 to 50 more gravel pits would be developed during the proposed 30-year permit period (DEIS/NFHCP 1999).

Although the sites have not been inventoried, Plum Creek's gravel pits tend to be located away from streams and near ridges because the best rock is generally along ridgetops (DEIS/NFHCP 1999). Furthermore, forest practices rules and BMPs in Montana, Idaho, and Washington prohibit gravel quarrying in streams or within equipment exclusion zones for riparian areas. New gravel quarries are not permitted in the SMZs of perennial and connected streams, and they would not be permitted in ICAs under the proposed NFHCP. ICAs modify and provide extra caution for forest management activities adjacent to but outside SMZs of perennial and connected streams. Thus, current Plum Creek operational procedures and state forest practice rules and BMPs minimize the potential for sediment delivery from gravel quarries to streams. Legacy quarries that no longer produce gravel also exist on Plum Creek lands; however, they would be inspected along with Plum Creek's road system under the proposed NFHCP and treated as hot spots when warranted.

The potential risk of adverse impacts from quarrying for gravel for roads on native fish and their habitats under the proposed NFHCP appears to be minimal because: 1) gravel operations proposed by Plum Creek are generally small and located away from sensitive aquatic areas; and 2) compliance with state BMPs and forest practice rules will minimize the potential for sediment delivery to streams.

Forest Nurseries and Seed Orchards.

Operation of Plum Creek's nursery and seed orchards is a covered activity under the proposed NFHCP. Operation and management of nurseries and seed orchards used for commercial forestry could pose a potential risk to native fish and their habitats through the use of water, chemicals, and fertilizers. At present, Plum Creek operates one seed orchard within the NFHCP covered lands at Plains, Montana. This facility is located in the Clark Fork River valley several hundred feet from the river. Plum Creek has indicated that chemicals used at this site cannot enter any stream courses (letter from Plum Creek to FWS dated February 28, 2000). Chemicals are disposed of in accordance with a state collection program and transported to a state collection facility. Water for the facility is taken from wells. The potential for adverse effects on the covered species as a result of this facility appears to be minimal because: 1) the facility is located in an area

and operated in a fashion that makes chemical contamination of sensitive fish habitats unlikely; and 2) water sources for the facility will not likely influence riparian, stream or other aquatic areas.

Forest Product Mill Sites

Plum Creeks owns and operates four forest products manufacturing facilities on NFHCP covered lands. All are located in Montana, Columbia Falls, Kalispell, Fortine, and Pablo. The facilities produce finished lumber, plywood, and medium-density fiberboard products for retail, industrial, and other specialty markets. The facilities include four sawmills, two plywood plants, one medium-density fiberboard plant, and one remanufacturing plant (DEIS/NFHCP 1999). These plants would be covered under the proposed NFHCP.

Logs are brought to the facilities by truck and stored onsite prior to processing. No wood treating or processing of treated lumber is conducted on the facilities. Typical structures at the facilities include office buildings, sawmill/planer buildings, drying kiln buildings and cooling sheds, boilers, maintenance shops, and various storage buildings. The facilities have large areas of log and finished product storage. Water-holding ponds in the event of fire, process water infiltration ponds, stormwater retention basins, and gravel pits may be present.

Operations at manufacturing mill sites that discharge chemical, wastewater, or stormwater effluent into nearby fish-bearing streams could have potential impacts to native fish and their habitats. Poorly treated effluents and accidental spills of waste can be acutely or sublethally toxic to fish and to the organisms that support them (Meehan 1991). Further, toxicants can bioaccumulate throughout the food chain and mill site wastes can affect reproduction, growth, behavior, and physiology of salmonids. Stormwater runoff can contain numerous concentrations of heavy metals, nutrients (phosphates and nitrates), organics (oil, grease), dust and dirt, pesticides, and bacteria. Concentrations of these chemicals can be greater than 10 to 100 times that of treated wastewater (Spence et al. 1996). Meehan (1991) suggested the best defenses against effluent toxicity are to treat mill wastes properly and to take all possible precautions against waste spills. It has been recommended that stormwater runoff be routed through waste treatment facilities where possible (Spence et al. 1996).

At Plum Creek's mill sites, log yard waste of mixed bark, soil, and rock is handled according to state solid waste regulations. Onsite waste storage occurs away from aquatic areas and potential receiving waters, or is separated by erosion control structures to prevent discharges. Solidified waste resins and non-log-yard wastes are transported to municipal landfills for proper disposal. Industrial chemicals and fuels, such as diesel fuel, gasoline, lubricating and hydraulic oils, and boiler water treatment chemicals, are stored in above ground storage tanks and containers surrounded by concrete secondary containment areas. Each facility has a Spill Prevention Control and Countermeasure (SPCC) Plan, if required.

Office trash and packaging materials are hauled to approved municipal landfills for disposal. Used oil is completely consumed onsite for equipment lubrication or properly disposed of by a licensed used oil recycler.

The facilities do not engage in any ongoing, direct discharges of process water to surface waters; however, periodic discharges of stormwater may occur (DEIS/NFHCP 1999). The mills generate wastewater from the boiler blowdown, boiler water treatment, and equipment washing. The boiler blowdown water and boiler water treatment blowdown water are sent to holding ponds where it is reused or sent to a public wastewater treatment plant for disposal. Boiler steam condensate is returned to the boiler and reused. Wash water from equipment washing is run through oil/water separators. Water used for watering logs for blue stain fungus control (wet decking) is collected and recycled back to the log watering system. With the exception of minimal sheet flow from a few areas, all stormwater is collected in retention basins or in stormwater ponds. Groundwater and surface water discharges are regulated under state water quality discharge permits and monitored for compliance. Sanitary wastewaters are disposed of onsite in septic tank/drainfield systems, or piped to a public wastewater treatment plant.

The Kasanka mill site at Fortine, Montana, is the only mill site located near a fish-bearing stream and is the only one that could potentially affect the covered species. However, this mill has extensive erosion and water pollution control measures onsite that minimize this risk significantly. These measures are discussed above and comply with state regulations. Periodic state inspections ensure that onsite water pollution controls are implemented and remain effective. Nevertheless, because this site has a water diversion and headgate on Deep Creek, which is only used as needed to refill a fire pond, there is a small risk that discharge from a hazardous waste spill or stormwater runoff event could result in toxic water delivery to Deep Creek. The probability of a single occurrence of either event during the 30-year permit period is likely; however, the preventative measures already in place should minimize impacts. Should a hazardous spill occur, Plum Creek would implement spill management procedures immediately. Also, Plum Creek has stated that a 100-year flood event would have to occur for a discharge to occur into Deep Creek between the time of the spill and the cleanup. The headgate at this mill site is rarely used (about once every 5 years) because fires at the Kasanka mill are virtually nonexistent and the fire pond is rarely used. Occasionally, the area around the headgate needs to be cleared of silt and the headgate is checked for operation and maintenance. This action may release a small amount of sediment; however, it is not expected to cause a significant impact to native fish. The reach of Deep Creek where the headgate is located is a riffle area and not a spawning or rearing site for native fish. Therefore, it is unlikely that fish would be present in the immediate area when a sediment pulse is released or that fish would be entrained into the fire pond. In addition, a vegetation buffer between the creek and erosion control sediment trenches has been established at the logging yard to prevent sediment-laden stormwater runoff from the yard from reaching Deep Creek.

Commercial Outfitting.

Commercial outfitting is permitted by Plum Creek when professional outfitters wish to use Plum Creek lands to conduct their business. Commercial outfitters provide guiding services to recreationists who wish to pursue hunting, fishing, or photography activities. Outfitters must conduct their business on Plum Creek lands in compliance with Plum Creek's environmental and land use principles, applicable state fishing and hunting regulations, and other state regulations directed specifically at commercial outfitting.

In 1999, 17 licensed commercial outfitters were permitted by Plum Creek, all for the purpose of hunting big game, although some outfitters included fishing activities. Permits are generally issued for one season and can begin in April or June to December 1, and again for the lion season from December 2 to January 30. Average party size is five clients and the number of trips per season is about 10 trips.

The potential adverse effects that may occur to bull trout or other native fish on covered lands in the NFHCP as a result of permitting 17 commercial outfitters relates to outfitter camps that are located in close proximity to streams inhabited by native fish, livestock trampling of native fish redds, and poaching. Impacts may occur directly or indirectly.

The heaviest period of use of outfitter camps during the big game season coincides with bull trout spawning in September and October. Direct impacts may result from trampling by horses on bull trout redds which may destroy or disrupt eggs buried in gravel. The potential exists that an outfitter or his clients may cross stream reaches or may ride horses up or down a stream reach where bull trout eggs have already been buried in redds. The mechanical action of trampling can destroy eggs immediately or dislodge and expose eggs as a result of disturbance of the substrate.

Indirect effects may result from spawning adult bull trout being harassed off redds, intentionally or unintentionally. Foot traffic or horse traffic in or along a spawning reach may interrupt spawning behavior or cause bull trout to be displaced from redds. The more often this happens, the less likely there will be successful spawning. However, interruption of spawning behavior, if temporary and infrequent, may not impede redd construction and spawning behavior. The actual effect is indeterminate at this time.

The degree of impact from trampling and harassment would probably depend on the frequency and duration of the disturbing action, but is more likely at stream crossings or in stream reaches near camps located in or near riparian areas. Livestock corralled in the riparian zone may also contribute to riparian habitat degradation, streambank instability, and water quality deterioration. In addition, camps located near streams inhabited by native fish would provide opportunities for clients to fish recreationally which may in turn lead to incidental taking of bull trout. Adverse

effects to bull trout might result from hooking and handling mortality when bull trout are inadvertently caught and then released. The State of Montana's fishing regulations prohibit the harvest of bull trout. The FWS acknowledged that incidental catch of bull trout could occur while fishing for other species and promulgated a special 4(d) rule which authorizes incidental take of bull trout that is accordance with the state's fishing regulations. Prespawning bull trout can be especially vulnerable to catch when staging at the mouths of tributaries prior to entering spawning streams.

In addition to these types of potential effects, there may be adverse effects to bull trout from illegal harvest, which has been identified as a problem in remote wilderness areas and other backcountry areas on Flathead National Forest in Montana. Poaching is easy due to the small size and remoteness of some streams in backcountry areas. Prespawning fish are more susceptible to poaching than nonspawners because they concentrate in predictable habitats, are highly visible, and remain in tributaries for several weeks (Swanberg 1997).

Of the 17 commercial outfitters permitted by Plum Creek, only three have hunting camps. Two of these are located well away from the riparian zone of the nearest water course. However, one camp is located in the riparian area of Lion Creek in the Swan River sub-basin in Montana. Lion Creek is a major bull trout spawning stream for the adfluvial population from Swan Lake, and an index stream in which redd counts are conducted annually by MFWP. There is one stream crossing. Most of the spawning occurs downstream, but redds may occur in the vicinity of the camp since it has not been surveyed to determine whether redds are present in the area. Livestock are corralled away from the stream. Water is siphoned from the creek up to the corral. Plum Creek has provisioned this permit to minimize impacts from the corral and watering away from the stream.

As indicated above, it appears that one commercial outfitter permitted by Plum Creek has the potential to impact covered species, particularly bull trout. Notwithstanding measures to minimize injury to bull trout and assuming spawning bull trout may be present when the outfitter is operating, a small risk exists that direct or indirect mortality of adult and juvenile bull trout or bull trout embryos could occur. Direct mortality could occur if a bull trout redd is trampled and eggs are destroyed by outfitter horses crossing Lion Creek. Further, there is the possibility of incidental catch of bull trout while legally angling for other game fish, or, although uncertain and unpredictable, illegal harvest of bull trout. An indirect effect may occur through harassment by horse or human traffic on or near spawning areas, thus causing displacement and interruption of spawning behavior.

In summary, because the Lion Creek camp activity occurs near known spawning areas and coincides with the bull trout spawning and migration period, there is a minor possibility that livestock or human activity associated with this outfitter camp may cause adverse effects to native fish. If there is an adverse effect, however, it would be localized and likely not significant on a metapopulation scale, particularly in light of the healthy, stable population status in this sub-basin.

Recreation and Other Special Forest Uses

Recreational activities are diverse and include, but are not limited to, hiking, biking, camping, fishing, hunting, and off-road vehicle use. All these actions can take place in areas where native salmonids are present. In general, recreationists are drawn to riparian areas more than other areas and may engage in activities that adversely affect fish production. If usage is intense, any fish population or its habitat can be affected by recreationists. The effects vary depending on type of recreation, numbers of recreationists, timing of use, degree of concentration in space and time, water body characteristics, and fish species affected (Clark and Gibbons 1991).

Fishing can have direct affects and, depending on intensity, may have either minor or major influences. Even if fish are released, hooked fish and associated handling can result in injuries and disease that may lead to mortality. Rafting on the Salmon River in Idaho was observed to disturb spawning chinook salmon from redds during low flow conditions (Quigley and Arbelbide 1997). Campgrounds and vacation spots may cause impaired water quality by elevating coliform bacteria and nutrients in streams (Spence et al. 1996). Power boats in lake and large river environments have numerous negative effects, which include resuspension of bed sediments, chemical contamination from hydrocarbon emissions and gasoline spills, exotic plant species introductions, and shoreline erosion from boat wakes, to name a few.

Effects on habitat are complex and little documentation is available since research in this area is limited and changes in fish habitat quality attributable to recreational use is uncertain. However, Settergren's (1977) examination of effects of recreation on soils along rivers showed changes in the soil profile due to compaction, loss of vegetation, root exposure, reduction in organic matter, decreased soil moisture, and increased bulk density. This review suggested that recreational activities could lead to loss of overstory trees and understory vegetation, or at least a change in species composition. When visitor use is high, trampling associated with foot traffic along lakes and streams through direct mechanical action and indirectly through changes in soil can negatively affect riparian vegetation. In turn, this change results in increased sedimentation and soil loss, which reduces the quality of native fish spawning and rearing habitat. Hiking, camping, and off-road vehicle use may also lead to increased soil erosion by creating ruts and trails that collect runoff (Clark and Gibbons 1991). Off-road use in streams can result in destruction of redds, eggs, and young fish and cause loss of vegetation from wetlands, steep slopes, and stream, lakes, and river shorelines resulting in soils erosion and sedimentation (Quigley and Arbelbide 1997).

Loss of riparian vegetation can affect fish production by removing cover and reducing available food. Pools used by recreationists for swimming, boating, suction dredge mining, bathing, and other activities can change the pool character (depth, width, debris) which generally results in poorer pool quality for native fish. Also, activities such as use of off-road vehicles, swimming, and boating can affect riffle quality by altering the depth and flow of water over and through the

riffles, which can lead to decreases in food availability for fish; and, actions such as boat passage can disturb fish from prime feeding areas associated with riffles (Clark and Gibbons 1991). Most recreational activities can also produce suspended sediment that may elevate concentration levels enough to displace rearing fish or possibly cause fish mortality through gill abrasion (Noggle 1978).

Special forest use permits may be required by Plum Creek for various categories of recreational activities. One activity category is group recreation, although this activity is not common on NFHCP covered lands. For example, a permit may be required if a club sponsors a group mountain bike ride on Plum Creek lands and the participants pay an entry fee. Also, a permit may be sold by Plum Creek to grant the right to use a Plum Creek road for a specific purpose, such as hauling logs. Special forest use permits require certain provisions for the permitted activity so that it complies with Plum Creek's Environmental Principles, applicable government regulations, and BMPs, and they require insurance coverage by the permittee.

Potential adverse impacts to covered species from permitted recreational activities on covered lands under the NFHCP is possible, but likely to be small scale effects, isolated, and temporary. Clark and Gibbons (1991) believed that recreation usually has minor negative effects on fish habitats and that effects of recreational activities on salmonids is so variable, that they must be evaluated locally, and onsite actions to address vegetative changes along streams and rivers must be made on a case by case basis. Plum Creek, in keeping with their environmental and land use principles to promote healthy forest stands, soil conditions, and water quality would likely develop site specific required mitigation as appropriate to address recreational impacts.

Electronic Facility Sites

Plum Creek leases sites for construction and operation of electronic transmission facilities. The sites are located at the tops of mountains. There are less than two dozen electronic transmission sites on Plum Creek lands (DEIS/NFHCP 1999). Existing roads provide access to these sites. The risk to the covered species as a result of permitting and use of electronic facilities is likely very low. The sites are located on ridgetops and would not directly affect covered species habitat. However, existing access roads and new roads that need to be constructed to access new facilities are mostly forest roads that pose the same risk of potential sedimentation delivered to streams as forest roads for commercial forestry operations (see above). It is likely that new facilities could be built on Plum Creek lands over the permit term as population growth continues and demands for these services increase. Consequently, new access roads will be constructed which may involve stream crossings and road segments next to streams.

However, new and existing access roads to electronic sites on Plum Creek lands would be required to follow state regulations, BMPs, and NFHCP road management prescriptions. New roads would be planned, designed, located, constructed, and maintained to avoid or minimize

impacts to native fish and their habitats. Existing roads would be inspected and maintained under the NFHCP prescriptions and any sedimentation would be addressed. Consequently, the risk, although somewhat indeterminate, that sedimentation from construction and maintenance of new access roads would adversely affect native fish habitat is low.

Legacy/Restoration/Scientific Surveys

Legacy and restoration commitments include Key Migratory River provisions, instream habitat restoration, water diversion conditions, enforcement cooperation, watershed cooperation, and brook trout suppression. Under the NFHCP, restoration of legacy riparian area degradation would be performed opportunistically through cooperative efforts with other entities (e.g., state fish and wildlife agencies) on restoration efforts on NFHCP covered lands. Plum Creek would participate as a cooperator and help fund cooperative conservation projects in Tier 1 watersheds.

Some rivers that serve as actual or potential migratory pathways and overwintering areas for fluvial bull trout and other species may have degraded habitat conditions resulting from previous human activities. Plum Creek has identified 124 river miles of known or potential migratory river segments on Plum Creek lands. These are designated "Key Migratory Rivers" for the purposes of the plan. The NFHCP requires habitat conditions of these river segments be assessed by year 7 of the plan, that a draft restoration plan be submitted to the Services by year 8, that Plum Creek implement whatever restoration actions are agreed to by Plum Creek and the Service, and that subsequent monitoring be implemented to determine the effectiveness of the restoration actions.

Bull trout rely on migratory corridors for traveling from wintering areas to foraging and spawning areas. Bull trout have been noted to travel up to 150 miles during migration (MBTSG 1998). These movements contribute to the persistence of local populations, gene flow between populations (Rieman and McIntyre 1993), increased growth potential (Elle 1995 *in* MBTSG 1998) and, potentially, recolonization of areas where populations have been extirpated. The ecological integrity of river corridors is therefore important to the maintenance and potential recovery of these migratory forms (MBTSG 1998). Cutthroat trout move about in the fall and winter, apparently to locate suitable overwintering habitat (Brown and Mackay 1995). The ecological function of riparian areas therefore contributes to the migration patterns of several species, and to a range of ecological attributes necessary to such migration, including structural complexity, linear continuity (for migration corridors), and influence on aquatic habitat (Kondolf et al. 1996).

Although the exact degree to which restoration efforts on Key Migratory Rivers under the NFHCP will be implemented is dependent on the results of the assessments, and the results of any such efforts will not be known until monitoring efforts have been implemented, any restoration of degraded riparian habitats can be expected to contribute to water quality improvements and be beneficial in terms of enhancing the migratory capabilities of covered species. Furthermore, the

Services anticipate, given Plum Creek's commitment to the NFHCP's biological goals and future Service's involvement in restoration decisions, that restoration of Key Migratory Rivers will yield substantial benefits to aquatic habitats and the covered species.

Because the degree to which any such projects will be implemented and the potential effectiveness of any such projects is unknown, it is impossible to describe potential effects with any degree of confidence. Typically, however, such projects, if properly designed, would result in some degree of short-term adverse impacts (e.g., introduction of sediment during manual LWD placement) in return for long-term beneficial impacts (e.g., improvement in channel complexity) to native fish. These short-term, localized impacts may be expected during the construction of these projects. The associated pre- and post-construction impacts and mitigation opportunities will be addressed through appropriate state and Federal permitting/regulatory processes as the needs arise. Sediment delivery would be expected to decline over the long-term and sediment transport would be expected to improve in the system and result in better habitat conditions for native fish.

Under its Legacy and Restoration commitments, Plum Creek also proposes to develop a management plan to address impacts from existing irrigation diversions on NFHCP project lands as discussed below. In addition to reducing connectivity, diverting water can adversely affect native fish by reducing both the quantity and quality of stream flows. Reduced flows can limit aquatic habitat available to native fish, negatively affect invertebrate populations, and could result in elevated water temperature for affected stream segments, especially in summer. Because the degree to which any such projects will be implemented and the potential effectiveness of any such projects is unknown, it is impossible to describe potential effects with any degree of confidence. Generally, however, any reduction in water diversions within covered lands of the NFHCP would be to the benefit of water quality and native fish populations.

Plum Creek also proposes to develop a brook trout suppression project in a Tier 1 watershed in cooperation with the Montana Department of Fish, Wildlife, and Parks. The purpose of the project would test the effectiveness of brook trout suppression in benefitting the NFHCP's covered species. If successful, such a program could be applied to various locations on NFHCP covered lands. Brook trout are known to hybridize with bull trout and compete for resources (Rieman and McIntyre 1993; MBTSG 1998). Griffith (1988) identified several examples where brook trout introductions coincided with declines in cutthroat trout populations, although the precise mechanisms were unclear. Brook trout have also been implicated as potential predators of cutthroat trout, and the diet of brook trout also overlaps with that of many native salmonids (Wydoski and Whitney 1979), indicating the potential for competition.

A brook trout suppression program, if successful, would result in some beneficial effects to bull trout and other native fish. However, the degree to which any such projects will be implemented, and the effectiveness of a specific project, is dependent upon many unknown factors, including extent of area treated and relative densities of native fish and brook trout. There are also potential

adverse effects associated with the proposed program, since Plum Creek has indicated that they intend to employ electrofishing techniques to capture and remove brook trout. Electrofishing can injure or kill non-target fish incidentally shocked (Sharber and Carothers 1988; Dwyer and White 1995; Fredenberg 1992). However, brook trout suppression programs utilizing electrofishing or netting techniques are unlikely to affect water quality.

Implementation of the NFHCP, commits Plum Creek to cooperate with state fish and wildlife management agencies in enforcement efforts against illegal activities that affect native fish. Such programs would be unlikely to adversely affect water quality, while increased law enforcement or restriction of public access to sensitive areas, for example, could result in beneficial effects to the covered species, both in reductions in direct effects (e.g., fishing) and indirect effects (e.g., potential habitat degradation).

Finally, Plum Creek's Legacy and Restoration commitment to participate in watershed planning efforts is unlikely to adversely affect water quality or covered species. Such activities may have the beneficial effect of coordinating various landowner efforts in ensuring conservation of fish and wildlife and their habitats.

Plum Creek staff, contractors, consultants, and independent researchers perform scientific surveys and studies on covered lands. Surveys and studies of listed species, including listed covered species, are subject to approval by the Federal and state agencies with jurisdiction over the species. If collection, or other forms of take are involved for projects that aid recovery of bull trout, or other listed species covered under the NFHCP, a Federal section 10(a)(1)(A) permit and equivalent state authorization is required as appropriate. Actions such as electrofishing and snorkeling may require a section 10(a)(1)(A) permit, as well as some habitat restoration projects whose purpose is to promote the long-term survival and propagation of a listed species, but may cause a short-term adverse impact during construction. The Services expect that Plum Creek would coordinate with the appropriate Federal agency about applying for a section 10(a)(1)(A) permit if needed.

Summary Effects on Westslope Cutthroat Trout in Montana

The effects and responses described above for bull trout and other native fish species are also relevant to WCT. WCT are likely to be affected by changes in habitat conditions over the permit period in much the same way as bull trout, although this species would probably be less sensitive to changes from the proposed land management activities overall than bull trout. The FWS expects WCT would respond similarly to the effects of the proposed action and similarly to the implementation of conservation measures because the habitat requirements of WCT, although not as rigid as bull trout, are similar. In actuality, WCT may respond rather positively because of this species habitation of a wider range of environmental conditions across the action area.

The number of stream miles in the action area (i.e., all planning area sub-basins) inhabited by WCT total 9,272.4 miles. Of this total 649.4 stream miles, or 7 percent, occur on Plum Creek lands under the NFHCP in Montana; 17.94 stream miles (.2 percent) in Washington; and 28.06 stream miles (.3 percent) in Idaho. The extent of stream miles inhabited by WCT that would be influenced by the conservation measures in the NFHCP has been estimated as discussed below.

The following information focuses on Plum Creek lands in Montana because most of the WCT stream miles occur there and substantially more detailed data on WCT exist for this area. Approximately 206.3 stream miles occur in Tier 1 watersheds and 443.1 stream miles occur in tier 2 watersheds on Plum Creek lands in Montana, or 31.8 percent and 68.2 percent respectively. Under the NFHCP, almost 1/3 of the WCT stream miles affected will occur in Tier 1 watersheds. WCT stocks in these stream segments will benefit from the prioritized and enhanced protection measures to protect sensitive bull trout spawning and rearing areas.

The following information was provided by Plum Creek and is based on data received from the Montana Department of Fish, Wildlife, and Parks. The categories in Tables 26 and 27 were developed in consultation between the FWS and Plum Creek for purposes of this assessment.

Table 26. WCT stream miles on Plum Creek NFHCP lands in Tier 1 watersheds by abundance and genetic purity.

	Genetically Pure	Potentially Pure with no record of Contaminating spp	Potentially pure with Contaminating spp	<90 percent hybridized spp	Unknown	Total
Abundant		.3	14.5	.9		15.7
Common	13.9	7.9	36.5	11.7		70.0
Present	5.4	8.1	45.3	3.6		62.4
Uncommon		8.8	22.8	7.0		38.6
Rare	.6	1.9	9.1			11.6
Incidental		.5				.5
Unknown					7.5	7.5
Total	19.9	27.5	128.2	23.2	7.5	206.3

Table 27.	WCT stream miles on Plum Creek NFHCP lands in Tier 2 watersheds by abundance and genetic purity.					
	Genetically Pure	Potentially Pure with no record of Contaminating spp	Potentially pure with Contaminating spp	<90 percent hybridized spp	Unknown	Total
Abundant	5.3	8.1	9.6	4.7		27.7
Common	7.9	14.9	48.7	11.1	.7	83.3
Present	10.6	11.0	91.2	27.8	3.0	143.6
Uncommon	5.3	3.9	57.8	9.9		76.9
Rare	1.6	4.3	68.0	6.4		80.1
Incidental	.2					.2
Unknown	4.1			10.9	16.3	31.3
Total	34.8	42.2	275.3	70.8	20.0	443.1

Known genetically pure WCT stream miles that occur on Plum Creek NFHCP lands in Montana total 54.7 miles. Approximately 36.4 percent, or 19.9 stream miles, occur in Tier 1 watersheds and 63.6 percent, or 34.8 stream miles, occur in tier 2 watersheds. Of the known genetically pure WCT stream miles that occur on Plum Creek NFHCP lands, over half (51 percent) occur in large stream segments of major rivers in Montana, all of which are tier 2 watersheds: 1) upper Clark Fork River (6.4 stream miles); 2) Blackfoot River (6.6 stream miles); 3) lower Kootenai River (5.7 stream miles); and 4) middle Kootenai River (9.1 stream miles). In addition, all four river systems are key migratory corridors for bull trout to access Tier 1 spawning or rearing streams.

Approximately 403.5 stream miles on Plum Creek lands in Montana have WCT stocks that are potentially pure, but may have contaminating species in the system. This situation occurs on 68 percent of the WCT stream miles that are affected by the NFHCP. These stream segments may be the areas where potentially the largest margin of improvement could occur for pure WCT stocks if habitat conditions are upgraded.

Presumably, known genetically pure WCT streams in Montana will receive the greatest importance in terms of conservation and management. The first objective in the Memorandum of Understanding of the Westslope Cutthroat Trout Agreement (MFWP 1999) is to "protect all genetically pure WCT populations." Signatories to this agreement acknowledged the need to ensure the persistence and long-term survival of pure WCT. Plum Creek will be able to support this principle under the NFHCP because of their commitment to designate streams to Tier 1 level irrespective of species when biologically justified. MFWP has identified and designated priority

areas for management of WCT in the State of Montana, which should aid in providing the biological justification and focus of NFHCP conservation efforts where most beneficial for this species.

Summary Effects on Redband Trout in Montana

As mentioned above for WCT, the effects and responses described above for bull trout and other native fish species are also relevant to RBT. RBT, similar to WCT, are likely to be affected by changes in habitat conditions over the permit period in much the same way as bull trout. The FWS envisions RBT would respond similarly to the effects of the proposed action and similarly to the implementation of conservation measures because the habitat requirements of RBT, although not as rigid as bull trout, are similar. RBT are expected to respond positively because the baseline habitat conditions in the Kootenai River drainage where most RBT occur in the action area should improve measurably over the permit period. Further, there are state, federal, and private restoration projects and comprehensive watershed planning efforts being developed in the Kootenai River sub-basin that will be benefit RBT in conjunction with the NFHCP (Kootenai River Network 2000, FWS 2000b).

Stream miles within the sub-basins of the action area that have RBT total 286.3 miles. Nearly all occurs in Montana (98 percent). On Plum Creek lands in Washington State RBT occupy 4.53 stream miles in the lower Tieton River and in Idaho at least 16 stream miles in the Lochsa River sub-basin have RBT. This data was provided by Plum Creek.

In Montana about 31.9 stream miles involve Plum Creek NFHCP lands or 11.3 percent of the total stream miles in the action area sub-basins. Of this total 2.2 stream miles, or 6.9 percent, occur in Tier 1 watersheds, and 29.7 stream miles, or 93.1 percent, in Tier 2 watersheds. Similar to WCT streams, most of the RBT stream miles (29.4) occur in a large river, the middle Kootenai River, which is a Tier 2 watershed and key migratory habitat for bull trout (see Table 28 below).

Table 28. RBT occurrence on Plum Creek NFHCP lands in Montana.

Planning Sub-basin	Sub-basin Name	Tier Number	Stream Miles
Lower Kootenai River	Callahan Creek	1	0.8
Lower Kootenai River	Keeler Creek	1	0.9
Middle Kootenai River	Parmenter Creek	1	0.5
Middle Kootenai River	Lower Kootenai River	2	0.3
Middle Kootenai River	Middle Kootenai River	2	29.4

Summary Effects on Anadromous Fish in the Lochsa River Sub-basin

Snake River Spring/Summer Chinook

Plum Creek lands in the Lochsa River drainage support spring chinook salmon. Snake River spring/summer chinook salmon are not listed in the Lochsa River, however, unlisted spring/summer chinook salmon are potentially affected by Plum Creek activities in the Lochsa River drainage. Re-introduction of non-indigenous spring chinook salmon appears to be successful, based on increasing redd counts in recent years. Spring chinook are observed on Plum Creek lands. Potential spring chinook spawning and rearing areas are generally in fair to good condition. Road-related sediment and elevated stream temperatures are the primary factors affecting potential spring/summer chinook habitat in the Lochsa River sub-basin. Additional HCP commitments (e.g. deferred riparian timber harvest, additional road closures, accelerated road upgrades, landslide hazard assessment) were established in the Lochsa River drainage to maximize sediment reduction and to increase stream shading. Most of the riparian areas on Plum Creek lands have been harvested in recent decades, and are currently in an improving trend. The primary effect of Plum Creek activities on designated critical habitat for spring/summer chinook is through their influence on the amount of LWD, water temperature, peak flows, and sediment in the South Fork Clearwater River. Any influence of Plum Creek activities on critical habitat is expected to be negligible since Plum Creek lands are more than 100 miles upstream, and comprise only a small portion of the sub-basin. Habitat quality for the unlisted spring chinook stock is expected to be maintained or improved from the NFHCP commitments.

Snake River Fall Chinook

Plum Creek lands in the Lochsa River drainage are upstream from areas that support fall chinook salmon. Critical habitat for Snake River fall chinook includes the Clearwater River upstream to the confluence with Lolo Creek, which excludes the Lochsa River and it's tributaries. Fall chinook are not known to occur in the Lochsa River, and the most spawning occurs in the mainstem Clearwater River. The primary effect of Plum Creek activities on fall chinook and designated critical habitat is through their influence on water temperature, peak flows, and sediment. Any influence of Plum Creek activities on critical habitat is expected to be negligible since Plum Creek lands are more than 60 miles upstream, and comprise only a small portion of the sub-basin.

Snake River Steelhead

Plum Creek lands in the Lochsa River drainage support Snake River steelhead. The Lochsa River sub-basin is designated critical habitat for Snake River steelhead, and steelhead are know to occur in many portions of Plum Creek property. Known and potential steelhead spawning and rearing areas are generally in fair to good condition, and a few areas are in excellent condition. The

majority of spawning and rearing areas for steelhead on located on adjacent Forest Service lands, however, Plum Creek activities could have a strong influence on habitat in the Brushy Fork drainage, which is an important stream for steelhead production. Road-related sediment and elevated stream temperatures are the primary factors affecting steelhead habitat in the Lochsa River basin, and reduced LWD is a concern in isolated watersheds. Additional NFHCP commitments (e.g. deferred riparian timber harvest, additional road closures, accelerated road upgrades, landslide hazard assessment) were established in the Lochsa River drainage to maximize sediment reduction and to increase stream shading. The Lochsa River is designated in the NFHCP as Tier 1, which requires additional riparian protection, including a no-harvest zone at stream confluences to protect important rearing areas for anadromous fish. Most of the riparian areas on Plum Creek lands have been harvested in recent decades, and are currently in an improving trend. The primary effect of Plum Creek activities on designated critical habitat for steelhead is through their influence on amount of LWD, water temperature, peak flows, and sediment. Habitat quality is expected to be maintained or improved from the NFHCP commitments.

Summary Effects on Western Cascade Species

Coastal Cutthroat Trout, Coastal Rainbow Trout, Mountain Whitefish, Lower Columbia River Steelhead, Lower Columbia River Chinook Salmon

Freshwater habitat within the Lewis River sub-basin has declined in quality due to 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 (Washington Department of Fish and Wildlife [WDFW] 1999a). Limiting factors (i.e., 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 (e.g., high erosion rates, 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 USFS (1996) confirm the WSCC limiting factors conclusions. In addressing key habitat attributes for salmonids, the USFS 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: 1) levels of LWD are reduced in quantity; 2) pool frequency is reduced; 3) stream temperatures are elevated; 4) aquatic habitat is fragmented, and 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), as well as several of the factors identified above as negatively affecting all salmonids in the Lewis and Cowlitz River watersheds, the proposed NFHCP is likely to have positive effects on salmonid populations in the action area. The NFHCP proposes to improve habitat conditions relative to several of the factors identified by the WSCC (2000) (e.g., bank and channel stability, erosion rates, water quality) and the USFS (1996) (e.g., LWD, stream temperatures, 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 the Act and landowner needs, aspects of the Clean Water Act will also be incidentally addressed (e.g., NFHCP cold water temperature maintenance/reduction commitments, sediment reduction commitments). Although results of NFHCP implementation within the range of these species will be relatively minor on a landscape scale relative to watershed conditions on the whole (i.e., 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 USFS lands and the possible future implementation of the Washington Forest and Fish process (currently under development with the intention of meeting the Act requirements for listed salmonids) on non-Federal lands.

Upper Columbia River Summer/Fall Chinook

Fall chinook occur in the lower Yakima River from Sunnyside Dam to the mouth, and in the Marion Drain, and are not in the vicinity of Plum Creek property. Upper Columbia River summer/fall chinook are not listed under the Act. Indigenous summer chinook were extirpated in the 1970s. Plum Creek lands are located in the Naches River and Ahtanum Creek drainages, upstream from areas where fall chinook salmon occur. The Marion Drain, in the Yakima River sub-basin, includes one of the few stocks of native origin that is sustained by natural production. Stream flows and water quality in the Marion Drain and the lower Yakima River are strongly influenced by reservoirs and irrigation withdraws. Plum Creek activities have negligible potential to affect fall chinook salmon or their habitat since fall chinook occur more than 25 miles downstream, and stream flows and water quality from reservoir release and water from other parts of the Yakima drainage overwhelm the influence of the Naches River and Ahtanum Creek.

Mid-Columbia River Spring Chinook

The Mid-Columbia River spring chinook ESU includes the Yakima River drainage. Spring chinook are known to occur in the vicinity of Plum Creek lands. Mid-Columbia River spring chinook are not listed under the Act. Spring chinook spawning and rearing occurs in the lower 3 miles of Ahtanum Creek, and the lower reaches of the Tieton River, Cowiche Creek and Oak

Creek are used for migration or rearing. Juveniles are found most commonly in the first river mile of tributaries to larger streams such as the Naches River. Plum Creek lands are more than 15 miles upstream from spawning habitat in Ahtanum Creek, but some lands may be used by spring chinook for migration or rearing in portions of the Tieton River, and Cowiche and Oak Creek drainages. Stream de-watering, impassable irrigation dams, and flow problems from dam releases currently preclude spring chinook from using streams on Plum Creek property. If these problems were fixed, chinook salmon could potentially use streams in the vicinity of Plum Creek property. Numerous problems with habitat quality occur in the upper reaches of the Naches River and Ahtanum Creek. High road densities, extensive timber harvest, motorized recreation impacts, and over-grazing are some of the causes for habitat degradation. NFHCP commitments for grazing, sediment reduction from roads and increased riparian protection would ameliorate some of the more significant habitat limitations. Overall, the NFHCP is expected to maintain LWD supply, stream temperature, levels of fine sediment, and channel morphology in streams that are presently functioning properly for these habitat indicators, and to facilitate recovery of proper function where it is degraded. The pattern of mixed land ownership, and widespread nature of habitat degradation in the action area, limit the potential for Plum Creek to singularly restore proper functioning condition in NFHCP basins within the ESU boundary for this species.

Mid-Columbia River Steelhead

The Mid-Columbia River steelhead ESU includes the Yakima River drainage, and all accessible reaches are designated critical habitat. Steelhead are more widely distributed than chinook in the Yakima River drainage, and they are not as strongly affected by problems created by irrigation management because migration and spawning do not occur during the irrigation season. Steelhead are known to occur in the vicinity of Plum Creek lands, but little information exists on the location of spawning areas in Naches River and Ahtanum Creek drainages. The Naches River drainage produces about 10 percent of the steelhead in the Yakima River basin, and a large percentage of the adult returns are destined of the Naches River system. Plum Creek lands in the South Fork of Ahtanum Creek, and in the North Fork Ahtanum Creek, above Foundation Creek, are Tier 1. Plum Creek lands in Foundation Creek and the Naches River drainages are Tier 2. The effects of the HCP for steelhead are similar to those described above for Mid-Columbia River spring chinook salmon - the NFHCP is expected to ameliorate some of the more significant habitat limitations from roads, timber harvest and grazing. Overall, the NFHCP is expected to maintain LWD supply, stream temperature, levels of fine sediment, and channel morphology in streams that are presently functioning properly for these habitat indicators, and to facilitate recovery of proper function where it is degraded. The pattern of mixed land ownership, and widespread nature of habitat degradation in the action area, limit the potential for Plum Creek to singularly restore proper functioning condition in NFHCP sub-basins designated as critical habitat for this species.

Lower Columbia River Chinook

The Lower Columbia River chinook salmon ESU includes Plum Creek lands in the Lewis, Cowlitz and Kalama River drainages. The ESU includes both fall and spring chinook. All accessible reaches in these drainages are designated critical habitat, and unaccessible reaches above the Mayfield Dam, in the Cowlitz River, are also included because fish are trucked above the dam. The Lower Columbia River chinook ESU is heavily influenced by hatchery programs, and natural production is low or non-existent in many areas. Nearly all spring and fall chinook spawning in the Lewis, Cowlitz, and Kalama River drainages occurs downstream from Plum Creek property, or in tributaries where Plum Creek does not own land. In the Cowlitz River, adult chinook are trucked to the Tilton River above the Mayfield Dam, to provide a sport fishery. Only occasional spawning occurs above the Mayfield Dam. Juvenile chinook are also planted above the Mayfield Dam, and passed downstream as smolts. Plum Creek activities potentially have the largest effect on chinook habitat in the Tilton River and other areas above Mayfield Dam. However, the chinook population above the dam is sustained by hatchery production, therefore, the role of critical habitat above the dam is principally to support rearing by juveniles that are stocked in the Tilton River and vicinity. Chinook habitat in western Washington locations besides the Tilton River are affected by Plum Creek activities primarily through downstream effects on water temperature, peak flows, and sediment. There are several tracts of Plum Creek lands in the Kalama River drainage and Lewis River below Merwin Dam where chinook might use the mouths of streams draining Plum Creek property. In those locations, Plum Creek activities could directly influence the suitability of rearing habitat through changes in LWD, water temperature, and sediment.

With the exception of the Tilton River, covered activities are expected to have little effect on Lower Columbia River chinook habitat, since the majority of accessible habitat is in tributaries that do not drain from Plum Creek property, and Plum Creek has only minor effects on the mainstem rivers because of dams and limited ownership. Plum Creek owns a significant portion of the lower Tilton River drainage, where their activities could have a dominant effect on critical habitat used by hatchery-influenced salmon that are trucked to the river to maintain a salmon sport fishery. Currently, a small portion of salmon stocked in the Tilton River spawn successfully, the hatchery stock is considered essential for recovery, but is not part of the listed ESU. The NFHCP is expected to maintain, or possibly enhance spawning success in the Tilton River. Overall, the NFHCP is expected to maintain LWD supply, stream temperature, levels of fine sediment, and channel morphology in streams that are presently functioning properly for these habitat indicators, and to facilitate recovery of proper function where it is degraded. The pattern of mixed land ownership, and widespread nature of habitat degradation in the action area, limit the potential for Plum Creek to singularly restore proper functioning condition in NFHCP sub-basins designated as critical habitat for Lower Columbia River Chinook.

Lower Columbia River Steelhead

The Lower Columbia River steelhead ESU covers the same areas as the Lower Columbia River chinook salmon ESU, and the same effects on habitat are generally expected to occur.. Adult and juvenile steelhead are managed similarly to chinook salmon above Mayfield Dam, and some spawning occurs, however, the hatchery stock that is trucked above the dam is not part of the ESU and is not essential for recovery. The distribution of steelhead spawning areas, and effects of the HCP are also similar, except that steelhead occur on Plum Creek lands in a greater number of locations than chinook. Steelhead spawning and rearing occurs on several tracts of Plum Creek lands in Arnold, and Jacks Creeks (tributaries to the Kalama River) and in several tributaries to the Lewis River, below Merwin Dam. In the Cowlitz River drainage, most of the natural spawning takes place in tributary watersheds that do not include Plum Creek land, but some tributaries may be used for rearing. In the Lewis drainage, most of the spawning and rearing occurs in the East Fork Lewis River, where Plum Creek does not own property. The NFHCP will help to ameliorate habitat degradation in Arnold and Jacks Creeks that has occurred from roads and riparian harvest, but will have little effect on steelhead habitat in other Plum Creek drainages.

Lower Columbia River/SW Washington Coho

The Lower Columbia River/SW Washington coho ESU covers the same areas as the Lower Columbia River chinook salmon and steelhead ESUs. Adult and juvenile coho are managed similarly to chinook and steelhead above Mayfield Dam. Virtually all coho in the Lewis watershed are from hatchery production. In the Kalama River, coho salmon are limited to the lower 10 miles, up to the Lower Kalama Falls. In the Cowlitz River drainage nearly all of the natural spawning occurs in tributary watersheds that do not include Plum Creek land. Naturally spawning coho in the Toutle River drainage are of unknown stock of composite production, but currently spawn in all accessible tributaries. The effects of the NFHCP on coho are similar to those described for steelhead in the preceding paragraph.

Columbia River Chum

The Columbia River chum salmon ESU includes the Cowlitz, Lewis, and Kalama River drainages. All accessible reaches in these drainages are designated critical habitat. Chum salmon are found in extremely low numbers and little data is available on their historical abundance and life history in SW Washington. Chum salmon have been reported in the Toutle River, and a small amount of natural production occurs in the North Fork Lewis River drainage, below Merwin Dam. Chum salmon are almost nonexistent in the Kalama River drainage. Chum salmon are not known to occur on Plum Creek property, but they could potentially use the mouths of streams that drain into the North Fork Lewis River from several small tracts of land. Otherwise, the primary effect of the NFHCP are downstream effects on water temperature, peak flows, and sediment.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to this consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

There are few cumulative effects anticipated on Plum Creek lands covered by the NFHCP since nearly all commercial forestry activities anticipated by Plum Creek are evaluated in this opinion. Therefore cumulative effects of activities on Plum Creek lands would be limited primarily to future regulatory changes in state laws. However, any changes in state law allowing less protection for fish habitat would not affect implementation of the NFHCP - the more conservative, permitted actions would continue to be applied. It is possible that State regional planning efforts and changes in forest practice regulations may occur, and could require Plum Creek to modify their practices. However, specific changes and their potential effects are unknown.

Cumulative effects may also occur in the action area on lands adjacent to Plum Creek. Plum Creek lands are interspersed with lands managed for a wide variety of purposes by many different landowners. The majority of lands adjacent to Plum Creek property are managed principally for commercial timber, but other activities such as grazing, mining, recreation, agriculture and residential development also occur on adjacent lands. The effects of these types of activities would be similar to those described in the DEIS/NFHCP (1999). The Northwest Forest Plan Final Supplemental Environmental Impact Statement (USDA and USDI 1994) presents an overview of management on non-Federal lands and describes the probable fate of habitat for listed species on non-federal lands within the range of the Northern Spotted Owl.

Changes in land use and population expansion are likely to occur in the action area. Conversion of forest lands to residential, urban, or industrial uses could potentially degrade or fragment fish and wildlife habitat. Many Washington and Montana lands in the action area that were historically managed for timber production are now being converted into housing and urban developments. It is reasonable to assume that some of the forested areas that provide fish and wildlife habitat, especially migratory corridors in valleys, will eventually be converted in this way. Urbanization can create a lasting effect on streams through increases in impervious surfaces, loss of riparian vegetation, alterations in stream channel configuration, and changes in water quality through urban runoff and effluents. Further, over the remaining 30-year life of the permit as population expansion abides, it is likely that acts that could negatively impact native fish species, such as introduction (illegal private action) and/or establishment of non-native fish species, or poaching, will continue to occur. However, provisions in the NFHCP would minimize risk of development of forest lands in the NFHCP project area.

In western Montana state, tribal and private efforts are planned or currently ongoing or being initiated to restore native species like bull trout and westslope cutthroat trout. The State of Montana is expected to finalize a bull trout restoration plan in the near future which is intended to guide state restoration efforts and complement federal conservation and recovery processes (July 6, 1999, letter from the chair of the Montana bull trout restoration team to the restoration and science team). Also, the state's section 6 Bull Trout Conservation Plan with the Service identified numerous bull trout recovery actions in the year 2000, 48 habitat restoration projects in the Kootenai, Clark Fork, Blackfoot, and Bitterroot river sub-basins will be implemented (MFWP 2000a). In addition, the Service recently signed an agreement with the Montana Department of Natural Resources and Conservation in support of developing a Habitat Conservation Plan which may include native fish and cover Montana trust lands and private forest landowner activity.

Recently, MFWP has proposed a conservation easement with Plum Creek on 142,000 acres of timberland in the Thompson and Fisher river valleys in western Montana (MFWP 2000b). The easement would restrict future growth, such as residential and commercial developments, in return for assurance of traditional forest recreational uses and public access. Fisheries habitat is expected to be preserved as a result of prohibiting residential and commercial development on these lands. In the Thompson River, about 13,000 acres of riverfront lands and in the Fisher River approximately 4,000 acres of riparian/wetlands would be protected. Bull trout occur in both of these watersheds as well as westslope cutthroat trout. Redband trout occur in the upper reaches of Wolf Creek, a major tributary to the Fisher River. If the easement is signed, the threat of streamside development would be eliminated and water quality and existing fish habitat protected in two major bull trout watersheds within the action area of the NFHCP.

In the lower Flathead River sub-basin, the Confederated Salish and Kootenai Tribe (CSKT) have planning efforts underway to develop a tribal bull trout restoration plan to restore riparian areas and fish habitat in key bull trout watersheds like the Jocko and Mission river drainages (CSKT 2000). In the Kootenai River sub-basin the Kootenai River Network; an alliance of diverse citizen's groups, individuals, businesses and industry, government, and management agencies; is poised to engage various interests in participating in resource management practices to restore water quality and aquatic resources, and have supported, and will likely continue to support, various habitat restoration projects to that end (Kootenai River Network, International Alliance for Water Quality and Aquatic Resources, no date). Further, local watershed councils in the Lower Clark Fork River sub-basin (Rock Creek Watershed Council, Prospect Creek Watershed Council, Bull River Watershed Council, Elk Creek Watershed Council) are actively planning restoration projects to improve native fish habitat and address various watershed issues - the Elk Creek Watershed Council completed restoration work on 25 stream sites and continues to work on improving water quality and fish habitat (Rock Creek Watershed Council minutes, June 25, 1999).

The potential magnitude of cumulative effects varies across the action area, depending on the land ownership pattern. Sub-basins with a high percentage of either Plum Creek or Federal ownership have lower potential for cumulative effects than areas with low percentage of Federal land, since actions on Federal lands are subject to future section 7 consultations. Based on land ownership patterns, there would be limited potential for cumulative effects to occur in sub-basins such as the Lochsa River and Kootenai River, and a very high potential in sub-basins such as Bitterroot River, Blackfoot River, Swan River, Clark Fork River, Ahtanum Creek and North Riffe Lake (Table 29).

Table 29. Percentage of land ownership in action area sub-basins.

Sub-basin	Other Non-Federal Land (%)	Plum Creek Land (%)	Federal Land (%)
Upper Kootenai River	16	1	83
Middle Kootenai River	13	36	51
Lower Kootenai River	7	5	88
Flathead River	32	4	65
Swan River	22	18	60
Blackfoot River	34	19	47
Bitterroot River	27	4	69
Upper Clark Fork River	50	4	46
Middle Clark Fork River	47	13	39
Lower Clark Fork River	18	<1	82
Lochsa River	<1	5	95
Ahtanum Creek	85	14	1
Lewis River	25	6	69
Lower Tieton River	21	14	64
North Riffe Lake	76	12	13

CONCLUSION

Within those riparian lands that will experience timber harvest, some adverse effects to the NFHCP's covered species and their habitat are likely to occur, since the NFHCP conservation commitments are expected to minimize, not eliminate, those effects. Such effects would likely be limited to temporary and relatively minor increases in sediment levels and water temperatures and decreases in the availability of large woody debris in affected streams.

The Services believe that over the life of the proposed NFHCP, considering the extensive area and many watersheds covered by the plan, some take of the NFHCP's covered species is likely to occur. The adverse effects of timber harvest in riparian areas may cumulatively increase to the extent that federally listed species are killed, harmed, or harassed. Bull trout are particularly susceptible to take from riparian harvest under the NFHCP due to their widespread occurrence in areas where timber harvest will occur, while anadromous fish in the NFHCP area are generally distant from these locations, and are affected more by general watershed conditions. The actual levels of take that are likely to occur under the NFHCP are extremely difficult to quantify–because the point at which relatively subtle aquatic effects such as increased sediment and temperature levels actually result in death, injury, or harassment of individual fish is unknown, and because the extent to which such events, even when they occur, can be tied back to obvious habitat modifications is also difficult to determine.

Consequently, the Services believe that an unquantified, but limited, level of take of the NFHCP's covered species will occur over the life of the NFHCP. To make the determination that the proposed action will not jeopardize the continued existence of listed or proposed species, or adversely modify or destroy designated critical habitat, the Services must consider the status of the species under the environmental baseline, and any associated direct, indirect or cumulative effects. A similar approach has been taken for unlisted anadromous salmonids addressed in this opinion. Considering the species' current status, the existing environmental baseline, and the expected effects of the NFHCP, there are likely to be effects of the proposed action that are largely beneficial to all permit species, as well as those that are detrimental. Implementing the HCP will likely contribute to conservation of threatened bull trout, steelhead and salmon, and unlisted native fish in the area affected by the NFHCP.

Listed and Proposed Covered Species

After reviewing the current status of the covered species, the environmental baseline for the action area, the effects of the proposed action on these species, and the cumulative effects, it is the FWS and NMFS's biological opinion that issuance of an incidental take permit to Plum Creek is not likely to jeopardize the continued existence of the bull trout, coastal cutthroat trout, Snake River steelhead ESU, lower Columbia River steelhead ESU, mid-Columbia River steelhead ESU, Snake River spring/summer chinook salmon ESU, Snake River fall chinook salmon ESU, lower Columbia River chinook salmon ESU, and Columbia River chum salmon ESU or result in destruction or adverse modification of critical habitat for those species for which it has been designated.

Unlisted Covered Species

After reviewing the current status of westslope cutthroat trout, redband trout, coastal rainbow trout, upper Columbia River summer/fall chinook salmon ESU, mid-Columbia River spring

chinook salmon ESU, lower Columbia River/Southwest Washington coho salmon ESU, mountain whitefish, and pygmy whitefish; the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Services' conference opinion that the proposed action is not likely to jeopardize the continued existence of the unlisted species. Should any of these species be listed in the future, the issuance of the subject incidental take permit and execution of the associated Implementation Agreement (IA) for the proposed action, as set forth in the NFHCP, are not likely to jeopardize the continued existence of the 8 covered species.

No critical habitat has been designated for the aforementioned unlisted or proposed species, therefore none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap capture or collect, or to attempt to engage in any such conduct. Harm is further defined by Federal regulation to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

Note that 9 of the 17 covered species addressed in this Biological and Conference Opinion are not currently listed (1 of the 9 is currently proposed). Therefore, there is no take prohibition in place for these 9 species at the time of this writing. The incidental take statement below, and the section 10(a)(1)(B) permit, do not become effective until the currently unlisted species are listed under the Act.

Amount or Extent of Take

The proposed Plum Creek NFHCP and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the proposed NFHCP, together with the terms and conditions described in any associated specific commitments indicated in the Implementing Agreement and any conditions associated with the section 10(a)(1)(B) permit or permits issued with respect to the proposed HCP, comprise the basis for Permit(s) issuance. If the basis for permit issuance changes, the protective coverage of

the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the proposed NFHCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the NFHCP and its accompanying section 10(a)(1)(B) permit.

Based on the proposed NFHCP and on the analysis of the effects of the proposed action provided above, the FWS and NMFS anticipate that the following take may occur as a result of the proposed action.

Listed Species (Bull Trout)

The FWS expects that this action is likely to result in incidental take of bull trout in the form of harm, harassment, and injury or death due to effects from forest and range management operations and related activities, including road maintenance and removal, stream crossings, canopy removal, and potential site specific increases in sediments and stream temperature which may adversely impact bull trout at a number of life-history stages. Because of the inherent biological characteristics of bull trout, the likelihood of discovering an individual death or injury attributable to this action is very small.

The FWS anticipates that impacts to bull trout resulting from the proposed action will be difficult to detect at the individual organism level for the following reason(s): 1) bull trout are wide-ranging and are affected by factors beyond the control of Plum Creek; 2) juveniles, fry, and eggs have small body size and are, therefore, difficult to detect when alive; 3) finding dead or impaired specimens is unlikely, especially considering the often small body size of eggs and fry, denseness of vegetation/ substrate, and remoteness of the area; 4) losses may be masked by natural seasonal fluctuations in numbers or other causes; 5) dead or impaired specimens may be washed downstream of the site where the impact occurred; and 6) dead or impaired specimens may be consumed by other fish and wildlife species. The NFHCP project area is large with many stream miles to monitor. However, other variables may be used as a surrogate preliminary indicator of take or impact. This assessment focused on the most relevant habitat variables to covered species, the potential changes to these habitat components, and the potential attainment of the relevant environmental conditions supporting the covered species. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, which will be judged through data forthcoming during intensive monitoring and adaptive management. Therefore, even though the FWS expects incidental take to occur from the effects of the action, the best scientific and commercial data at this time is not available or sufficient to enable the FWS to estimate a specific number of individuals that may be incidentally taken based on loss or injury of individuals of the species. For instance, if bull trout populations were to increase during the permit period, a larger number of individuals may become subject to some level of take. Conversely, if bull trout populations were to decrease, less take might occur. Consequently, take is correlated with habitat conditions likely to result from implementation of conservation measures during the 30-year NFHCP period.

The following two mechanisms may result in harm, harassment, injury, or death of bull trout:

1. Incidental take of bull trout may occur as a result of timber harvest and related activities, including but not limited to, reduced riparian vegetation density, upland harvest activities affecting downslope streams, and canopy removal; and range management activities on individual allotments, including but not limited to livestock grazing in riparian areas. Although the NFHCP commits Plum Creek to maintaining or reducing stream temperatures and reducing sediment input resulting from their land management activities over the entire NFHCP project area, these activities can cause potential site specific increases in sediment and stream temperature which may adversely impact bull trout at a number of life-history stages.

2. Incidental take of bull trout may occur from on-going negative effects of roads on Plum Creek lands in the NFHCP project area. The FWS anticipates incidental take of bull trout associated with the construction of about 1,300 miles of new roads and maintenance of about 20,000 miles of currently maintained roads, and with the ground disturbance associated with abandoning about 1,000 miles of existing roads during the 30-year permit period. Although the NFHCP commits Plum Creek to maintaining or reducing stream temperatures and reducing sediment input resulting from their land management activities over the entire NFHCP project area, these activities can cause potential site specific increases in sediment and stream temperature which may adversely impact listed permit species at a number of life-history stages.

Estimates of take are based on the assumption that bull trout occur throughout lands managed by Plum Creek Timber Company. Because their distribution is not continuous, only a portion of the acres and activities described above have the potential to impact bull trout. Take is generally expected to be avoided; but, if it occurs, only a limited number of individuals would likely be affected and impacts should be infrequent and localized. Therefore, the number of individuals likely to be subject to disturbance at any particular time, or the numbers of individuals which may be taken, is low, yet unquantifiable.

Snake River Spring/Summer Chinook

The NMFS anticipates that an undetermined number of listed Snake River spring/summer chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of chinook potentially present in areas affected by Plum Creek activities, and by the life stages involved.

Snake River spring/summer chinook occur in the Lochsa River sub-basin of the action area, but the ESU boundary and designated critical habitat is more than 100 miles downstream from Plum Creek land. The native chinook population was extirpated in most of the Clearwater River basin, and the native stock was replaced by non-indigenous chinook that were used to re-populate the basin. Consequently, the listed spring chinook ESU does not include the Clearwater River drainage and listed fish do not occur where water quality is likely to be affected by Plum Creek activities. It is possible, but unlikely, that critical habitat would be altered or that take would occur 100 miles downstream from Plum Creek land. Snake River spring/summer chinook salmon could potentially be harmed by impaired water quality or sediment resulting from NFHCP activities, but it is unlikely.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed spring/summer chinook or destruction or adverse modification of critical habitat.

Snake River fall chinook

The NMFS anticipates that an undetermined number of listed Snake River fall chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of chinook potentially present in areas affected by Plum Creek activities, and by the life stages involved.

Fall chinook are not known to occur in watersheds that include Plum Creek land, and the ESU boundary and designated critical habitat are more than 60 miles downstream from Plum Creek Land, in the mainstem Clearwater River. It is possible, but unlikely, that critical habitat would be affected, or that take would occur, 60 miles downstream from Plum Creek NFHCP activities. The mainstem Clearwater River is used by listed fall chinook salmon for spawning, rearing, and migration by juveniles and adults. Listed fall chinook salmon or designated critical habitat could potentially be harmed by impaired water quality or sediment resulting from NFHCP activities.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed fall chinook or destruction or adverse modification of critical habitat.

Snake River steelhead

The NMFS anticipates that an undetermined number of listed Snake River steelhead may be taken as a result of full implementation of the proposed action and associated level of protection over

the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of steelhead potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Snake River steelhead ESU boundary and designated critical habitat includes the Lochsa River sub-basin, that encompasses Plum Creek lands in this ESU. All life stages of listed Snake River steelhead are present in watersheds where Plum Creek NFHCP activities occur, and all accessible reaches in the Lochsa River sub-basin are designated critical habitat. Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed Snake River steelhead or destruction or adverse modification of critical habitat.

Mid-Columbia River steelhead

The NMFS anticipates that an undetermined number of listed Mid-Columbia River steelhead may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of spring chinook potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Mid-Columbia River steelhead ESU boundary and designated critical habitat includes the Yakima River sub-basin that encompasses Plum Creek lands covered by the NFHCP. All life stages of listed Mid-Columbia River steelhead may be present in watersheds where Plum Creek NFHCP activities occur, and all accessible reaches in the Yakima River basin are designated critical habitat. Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed Mid-Columbia River steelhead or destruction or adverse modification of critical habitat.

Lower Columbia River chinook

The NMFS anticipates that an undetermined number of listed Lower Columbia River chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of chinook potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Lower Columbia River chinook salmon ESU boundary and designated critical habitat includes the Lewis, Cowlitz and Kalama River sub-basins, that encompass Plum Creek lands covered by the NFHCP. All life stages of listed Lower Columbia River chinook salmon are present in portions of these sub-basin, and listed fish are found in portions of Plum Creek property. All accessible reaches in the Lewis, Cowlitz and Kalama River basins are designated critical habitat, and unaccessible reaches above the Mayfield Dam, in the Cowlitz River sub-basin, are also included where fish are trucked above the dam. In most watersheds, chinook salmon occur far enough downstream from Plum Creek activities that the potential for take is buffered by the influence of other portions of the drainage. Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed Lower Columbia River chinook salmon or destruction or adverse modification of critical habitat.

Lower Columbia River steelhead

The NMFS anticipates that an undetermined number of listed Lower Columbia River steelhead may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of steelhead potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Lower Columbia River steelhead ESU boundary and designated critical habitat includes the Lewis, Cowlitz and Kalama River sub-basins, that encompass Plum Creek lands covered by the NFHCP. All life stages of listed Lower Columbia River steelhead are present in portions of these sub-basin, and listed fish occur in portions of Plum Creek property. All accessible reaches in the Lewis, Cowlitz and Kalama River basins are designated critical habitat, and unaccessible reaches above the Mayfield Dam, in the Cowlitz River sub-basin, are also included where fish are trucked above the dam. Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed Lower Columbia River steelhead or destruction or adverse modification of critical habitat.

Columbia River chum

The NMFS anticipates that an undetermined number of listed Columbia River chum salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of chum salmon potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Columbia River chum salmon ESU boundary and designated critical habitat includes the Lewis, Cowlitz and Kalama River sub-basins, that encompass Plum Creek lands covered by the NFHCP. All life stages of listed Columbia River chum salmon may be present in watersheds where Plum Creek NFHCP activities occur, and all accessible reaches in the Cowlitz, Lewis, and Kalama River drainages are designated critical habitat. Chum salmon are known to occur in the Toutle River and in the in the North Fork Lewis River drainage, below Merwin Dam, but are in extremely low numbers. Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to listed Columbia River chum salmon or destruction or adverse modification of critical habitat.

Unlisted Species

Westslope Cutthroat Trout, Redband Trout, Coastal Rainbow Trout, Coastal Cutthroat Trout, Mountain Whitefish, Pygmy Whitefish

The FWS expects that this action is likely to result in incidental take of unlisted, primarily resident salmonid permit species in the form of harm, harassment, and injury or death due to effects from forest and range management operations and related activities, including road maintenance and removal, stream crossings, canopy removal, and potential site specific increases in sediments and water temperature which may adversely impact these species at a number of life-history stages. Because of the inherent biological characteristics of salmonids, the likelihood of discovering an individual death or injury attributable to this action is very small.

The FWS anticipates that impacts to unlisted permit species resulting from the proposed action will be difficult to detect at the individual organism level for the following reason(s): 1) many of the unlisted permit species are wide-ranging and are affected by factors beyond the control of Plum Creek Timber Company; 2) juveniles, fry, and eggs have small body size and are, therefore, difficult to detect when alive; 3) finding dead or impaired specimens is unlikely, especially considering the often small body size of eggs and fry, denseness of vegetation/ substrate, and remoteness of the area; 4) losses may be masked by natural seasonal fluctuations in numbers or other causes; 5) dead or impaired specimens may be washed downstream of the site where the impact occurred; and 6) dead or impaired specimens may be consumed by other fish and wildlife species. The NFHCP project area is large with many stream miles to monitor. However, other variables may be used as a surrogate preliminary indicator of take or impact. This assessment focused on the most relevant habitat variables to covered species, the potential changes to these habitat components, and the potential attainment of the relevant environmental conditions supporting the covered species. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, which will be judged through data forthcoming during intensive monitoring and adaptive management. Therefore, even though the FWS expects incidental take to occur from the effects of the action, the best scientific and commercial data at this time is not available or sufficient to enable the FWS to estimate a specific number of individuals incidentally taken based on loss or injury of individuals of the species. For instance, if the populations of unlisted species were to increase during the permit period, a larger number of individuals may become subject to some level of take. Conversely, if these populations were to decrease, less take might occur. Consequently, take is correlated with habitat conditions likely to result from implementation of conservation measures during the 30-year NFHCP period.

The following two mechanisms may result in harm, harassment, injury, or death of unlisted permit species:

1. Incidental take of unlisted listed permit species may occur as a result of timber harvest and related activities, including but not limited to reduced riparian vegetation density, upland harvest activities affecting downslope streams, and canopy removal; and range management activities on individual allotments, including but not limited to livestock grazing in riparian areas. Although the NFHCP commits Plum Creek to maintaining or reducing stream temperatures and reducing sediment input resulting from their land management activities over the entire Project Area, these activities can cause potential site specific increases in sediment and stream temperature which may adversely impact unlisted permit species at a number of life-history stages.

2. Incidental take of unlisted permit species may occur from on-going negative effects of roads on Plum Creek lands in the NFHCP project area. The FWS anticipates incidental take of unlisted permit species associated with the construction of about 1,300 miles of new roads and maintenance of about 20,000 miles of currently maintained roads, and with the ground disturbance associated with abandoning about 1,000 miles of existing roads during the 30-year permit period. Although the NFHCP commits Plum Creek to maintaining or reducing stream temperatures and reducing sediment input resulting from their land management activities over the entire NFHCP project area, these activities can cause potential site specific increases in sediment and stream temperature which may adversely impact unlisted permit species at a number of life-history stages.

Estimates of take are based on the assumption that unlisted permit species occur throughout lands managed by Plum Creek Timber Company. Because their distribution is not continuous, only a portion of the acres and activities described above have the potential to impact unlisted permit species. Take is generally expected to be avoided; but, if it occurs, only a limited number of individuals would likely be affected and impacts should be infrequent and localized. Therefore, the number of individuals likely to be subject to disturbance at any particular time, or the numbers of individuals which may be taken, is low, yet unquantifiable.

Unlisted salmon and steelhead from hatchery-origin stocks, and not part of an ESU

Unlisted hatchery fish, and wild populations of introduced fish from unknown stock origins, occur throughout the Action Area in Idaho and Washington. Many of these hatchery stocks are mixed with listed anadromous fish in portions of the action area. Unlisted hatchery spring chinook in the Cowlitz River are the only unlisted hatchery stock in the action area considered essential for recovery (64 FR 14308, March 24, 1999). An unlisted wild stock of non-indigenous spring chinook salmon is present in Lochsa River sub-basin, upstream from the listed Snake River spring/summer chinook salmon ESU, and is known to occur on Plum Creek lands. The incidental take of these species are expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities,

the number of fish potentially present in areas affected by Plum Creek activities, and by the life stages involved.

Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to unlisted salmon and steelhead from hatchery-origin stocks.

Upper Columbia River summer/fall chinook

The NMFS anticipates that an undetermined number of unlisted Upper Columbia River summer/fall chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of summer/fall chinook potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Columbia River summer/fall chinook salmon ESU boundary includes the Yakima River sub-basin, that encompasses Plum Creek lands covered by the NFHCP. Upper Columbia River summer/fall chinook are not known to be present in watersheds where Plum Creek NFHCP activities occur. Summer chinook were extirpated in the 1970's, and are no longer present. Fall chinook occur more than 25 miles downstream from Plum Creek land, in the lower Yakima River, below Sunnyside Dam, and in the Marion Drain. It is possible, but unlikely, that the influence of NFHCP activities 25 miles downstream, below the Sunnyside Dam, would result in alteration of critical habitat, or take of chinook. All life stages of fall chinook could potentially be harmed by impaired water quality resulting from NFHCP activities.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to Upper Columbia River summer/fall chinook salmon.

Mid-Columbia River spring chinook

The NMFS anticipates that an undetermined number of unlisted Mid-Columbia River spring chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species

is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of spring chinook potentially present in areas affected by Plum Creek activities, and by the life stages involved.

The Mid-Columbia River spring chinook salmon ESU boundary includes the Yakima River sub-basin, that encompasses Plum Creek lands covered by the NFHCP. All life stages of unlisted Mid-Columbia River spring chinook are present in lower reaches of Yakima River watersheds where Plum Creek NFHCP activities would occur. Harm to Mid-Columbia River spring chinook may occur due to habitat alterations resulting from activities such as timber harvest, cattle grazing, or road management. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures. Existing operation of reservoirs and irrigation diversions precludes use of many streams that would otherwise be occupied by spring chinook. The extent of take would potentially increase if flow problems from reservoirs and diversions are reduced sufficiently to allow spring chinook to use the upper portions of watersheds that are presently unoccupied.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to Mid-Columbia River spring chinook salmon.

Lower Columbia River/SW Washington coho

The NMFS anticipates that an undetermined number of unlisted Lower Columbia River/SW Washington coho salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 30-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harass, kill and injury, resulting from covered activities under the NFHCP. The amount of take is largely dependent upon the effectiveness of the NFHCP conservation measures, the area affected by Plum Creek activities, the number of coho potentially present in areas affected by Plum Creek activities, and by the life stages involved. The Lower Columbia River/SW Washington coho salmon ESU boundary includes the Lewis, Cowlitz and Kalama River sub-basins, that encompass Plum Creek lands covered by the NFHCP. All life stages of unlisted Lower Columbia River coho are known to occur in the Cowlitz River sub-basin, below Mayfield Dam, in several watersheds where Plum Creek lands occur. Unlisted adult and juvenile coho are present above Mayfield Dam in nearly all watersheds where Plum Creek NFHCP activities occur. Harm may occur due to habitat degradation resulting from existing roads, and activities including, but not limited to, timber harvest, road construction, maintenance, repair and abandonment, and cattle grazing. Harassment may occur from riparian or instream activities when listed fish are present. Fish may be killed or injured from actions such as installation of culverts, cattle walking on redds, or fish habitat structures.

As analyzed previously in this opinion, NMFS has determined that this level of anticipated take is not likely to result in jeopardy to Lower Columbia River/SW Washington coho salmon.

Effect of Take

In the accompanying biological/conference opinion, the FWS and NMFS have determined that this level of anticipated taking is not likely to result in jeopardy to any covered species or result in the destruction or adverse modification of critical habitat. The estimated level of incidental take will not substantially reduce the size, distribution, or productivity of the local, regional or range-wide populations of these species. Further, because of the NFHCP commitments to improve specific habitat parameters (e.g., sediment, water temperature), the Services expect that the proposed action will result in positive benefits to all covered species resulting from improvements in habitat quality at the local and possibly regional scales when compared to conditions expected to exist absent the NFHCP.

Reasonable and Prudent Measures and Terms and Conditions

The FWS believes the following reasonable and prudent measure is necessary and appropriate to minimize the incidental take identified in this Biological Opinion:

1. The FWS shall ensure that participation in the implementation of the NFHCP and coordination with Plum Creek and other parties to implement the practices and programs of the NFHCP are accomplished.

To be exempt from the prohibitions of section 9 of the Act, the FWS must ensure compliance with the following terms and conditions which implement the reasonable and prudent measure described above:

1. The FWS shall provide technical assistance to Plum Creek throughout the term of the incidental take permit, including providing necessary personnel and/or funding to ensure that the regulatory agency requirements for monitoring and implementation necessary to meet NFHCP goals are met, as identified in the NFHCP, FEIS, IA, and this Opinion.

2. The FWS shall conduct regular compliance monitoring exams and review periodic, scheduled monitoring reports, and participate in the decision-making process under the adaptive management process described in the NFHCP, FEIS, and IA.

3. The FWS will, at the time of listing of any of the 9 currently unlisted covered species, reassess the analyses in this Biological and Conference Opinion, and determine if any new information that may be available affects the analysis and conclusions relative to such species.

4. The FWS shall participate in studies designed to determine the effects of Plum Creek's forest, road, and range management activities under the NFHCP on covered species and their habitats.

Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 7 (o)(2) of the Act to apply. If the FWS fails to adhere to these terms and conditions the protective coverage of section 7 (o)(2) may lapse.

Reporting Requirements

In accordance with 50 CFR 402.14 (I)(3), the NFHCP and accompanying documents specify provisions for monitoring and reporting the effects and effectiveness of the mitigation and minimization measures on the covered species and their habitats. Accordingly, Plum Creek will also submit periodic monitoring reports to the Services, according to the monitoring and reporting schedule contained in the NFHCP (see section 7 and 8 and the IA).

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The FWS recommend that the following conservation measures be implemented:

1. The FWS and Plum Creek should coordinate and work with surrounding landowners, municipalities and regulatory entities to aid the recovery of listed fish throughout the term of the permit.

2. The FWS and Plum Creek should apply, as appropriate, the recommendations and direction of the FWS's Federal Recovery Plan for Bull Trout once it is finalized, anticipated in 2001.

In order for the FWS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the FWS requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the proposed issuance of section 10(a)(1)(B) incidental take permits to Plum Creek by the Services. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

At the time of listing of any of the currently unlisted permit species, should that occur, the Services are to confirm the conference opinion as a biological opinion. If the Services review the proposed action and find that there have been no significant changes in the action as planned or in the information used during the conference, the Services will confirm the conference opinion as the biological opinion on the project and no further section 7 consultation will be necessary.

The incidental take statement provided in this conference opinion relative to currently unlisted species does not become effective until such species are listed and the conference opinion is adopted as the biological opinion.

APPENDIXES

APPENDIX A

Baseline Conditions for Covered Species in the Action Area

On NFHCP lands within the action area, bull trout occur in three states, Washington, Idaho, and Montana. In Washington these areas include the Lower Columbia River area (Lewis, Cowlitz, and Kalama River sub-basins) and the Mid-Columbia River area (Ahtanum and Tieton river drainages in the Yakima sub-basin). In Idaho these lands include the Snake River area (Lochsa River sub-basin) and in Montana the Upper Columbia River area (Kootenai, Flathead, Clark Fork, Blackfoot, Bitterroot, and Swan River sub-basins). Within the action area, bull trout are most widely distributed in Montana, specifically the Swan, Blackfoot, Kootenai, and Clark Fork River sub-basins. Bull trout populations are present in the other major drainages of the action area, but they are generally limited to a few headwater streams. Refer to the FEIS (Map 4.6-2, page 221) which shows bull trout distribution in action area sub-basins in Montana, Idaho, and Washington.

Baseline discussions below for bull trout are grouped within each state by major river sub-basins which are generally 4th-field hydrologic unit codes (HUCs) in the U.S. Geological Survey's system for classifying watersheds. Where possible, more detailed information is provided at the finer scale of the 6th -field HUC sub-watershed level.

The native distribution of westslope cutthroat trout (WCT) within the action area is primarily in western Montana, eastern and northern Idaho, and central Washington. Within their primary range in the action area, WCT occur in the Kootenai River, Clark Fork River, and Pend Oreille River drainages (Behnke 1992). WCT also occur in the Salmon and Clearwater drainages of the Snake River system (Behnke 1992). Within the action area, WCT are widely distributed throughout many of the river drainages (mainstems and tributaries) (see Map 4.6-4 in the FEIS, page 237). WCT are a native trout that provides much of the recreational fishery throughout the action area.

Similar to bull trout, the baseline discussions for westslope cutthroat trout (WCT) are grouped on the basis of major river sub-basins of the 4th-field HUCs and where possible discussions at the 6th field HUC sub-watershed level are provided. This is because most of the existing baseline information for bull trout and WCT in Montana was analyzed with this approach. The WCT baseline discussions for the Blackfoot and Bitterroot sub-basins are incorporated into the Clark Fork River sub-basin section.

As previously indicated redband trout distribution is restricted within the action area (see Status of Redband Trout Section) to the Kootenai River, which is a major tributary to the upper Columbia River (see Map 4.6-5 in the FEIS, page 243). Within the action area, RBT occur in the Kootenai River and it tributaries in the northwest Montana. Therefore, the only discussion on baseline conditions for RBT occurs under the Montana and the Kootenai River sub-basin section below.

The best available baseline information found on mountain and pygmy whitefish in the action area is largely general characterizations of the status of each species in each state. Consequently, the discussion for both of these species is by state. Sub-basin or watershed level information is provided when possible however.

Montana

In Montana the majority of migratory bull trout spawning occurs in a small percentage of total available stream habitat (MBTSG 1998). In some areas groundwater influence plays a major role in spawning success and production, and lake and reservoirs are essential to adfluvial bull trout populations. In six of twelve state-designated bull trout conservation areas in Montana, large bodies of water provide the primary rearing environment for subadult bull trout, which achieve rapid growth and large size in these waters (MBTSG 1998). Migratory bull trout migrate long distances in response to spawning and rearing habitat needs. Stream-resident bull trout migrate within tributary networks for spawning purposes and in response to changes in seasonal habitat conditions. Connectivity between large rivers, tributary streams, and lake systems are critical for maintaining bull trout populations in Montana (MBTSG 1998), but lack of connectivity has been identified in some sub-basins as the reason recovery and restoration is a very high risk.

Forestry practices in western Montana have been identified as a high risk factor in all bull trout restoration/conservation areas (MBTSG 1998). Upland timber management is the predominant land management activity in most bull trout watersheds and is often conducted in close proximity to bull trout core areas and nodal habitats. Further, forest management activities have been shown to directly affect bull trout spawning, incubation, and juvenile rearing habitat quality in the Flathead River system (Weaver and Fraley 1991b; Sheppard et al. 1984). Old forest roads in Montana within the range of bull trout continue to be a problem in some areas. Surveyors have reported that old forest road systems in some Flathead drainage watersheds act as first-order streams resulting in increased drainage network and channel instability in downstream bull trout spawning and rearing areas (Weaver 1992; MBTSG 1998).

Over concern of forest management practices, the Montana legislature directed a technical committee to produce a revised list of best management practices (BMPs) in 1989 for minimum water quality standards for forest operations in Montana. A team audit process is used to evaluate application and effectiveness of the BMPs. Application of BMPs may reduce sediment delivery from forest roads and timber harvest operations to stream channels. However, qualitative assessments and site visits do not ensure that water quality or aquatic habitat will be protected. Targeted research and quantitative monitoring are needed to evaluate effectiveness of BMPs (MBTSG 1998). To date this research has not been conducted.

There are 42 reaches of 303(d) listed streams in the NFHCP area, all in Montana, that have been assigned a TMDL priority of high, moderate, or low. High priority has been assigned five of the 42 reaches, primarily because of mining-related water quality impairment. TMDL priority is moderate in 8 of the reaches and low in 28 of the reaches, reflecting agricultural, silviculture,

mining, and/or highway and road related effects. TMDL priority has not been assigned in one reach (DEIS/NFHCP 1999). Reaches of certain drainages in 6 of the 15 NFHCP action area sub-basins have impaired water quality conditions that may threaten some subpopulations of bull trout (FWS 1998a).

The following information in this section of the biological opinion on status and distribution of WCT in Montana is largely derived from 3 sources: 1) USDI, FWS, Status Review for Westslope Cutthroat trout in the United States, September 1999; 2) draft conservation agreement and management plan for westslope cutthroat trout in Montana prepared by the Montana Department of Fish, Wildlife, and Parks, June 1998; and 3) Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat trout in Montana, May 1999.

WCT have been present in Montana since at least the Pleistocene Epoch, a period of continental glaciation that ended in Montana approximately 12,000 years ago. They are thought to have historically occupied nearly all of the drainages west of the Continental Divide in Montana, including the Kootenai, Clark Fork, and Flathead River sub-basins (MFWP 1998). An estimated 10,950 stream miles (35 percent) of the 31,065 stream miles that comprise the range of WCT west of the Continental Divide have been surveyed. Of that, WCT of varying degrees of introgression have been documented in reaches totaling 8,424 stream miles (77 percent).

Recent extensive surveys and genetic testing of populations has been ongoing, with data being entered into the Montana Rivers Information System (MRIS) database. A summary of the MRIS GIS database shows that WCT in Montana occur in only 14 percent of their historic range, occupying approximately 12,410 miles of the estimated 87,918 stream miles within their historical range (based on 1:100,000 scale hydrography). Pure WCT presently occur in 2.9 percent of their historic distribution, or about 2,630 stream miles. Forty-five percent of remaining (existing) populations are considered viable (Van Eimeren 1996). Of the remaining populations in Montana, only 20 percent are known to be genetically pure, and an additional 13 percent are suspected to be pure. Federal lands are estimated to support over 75 percent of the remaining WCT in Montana.

WCT (>95 percent) are known to occur in reaches totaling 2,181 miles of those 10,950 surveyed stream miles (20 percent), which is 7 percent of their historical range in the upper Columbia River basin in Montana. Genetically pure (100 percent pure) populations occur in only 18 percent (1,941 miles) of surveyed habitat and 6 percent of historic range. Populations occupying 240 miles of surveyed habitat are 95-99.9 percent pure (11 percent); populations occupying 679 miles of surveyed habitat are less than 95 percent pure (31 percent), and those occupying 5,565 miles of surveyed habitat remain untested (based on MFWP's MRIS data last updated on 1/1/97). Populations in the Columbia River basin appear to be more secure than those east of the Continental Divide due to a number of reasons. Western Montana has less irrigated agriculture, less influence of introduced fishes, more federally managed lands, and more land designated as wilderness or National Park (Shepard 1996).

There are presently 2,422 stream reaches containing WCT distributed throughout 18 sub-basins in the upper Columbia River Basin in Montana. Of these WCT 495 reaches are known to be pure, 64 are between 95 percent and 99.9 percent pure, 164 are less than 95 percent pure, and the remaining 1,699 are untested (based on MFWP's MRIS data last updated on 1/1/97). Of the 2,422 reaches with known WCT populations (comprising 8,424 stream miles), 1,282 (53 percent) comprising 4,503 (53 percent) miles are classified in the MFWP's MRIS database as abundant. The populations in the remaining 1,140 stream reaches consisting of 3,922 miles are considered rare. Of the 559 reaches with known populations of >95 percent purity, 366 (69 percent) comprising 1,434 stream miles are considered abundant.

WCT were noted to already be restricted to headwater streams in Montana by as early as 1959 (Hanzel 1959). WCT have been listed as a Class A State Species of Special Concern by the Montana Department of Fish, Wildlife and Parks and the Montana Chapter of the American Fisheries Society since 1972. Class A designation indicates limited numbers and/or limited habitats both in Montana and elsewhere in North America. WCT are considered a species of special concern by the Bureau of Land Management (BLM), a sensitive species by USFS in Montana.

The furthest inland penetration is redband trout in the Columbia River Basin is Montana, specifically the Kootenai River drainage, which is the extent of the redband trout population distribution in Montana as currently known at this time. At present, two distinctive life histories occur, the smaller resident stream form and the large lake dwelling or kamloops form (Behnke 1992). However, a migratory adfluvial form may have been present but is undetectable due to hybridized populations in the lower portions of the drainage (Muhfield 1999). Genetic surveys indicate that redband trout were native to low-gradient valley-bottom streams throughout the Kootenai River drainage, but are presently restricted to headwater streams (Muhfield 1999). Planting of hatchery rainbow trout has resulted in extensive hybridization and significant divergence among local populations. According to Muhfield (1999) the remnant populations of redband trout inhabiting Callahan Creek and the upper Yaak River drainage represent the only known remaining sources of native redband trout capable of "refounding their historic distribution in Montana" downstream of Kootenai Falls.

Redband trout are state sensitive species in Montana. In 1994 a petition to list the species under the Act was dismissed because the petition did not present substantial scientific or commercial information that warranted further actions because it failed to substantiate the redband trout of the Kootenai River as a distinct population segment. Both MFWP and the American Fisheries Society considers the Kootenai River redband trout a "species of special concern" and it is on the "sensitive species" list for the USFS. In addition, there is concern about the risk of extinction of the pure form of Kootenai River redband trout to the degree that MFWP has proposed a brood stock development program to address the recovery opportunities in the area (MFWP, draft EA, Development of Inland Rainbow Trout Brood, September 17, 1998).

Mountain whitefish in western Montana are widely distributed. Most lakes, reservoirs, rivers and streams support large populations of this species. At present, it is abundant in all major river

systems within the action area of the NFHCP in Montana. In contrast, very little information is known about distribution of pygmy whitefish in Montana. It has been found in a few large lakes in western Montana, but little is known about its abundance where it occurs. It is likely it occurs in many other areas, but its small size and nonrecreational importance as a game fish have probably played a role in lack of available data on this species even though it may be an important forage species (Brown 1971).

Kootenai River Sub-basin

Plum Creek lands in the Upper Kootenai River sub-basin consist of a few sections in the southwest portion of the sub-basin just west of Koocanusa Reservoir. These lands total 7,030 acres and are in a checkerboard pattern with USFS lands. No Tier 1 watersheds occur in the Upper Kootenai River sub-basin, either on Plum Creek lands or on lands under other ownership. Tier 2 lands, however, total 664,643 acres under Federal ownership (83 percent of the drainage), and 7,030 acres under Plum Creek ownership (1 percent of the drainage). Several miles of Key Migratory Rivers occur in the Upper Kootenai River drainage, none of which, however, occur on Plum Creek lands. Perennial streams on Plum Creek lands in the Upper Kootenai total 7 miles. A total of 149 miles of roads occur on Plum Creek lands in the Upper Kootenai and another 4 miles are proposed.

Plum Creek lands in the Middle Kootenai River sub-basin consist of 328,597 acres distributed primarily throughout the central and eastern portions of the watershed. Some of these lands are in a checkerboard pattern with USFS lands, while other portions are in relatively uniform Plum Creek ownership. Tier 1 watersheds in the Middle Kootenai drainage total 145,303 acres (approximately 16 percent of the drainage), of which 12,149 acres (approximately 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 764,788 acres (84 percent of the drainage), of which 315,902 acres (35 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Middle Kootenai River drainage total 87 miles; 34 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Middle Kootenai total 257 miles. Grazing leases on Plum Creek lands in this drainage total 114,650 acres along 283 miles of streams, all of which are on Tier 2 lands. A total of 3,562 miles of roads occur on Plum Creek lands in the Middle Kootenai and another 179 miles are proposed.

Plum Creek lands in the Lower Kootenai River sub-basin consist of 32,232 acres distributed in a checkerboard fashion in the southern half of the sub-basin. Tier 1 watersheds in the Lower Kootenai drainage total 104,739 acres (approximately 16 percent of the drainage), of which 4,854 acres (approximately 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 544,869 acres (83 percent of the drainage), of which 28,363 acres (4 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Lower Kootenai River drainage total 35 miles; 4 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Lower Kootenai total 49 miles. There are no grazing leases on Plum Creek lands in this drainage. A total of 427 miles of roads occur on Plum Creek lands in the Lower Kootenai and another 19 miles are proposed.

The Kootenai River watershed is international, originating in Kootenay National Park in British Columbia, Canada. From there the river flows south into extreme northwestern Montana, west into northern Idaho, then returns to British Columbia and its confluence with the Columbia River. Nearly two-thirds of the Kootenai River watershed occurs within British Columbia. The total drainage area of the Kootenai River watershed is 14,000 square miles, 3,750 square miles of which are in Montana (Knudsen 1994 in MBTSG 1996a).

Bull Trout

Bull Trout Status in the Kootenai River Sub-basins: The Kootenai River watershed in Montana consists of five bull trout subpopulations: 1) upper Kootenai, upstream of Libby Dam including Lake Koocanusa; 2) Sophie Lake; 3) middle Kootenai, from Libby Dam downstream to Kootenai Falls; 4) lower Kootenai, from Kootenai Falls downstream through Idaho, and 5) Bull Lake. The priority watersheds for the Kootenai National Forest (KNF) include Rock Creek, Vermillion River, Bull River, lower Yaak River, Wigwam River, West Fisher River, Phillips/Sophie creeks, Pipe Creek, Libby Creek, Lake Creek, Silver Butte Creek, Quartz Creek, O'Brien Creek, Grave Creek, and Callahan Creek.

The Kootenai river flows into Koocanusa Reservoir, created by the construction of Libby Dam in 1972, and Kootenai National Forest. About 600 mi^2 of the KNF are considered to have bull trout habitat; however, about 100 mi^2 have no current evidence of bull trout presence (MBTSG 1996a). With the exception of Lake Koocanusa, all bull trout stocks on the KNF are uncommon to rare and at risk of extinction (Thomas 1992). The principle threats to bull trout in this area include natural environmental fluctuations working in concert with genetic inbreeding, habitat modification (both direct and indirect), hybridization and competition with nonnative species, and intentional and unintentional consumptive use in the fishery. It is unclear whether Kootenai Falls, downstream of Libby Dam, was an upstream migration barrier to bull trout and other species prior to construction of the dam. Prior to dam construction, high spring flows may have enabled passage by some fish species, thereby connecting the entire river system (MBTSG 1996a). Now, because Libby Dam acts as an upstream passage barrier and reduces high spring flows, it is believed only downstream genetic exchange occurs, primarily over Kootenai Falls but also through the dam (MBTSG 1996b). Historic information about bull trout abundance in the Kootenai River drainage is very limited (MBTSG 1996a).

Upper Kootenai River Subpopulation: This subpopulation was created by the construction of Libby Dam in 1972 and constitutes the Kootenai drainage upstream of Libby Dam, including the 90 mile long Koocanusa Reservoir. Libby Dam is an upstream migratory barrier to fish (MBTSG 1996a); thus, no bull trout or other species have been known to migrate upstream past the dam since its construction. However, migratory bull trout are known to inhabit Koocanusa reservoir and to migrate from the reservoir into tributary drainages to spawn; the juvenile fish rear for several years before moving back downstream to the river or reservoir, where sub-adults rear for several more years prior to maturity. Furthermore, though resident bull trout have not been documented in this subpopulation, they but may be present (MBTSG 1996a). Bull trout have also

been known to pass through Libby dam and move downstream to below Kootenai Falls. An adult bull trout tagged in the Wigwam drainage in British Columbia was trapped in a wier on O'Brien Creek, below Kootenai Falls near Troy, Montana (pers. comm., Mike Hensler, MFWP).

Most of the upper Kootenai River bull trout subpopulation occurs in British Columbia. The Wigwam River drainage in British Columbia supports most of the subpopulation's known spawning and rearing habitat. Recent telemetry studies on bull trout by MFWP personnel show that individual fish use vast portions of Koocanusa Reservoir in Montana and the Kootenai River in Canada during different times of the year. On the U.S. side, the only known spawning and rearing habitat is located in the Grave Creek drainage. This drainage and its tributaries: Clarence Creek, Lewis Creek, Stahl Creek, Williams Creek, and Blue Sky Creek, are the only known areas in the U.S. portion of the upper Kootenai River subpopulation inhabited by bull trout.

Bull trout migrate from Lake Koocanusa up the Tobacco River to reach the Grave Creek drainage to spawn and rear. Since surveys were initiated in 1983, redd counts from Grave Creek have fluctuated widely reaching a low of 15 in 1995, but in the last 3 years, redd counts have increased steadily with totals of 49, 66, and 134 for 1997, 1998, and 1999, respectively (MFWP, unpubl. data, 1999). However, the State of Montana has designated Grave Creek as Water Quality Limited Segments (WQSL), which are bodies of water where existing pollution controls are inadequate to attain and maintain water quality standards. The pollutant of concern in Grave Creek is sediment derived from agriculture and silviculture. Past management and road construction activities have altered the hydrologic and streamflow regime in several Grave Creek tributaries, resulting in elevated levels of fine sediment produced in the watershed. The lower portion of Grave Creek was also exposed to log drives around the turn of the century. Furthermore, large volumes of bedload (cobble/rubble) is redistributed each year in portions of Grave Creek, partially the result of a flood in 1974 flood and subsequent instream channel work. Efforts are underway in the Grave Creek drainage to offset these impacts of irrigation diversion, fish passage, and habitat degradation. It is likely that these efforts will result in increased bull trout production in the relatively near future.

Redd surveys in Wigwam Creek, most of which occurs in British Columbia, were initiated in 1994. The number of redds documented in this portion of the Wigwam are some of the highest in the bull trout's range, indicating this likely is one of the strongest remaining bull trout areas (pers. comm., Mike Hensler, MFWP) In 1997, 589 redds were counted, there were 679 redds in 1998, and 868 redds in 1999 (MFWP, unpubl. data, 1999). In the U.S. portion of the drainage, redd counts ranged from 12-21 from 1996 through 1999. Initiation of catch and release angling regulations in 1995 has been suggested as a primary factor for this increase (pers. comm., B. Westover, BC Environment, in MBTSG 1996a). The FWS does not consider the upper Kootenai bull trout subpopulation to be at risk of stochastic extirpation (FWS 1998b).

Sophie Lake Subpopulation: A disjunct adfluvial bull trout subpopulation exists in Sophie Lake, but no abundance or distribution information is available (MBTSG 1996a). Bull trout were documented in Sophie Lake in the 1960s (Platts et al. 1995). Because of its isolation, the FWS considers the Sophie Lake subpopulation to be at risk of stochastic extirpation (FWS 1998b).

Middle Kootenai River Subpopulation: This subpopulation consists of the 29 mile reach between Libby Dam downstream to Kootenai Falls. Currently, bull trout are isolated within this area (MBTSG 1996b). Downstream gene flow likely occurs at Kootenai Falls and to a lesser extent at Libby Dam. This bull trout subpopulation is primarily migratory with spawning and rearing documented in four tributaries draining into this portion of the Kootenai River. These migratory fish spend their adult lives in the Kootenai River. Resident bull trout exist in upper Libby Creek and Flower Creek and one fish was captured in Parmenter Creek (MBTSG 1996b). Bull trout were documented in the 1950s and 1960s in Flower Creek and Pipe Creek (Platts et al. 1995, MBTSG 1996b).

Presently, the Quartz Creek drainage is the most important spawning and rearing area in this subpopulation. Redd counts in the Quartz drainage (including the West Fork of the Quartz) since 1985 have ranged between 16 to 105 redds (MBTSG 1996b; MFWP, unpubl. data, 1996). Redd counts in 1998 and 1999 in the Quartz were the highest on record with 105 and 102 observed, respectively. Most of the redds have been observed in the West Fork of Quartz Creek. The remaining redds were observed in Quartz Creek downstream of the confluence with the West Fork. MFWP and the Kootenai National Forest conducted spawning site inventories on several other tributaries to the Middle Kootenai and found that Pipe Creek, Granite Creek, Midas Creek, Dunn Creek, and the Fisher River has small amounts of spawning activity. Pipe Creek supports some limited bull trout spawning in which the last 3 years redd counts have ranged from 36 to 47 redds. Bull trout redd surveys have not identified other streams with significant redd concentrations to date (MBTSG 1996b), although Bear Creek redd counts in recent years have increased from 13 redds in 1997 to 36 redds in 1999. The Fisher River is a major tributary to the Kootenai River and may have been an important bull trout stream historically. Over 50 percent of the middle Kootenai River bull trout subpopulation live in its waters and tributaries.

The entire length of the Fisher River, the largest tributary to the Middle Kootenai, and the confluence of all the Fisher River's tributaries are on private lands owned primarily by Plum Creek. The two largest tributaries to the Fisher (Wolf Creek and Pleasant Valley Fisher River) are situated in wide valley bottoms owned by Plum Creek and a few private individuals. These private lands, including Plum Creek's, extend upslope for 1 to 4 miles along the entire valley corridor. All of these lands have been roaded and harvested on at least one occasion. Timber harvest, road construction, railroad construction, cattle grazing, and channel realignments have been major impacts in this portion of the Fisher River. The mainstem Fisher River and Wolf Creek flows through soils that are highly erodible, and flushing of accumulated sediment in major sections of these drainages has been limited by low gradients. These factors and past management practices have resulted in increased erosion and damage to riparian vegetation in the Fisher River drainage (May 1971 as cited in Kootenai National Forest, 1999).

The Fisher River has also been extensively channelized; this occurred in 1966 in conjunction with construction of Libby Reservoir during relocation of an existing railroad bed from the mouth of the river upstream to below Wolf Creek junction (Kootenai National Forest 1999). Most of this

work was completed by September 1967. Approximately 44 percent of this portion of the Fisher River was channelized, with a net loss of almost one mile of stream channel and an increased gradient. Further, from its confluence with the Kootenai River upstream for about 10 miles, the Fisher River is sandwiched between a major road system and the Burlington Northern railroad tracks. The fill associated with the railroad tracks has been rip-rapped for most its length; the road has also been rip-rapped for most of its length. Flooding in recent years has caused extensive erosion of the fill material. The entire valley bottom in this area has been harvested and shade cover is minimal along most of the stream channel. Stream temperatures on this portion of the Fisher River are extremely high during summer low flow periods, often reaching over 80 °F. Fall spawning species have had to adjust to this by entering the Fisher River in late September or October. Furthermore, pools associated with the construction of the rip-rap mentioned above has had an impounding effect and produced backwater type habitat favoring longnose and largescale suckers. This has resulted in considerably more habitat for suckers and other rough fish rather than in habitat for bull trout (Kootenai National Forest 1999).

The channelization of Fisher River and Wolf Creek and subsequent maintenance activities has resulted in significant impacts to the aquatic habitats in this portion of the Middle Kootenai drainage. These include the establishment of man-made streambeds that are relatively unsuitable for bull trout and other salmonid species, denuding of large land areas and creation of steep slopes along the railroad grade, changes in the stream channel which are susceptible to erosion, and increased erosion rates as a result of these factors (Kootenai National Forest 1999). Large sections of the channel continue to exhibit severe bank erosion and channel instability. Furthermore, these patterns were the result, in part, of a failure to revegetate disturbed streambanks immediately after construction, and the fact that extensive timber harvest and road construction occurred soon after construction in response to a mountain pine beetle epidemic which killed trees across large acreages in the Fisher River drainage, particularly Wolf Creek and its tributaries. This was then followed by two large fires which occurred in 1988 and 1994, with subsequent salvage of those areas (Kootenai National Forest 1999).

However, poor aquatic habitats resulting from past construction and land management activities is apparently limiting bull trout populations in the Fisher River. All trout populations dropped off markedly from 1970 to 1971 in sections of the Fisher River and Wolf Creek influenced, apparently, by these activities. This decline in trout numbers after construction activities appears to be due to natural variation in year class strength coupled with adverse environmental conditions which caused excessive mortalities of age 1 and older fish. Sediment pollution and increases in water temperatures were caused by the destruction of riparian vegetation. This environmental damage and extensive modifications to the river and creek channels are the most probable factors adversely affecting bull trout populations and other native fish in the Fisher River and Wolf Creek drainages.

However, two tributaries to the Fisher River (West Fisher and Silver Butte) have their origin in the Cabinet Mountain Wilderness, and are the only portions of the Middle Kootenai River sub-basin that are considered priority watersheds by the USFS (Kootenai National Forest 1999).

These two drainages make up about 16 percent of the total Fisher River drainage. However, timber production, mining, and recreation occur in these tributaries, and 4 to 7 miles of these streams is characterized by channel instability, increased sediment loading, channel migration, and bank cutting. Potential pollution from mine-tailing seepage and magnified peak flow events are also possible events that could negatively impact native fish and their habitat.

Bull trout are known to migrate several miles up the Fisher from the Kootenai River. For example, nine bull trout were captured in the Fisher River in a migrant trap 11.5 miles upstream from its confluence with the Kootenai River, and in 1993 redd counts were completed in the Fisher River drainage on 13 streams and a total of 13 bull trout redds were observed; 4 in the East Fisher, 8 in Silver Butte Fisher River, and 1 in the Fisher River (MBTSG 1996b). In this same year, traps captured 11 bull trout (MBTSG 1996b). During the 1993 surveys, most Fisher River tributaries were found to have fish passage problems and very few quality spawning sites due to high gradient, large stream bed substrate, low pool-to-riffle ratio, and subterranean water flow (MBTSG 1996b).

Migratory bull trout have been observed in Libby Creek, and resident bull trout may be present in Libby Creek as well as in its tributary Big Cherry Creek. Bull trout have also been sampled in several other tributaries to Libby Creek on occasion in the past. During the late 1980s, bull trout were sampled in Poorman Creek and Ramsey Creek, but not in Little Cherry Creek, which is a neighboring drainage (MBTSG 1996b).

Lower Kootenai River Subpopulation: This subpopulation consists of the Kootenai River drainage from Kootenai Falls downstream into Idaho. In this subpopulation bull trout are distributed from Kootenai Falls downstream to Kootenay Lake in British Columbia. These fish are migratory and spawn in tributaries in Montana, Idaho, and British Columbia, while spending their adult lives in Kootenay Lake and/or Kootenai River (MBTSG 1996c). On the lower Kootenai River, face watersheds, terraces and benches often serve as sediment traps that reduce sediment delivery to stream courses. Typically, stream gradients in this area are gentle in their headwaters, steepen considerably as they drop down the breaks, and then flatten again when they reach the Kootenai River terrace. These face drainages do not provide habitat for bull trout because of their extremely small size, gradient, subsurface flows, and inaccessibility; consequently, bull trout distribution in the Lower Kootenai sub-basin is very limited and virtually no historic data exists for bull trout in this subpopulation. Resident bull trout have not been documented in this subpopulation, although they may exist (MBTSG 1996c). No bull trout spawning anywhere in the mainstem Kootenai River has ever been documented (MBTSG 1996c). Besides the disjunct Bull Lake subpopulation (see below), the only known bull trout spawning areas in the lower Kootenai River below Kootenai Falls in Montana occur in O'Brien Creek and Callahan Creek.

Currently, O'Brien Creek is considered the most important spawning and rearing area in the lower Kootenai subpopulation in Montana (MBTSG 1996c). Spawning inventories have occurred in O'Brien Creek since 1992. Redd counts since 1992 through 1999 have ranged between 12 and 47 (MBTSG 1996c; MFWP, unpubl. data, 1999). Lower main and South Fork Callahan creeks are

also important for bull trout even though spawning redds have not been observed. A fish trap installed on Callahan Creek just above the confluence with the Kootenai River in an attempt to catch out-migrant adult bull trout in the fall after spawning yielded three adult fish and one radio-tagged adult female. Additionally, bull trout have been observed in Star and Ruby creeks just upstream of their mouths; however, spawning is limited and has not been observed in these Kootenai River tributaries (Kootenai National Forest, unpubl. data 1996-1997). Fish habitat surveys and snorkeling surveys conducted in 1997 documented bull trout throughout these areas as well as the lowest portion of North Fork Callahan Creek below the migration barrier (Kootenai National Forest, unpubl. data, 1997). The quality of bull trout habitat in both Callahan and O'Brien creeks has been compromised as a result of past human disturbances, including catastrophic fire, mining, salvage logging, water diversion, road construction, and poaching. These activities have occurred in Callahan Creek since the early 1900s and more recently in O'Brien Creek. Currently, the FWS does not consider this population to be at risk of stochastic extirpation (FWS 1998b).

Bull Lake Subpopulation: Bull Lake, located south of the mainstem Kootenai hear the Idaho/Montana border, now contains adfluvial bull trout representing a disjunct subpopulation from the balance of the lower Kootenai. The isolation of Bull Lake occurred when migration from the lower Kootenai River up Lake Creek into Bull Lake was blocked by the construction of Lake Creek Dam in 1917 (MBTSG 1996c). Bull trout in Bull Lake migrate downstream through Lake Creek to access Keeler Creek drainage to spawn. Keeler Creek and its North and South Fork tributaries were surveyed for the first time in 1996; redd counts in the Keeler Creek drainage totaled 74, 59, 92, and 99 for 1996, 1997, 1998, and 1999, respectively (MFWP, unpubl. data, 1999). Other tributaries contain spawning habitat; however, spawning has not been confirmed anywhere except in Keeler Creek drainage. Spawning in South Fork Keeler is limited to the lowest mile of the creek where it drains a wetland which is strongly influenced by subsurface flow. Interestingly, the riparian area throughout the South Fork Keeler watershed is fragmented and poorly connected with loss of function in certain areas, the effects of which may be muted due to the wetland/groundwater influence (pers. comm., Shane Jones, Kootenai National Forest). The KNF estimates population size to be 155, 124, and 193 adult bull trout for 1996, 1997, and 1998, respectively. The FWS does not consider this population to be at risk of stochastic extirpation (FWS 1998b).

Summary of Factors Affecting Bull Trout in the Kootenai River Sub-basin: The dominant land use in the entire Kootenai River watershed is timber harvest. Extensive road construction to support logging operations exists throughout the watershed. Seven streams (95 miles) in the upper Kootenai drainage, 5 streams (124 miles) in the Middle Kootenai, and one stream (7 miles) in the Lower Kootenai are water quality impaired as a result of silviculture activities (MDHES 1994). As a result of salvage logging, which began in the watershed in 1996, the number of acres of timber sold and clearcut increased substantially over the previous 3 years (Kootenai National Forest 1997). However, since 1995, KNF is required to follow INFISH requirements in an effort to conserve bull trout.

The Montana Bull Trout Scientific Group (MBTSG) (1996a,1996b,1996c) reported that past forestry practices (road construction, log skidding, riparian harvest, clearcutting, and terracing) were major contributing causes to the decline of bull trout in the upper, middle, and lower Kootenai drainages (which are roughly equivalent to the Upper Kootenai, Middle Kootenai, and Lower Kootenai planning area sub-basins). Even though current forestry practices are less detrimental than past practices, the MBTSG (1996a,1996b,1996c) rated the risk of forestry management practices adversely affecting bull trout survival as very high. Virtually all drainages currently supporting bull trout in the Kootenai watershed are managed timberlands. Even given the greater efforts at bull trout conservation as a result of INFISH and other conservation efforts, risks to bull trout are still high because of the existing road system, mixed land ownership, forestry practices on private lands, and the lingering effects of past activities. The latent effects from past activities on habitat include increased sediment in streams, increased peak flows, thermal modifications, loss of instream woody debris, channel instability, and increased access for anglers and poachers.

The three primary concerns of the MBTSG (1996a) in the upper Kootenai area are forestry practices, cooperation with Canada, and illegal fish introductions. Other high risks reported were introduced species already present, dam operations (e.g., Libby Dam), and illegal harvest. In the upper Kootenai River drainage, both Grave Creek and Wigwam drainages, which are known bull trout spawning habitat, are largely second growth and timber harvest continues. Extensive road construction has resulted in increased water and sediment yields in these drainages. Only the headwaters of Grave Creek is protected from future timber management activity (MBTSG 1996a). Due to the proximity of forest management activities to limited bull trout spawning and rearing areas, the current risks will continue to remain high (MBTSG 1996a).

Canadian cooperation is essential because the majority of bull trout spawning in the Kootenai watershed occurs in Canada. The Wigwam drainage in British Columbia, possibly the strongest population remaining rangewide, is undergoing assessment under British Columbia's forest practices rules for proposed logging and road building scheduled to begin in 1997 (P. Graham, MFWP, *in litt.* 1997).

In addition, there is concern about management of Lake Koocanusa reservoir levels, which could have an overriding effect on the entire system (MBTSG 1996a, 1996b). Drawdown limits for Koocanusa Reservoir have been exceeded in 6 years since 1987 when the limits went into effect; this impacts the food chain in the reservoir (MBTSG 1996a, 1996b). Determining operational rules for the reservoir that are adequate to protect bull trout has yet to be done.

Poachers target concentrations of large bull trout in the Kootenai drainage (Long 1997). In the upper Kootenai, illegal harvest is a threat because adult fish in Grave Creek are targeted by poachers. In addition, bull trout outmigrating from Grave Creek into Glen Lake irrigation ditch are lost from the upper Kootenai River subpopulation because they are prevented from returning by a concrete drop structure (MBTSG 1996a). The MBTSG (1996a) identified Grave Creek as the only bull trout core area in the upper Kootenai; therefore, loss of fish from this core area is a

significant threat. Glen Lake ditch also dewaters several tributaries of Grave Creek (MBTSG 1996a). Efforts are currently underway to design and construct a fish screen for the Glen Lake irrigation ditch.

Another risk factor for bull trout habitat is rural residential development, which is increasing along tributaries in the upper Kootenai drainage (MBTSG 1996a); this is because large tracts of private land exist along the stream channels throughout this area. Rapid population growth in the area brings with it an increase in other threats such as increasing numbers of permits to construct fish ponds within the 100-year floodplain.

Libby Dam is an upstream passage barrier to bull trout in the middle and lower Kootenai drainages, and restricts this migratory population to 25 miles of river. Libby Dam also reduces high spring flows, making upstream passage over Kootenai Falls impossible. Only downstream genetic exchange now occurs (MBTSG 1996b). Libby Dam has altered temperatures, flow regimes, and sediment loads in the Kootenai River (MBTSG 1996b). Deltas have been forming at the mouths of some tributaries that could impede upstream movement of bull trout spawners during low flows (MBTSG 1996b). The threat from dam operations is considered high by the MBTSG (1996b) due to uncertainties concerning the biological impacts associated with flow fluctuations and gas super-saturation that arises as a result of spilling water.

A major tributary to the middle Kootenai River drainage, the Fisher River drainage, has several watershed problems. Frequent flooding and concentrated high water yields, sedimentation, and small slumps below clearcuts and roads occur, and over 124 miles of five streams are considered to have impaired water quality as a result of timber harvest activity in this drainage (MTDHES 1994).

The risk to bull trout in the Quartz Creek core area remains high because of impacts associated with past salvage logging sales and the proximity of sale areas to the few bull trout spawning and rearing areas in the drainage (MBTSG 1996b). Additionally, the majority of managed timber lands in the west half of the Kootenai National Forest has watershed problems such as flooding, sedimentation, slumps, and high water yields (MBTSG 1996b).

In the middle Kootenai river drainage, Snowshoe Creek, Libby Creek, and Big Cherry Creeks are water quality impaired because of past mining activities (MDHES 1994). Furthermore, a large copper and silver mine is currently being proposed in the Libby Creek watershed. Tailings from this mine would be stored behind a high dam in Little Cherry Creek, which would be relocated (MBTSG 1996b).

Lake Creek Dam in the lower Kootenai is located at the site of a natural waterfall that may have created a seasonal passage barrier between the Kootenai River and Bull Lake even before the dam was constructed. However, Lake Creek Dam now completely isolates bull trout in Bull Lake from downstream areas, and the lake population is supported by spawning areas within the drainage itself (MBTSG 1996c). Threats to bull trout habitat in Bull Lake include forestry

practices, residential development, and toxic substance spills from the adjacent highway (MFWP 1997). A newly proposed housing development on the west shore of Bull Lake may result in an increase in the incidental catch of bull trout through increased angling pressure; water quality impacts may also increase as a result of the development due to potential increases of phosphates and other chemicals. Bull Lake contains a number of nonnative fish including largemouth bass and kokanee (MFWP 1997). The management objective for Bull Lake is to maintain bull trout while managing the largemouth bass fishery, though the State of Montana acknowledges that the goals of managing for bull trout and warmwater fisheries could conflict and may require modification (MFWP 1997).

Brook trout exist in each of the Kootenai subpopulations, and bull trout/brook trout hybrids have been documented in the middle Kootenai subpopulation (MBTSG 1996c). Additionally, in Lincoln County in the middle Kootenai, there has been an increase in the number of applications for private pond stocking permits for brook trout (MBTSG 1996a, 1996b, 1996c); Watson and Hillman (1997) found an inverse relationship between bull trout occurrence and the presence of brook trout.

Several risks to bull trout exist in the lower Kootenai River drainage. Forestry practices remain a significant threat to bull trout here. For example, although the use of splash dams for log drives as a past logging practice has ceased, the effects on the habitat of past such activities are still evident and include increased sedimentation, increased peak flows, thermal modifications, loss of instream woody debris, and channel instability. Another current and ongoing factor in this area is Libby Dam, whose operations have altered the aquatic environment downstream from the dam. Downriver discharge patterns from Libby on both a seasonal and daily basis have undoubtedly altered periphyton and aquatic insect composition and production, as well as resident native fish populations. The effects of the dam on juvenile bull trout rearing and food supply have not been studied (MBTSG 1996b). Recent water releases reflect more natural flow regimes, but the effects of these flow modifications on bull trout are also unknown at this time (MBTSG 1996b).

In the lower Kootenai River drainage, a major risk to bull trout populations is illegally introduced species (MBTSG 1996c). Brook trout are present in the only core area, O'Brien Creek, and there is risk of lake trout introductions into Bull Lake and Kootenay Lake in British Columbia. In 1994, brown trout were collected in Lake Creek which is a tributary to Bull Lake. Northern pike are present in some valley lakes and backwater areas of the Kootenai River. In addition to illegal introductions, legal introductions by fish management agencies and individuals who have stocked a variety of species pose a risk to bull trout; these include stocking programs in Idaho and Canada. According to the MBTSG (1996c), the legacy of these past stocking practices poses a significant threat to the survival of bull trout today.

Westslope Cutthroat Trout

Principal tributaries of the Kootenai River sub-basin are the upper Kootenai, Fisher, Yaak, lower Kootenai, and Moyie rivers. Twenty-five percent of the Kootenai River sub-basin streams are

occupied by WCT and of these 13 percent were found to be pure (MFWP 1998). Land ownership in the drainage is 74.2 percent USFS, 1.5 percent State of Montana, and 24.3 percent private and other public entities (USDI 1999a).

Westslope cutthroat trout are believed to have historically occupied all of the streams and lakes to which they had access in the Kootenai River sub-basin (MFWP, *in litt.* 1998 as cited in USDI 1999a). In the sub-basin, however, only 1,615 miles (39.2 percent) of the estimated 4,119 miles of historic stream habitat have been surveyed for WCT. Thus, WCT could occupy additional stream miles that have not yet been surveyed. Among those 1,615 surveyed stream miles, WCT have been documented in 1,051 miles of stream (65.1 percent). Those WCT stocks have various degrees of genetic purity or have not yet been tested genetically. Of the total linear amount of stream habitat known to be occupied by WCT in the Kootenai River sub-basin, 74.2 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a).

WCT stocks are strong or predicted strong in 15 HUCs, depressed or predicted depressed in 159 HUCs, and absent or predicted absent in the remaining 11 HUCs that collectively constitute the Kootenai River sub-basin (USDI 1999a). Among the 1,615 miles of stream surveyed, stocks of genetically pure WCT occupy 138 miles (31 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 32 miles; and stocks that are < 90.0 percent pure occupy 309 miles (MFWP, *in litt.* 1998 as cited in USDI 1999a). Westslope cutthroat trout stocks inhabiting 572 miles of stream (196 stream reaches) remain untested genetically (Appendix Table 3, USDI 1999a). Among the 1,051 miles of stream occupied by WCT stocks, 104 of the stream miles have stocks that are genetically pure and considered abundant; genetically pure stocks in the remaining 34 miles of stream are considered rare. Of the 170 stream miles with WCT stocks that have genetic purity of 90 percent, fish in 125 miles of stream are considered abundant.

In the upper Kootenai River watershed, stocks of genetically pure WCT occupy 43 miles (7 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 26 miles; stocks that are < 90.0 percent pure occupy 250 miles; and stocks in 355 miles of stream (115 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 674 miles of stream occupied by WCT stocks, 512 of the stream miles have stocks that are considered abundant; stocks in the remaining 162 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the upper Kootenai River watershed, 47.2 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 15 HUCs; depressed or predicted depressed in 159 HUCs; and absent or predicted absent in the remaining 18 HUCs that collectively constitute the upper Kootenai River watershed (USDI 1999a).

In the Fisher River watershed genetically pure WCT occupy 9 miles (5 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 2 miles; stocks that are < 90.0 percent pure occupy 20 miles; and stocks in 142 miles of stream (43 stream reaches) remain untested genetically

(Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 173 miles of stream occupied by WCT stocks, 97 of the stream miles have stocks that are considered abundant; stocks in the remaining 76 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Fisher River watershed, only 18.2 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in none of the HUCs; depressed or predicted depressed in 29 HUCs; and absent or predicted absent in the remaining four HUCs that collectively constitute the Fisher River watershed (USDI 1999a).

In the Yaak River watershed, stocks of genetically pure WCT occupy 86 miles (18 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 4 miles; stocks that are <90.0 percent pure occupy 39 miles; and stocks in 75 miles of stream (35 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 204 miles of stream occupied by WCT stocks, 125 of the stream miles have stocks that are considered abundant; stocks in the remaining 79 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Yaak River watershed, 81.1 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in five HUCs; depressed or predicted depressed in 15 HUCs; and absent or predicted absent in the remaining two HUCs that collectively constitute the Yaak River watershed (USDI 1999a).

In the lower Kootenai River watershed, stocks of WCT are known to occur in three stream reaches but remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in two HUCs and depressed or predicted depressed in the remaining 31 HUCs that collectively constitute the Lower Kootenai River watershed (USDI 1999a).

The Moyie River watershed encompasses 208 square miles most of which is mostly under the jurisdiction of the USFS. WCT stocks are strong or predicted strong in two HUCs and depressed or predicted depressed in the remaining six HUCs that collectively constitute the Moyie River watershed (USDI 1999a).

In summary, WCT in the Kootenai River sub-basin, Montana, occur in about 227 tributaries or stream reaches that collectively encompass 1,051 linear miles of stream habitat, distributed among 5 watersheds (USDI 1999a). Of the total linear amount of stream habitat known to be occupied by WCT in the drainage, 74.2 percent lies on lands administered by federal agencies (USDI 1999a).

Summary of Factors Affecting the Species in the Kootenai River Sub-basin (based on USDI 1999a): Forestry practices, an extensive road system, and associated timber management activities have had adverse effects on the habitats of WCT in some areas of the Kootenai River sub-basin. Seven streams (95 miles) in the upper Kootenai River sub-basin, five streams (124 miles) in the middle Kootenai River sub-basin, and one stream (7 miles) in the lower Kootenai River sub-basin are considered water-quality impaired as a result of forestry practices (MDHES 1994). Twenty-three streams in the Kootenai River sub-basin are listed as being water-quality

impaired as the result of forestry practices, nine impaired by agricultural practices, and 18 impaired by water withdrawals; additional impairments result from other land-use practices (USDI 1999a). Many of these streams are water-quality impaired by more than one activity. Information on the possible occurrence of WCT in these streams is presently unavailable, however.

Although angler harvest of WCT may have caused appreciable declines in some westslope stocks earlier in this century, angler harvest is now closely regulated in Montana and is not considered a threat to the subspecies (MFWP, *in litt.* 1999 as cited in USDI 1999a). In many waters in the Kootenai River sub-basin, fishing for WCT is restricted to catch-and-release. Elsewhere in the drainage, harvest is greatly restricted. There are no evident, inherent inadequacies in existing federal, state or local regulatory mechanisms that affect WCT in the sub-basin (USDI 1999a).

Whirling disease has not been found in the Kootenai River sub-basin (Gustafson 1996 as cited in USDI 1999a). No one is aware of other diseases or predators than pose threats to WCT in the drainage.

As the result of stocking for recreational purposes, normative brook trout, brown trout and rainbow trout became established long ago in many streams and lakes throughout the Kootenai River sub-basin. Although such stocking has not occurred for more than two decades, the normative fishes that became established probably constitute the greatest contemporary threat to the maintenance and restoration of WCT in the Kootenai River sub-basin and the state (MFWP, *in lift.* 1999 as cited in USDI 1999a).

Redband Trout

RBT, or inland rainbow trout, are native to the lower Kootenai River drainage in northwestern Montana (Huston 1998; Hensler, Huston, and Sage 1996). RBT historically inhabited low-gradient valley-bottom streams throughout the Kootenai River drainage, but currently the distribution has been reduced and confined to isolated headwater areas. These remnant populations may represent the only known sources capable of refounding the historic distribution of pure RBT in Montana (Muhlfeld 1999).

Genetic surveys of fish in the Kootenai River drainages from 1980 through 1995 showed that RBT (i.e., interior rainbow trout) were present above and below Kootenai Falls in certain watersheds and subwatersheds (Hensler, Huston, and Sage 1996). Allendorf and Utter (1979) observed local heterogeneity in their genetic samples of rainbow trout that they attributed to planting of hatchery rainbow which created the genetic divergence among the local stocks. Allendorf et al. (1980) believed they had found five genetically pure remaining populations in Callahan Creek, Porcupine Creek, and the upper East and North Forks of the Yaak River.

In the Kootenai River drainage, Muhlfeld (1999) studied RBT in two small streams, Callahan and Sub-basin creeks. This investigation examined summer habitat use and distribution and fall and winter habitat use and movement of adults. From a land management viewpoint, results indicated

that maintaining and enhancing features that promote channel complexity (e.g., large woody debris, boulders) would provide RBT with resting and feeding habitat. In fall and winter for adults, maintaining habitat features that influence pool formation and depth throughout their limited range is likely essential for overwintering habitat. Land management activities that have altered the magnitude, timing and frequency of channel-forming discharges which have resulted in degradation of stream habitat in the Kootenai River drainage, including Callahan and Sub-basin creeks. The low quality stream habitat and spatial fragmentation, plus the likelihood of local disturbance in these two watersheds, may put these local populations at potential risk of extirpation if a stochastic event occurred (Muhlfeld 1999).

Currently, in the Fisher River and Libby Creek drainages RBT are confined to parts of these drainages where they occupy some streams and lakes. They are found in several Cabinet Wilderness lakes. Waters in the Kootenai River Sub-basin in northwest Montana that have been identified as containing genetically pure RBT include: North Fork and East Fork Yaak River drainages; Yaak River below Yaak Falls; Wee Lake in the Yaak River drainage; Callahan Creek drainage; Wolf Creek drainage; Silver Butte Fisher River; and Big Cherry Creek. Presently, MFWP has a no-planting policy in all but two of these listed areas.

Pleasant Valley above Loon Lake may have contained native RBT according to genetic analyses of fish collected from Barnum and Mark creeks and the mainstem Fisher in Pleasant Valley (Hensler, Huston, and Sage 1996). This analysis indicated there was a mix of coastal rainbow, westslope cutthroat trout, but primarily inland rainbow (i.e.; redband). MFWP suggests this area may have potential to increase RBT through restoration since no stocking has occurred in the Pleasant Valley Fisher River area since 1952 (Hensler, Huston, and Sage 1996).

Summary of Factors Affecting RBT in the Action Area: Environmental factors potentially affecting RBT in the action area essentially the same as those for bull trout and WCT. Hybridization, fragmentation and isolation of habitats, and habitat degradation are the major environmental risk factors affecting the status of RBT. Hybridization and competition are biotic factors influencing RBT status. Introduced rainbow trout are now the most widely distributed fish in the action area that have contributed to losses of native RBT. Watershed disturbances that result in loss of corridors or connecting habitats can progressively isolate RBT populations into smaller and smaller habitat patches increasing their risk of local extirpation. Land management activities that have led to, and continue to lead to, alteration of stream channels; loss or conversion of riparian cover; water diversions; and blockage of fish passage are principle threats to the quality of remaining habitat for RBT. Remaining populations of native RBT in the action area appear to be highly fragmented and restricted to small patches of known or potential habitat.

RBT are considered a species of special concern by MFWP. Conservation of RBT in northwest Montana is largely linked to two concerns: maintenance of existing habitats and genetic integrity (Hensler, Huston, and Sage 1996). Special consideration should be given to habitat protection and enhancement when designing and implementing land management activities such as timber harvest, livestock grazing, and mining. Introduction of other fish species can result in extirpation

of native fish through loss of genetic integrity, particularly when accompanied by habitat degradation which favors the introduced species. Maintenance of genetic integrity of RBT is a primary concern of MFWP. MFWP are presently examining fishery management actions and potential habitat restoration projects in the Kootenai River Sub-basin to aid in the recovery of native RBT (Hensler, Huston, and Sage 1996).

Flathead River Basin/Flathead Lake

The Flathead River Basin as described in this biological opinion contains two NFHCP planning area sub-basins, the Flathead River planning area sub-basin and Swan River planning area sub-basin.

Plum Creek lands in the NFHCP's Flathead River planning area sub-basin consist of 102,980 acres situated in two general locations–west and northwest of Flathead Lake and just north of Whitefish Lake. Tier 1 watersheds in the Flathead River basin total 157,670 acres (approximately 6 percent of the drainage), of which 11,439 acres (less than 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 2,424,512 acres (94 percent of the drainage), of which 90,965 acres (4 percent of the drainage) are owned by Plum Creek. No Key Migratory Rivers occur in the Flathead, on either Plum Creek or other lands. Perennial streams on Plum Creek lands in the Flathead total 88 miles. Grazing leases on Plum Creek lands in the Flathead total 46,757 acres along 105 stream miles. Of these, 3,263 acres and 7 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 1,288 miles of roads occur on Plum Creek lands in the Flathead and another 15 miles are proposed.

The Flathead River drainage is the largest tributary to the Clark Fork River and consists of the North, South, and Middle Forks of the Flathead River, Stillwater River, Swan River, Whitefish River, Flathead Lake, and the lower Flathead River. Flathead Lake is the largest natural freshwater lake in the western U.S. with a surface area of 126,000 acres. The lake has a mean depth of 165 feet and a maximum depth of 370 feet (MBTSG 1995a). The South Fork of the Flathead River drainage, the Swan River drainage, and the lower Flathead River (that portion of the river downstream of Flathead Lake) were all historically connected but are now disjunct due to dams. From the confluence of the North and Middle Forks, the Flathead River flows 55 miles to the inlet of Flathead Lake. The South Fork of the Flathead River enters the Flathead River approximately 10 river miles downstream of the confluence of the North and Middle Forks. The lower Flathead River flows out of Flathead Lake at Kerr Dam which is four river miles downstream from the original outlet of the lake. Kerr Dam partially controls water elevation in the lake. The North Fork of the Flathead River begins in British Columbia, Canada; the Middle Fork headwaters are in the Bob Marshall and Great Bear Wilderness areas; and the South Fork originates entirely within the Bob Marshall Wilderness.

Bull Trout

Bull Trout Status in the Flathead River/Flathead Lake Basin: There are three major sub-basins within the Flathead River basin: 1) the sub-basin including the North and Middle Forks of the Flathead River, Flathead Lake, the lower Flathead River, and the Stillwater and Whitefish Rivers

(both of which flow directly into Flathead Lake); 2) the sub-basin including Swan Lake and the Swan River system upstream from Swan Lake; and 3) the sub-basin including Hungry Horse Reservoir and the South Fork of the Flathead River. Each of these three sub-basins is synonymous with a bull trout population, and each population has a number of subpopulations. All three populations are dominated by a migratory life history. In addition, approximately 23 disjunct bull trout subpopulations occur in glacial lakes within the Flathead River basin (MBTSG 1995a). In the following sections, baseline conditions for the bull trout in the North and Middle Forks of the Flathead/Flathead Lake Sub-basin (including a bull trout subpopulation in the lower Flathead, which is separated from the balance of the sub-basin by Kerr dam), the Swan Lake/Swan River Sub-basin, and the disjunct bull trout subpopulations are described. The Hungry Horse/South Fork of the Flathead Sub-basin is not addressed, however, it is outside the action area.

Historically, the Flathead River drainage and all its major tributaries were interconnected, allowing migratory bull trout to be widely distributed throughout the system (Fraley and Shepard 1989, MBTSG 1995a). Bull trout in the Flathead system had access to the South Fork Flathead River drainage and the Swan River drainage; however, upstream passage from the Flathead into these two systems has since been blocked by construction of major hydroelectric dams on the South Fork Flathead River and Swan River. Kerr dam blocks passage from the lower Flathead River upstream into Flathead Lake. There are numerous historic reports of bull trout presence throughout the Flathead system and in the disjunct lake subpopulations in Glacier National Park (MBTSG 1995a). The interconnected Flathead basin possibly supported the largest migratory bull trout assemblage in the world (Flathead Basin Commission 1996).

Recent genetic testing has shown bull trout in Big Salmon Creek in the South Fork Flathead River drainage, Swan River, and Stillwater River and tributaries are genetically distinct from each other as well as from those in the Flathead River tributaries. It is likely that bull trout in Whitefish Lake, upper Whitefish Lake, Cyclone Lake, Frozen Lake, and each of the Glacier Park lakes are also genetically distinct, although little testing has occurred to date (Flathead Basin Commission 1998).

North/Middle Fork of the Flathead River/Flathead Lake Population: Bull trout that spawn in the Flathead River North Fork tributaries and Middle Fork tributaries are considered one meta-population since they depend on Flathead Lake for a major part of their life cycle. Flathead Lake has undergone significant changes in the last two decades. Oppossum shrimp (*Mysis relicta)* were stocked by MFWP into four lakes (Ashley, Swan, Tally, and Whitefish) in the Flathead system between 1968 and 1975, and first showed up Flathead Lake in 1981. *Mysis* shrimp had migrated down from the stocked lakes, through the river network, and into Flathead Lake and eventually reached a peak population by 1986. *Mysis* shrimp competition for the zooplankton prey also utilized by kokanee salmon (*Oncorhynchus nerka*) caused the kokanee population to plunge. By 1987, only 330 spawning salmon were observed in McDonald Creek down from numbers that varied from 26,000 to 118,000 from 1979 to 1985. Very few kokanee currently occur in the Flathead Lake system and these are likely individuals left from a kokanee stocking program. However, this program failed to reestablish the kokanee population because of lake trout

predation. Populations of lake trout (*S. namaycush*) and lake whitefish (*Coregonus clupeaformis*) increased as a result of the *Mysis* introduction. In turn, the expansion of these species has resulted in the decline of bull trout. The mechanism of the decline is not well understood since only a few bull trout have been observed in lake trout stomach analyses. However, it is known that lake trout prey on juvenile bull trout entering Flathead Lake (MBTSG 1995a), and Donald and Alger (1992) concluded that lake-dwelling populations of bull trout usually cannot be maintained if lake trout have been introduced (although, at the time of their paper, they considered Flathead Lake to be an exception). Donald and Alger (1993) examined 34 lakes where lake trout and bull trout overlapped in distribution and found that in 28 cases only one species was present. Furthermore, where the two species were sympatric, lake trout were the dominant species and in three case histories, lake trout completely displaced bull trout.

Currently, migratory bull trout reside in Flathead Lake but spawn primarily in the North Fork Flathead tributaries and Middle Fork Flathead tributaries (Fraley and Shepard 1989, MBTSG 1995a). This drainage supports one of the highest profile bull trout populations in the U.S. Redd counts of North Fork Flathead tributary monitoring areas in the 5 years from 1995 to 1999 averaged 78 redds annually, ranging from 44 to 111 redds (MDFWP, unpublished data, 1999). Of special note is a comparison of the 5-year period from 1980 to1984 in which redd counts were much higher, averaging 252 redds. Redd counts for the same 1995 to 1999, 5-year period in the Middle Fork Flathead tributary monitoring areas averaged 74 redds annually, ranging from 34 to 104 redds (MDFWP, unpubl., 1999). By comparison to the 1980 to 1984, 5-year period, redd counts averaged 141 redds.

These data suggest that, since 1991, the Flathead Lake bull trout subpopulation has declined drastically. The 1992 redd count of 61 redds for the North Fork tributaries was 72 percent below average (T. Weaver, MDFWP, *in litt.* 1992). Redd counts have continued to decline until, only recently (in 1996), the total redd count for North Fork Flathead tributaries was 52, the lowest on record (MDFWP, *in litt.* 1996). In 1992, the Middle Fork Flathead tributaries total redd count of 62 redds was 54 percent below average (T. Weaver, MDFWP, *in litt.* 1992). Total redds counted in the Middle Fork Flathead declined to a total of 31 redds in 1996 (MDFWP, *in litt.* 1996); however, since that time redd counts have increased with total counts of 70, 86, and 104 in 1997, 1998, and 1999, respectively. Of both the North and Middle Forks, only one of the monitoring areas had more than 10 redds in 1996 (MDFWP, *in litt.* 1996). An analysis of North and Middle Fork redd count data from 1988 to 1993 demonstrated a highly significant decline ($p<0.001$) (Weaver 1997). Additionally, a significant negative trend was apparent when the long term data from these monitoring streams was analyzed (Rieman and Meyers 1997). In contrast, Platts et al. (1995) concluded that bull trout in these Flathead tributaries were stable. Recent increases in redd counts in the last 2 years, particularly since bull trout were listed under the Endangered Species Act, are encouraging. However, it is too early to determine if this trend will continue or whether it will reach pre-1990 levels.

MFWP estimated the total number of adult bull trout in Flathead Lake in 1982 at 12,980 fish. The average adult population size during the 1980s was estimated at 13,188 fish (Fredenberg 2000).

Since 1992 (the last 8 years) this average has dropped to 2,426 fish. In 1997 MFWP estimated the population at 1,662 adult bull trout (MFWP internal memo 1998). Fredenberg (2000) estimated the 1997 total adult population at 1,581, and in 1998 and 1999, the estimates were 2,591 and 2,981, respectively. Recently, the 1998 and 1999 index spawner counts for the Flathead Lake migratory population were among the highest on record since 1991, indicating an improvement in spawner escapement. The reason for this improvement is unknown, but could be due to one or a combination of the following: 1) a single strong year class resulting from any number of reasons that result in better survival conditions for the 1998 cohort of spawning bull trout; 2) more restrictive angling regulations for bull trout, coupled with better enforcement and education efforts; and/or 3) stabilizing trophic dynamics in Flathead Lake that have less negative interaction on bull trout now than in the 6 previous years (Flathead Basin Commission 1998). Because of the extreme declines in the migratory bull trout population since the 1980s, it is uncertain whether recovery to historic levels is possible (Flathead Basin Commission 1996). Fredenberg (2000) postulated that the recovery of the Flathead Lake population to 1980s redd count levels (average total of 391 redds in the index streams) may represent an adult population of about 5,419 bull trout. This number is conservative and less than half of what was likely present in the system in the 1980s, since harvest of bull trout no longer impacts this population as it did in the 1980s.

The rapid decline of the bull trout in the Flathead Lake system in the 1990s generated much interest among fishery resource managers. A panel of fishery experts concluded that if bull trout were to return to population levels of the 1980s, lake trout numbers would have to be reduced by 70-90 percent of current levels (McIntyre 1998). This conclusion is substantiated by the fact that both Hungry Horse Reservoir and Swan Lake have healthy bull trout populations and lake trout are absent in these systems. Most of the experts gave a 60 to 80 percent probability that lake trout can be reduced to achieve this goal. Additionally, it was concluded that introduced species are contributing to the decline of bull trout and westslope cutthroat trout. The evidence of adverse impacts to bull trout from introduced species has suggested that these interactions may be the major limiting factor for bull trout in the Flathead Lake system rather than habitat degradation.

Bull trout historically were also widespread and likely common to abundant in the Stillwater and Whitefish River drainages in the Flathead system (MBTSG 1995a). However, today bull trout in these drainages area are uncommon (MBTSG 1995a). Bull trout still occur in Griffin Creek, Logan Creek, Good Creek, Martin Creek, and Sunday Creek in the Stillwater drainage, however (MBTSG 1995a).

Summary of Factors Affecting Bull Trout in the North/Middle Forks/Flathead Lake Sub-basin: According to the MBTSG (1995a), there is no single reason to account for the declining number of bull trout spawners in the North and Middle Forks of the Flathead River and Flathead Lake in recent years. However, evidence suggests that lake trout introductions and the resulting high numbers of lake trout are responsible. In contrast, bull trout in the Swan River system have increased (see Swan River sub-basin section) and bull trout populations in the South Fork of the Flathead River drainage have remained healthy and stable to date. Both systems, ostensibly, do not have lake trout or lake whitefish, two species that have been implicated in upsetting the

trophic dynamics of Flathead Lake to the detriment of bull trout and other native species. Lake trout are believed to be one of the most important factors causing the decline of bull trout in the Flathead Lake system and possibly several lakes in Glacier National Park (MBTSG 1995a). Furthermore, lake trout have been recently reported in the Swan River/Lake system (MFWP news, December 16, 1999).

Such introductions of lake trout and other nonnative species has resulted in what is likely the most significant threat to the persistence of bull trout in the Flathead basin (MBTSG 1995a, Flathead Basin Commission 1996). In the Flathead Lake basin, past stocking of numerous nonnative fish and invertebrates by Federal and State agencies have resulted in widely-distributed, self-sustaining populations of these species. In the Flathead Lake area alone, 13 introduced, nonnative fish species with which bull trout must coexist (MBTSG 1995a) are known to occur. These nonnative fish prey on and compete with bull trout. Furthermore, opossum shrimp (*Mysis relicta*) were introduced into lakes within the Flathead basin in the 1960s and 1970s, causing substantial changes in the food chain in Flathead Lake. As a result, introduced lake trout have become the dominant species (MBTSG 1995a), demonstrating that native fish populations can suffer indirectly even as a result of nonfish introductions. Furthermore, although lake trout are known to be the biggest threat to bull trout in the Flathead Lake basin, Flathead Lake continued into 1997 to be managed to maintain a trophy lake trout fishery.

Other illegal introductions of nonnative fish, usually involving warmwater fish that compete with or prey on bull trout, are also prevalent in this region of Montana and are a threat to bull trout (MBTSG 1995a). In Flathead River upstream of Flathead Lake are oxbow sloughs containing northern pike, largemouth bass, and yellow perch; pike and bass may compete with or prey on bull trout (MFWP 1997) and bull trout may use these sloughs seasonally (MFWP 1997). According to the MFWP (1997), primary management emphasis in these sloughs will be bull trout and westslope cutthroat, while maintaining bass and northern pike populations. Brook trout are also known to compete with bull trout. Watson and Hillman (1997) found an inverse relationship between bull trout occurrence and the presence of brook trout. Brook trout are found in the tributaries of the Middle Fork of the Flathead tributaries; however, few brook trout have been found in North Fork of the Flathead tributaries (MBTSG 1995a).

Past forest practices in the Flathead River basin (e.g., road construction, log skidding, riparian tree harvest, clearcutting, and splash dams) are also considered a significant factor in the decline of bull trout in the basin, and are considered a high risk to bull trout restoration in the basin (MBTSG 1995a). Because of the bull trout's sensitivity to sedimentation and water quality degradation, Fraley and Shepard (1989) considered timber harvest and road construction in both the North and Middle Fork of the Flathead drainages to be threats to bull trout spawning and rearing habitat. Although forest practices have improved, past effects still impact bull trout because existing roads still cause erosion and sedimentation and increase water yields to streams. Silvicultural activities are the cause of 202 miles of 17 streams in the Flathead River basin being classified as water quality impaired (MDHES 1994).

Other activities in the Flathead basin have also impacted aquatic habitats in the past and may do so in the future, including mining, road construction, railroad operation, residential development, dam operation, and fishing. In the headwaters of the North Fork of the Flathead in Canada, there is a large coal deposit that has been proposed for mining in the past (MBTSG 1995a). Mining this deposit could result in the loss of bull trout spawning habitat and downstream water quality impacts (MBTSG 1995a). There is also currently a proposal to pave the lower nine miles of the dirt road along the North Fork, which may or may not benefit bull trout. In Bear Creek in the Middle Fork of the Flathead, the stream has been channelized for a railroad, spills of foreign substances from train derailments have occurred, and there is the potential for future spills of toxic materials, which would impact Bear Creek, the Middle Fork Flathead, and the mainstem of the Flathead (MBTSG 1995a). Rural residential development in the Flathead Lake system is increasing and is considered a potential impediment to bull trout restoration because of water quality impacts and changes to stream morphology (MBTSG 1995a). Wildfire and drought are other factors that may have impacting bull trout spawning success in localized sites in the North Fork of the Flathead and Middle Fork of the Flathead (MBTSG 1995a).

Hungry Horse Dam has impacted bull trout in the past by releasing cold water into the Flathead River, decreasing productivity and possibly enabling lake trout to migrate into the river system. However, a selective withdrawal system is now in operation on Hungry Horse Dam, allowing for some control of downstream temperatures (MBTSG 1995a).

Montana bull trout fishing regulations have gotten progressively more restrictive, culminating in the 1992 closure of the Flathead Lake basin to bull trout harvest. The mouths of some important bull trout spawning tributaries in the North Fork of the Flathead have been closed to angling to protect bull trout in staging areas from June 1 to August 30 (MFWP 1996). Additionally, some significant bull trout spawning tributaries in the North Fork of the Flathead and Middle Fork of the Flathead are closed all year to angling (MFWP 1996). The Confederated Salish and Kootenai Tribes closed all tribal lands (Flathead Reservation) to bull trout fishing since 1987. However, concern that incidental catch of bull trout may be high in this basin remains because of the substantial amount of angling for other sport fish (MBTSG 1995a). Anglers may be illegally and unintentionally harvesting bull trout because of misidentification, only 40 percent of anglers were able to correctly identify bull trout from other salmonids in westcentral Montana (M. Long and S.P. Whalen, MFWP, *in litt.* 1997).

Since 1995, the USFS and BLM is required to follow INFISH requirements in an effort to conserve bull trout. Since the listing of bull trout in June 1998, the FWS has worked closely with these agencies in Montana to address ongoing and proposed projects that may impact bull trout

Lower Flathead River Subpopulation: The lower Flathead River is one of Montana's largest rivers. Flow in this portion of the river is regulated by Kerr Dam, located four miles downstream of the original outlet of Flathead Lake. From here the river flows south and west for 72 miles to its confluence with the Clark Fork River near Paradise, Montana (DosSantos et al. 1988). Bull trout in this reach of the Flathead River are considered a subpopulation within the North/Middle Fork/Flathead Lake Sub-basin, but are isolated from other upstream subpopulations by Kerr Dam.

The present distribution of bull trout in the lower Flathead River system is much reduced from historic levels. The primary factors in this system detrimental to bull trout are the mainstem river dams, which limit bull trout migration, and water quality degradation related to agricultural practices and timber harvest. Kerr Dam blocks fish passage between the lower Flathead/Clark Fork River systems and Flathead Lake. In total, five hydroelectric dams have fragmented the Clark Fork and Flathead river systems. Three of these (Cabinet Gorge, Noxon, and Thompson Falls) are on the mainstem Clark Fork River and have completely eliminated bull trout migration from Lake Pend Oreille in Idaho. Although the migratory life form still persists and continues to have access to some tributaries, many tributaries are no longer accessible to or are no longer used by bull trout.

About 1910, extensive construction of an irrigation system broke the connection between the lower Flathead River and many of its tributary streams. Construction of irrigation diversions, canals, and dams on these tributaries eliminated access to more than 62 miles of spawning and rearing habitat (Cross and DosSantos 1988). These developments have resulted in several isolated and disjunct bull trout populations on the Flathead Indian Reservation.

During extensive electrofishing surveys on the lower Flathead River between 1983 and 1986, 17 bull trout were captured, ranging in length from 7.5 to 33.5 inches. These fish averaged 19 inches in length and 2.9 pounds in weight. The authors noted that bull trout were the least common of the seven salmonid species found in the river (DosSantos et al. 1988).

Summary of Factors Affecting the Lower Flathead River Bull Trout Subpopulation: According to the MBTSG (1996d), the highest threat to bull trout in the lower Flathead River system is dams, water diversions, and agricultural practices. Kerr Dam, completed in 1938 on the Flathead River four miles downstream of Flathead Lake, blocked upstream passage from the lower Flathead River into Flathead Lake. The impacts of this development on fish populations have not been fully determined; however, operation of the dam and resulting flow fluctuations are known to have reduced the food base (aquatic macroinvertebrates) in the lower Flathead River, which in turn, has reduced the carrying capacity of the river for fish (Cross and DosSantos 1988).

An extensive irrigation system in the lower Flathead River, also a result of Kerr Dam, has probably been one of the primary causes of bull trout decline in this portion of the Flathead basin. Temperature appears to limit bull trout habitat in several tributaries and in the mainstem Flathead River below Flathead Lake. In the lower Flathead River, summer water temperatures are near 68 °F and may limit bull trout distribution (DosSantos et al. 1988). However, these warm water temperatures may be a natural occurrence, indicating more research is needed to determine specific causes of thermal problems and the resultant impact on bull trout (MBTSG 1996d).

Disjunct Subpopulations in the North/Middle Fork/Flathead Lake Sub-basin: Numerous lakes in the Flathead River basin, particularly in Glacier National Park and the upper Stillwater drainage, contain disjunct bull trout subpopulations. These subpopulations are considered to be functionally isolated from other subpopulations, though not necessarily as a result of physical barriers. Most

have become isolated due to natural thermal conditions that preclude upstream or downstream migration (MBTSG 1995a), though it is possible a small amount of movement occurs into and out of some these subpopulations (L. Marnell, Glacier National Park, *in litt.* 1995). For most, little bull trout status information is available. Three sets of disjunct bull trout subpopulations occupying lakes within the North/Middle Fork/Flathead Lake Sub-basin are described below: 1) Stillwater/Whitefish Rivers Disjunct subpopulations; 2) the North Fork Flathead River Disjunct subpopulations; and 3) Middle Fork Flathead River Disjunct subpopulations.

Stillwater/Whitefish Disjunct Subpopulations: The Stillwater River and Whitefish River are tributaries of Flathead Lake. Both were dammed at one time, temporarily creating migration barriers to fish (MBTSG 1995a). Habitat in these drainages has been highly degraded for many years as a result of road-building, logging, irrigation water withdrawals, and subdivisions (MBTSG 1995a) The Stillwater River downstream of Lower Stillwater Lakes has been impacted by high sediments and high water temperatures (MFWP 1997). In the Stillwater/Whitefish river drainage, the numbers and distribution of nonnative fish, particularly brook trout and lake trout, are likely a primary cause of the decline of bull trout in these drainages (MBTSG 1995a).

Whitefish Lake: Bull trout in this subpopulation spawn in Swift and West Fork Swift creeks and rear/overwinter in Whitefish Lake (MBTSG 1995a). This subpopulation is declining and is bull trout are considered rare (MBTSG 1995a, MFWP 1997). Introduced nonnatives are lake trout, brook trout, rainbow trout, northern pike, lake whitefish, and yellow perch. Lake trout is now the dominant predator in this system. Northern pike were illegally planted in 1970s (MFWP 1997). The management objective for this lake is protection of bull trout and westslope cutthroat while managing for a low density northern pike fishery, although it is acknowledged that northern pike may conflict with bull trout (MFWP 1997). Lake trout and lake whitefish are now the most abundant gamefish in Whitefish Lake (MFWP 1997). In the Whitefish Lake subpopulation, habitat risks include chemical spills in the lake from railroad derailments (MFWP 1997). Land ownership is private and there is extensive residential development along the shoreline (MFWP 1997).

Upper Whitefish Lake: Bull trout in this subpopulation spawn in East Fork Swift Creek and rear/overwinter in Upper Whitefish Lake (MBTSG 1995a). Little is known about the status of this bull trout subpopulation, and its stability is therefore unclear (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Stillwater State Forest. Because of its isolation, this population is at risk of stochastic extirpation.

Tally Lake: Bull trout in this subpopulation spawn in Logan Creek and rear/overwinter in Tally Lake (MBTSG 1995a). Tally Lake has contained a small bull trout population in recent decades, but it is now thought to be declining (MBTSG 1995a). During a 1990 survey, no bull trout were caught (L. Marnell, *in litt.*, 1995). Introduced nonnatives are lake trout, brook trout, rainbow trout, northern pike, kokanee, and yellow perch. Spawning habitat is limited due to low quality substrate and thermal conditions in upstream watersheds. The primary land manager is Flathead National Forest. Because of its isolation, declining numbers, and presence of nonnatives, this subpopulation is at risk of stochastic extirpation.

Upper Stillwater Lake: Bull trout in this subpopulation spawn in Fitzsimmons Creek and the upper portion of the Stillwater River and rear/overwinter in Upper Stillwater Lake (MBTSG 1995a). Bull trout numbers in Upper Stillwater Lake are declining (MBTSG 1995a). Introduced nonnatives are lake trout, brook trout, rainbow trout, northern pike, and yellow perch. The primary land manager is Stillwater State Forest and Flathead National Forest. Upstream fish passage is prevented by a waterfall between Lower and Upper Stillwater Lakes and a dam on Upper Stillwater Lake prevent upstream passage (MFWP 1997). Currently this lake contains predominantly northern pike, lake trout and yellow perch (MFWP 1997). Northern pike and lake trout predation and competition with yellow perch have resulted in negative impacts to bull trout (MFWP 1997) The primary management emphasis is protection of bull trout and westslope cutthroat while managing the existing northern pike fishery (MFWP 1997). In the Upper Stillwater Lake subpopulation, habitat risks include urban development and highway or rail hazardous substance spills (MFWP 1997).

Lower Stillwater Lake: Full trout in Lower Stillwater Lake are likely extirpated, although, historically, this lake connected bull trout habitat to the Flathead Lake system (MBTSG 1995a, MFWP 1997). Introduced nonnatives are lake trout, brook trout, rainbow trout, northern pike, and yellow perch. The primary land manager is Stillwater State Forest and Flathead National Forest. The most numerous fish in this lake is northern pike and the lake is managed as a pike fishery, lake trout are also present (MFWP 1997). In the Lower Stillwater Lake subpopulation, habitat risks include urban development, mill contamination, and rail and highway substance contamination (MFWP 1997). The northern end of the lake is used as a log pond for a sawmill (MFWP 1997). A state highway parallels the east side of the lake.

North Fork Disjunct Subpopulations: The following disjunct bull trout subpopulations occur in the North Fork of the Flathead River drainage.

Kintla Lake: Bull trout in this subpopulation spawn in Kintla Creek and rear/overwinter in Kintla Lake (MBTSG 1995a). This subpopulation is declining (MBTSG 1995a; L. Marnell, *in litt.*,1995). Introduced nonnatives are lake trout, lake whitefish, and kokanee. In lower Kintla Lake the presence of lake trout is believed to be the primary cause of the decline of bull trout in this subpopulation (L. Marnell, *in litt.*,1995). The primary land manager is Glacier National Park. Because of its isolation, declining numbers and presence of nonnatives, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Upper Kintla Lake: Bull trout in this subpopulation spawn in Kintla Creek, which is downstream from Upper Kintla Lake, where this bull trout subpopulation rears/overwinters (MBTSG 1995a). This subpopulation appears stable (MBTSG 1995a). Genetic data show that bull trout in Upper Kintla Lake are distinct from others in the North/Middle Fork/Flathead Lake Sub-basin (MBTSG 1995a). No introduced nonnative species are known to be present. The primary land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Cerulean Lake: Bull trout in this subpopulation spawn in Rainbow and Quartz creeks, which are downstream from Cerulean Lake, where they rear/overwinter (MBTSG 1995a). This bull trout subpopulation appears stable (MBTSG 1995a). No introduced nonnative species are known to be present. Primary land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Upper Quartz Lake: Bull trout in this subpopulation spawn in Rainbow and Quartz creeks and rear/overwinter in Upper Quartz Lake (MBTSG 1995a). This bull trout subpopulation appears stable (MBTSG 1995a). No introduced nonnatives are known to be present. Primary land manager is Glacier National Park.

Middle Quartz Lake: Bull trout in this subpopulation spawn in Quartz Creek, perhaps in both the inlet and outlet segments to Middle Quartz Lake, where this subpopulation rears/overwinters (MBTSG 1995a). This bull trout subpopulation appears stable (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Glacier National Park.

Lower Quartz Lake: Bull trout in this subpopulation spawn in Quartz Creek, perhaps in both the inlet and outlet segments to Lower Quartz Lake, where this subpopulation rears/overwinters (MBTSG 1995a). Little is known about the status of this bull trout subpopulation, making its stability uncertain (MBTSG 1995a). Introduced lake trout may be present based on unconfirmed reports (MBTSG 1995a). The primary land manager is Glacier National Park.

Akokala Lake: Bull trout in this subpopulation spawn in Akokala Creek and rear/overwinter in Akokala Lake (MBTSG 1995a). This bull trout subpopulation appears stable (MBTSG 1995a). No introduced nonnative species are known to be present. The primary land manager is Glacier National Park.

Logging Lake: Bull trout in this subpopulation spawn in Logging Creek and rear/overwinter in Logging Lake (MBTSG 1995a). Little is known about the status of this bull trout subpopulation, making its stability uncertain (MBTSG 1995a). Introduced lake trout are present. The primary land manager is Glacier National Park. Based on its isolation and presence of nonnatives, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Bowman Lake: Bull trout in this subpopulation spawn in Bowman Creek and rear/overwinter in Bowman Lake (MBTSG 1995a). This bull trout subpopulation is declining (MBTSG 1995a). Introduced lake trout are present. The primary land manager is Glacier National Park. Because of its isolation, declining numbers and presence of nonnatives, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Arrow Lake: Bull trout in this subpopulation once spawned in Camas Creek and reared/ overwintered in Arrow Lake (MBTSG 1995a). However, bull trout may be extirpated from this lake, which was known to contain the species in the 1960s (MBTSG 1995a). There is speculation that a flood in 1964 may have been a factor in the decline of bull trout in Arrow Lake (L. Marnell,

in litt., 1995). No introduced nonnatives are known to be present. The primary land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Cyclone Lake: Bull trout in this subpopulation spawn in Cyclone Creek, which is downstream from Cyclone Lake, where this subpopulation rears/overwinters (MBTSG 1995a). Little is known about the status of this bull trout subpopulation, making its stability uncertain (MBTSG 1995a). In 1994, 5 redds were counted in a short section of Cyclone Creek (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Stillwater State Forest. Based on its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Trout Lake: Bull trout in this subpopulation spawn in Camas Creek and rear/overwinter in Trout Lake (MBTSG 1995a). This bull trout subpopulation is thought to be stable; however, little information is available (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Frozen Lake: Bull trout in this subpopulation spawn in an unnamed stream in British Columbia and rear/overwinter in Frozen Lake (MBTSG 1995a). Little is known about the status of this bull trout subpopulation, making its stability uncertain (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Flathead National Forest and Canada. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Middle Fork Flathead Subpopulations: The following disjunct bull trout subpopulations occur in the Middle Fork of the Flathead River drainage.

Lower Isabel Lake: Bull trout in this subpopulation spawn in Park Creek and rear/overwinter in Lower Isabel Lake (MBTSG 1995a). No bull trout larger than 12 inches have been collected from this lake, leading to questions about the life history type present (MBTSG 1995a). This bull trout subpopulation appears stable (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Upper Isabel Lake: Bull trout in this subpopulation spawn in Park Creek, downstream of Upper Isabel Lake, where this subpopulation rears/overwinters (MBTSG 1995a). No bull trout larger than 12 inches have been collected from this lake, leading to questions about the life history type present (MBTSG 1995a). This bull trout subpopulation appears stable (MBTSG 1995a). No introduced nonnatives are known to be present. The primary land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Harrison Lake: Bull trout in this subpopulation spawn in Harrison Creek and rear/overwinter in Harrison Lake (MBTSG 1995a). Little is known about the status of this bull trout subpopulation, making its stability uncertain (MBTSG 1995a). Introduced brook trout are present. The primary

land manager is Glacier National Park. Because of its isolation, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Lake McDonald: Bull trout in this subpopulation spawn in McDonald Creek and rear/overwinter in Lake McDonald (MBTSG 1995a). This bull trout subpopulation is declining (MBTSG 1995a; L. Marnell, *in litt.*, 1995). Introduced lake trout are the dominant species in the lake; other nonnatives present are brook trout, lake whitefish, and kokanee (MBTSG 1995a). The primary land manager is Glacier National Park. The presence of lake trout is believed to be the primary cause of the decline of bull trout in this subpopulation (L. Marnell, *in litt.*,1995). Based on its isolation, declining numbers, and the presence of nonnatives, this subpopulation is at risk of stochastic extirpation (FWS 1998b).

Lincoln Lake: Bull trout in this subpopulation spawn in Lincoln Creek and rear/overwinter in Lincoln Lake (MBTSG 1995a). This bull trout subpopulation is thought to be declining (MBTSG 1995a). A large number of introduced brook trout are present (MBTSG 1995a). The primary land manager is Glacier National Park. Because of its isolation, declining numbers and presence of nonnatives, this subpopulation at risk of stochastic extirpation (FWS 1998b).

Westslope Cutthroat Trout

In the Flathead River sub-basin, 26 percent of the streams surveyed had WCT and of these populations 14 percent were considered pure. Principal tributaries of the Flathead River are the North Fork Flathead, Middle Fork Flathead, South Fork Flathead, Stillwater, Swan, and lower Flathead rivers, and Flathead Lake. Land ownership in the drainage is 44.2 percent USFS, 11.7 percent National Park Service, 11.9 percent tribal, 4.4 percent State of Montana, and 27.8 percent private and other public entities (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a).

WCT are believed to have historically occupied all of the streams and lakes to which they had access in the Flathead River sub-basin (MFWP, *in litt.* 1998 as cited in USDI 1999a). In the sub-basin, however, only 3,489 miles (33.9 percent) of the estimated 10,288 miles of historic stream habitat have been surveyed for WCT. Thus, WCT could occupy additional stream miles that have not yet been surveyed. Among those 3,489 surveyed stream miles, WCT have been documented in 2,609 miles of stream (74.8 percent). Those WCT stocks have various degrees of genetic purity or have not yet been tested genetically. Of the total linear amount of stream habitat known to be occupied by WCT in the Flathead River sub-basin, 55.9 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a).

WCT stocks are strong or predicted strong in 55 HUCs, depressed or predicted depressed in 220 HUCs, and absent or predicted absent in the remaining 37 HUCs that collectively constitute the Flathead River sub-basin (USDI 1999a). Among the 3,489 miles of stream surveyed, stocks of genetically pure WCT occupy 564 miles (148 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 87 miles; and stocks that are < 90.0 percent pure occupy 54 miles (MFWP, *in litt.* 1998 as cited in USDI 1999a). Westslope cutthroat trout stocks inhabiting 1,904 miles of

stream (528 stream reaches) remain untested genetically (USDI 1999a). Among the 2,609 miles of stream occupied by WCT stocks, 500 of the stream miles have stocks that are genetically pure and considered abundant; genetically pure stocks in the remaining 64 miles of stream are considered rare. Of the 651 stream miles with WCT stocks that have genetic purity of 90 percent, fish in 577 miles of stream are considered abundant (USDI 1999a).

In the North Fork Flathead River sub-basin, stocks of genetically pure WCT occupy 67 miles (27 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 27 miles; stocks that are < 90.0 percent pure occupy 6 miles; and stocks in 344 miles of stream (84 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 444 miles of stream occupied by WCT stocks, 266 of the stream miles have stocks that are considered abundant; stocks in the remaining 178 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the North Fork Flathead River sub-basin, 81.9 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in four HUCs; depressed or predicted depressed in 31 HUCs; and absent or predicted absent in the remaining one HUC that collectively constitute the North Fork Flathead River sub-basin (USDI 1999a). Within that portion of the sub-basin that lies in Glacier National Park, genetically pure WCT naturally inhabit 10 lakes that have a total surface area of 2,407 acres (Marnell 1988).

In the Middle Fork Flathead River sub-basin, stocks of genetically pure WCT occupy 19 miles (4 stream reaches) and stocks in 452 miles of stream (131 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 471 miles of stream occupied by WCT stocks, 246 of the stream miles have stocks that are considered abundant; stocks in the remaining 225 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Middle Fork Flathead River sub-basin, 94.1 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are depressed or predicted depressed in 41 HUCs and absent or predicted absent in the remaining one HUC that collectively constitute the Middle Fork Flathead River sub-basin (USDI 1999a). Within that portion of the watershed that lies in Glacier National Park, genetically pure WCT naturally inhabit 10 lakes that have a total surface area of 2,940 acres (Marnell 1988).

In the Flathead Lake watershed, stocks of genetically pure WCT occupy 66 miles (9 stream reaches); stocks that are < 90.0 percent pure occupy 2 miles; and stocks in 69 miles of stream (10 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 137 miles of stream occupied by WCT stocks, 70 of the stream miles have stocks that are considered abundant; stocks in the remaining 67 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Flathead Lake sub-basin, 7.2 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are depressed or predicted depressed in 19 HUCs and absent or predicted absent in the remaining 14 HUCs that collectively constitute the Flathead Lake sub-basin (USDI 1999a).

The upper two-thirds of the South Fork Flathead sub-basin lies entirely within the Bob Marshall Wilderness Area. In the watershed, stocks of genetically pure WCT occupy 289 miles (89 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 44 miles; stocks that are < 90.0 percent pure occupy 32 miles; and stocks in 244 miles of stream (29 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 609 miles of stream occupied by WCT stocks, 559 of the stream miles have stocks that are considered abundant; stocks in the remaining 50 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the South Fork Flathead River sub-basin, 97.4 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 51 HUCs and depressed or predicted depressed in the remaining 22 HUCs that collectively constitute the South Fork Flathead River sub-basin (USDI 1999a).

In the Stillwater sub-basin, stocks of genetically pure WCT occupy 12 miles (3 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 9 miles; and stocks in 425 miles of stream (132 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 446 miles of stream occupied by WCT stocks, 261 of the stream miles have stocks that are considered abundant; stocks in the remaining 185 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Stillwater River sub-basin 42.8 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are depressed or predicted depressed in 29 HUCs and absent or predicted absent in the remaining three HUCs that collectively constitute the Stillwater River sub-basin (USDI 1999a).

In the lower Flathead River sub-basin, stocks of genetically pure WCT occupy 88 miles (9 stream reaches); stocks that are < 90.0 percent pure occupy 10 miles; and stocks in 99 miles of stream (16 stream reaches) remain untested genetically (Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 197 miles of stream occupied by WCT stocks, 185 of the stream miles have stocks that are considered abundant; stocks in the remaining 12 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the lower Flathead River sub-basin, 42.9 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are depressed or predicted depressed in 49 HUCs and absent or predicted absent in the remaining 18 HUCs that collectively constitute the lower Flathead River sub-basin (USDI 1999a).

Hybridization between rainbow trout and WCT is prevalent in the mainstem Flathead River drainage. In the mainstem segment of the river near Columbia Falls, and estimated 44 percent of the population are hybrid trout and in the Kalispell segment about 20 percent consist of hybridized trout (MFWP 1999b). As a result, as basin-wide genetics/telemetry survey is currently underway to quantify the degree of introgression by rainbow trout with native WCT in the tributaries and to locate spawning areas where hybridizations occurring. Early results have identified some individual tributaries (e.g. Mill and Abbot creeks) where hybrids have made extensive movements, but lack of movement from the mainstem by some fish suggest that some spawning between

rainbow and hybrid trout may be occurring in the mainstem and side channels. More research is anticipated through spring of 2000 (MFWP 1999b).

In summary, WCT in the Flathead River sub-basin occur in about 676 tributaries or stream reaches that collectively encompass 2,609 linear miles of stream habitat, distributed among 7 watersheds (USDI 1999a). Of the total linear amount of stream habitat known to be occupied by WCT in the sub-basin, 55.9 percent lies on lands administered by federal agencies (USDI 1999a). In addition, WCT are known to occur naturally in at least 20 lakes that total 5,347 surface acres in Glacier National Park.

Summary of Factors Affecting WCT in the Flathead River Sub-basin (based on USDI 1999a): Timber management is the dominant land use in the Flathead River sub-basin, where an extensive road system to support forestry practices and other forest uses exists. In addition, rural residential development is increasing, particularly in the Flathead Lake area; resulting domestic sewage and human-caused changes to stream morphology are considered threats to water quality (MBTSG 1995a). The MTDEQ (1994) lists 17 streams in the Flathead River sub-basin as being water-quality impaired as the result of forestry practices and 16 streams impaired by agricultural practices; additional impairments result from other land-use practices (USDI 1999a). Many of these streams are water-quality impaired by more than one activity. Information on the possible occurrence of WCT in these streams is presently unavailable, however.

Angler harvest of WCT is closely regulated in Montana and not considered a threat to the subspecies in the Flathead River sub-basin (MFWP, *in litt.* 1999 as cited in USDI 1999a). In many WCT waters in the drainage, fishing for WCT is restricted to catch-and-release. Elsewhere in the sub-basin, only limited harvest of WCT is allowed. Existing regulatory mechanisms failed to prevent the more than 100 illegal fish introductions that have been documented in northwest Montana during the past 20 years. There are no other evident, inherent inadequacies in existing federal, state or local regulatory mechanisms that affect WCT in the sub-basin. However, effective implementation of the various regulatory mechanisms that potentially affect WCT depends largely upon the appropriation of adequate funding and, ultimately, commitment on the part of the management or regulatory agencies to fulfill their respective responsibilities. Where these responsibilities are not being fulfilled, WCT may be threatened by ongoing or planned, adverse changes in their habitat or by chronic, adverse effects that remain unabated.

Whirling disease poses a threat to WCT where WCT coexist with both the protozoan that causes the disease and the protozoan's intermediate host. However, extensive research is being conducted to determine the distribution of whirling disease in Montana, the susceptibility of WCT (a close relative of rainbow trout) to whirling disease, and possible control measures. Research suggests that WCT in headwater streams will not be affected by whirling disease because these streams are not suitable for colonization by the intermediate host for the whirling disease organism. Moreover, current research suggests that, although the whirling disease organism may be present in streams, low levels of the organism are unlikely to result in deleterious infections in fish, including cutthroat trout. Consequently, whirling disease is not considered an important threat to most extant WCT stocks in the Flathead River sub-basin.

Predation on WCT by normative predatory fishes poses a threat to WCT in a few localized areas. In the Flathead Lake basin, there are 13 introduced, normative species of fish with which WCT must coexist (MBTSG 1995a). Among these is lake trout, which has become the dominant species in Flathead Lake. Juvenile lake trout have also been found in major tributaries to the lake (MBTSG 1995a). Hungry Horse Dam protects native fishes in the South Fork Flathead River watershed, the most intact native fish assemblage in western Montana, by preventing the upstream movement of normative fishes, particularly lake trout, into the watershed (MBTSG 1995e). Over 100 illegal fish introductions have been documented in northwest Montana during the past 20 years (MBTSG 1995a). MFWP does not stock normative predatory fishes into waters harboring genetically pure WCT and aggressively prosecutes anyone caught illegally transferring live fish or attempting to do so (MFWP, *in lift.* 1999 as cited in USDI 1999a).

Although authorized stocking of normative fish species has not occurred for more than two decades, the normative fishes that became established probably constitute the greatest contemporary threat to the maintenance and restoration of WCT in the drainage. Normative fish species that have become established in the drainage include lake trout, kokanee salmon, northern pike, and largemouth bass (MBTSG 1996d).

Swan Lake/Swan River Sub-basin

Plum Creek lands in the NFHCP's Swan River sub-basin consist of 471,926 acres situated in the southern half of the sub-basin. Tier 1 watersheds in the Swan River sub-basin total 176,187 acres (approximately 38 percent of the drainage), of which 36,178 acres (8 percent of the drainage) are Plum Creek lands. Tier 2 lands total 295,739 acres (62 percent of the drainage), of which 46,417 acres (10 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Swan River sub-basin total 45 miles; 10 miles of these occur on Plum Creek lands. Perennial streams on Plum Creek lands in the Swan River sub-basin total 139 miles. Grazing leases on Plum Creek lands in the Swan River sub-basin total 6,654 acres along 20 stream miles. Of these, 339 acres along 2 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 822 miles of roads occur on Plum Creek lands in the Swan and another 79 miles are proposed.

Although the Swan River sub-basin is treated as a separate planning area sub-basin in the NFHCP, for purposes of this biological opinion it is treated as a sub-basin of the Flathead River Basin, with its own bull trout subpopulation.

The Swan River flows north from its headwaters in the Swan and Mission mountain ranges to Flathead Lake. The river flows through a heavily forested, glaciated valley that is three to six miles wide and relatively flat. Three major lakes occur in the Swan River drainage and all are linked to directly to the river. In addition, there are 53 named tributaries that enter the Swan River from the Swan Mountains to the east and from the Mission Mountains to the west. The upper Swan River flows through Lindbergh Lake, which is the southern-most lake. Holland Creek

enters the river about five miles downstream from Lindbergh Lake and connects Holland Lake. The Swan River flows for 35 miles to Swan Lake, which is the largest lake in the drainage. Swan River then flows out of Swan Lake for 14 miles before entering Flathead Lake.

Before the Swan River enters Flathead Lake, a small run-of-the-river impoundment is created by Bigfork Dam, which is scheduled for re-licensing by the Federal Energy Regulatory Commission (FERC) in 2002. Prior to construction of Bigfork Dam in 1902, the Swan drainage was connected to the Flathead Lake basin. Construction of Bigfork Dam blocked upstream passage of bull trout from the Flathead into the Swan drainage, although bull trout have been documented moving downstream over the dam (MBTSG 1996d). Downstream from Bigfork Dam, the river cascades for one mile prior to entering Flathead Lake.

The Swan River drainage sub-basin is approximately 671 square miles and is highly influenced by groundwater (MBTSG 1996d). The mean annual flow of the Swan River is 1,158 cubic feet per second (CFS). Peak discharge typically comes in June and is determined by the amount and rate of snowmelt. Peak flow is usually 15 to 30 times greater than low flow measured in the fall (Leathe and Enk 1985 as cited in MBTSG 1996d). About 45 percent of the Swan River drainage is on USFS lands, much of which is mid to upper elevations. Roughly 20 percent is in Plum Creek ownership, 10 percent is state lands, and 25 percent is in other private ownership.

Bull Trout

Three subpopulations occur in the Swan River sub-basin: 1) the Swan River; 2) Holland Lake; and 3) Lindbergh Lake. Migratory bull trout continue to be the dominant life form in the Swan River sub-basin, although low numbers of resident bull trout likely exist in some tributaries (MBTSG 1996d). Numerous historic accounts of the presence of bull trout in the Swan drainage exist, particularly from the 1930s (MBTSG 1996d).

Swan River Subpopulation: There are 15 major watersheds in the Swan River drainage according to USFS categorization (Flathead National Forest, unpubl. data, 1999). Baseline habitat condition ratings for these watersheds for bull trout indicate that two are functioning appropriately, 10 are functioning at risk, two are functioning at unacceptable risk, and one was not applicable. Elk Creek and Lion Creek are functioning appropriately and contain the strongest local spawning stock for this subpopulation. The two watersheds that are functioning unacceptably for bull trout are the Soup Creek and Glacier/Kraft Creek system. Both the Soup Creek and Glacier/Kraft Creek system were found to function at unacceptable risk because of poor habitat conditions, presence of exotic fish, warm water temperatures, and effects of land management activities. The remaining watersheds contain some population and/or habitat characteristics that are functioning at some degree of risk to bull trout.

Currently, the Swan River subpopulation likely supports the largest numbers of migratory bull trout remaining in Montana (MBTSG 1996d). A significant positive trend was found for the Swan River sub-basin when long term data from monitoring streams was analyzed (Rieman and Meyers

1997). Since 1982, annual redd counts have been conducted in four monitoring streams (Elk, Goat, Squeezer and Lion). These monitoring streams currently account for 70 percent of the drainage's total tributary spawning (Rumsey and Werner 1997). The number of redds counted in these monitoring streams has demonstrated a significantly increasing trend ($p < 0.05$) (Weaver 1997). Since 1982, total redd counts for these monitoring streams have ranged from 109 to 612 redds (MFWP, unpubl. data,1999). Redd counts since 1992 have continued to be record highs, increasing from 375 redds in 1992 to 501 redds in 1996 (MFWP, unpubl. data 1999). The last 3 years of redd counts have continued this record trend with highs in 1997 and 1998 at 586 and 612, respectively (Flathead Basin Commission 1998), and most recently, 501 redds in 1999 (MFWP, unpubl. data, 1999).

Lion Creek and Elk Creek are the most important migratory spawning streams in the Swan Valley. In 1995, 1996, and 1997, more redds were found in Lion Creek than any other stream in the Flathead area (170, 181, and 190, respectively). Only in the last 2 years have Elk Creek redd counts surpassed Lion Creek (259 and 261 in 1998 and 1999, respectively). Interestingly, sediment samples taken in Lion Creek in 1995 and 1996 resulted in 37 and 34 percent surface fine sediments, which is higher than desirable for bull trout but may not be detrimental to egg survival in this case (Flathead National Forest, unpubl. data, 1999). Road densities are low in the Swan River sub-basin, and timber harvest has been limited to date. Nonetheless, Lion Creek and Elk Creek, are on the Montana Department of Water Quality's 303(d) list as partially impaired to support aquatic life and coldwater fisheries, with the probable cause being habitat alteration and siltation due to silvicultural practices. These two drainages are relatively undisturbed watersheds, because past disturbances from timber harvest and road construction has been low to moderate and because the majority of habitat parameters important to bull trout, such as stream temperature, pool quantity and quality, presence of large woody debris, and substrate quality are near optimal conditions for bull trout (Flathead National Forest, unpubl. data, 1999).

Goat and Squeezer creeks appear to have strong stocks of spawning bull trout based on redd counts, but the watershed may be at risk due to cumulatively high timber harvest activity, road densities and riparian disturbance, which may be leading to habitat degradation (Flathead National Forest, unpubl. data, 1999). The major threats to the watershed may be the ground-disturbing activities associated with roads and timber harvest and the presence of brook trout.

In Piper Creek, the spawning bull trout population appears stable. Most habitat parameters for bull trout are in good condition; however, there is concern about substrate embeddedness, refugia, and large pool habitat, which may be limiting. The cause for these concerns is the cumulative effects of past riparian harvest that has occurred on USFS and Plum Creek lands. About 24 percent of the watershed has been disturbed by some type of harvest activity, regardless of ownership. There are areas of both heavy harvest and light harvest (Flathead National Forest, unpubl. data, 1999).

The most current, extensive, and detailed information on baseline habitat conditions and status of fish populations to date for the Goat/Squeezer and Pipe Creek watersheds is contained in Plum

Creek's water analysis by Watson et al. (1997). The fish module analysis provides information on fish distribution and fish habitat attributes according to geomorphic units for these individual watersheds. Perhaps the most important conclusion of the analyses for these watersheds was that empirical observations indicated that fish distribution and relative abundance was a function of channel geomorpholgy and accessibility, rather than the extent and degree of past land management actions.

Currently, Swan Lake is the only Montana state water where angling for and harvest of bull trout is legal. The current limit is one bull trout daily. The adult bull trout population in the Swan drainage is estimated to have increased from 3,983 fish in 1984 to 5,977 fish in 1995 (Rumsey and Werner 1997). Montana Fish, Wildlife, and Parks estimated the 1997 Swan Lake adult population at 6,102 bull trout (MFWP internal memo, 1998). In 1995, bull trout harvest ranked third in order of abundance, representing 5 percent of the catch, behind kokanee (*Oncorhynchus nerka*) and northern pike (*Esox lucius*) (Rumsey and Werner 1997). Based on estimates of total numbers of adult bull trout in Swan Lake (5,977 adults), 4 percent (482 adult fish) was harvested during the creel period in 1995 (Rumsey and Werner 1997). This is a decrease from 1983 to 1984, when 33 percent of the adult bull trout population in Swan Lake was harvested (Rumsey and Werner 1997). According to Rumsey and Werner (1997), bull trout anglers released an average of 65 percent of their catch annually. Based on the above information, these authors concluded that the bull trout fishery in Swan Lake is sustainable at the present harvest level. In addition, juvenile bull trout abundance estimates have shown healthy populations in the Swan River index streams. The Flathead Basin Commission (1998) reported that spawning and rearing habitat is considered good and since 1991 sediment levels have improved in critical spawning and rearing areas.

In general, high levels of bull trout spawning have been documented in several Swan River tributaries, including Jim, Cold, Piper, Lost, and Woodward creeks (MBTSG 1996d). Spawning has been documented in other tributaries as well, including Kraft, Cedar, Glacier, Soup, Buck, Condon, Cooney, and Dog creeks (MBTSG 1996d). It has been noted that bull trout from Swan Lake spawn in at least 13 of the 53 named tributary streams. Rearing fish were observed in ten additional streams (Leathe and Enk 1985 as cited in MBTSG 1996d).

In Swan River drainage surveys, bull trout were found to be most abundant in stream reaches having gradients of six percent or less; coarse, unembedded substrate material; summer maximum water temperatures of less than 16 °C; and areas that were influenced by groundwater upwellings (MBTSG 1996d). Spawning by migratory fish occurred in tributaries with late summer flows exceeding 10 cfs (Leathe and Enk 1985 as cited in MBTSG 1996d).

Juvenile bull trout in the Swan River drainage were found to grow slower than other bull trout populations, but growth accelerates rapidly after leaving the tributaries. The growth and condition of juveniles compared to the 1980s Flathead Lake population was higher in the Swan and there is some evidence of higher growth in repeat spawners (MBTSG 1996d).

The Swan drainage is unique because brook trout are abundant, it has high levels of timber harvest, sediment loads are high, but numbers of bull trout are increasing. The additional food source provided by introduced *Mysis* shrimp and restrictive angling regulations are likely responsible for the bull trout population increase (MBTSG 1996d). *Mysis* shrimp appear to be enhancing survival and growth of juvenile bull trout in the absence of lake trout and lake whitefish (Flathead Basin Commission 1998). In addition, the Swan River and its tributaries are closed to harvest of bull trout, which has likely contributed to the increasing trend. Swan Lake is the only water in the state where bull trout harvest is allowed, with a daily limit of one fish (Flathead Basin Commission 1998). The Swan River subpopulation is not considered to be at risk of stochastic extirpation. Nevertheless, in the last 2 years there have been four reports of lake trout being caught in the Swan River/Lake system and it is possible that lake trout are becoming established. Biologists are concerned that predaceous lake trout could impact bull trout as has happened in Flathead Lake and other lakes.

Swan River Sub-basin Disjunct Subpopulations: The Swan River Sub-basin has two disjunct supopulations of bull trout, one at Holland Lake and one at Lindbergh Lake.

Holland Lake/Lindbergh Lake Subpopulations: It is suspected that Holland Lake and Lindbergh Lake support disjunct adfluvial bull trout subpopulations that are functionally isolated from other subpopulations by natural thermal barriers (MBTSG 1996d). However, these subpopulations may not be truly disjunct because downstream migration is possible while upstream migration, though doubtful, remains unstudied. Holland Lake and Lindbergh Lakes each have a single spawning and rearing tributary, Holland Lake and upper Swan River, respectively. Holland Lake is isolated by thermal barriers in Holland Creek downstream from Holland Lake. Redd counts for the Holland Lake subpopulation have ranged from 10 to 18 redds (MBTSG 1996d). Lindbergh Lake is isolated by thermal barriers downstream in the Swan River. In the Lindbergh Lake subpopulation, 24 redds were counted in 1994 (MBTSG 1996d). Little is known about the status or trend of bull trout in Holland or Lindbergh lakes. It is likely that bull trout occupying Holland and Lindbergh lakes are genetically distinct from Swan Lake fish although no testing has been conducted to date (MFWP internal memo, 1998). These subpopulations are considered at risk of stochastic extirpation (FWS 1998b).

Summary of Factors Affecting Bull Trout in the Swan Lake/Swan River Sub-basin: The greatest threat to bull trout in the Swan River sub-basin is illegal introduction of lake trout, which are present in high numbers immediately downstream from Bigfork Dam (MBTSG 1996d). An angler caught a lake trout while fishing the Swan River upstream from Swan Lake in 1998. It is not known how this fish was introduced, how long it inhabited Swan River or whether more lake trout are present. If lake trout become established in the Swan River and Swan Lake, a scenario similar to what has occurred in Flathead Lake is likely (Flathead Basin Commission 1998). Nearly everywhere lake trout have been introduced into existing bull trout populations, bull trout have been extirpated (Donald and Alger 1992), or are in the process of extirpation, such as in the Flathead Lake system (MBTSG 1995a).

Introduced fish species that currently inhabit the Swan drainage pose a major risk to bull trout. Brook trout are the greatest threat because they hybridize extensively with bull trout in certain territories and directly compete with bull trout for resources. Brook trout are widely dispersed throughout the drainage (MBTSG 1996d). There are no bull trout streams in the Swan drainage that do not contain brook trout (MBTSG 1996d). Hybrids have been observed in several primary bull trout spawning streams in the Swan (Leathe and Enk 1985 as cited in MBTSG 1996d). Watson and Hillman (1997) found an inverse relationship between bull trout occurrence and the presence of brook trout. Bull trout/brook trout hybrids are present in many Swan River tributaries (MBTSG 1996d, Rumsey and Werner 1997). If the level of hybridization is higher than has been documented, then the bull trout numbers may actually be lower than currently estimated (MBTSG 1996d). Brook trout were found to be the most abundant species in lower gradient reaches (< 6 percent) according to Leathe and Enk (1985 as cited in MBTSG 1996d), who also observed that there were no bull trout streams in the in the Swan drainage that do not contain resident brook trout.

Northern pike occur in Swan Lake where they prey on juvenile bull trout and present a risk to migrants in the river immediately upstream from the lake as well as to subadults in the lake (MBTSG 1996d). Northern pike were illegally introduced into Swan Lake in the 1970s (MFWP 1997). Bull trout predation by northern pike in Swan Lake is documented (S. Rumsey, pers comm. in MBTSG 1996d). Northern pike are a risk to juvenile bull trout migrants in the river just upstream of the lake and subadults in the lake (MBTSG 1996d). Other nonnative introduced fish species exist in the drainage including kokanee salmon, rainbow trout (*O. mykiss*), Yellowstone cutthroat trout (*O. clarki bouvieri*), and largemouth bass (*Micropterus salmoides*) (MBTSG 1996d). The management emphasis for Swan Lake is protection of native salmonids, particularly bull trout, while managing northern pike to minimize impacts to native species (MFWP 1997).

In 1975, *Mysis* shrimp were introduced into Swan Lake by MFWP and are now well established. This reflects 1970s and 1980s conditions in Flathead Lake because Swan Lake has a similar species assemblage. With the recent reports of lake trout in Swan Lake, there is concern that this species could cause adverse effects to bull trout as happened in Flathead Lake. The presence of *Mysis* provides a food resource to bull trout and may contribute to their growth and survival during the subadult stage. At present, *Mysis* in Swan Lake does not appear to be detrimental to bull trout (MBTSG 1996d).

Bigfork Dam isolates the Swan River sub-basin from the balance of the Flathead basin; however, the dam is considered to have benefitted the Swan River drainage because it has prevented the upstream movement of introduced fish, particularly lake trout, into this watershed (MBTSG 1996d). The dam is operated as a run of the river impoundment and, therefore, has little impact on bull trout in the Swan drainage (MBTSG 1996d). The review process for relicensing Bigfork Dam has begun, because the FERC license expires in 2002 (MBTSG 1996d).

Extensive logging and road building has occurred throughout the Swan River sub-basin. However, because of the geomorphology and geology of the drainage, it is difficult to assess the effects of forestry in the drainage (MBTSG 1996d). Research conducted by Plum Creek did not reveal a relationship between bull trout distribution and management history, but instead found that bull trout spawning and distribution were a function of geomorphology and patch size with bull trout occurring mostly in larger watersheds (MBTSG 1996d). Frissell et al. (1995) observed that Swan river tributaries draining large areas of roadless land are disproportionately important for the persistence and recovery of bull trout and westslope cutthroat. The MBTSG (1996d) believes that in the Swan, bull trout distribution is a function of habitat type, and that the size of the drainage area and the riparian land type in combination determine the specific physical characteristics needed for bull trout spawning.

The Swan Valley Grizzly Bear Conservation Agreement signed in 1995 between FWS, Montana Department of Natural Resources and Conservation, Plum Creek, and Flathead National Forest guides forest management in the Swan River sub-basin with respect to grizzly bears. Timber harvest will be concentrated in certain areas for 3-year periods. Open road density in the area affected by the agreement will be limited, although total road density is not limited. A FWS conference opinion determined that this Conservation Agreement is not likely to jeopardize bull trout (FWS 1995a).

In the deeper portions of Swan Lake, a seasonal deficit of dissolved oxygen has occurred that was not present historically. Research by Butler et al. (1995) suggests that the source of organic carbon to Swan Lake is from Swan River during spring runoff, which in turn suggests that recently logged tributaries are one source of the organic carbon pool most associated with oxygen depletion in the lake. The MBTSG (1996d) suggested that this warrants further investigation and monitoring.

Fishing regulations for bull trout have gotten progressively more restrictive, resulting in the closure of all waters to the taking and/or intentional fishing for bull trout, except in Swan Lake. In Swan Lake, anglers are allowed a daily and possession limit of one bull trout (MFWP 1996). Additionally, some significant bull trout spawning tributaries in the Swan are closed all year to angling (MFWP 1996). Illegal harvest is considered a high risk in the Swan River drainage because of the concentration of large, highly vulnerable adult fish in relatively few tributary streams (MBTSG 1996d).

Since 1995, the USFS and BLM are required to follow INFISH requirements in an effort to conserve bull trout.

Westslope Cutthroat Trout

In the Swan River sub-basin, stocks of genetically pure WCT occupy 23 miles (7 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 7 miles; stocks that are < 90.0 percent pure occupy 4 miles; and stocks in 271 miles of stream (96 stream reaches) remain untested genetically

(Appendix Table 3; MFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 305 miles of stream occupied by WCT stocks, 126 of the stream miles have stocks that are considered abundant; stocks in the remaining 179 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Swan River sub-basin, 47.1 percent lies on lands administered by federal agencies (Appendix Table 4; MFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are depressed or predicted depressed in the 29 HUCs that constitute the Swan River sub-basin (USDI 1999a).

Summary of Factors Affecting WCT in the Swan River Sub-basin (based on USDI 1999a): The factors affecting WCT in the Swan River sub-basin are essentially the same as the factors affecting bull trout (see discussion above for bull trout). Whirling disease has been detected in trout in the Swan River (Gustafson 1996 as cited in USDI 1999a) and poses a potential threat to WCT in the drainage. In addition, because of the illegal fish introductions that have been documented in northwest Montana during the past 20 years (MBTSG 1995a), introduced species into the Swan River area are a risk to WCT. Similar to bull trout, Bigfork Dam has benefitted the Swan River WCT because the dam prevents the upstream movement of normative fishes, particularly lake trout, into the Swan River drainage (MBTSG 1996d). MFWP does not stock normative predatory fishes into waters harboring genetically pure WCT and aggressively prosecutes anyone caught illegally transferring live fish or attempting to do so (MFWP, *in lift.* 1999 as cited in USDI 1999a).

Clark Fork River Sub-basin

The Clark Fork sub-basin as described in this biological opinion contains three NFHCP planning area sub-basins, the Upper Clark Fork River planning area sub-basin, middle Clark Fork River planning area sub-basin, and lower Clark Fork planning area sub-basin. Each of these is roughly equivalent to the area inhabited by the bull trout subpopulations described above.

Plum Creek lands in the upper Clark Fork River planning area sub-basin consist of 2,367,280 acres situated along the northern edge of the. Tier 1 watersheds in the upper Clark Fork total 92,906 acres (approximately 4 percent of the drainage), of which 10,578 acres (less than 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 2,274,374 acres (96 percent of the drainage), of which 94,270 acres (4 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the upper Clark Fork total 46 miles; 2 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Flathead total 89 miles. Grazing leases on Plum Creek lands in the upper Clark Fork total 71,073 acres along 144 stream miles. Of these, 3,587 acres along 8 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 1,347 miles of roads occur on Plum Creek lands in the upper Clark Fork and another 122 miles are proposed.

Plum Creek lands in the middle Clark Fork River planning area sub-basin consist of 3,198,753 acres scattered about the northern, western, and southern portions of the sub-basin. Tier 1 watersheds in the middle Clark Fork total 468,837 acres (approximately 15 percent of the

drainage), of which 45,369 acres (approximately 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 2,729,956 acres (85 percent of the drainage), of which 377,121 acres (12 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the middle Clark Fork total 245 miles; 34 of these occur on Plum Creek lands. Perennial streams on Plum Creek lands in the middle Clark Fork total 360 miles. Grazing leases on Plum Creek lands in the middle Clark Fork total 307,017 acres along 760 stream miles. Of these, 20,223 acres along 81 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 15,284 miles of roads occur on Plum Creek lands in the middle Clark Fork and another 288 miles are proposed.

Plum Creek lands in the lower Clark Fork River planning area sub-basin consist of 716,525 acres. Tier 1 watersheds in the lower Clark Fork sub-basin total 68,008 acres (approximately 9 percent of the drainage), of which 1,912 acres (less than 1 percent of the drainage) are Plum Creek lands. Tier 2 lands total 648,517 acres (91 percent of the drainage), of which 739 acres (less than 1 percent of the drainage) are owned by Plum Creek. No Key Migratory Rivers or grazing leases occur on Plum Creek lands in the lower Clark Fork, though 23 miles of Key Migratory Rivers occur on other lands in the sub-basin. Perennial streams on Plum Creek lands in the lower Clark Fork total 89 miles. A total of 27 miles of roads occur on Plum Creek lands in the lower Clark Fork while another 2 miles are proposed.

The Clark Fork River is Montana's largest river in terms of discharge, encompassing a total drainage area of 22,073 square miles (MBTSG 1995b). All rivers in western Montana, except the Kootenai, drain into the Clark Fork. Originating at the confluence of Silver Bow and Warm Springs creeks in Deerlodge valley, the river flows primarily in a northwesterly direction for about 350 miles to its terminus at Lake Pend Oreille, Idaho.

Bull Trout

The Clark Fork River sub-basin is now divided into three bull trout subpopulations as a result of dam construction on the mainstem of the river: 1) upper Clark Fork (upstream of Milltown Dam); 2) middle Clark Fork (Milltown Dam downstream to Thompson Falls Dam); and 3) lower Clark Fork including Cabinet Gorge Reservoir (Noxon Dam downstream to Cabinet Gorge Dam) and Noxon Rapids Reservoir (Thompson Falls downstream to Noxon Dam). Prior to construction of these dams, migratory bull trout from Lake Pend Oreille used most major Clark Fork tributaries and there were no barriers to fish movement (Pratt and Huston 1993, MBTSG 1996g, Frissell 1997). Thompson Falls on the mainstem Clark Fork was not a barrier to upstream fish passage (Pratt and Huston 1993). Based on historic anecdotal reports, migratory bull trout in the lower and middle Clark Fork drainage area were common (Pratt and Huston 1993, Berg and Priest 1995, MBTSG 1996g). Over time, the migratory life history has generally been replaced by the resident life form, thereby increasing the risk of extinction (MBTSG 1996g).

Upper Clark Fork River Subpopulation: The upper segment of the Clark Fork River (above Milltown Dam) is about 119 miles long and has an annual average streamflow of about 1,354 cfs (MBTSG 1995b). The total drainage area is approximately 3,641 square miles upstream from

Bonner (not including the Blackfoot River drainage). In an average year, about 22 percent of the annual runoff occurs in May, 24 percent in June. The period of greatest consumptive demand for water is July and August.

Numerous water quality problems occur in the Clark Fork River as a result of a century of mining, smelting, and other land use activities in the Butte and Anaconda areas. The upper Clark Fork River and its tributaries are heavily polluted with toxic metals and other chemicals. The EPA has listed four superfund sites in the upper Clark Fork River, including the mainstem from Warm Springs to Milltown. The upper Clark Fork River is among the state's highest priority streams that will be incorporated into the Total Mean Daily Load (TMDL) process under the Clean Water Act.

Descriptions from early researchers make it clear that mining operations have had significant impacts to aquatic conditions and fish in the upper Clark Fork for many years. Silver Bow Creek, lower Warm Springs Creek, and the upper Clark Fork River were void of fish prior to the turn of the century as a result of mining related pollution. Evermann (1892, as cited in MBTSG 1995b) reported that mining operations were responsible for the absence of fish in the mainstem of the Clark Fork in the vicinity of Deerlodge. He also found the water of Silver Bow Creek fishless due to the consistency of the water, which he observed as "thick soup" made so by tailings of the mining operations from the Butte mines. Currently the entire length of Silver Bow Creek (25 miles) remains without fish due to mining wastes originating in Butte. The channel banks, stream banks and much of the floodplain are contaminated with mine tailings. Some of this damage is the result of hydraulic mining, which came into heavy use in the 1870s, with large scale destruction from this activity still evident in much of south central Montana (Periman 1994, as cited in MBTSG 1995b).

Historically, bull trout were distributed throughout the upper segment of the Clark Fork River. There were no major natural fish passage barriers that would have excluded bull trout from any significant portions of the upper Clark Fork drainage, except the barrier falls at higher elevations in tributary streams. However, as a result of this extensive history of mining pollution, 349 miles of streams within the upper Clark Fork have been identified as impaired by mining, and fish populations in the upper 120 miles of the river remain depressed in some reaches. Also as a result, bull trout have probably been eliminated from the upper Clark Fork mainstem and even portions of its headwater tributaries. This situation remains despite recent attempts to restore parts of the river.

Currently, with the exception of Rock Creek, bull trout are rare in the upper Clark Fork drainage and are primarily restricted to headwaters of relatively pristine tributaries (Berg and Priest 1995, MBTSG 1995a). Bull trout are rare to extirpated in much of the mainstem Clark Fork, Little Blackfoot, Flint Creek, Copper Creek, and Willow Creek (Berg and Priest 1995, MBTSG 1995b). Bull trout likely were extirpated from the mainstem and headwaters of the upper Clark Fork by the turn of the century (MBTSG 1995b) (see above). Resident bull trout reside in headwaters of some streams, such as Harvey, Warm Springs, Lost, Racetrack, and Schwartz creeks (Berg and Priest 1995, MBTSG 1995b), and some headwater lakes in this subpopulation still contain migratory bull trout.

Rock Creek, which enters the Clark Fork near Clinton, is the largest tributary to the Clark Fork upstream of the Blackfoot River. Rock Creek has a drainage area of 885 square miles and an average annual flow of 513 cfs (MBTSG 1996e). Rock Creek may be one of the best bull trout drainages in the state when compared to other drainages of its size (MBTSG 1996e). Mining pollution occurring prior to the turn of the century essentially eliminated fluvial bull trout from most of the upper Clark Fork drainage, except for Rock Creek. The Rock Creek drainage has had relatively few human impacts compared to other western Montana drainages of similar size, although there are some impacts from mining, logging, agriculture, and residential development.

The status and trend of the upper Clark Fork River bull trout subpopulation is unknown (FWS 1998b), although redd counts from four index streams indicated an increasing trend (Maxell 1996). In general, current populations of bull trout in the upper Clark Fork River sub-basin are highly depressed with the exception of the Rock Creek drainage.

In the mainstem of Rock Creek, bull trout are more common in the upper portion of the drainage above Welcome Creek. In 3 years of sampling, bull trout population estimates downstream of Welcome Creek were 49, 95, and 16 fish (>10 inches) per mile in 1986, 1989, and 1993, respectively. Upstream, in the Hogback Creek section, there were 32 bull trout per mile in 1989 and 12 bull trout per mile in 1993 (>10 inches) (MBTSG 1995b). Migratory bull trout occur only in the Rock Creek drainage in the Upper Clark Fork mainstem. Fish that migrate out of Rock Creek and pass downstream of Milltown dam cannot return back upstream.

Rock Creek may be one of the stronger migratory bull trout drainages remaining in Montana (MBTSG 1995b). Redd counts began in 1993. A total of 258 redds were counted in the drainage in 1996 (Maxell 1996). It appears that half of all bull trout spawning in the Rock Creek drainage occurs in just two areas (Maxell 1996). Four index tributaries have been surveyed consistently since 1993 and they have demonstrated increasing redd count trends (Maxell 1996). Total redds counted in these four tributaries in 1993 was 36, while in 1996 there were 79 redds (Maxell 1996). The Rock Creek watershed is considered high quality (MBTSG 1995b). Approximately two-thirds of the Rock Creek watershed consists of roadless areas in Deerlodge National Forest and designated Wilderness (Anaconda Pintlar and Welcome Creek). Radio-tagged bull trout collected below Milltown Dam and released upstream in the upper Clark Fork moved into Rock Creek (Swanberg 1996).

Rock Creek supports a very significant fishery, supporting 27,400 angler days in 1993. The sport fishery consists mainly of brown and rainbow trout. At this time, there is no evidence whether or not these species are a detriment to bull trout in the drainage. Bull trout comprised 1 percent (203 fish) of the total number of fish caught and released in Rock Creek in 1993. The current risk to bull trout from angling in Rock Creek is low because bull trout harvest is no longer legal in this drainage.

Brook trout are present in Rock Creek and apparent bull trout-brook trout hybrids occur in several tributary streams. Preliminary data indicate that the Rock Creek drainage could be a

critical component of the Clark Fork River's bull trout subpopulations. In 1994, several large bull trout were collected below Milltown dam on the Clark Fork River and fitted with radio telemetry devices. These fish were then released above the dam and two of the fish moved into Rock Creek. Rock Creek drainage is a core watershed for bull trout according to the MBTSG (1995b).

Summary of Factors Affecting Bull Trout in the Upper Clark Fork River: Mining over the past century in the Butte and Anaconda areas along the upper Clark Fork River has resulted in four EPA Superfund sites being designated in this area. Mining continues to result in water quality impairment of 349 miles of streams in the area (MDHES 1994). Water quality in this drainage has been severely impaired as a result of mine and smelter discharges, sewage, and waste effluents. Mine operations in these areas likely eliminated bull trout from the mainstem and headwaters of the upper Clark Fork by the turn of the century (MBTSG 1995b). In the mainstem Clark Fork, there was no sport fishery of any kind until pollution abatement programs were implemented in the headwaters in the 1970s (Titan Environmental Corporation 1997). Trout population estimates from 1927-1956 were zero (Spindler 1957 in Titan Environmental Corporation 1997). Even today many streams in this area remain fishless or fish populations are depressed (MBTSG 1995b). Eleven fish kills were documented between 1959 and 1991 caused by mining related contamination of the river (Titan Environmental Corporation 1997).

Water quality below Milltown Dam is much improved over that of the upper Clark Fork, primarily because of dilution by the large tributaries such as the Blackfoot and Bitterroot rivers. The major water quality issue in the reach below Milltown dam is the addition of nutrients and other pollutants to the river from sources like the Missoula municipal sewage plant and from the Stone Container Corporation kraft mill. Excessive concentrations of nutrients have led to blooms of filamentous algae in the upper Clark Fork River above Missoula, impairing beneficial uses of river water. The main sources of nonpoint pollution of sediments and nutrient are the Bitterroot River and Blackfoot River.

Water temperatures in the mainstem upper Clark Fork River frequently exceed 68 °F and temperatures in tributaries, including Little Blackfoot Creek and Flint Creek, may exceed bull trout tolerance limits (MBTSG 1995b). This is caused by dewatering for irrigation, warm irrigation return flows, and a lack of riparian vegetation to shade the water (MBTSG 1995b). Irrigation diversions, particularly in the Little Blackfoot and Flint Creek, are physical and thermal passage barriers (MBTSG 1995b). Diversion for irrigation is the primary cause of 389 miles of stream being chronically dewatered (MDHES 1994).

Intensive grazing, particularly in the upper Clark Fork mainstem in Deerlodge Valley, Flint Creek Valley, and parts of Rock Creek, has also had a substantial impact on fisheries in parts of the upper Clark Fork (MBTSG 1995b, Maxell 1996). The MBTSG ranked grazing as a very high risk to restoration of bull trout in the upper Clark Fork (MBTSG 1995b). Grazing can degrade stream banks and riparian vegetation, which in turn lowers water quality as a result of the increased sediment loads and temperatures in streams.

Dam failure in the East Fork Rock Creek Reservoir likely impacted bull trout upstream of this system (MBTRT 1997).

Middle Clark Fork River Subpopulation: The middle segment of the Clark Fork River extends from Thompson Falls Dam upstream 120 miles to Milltown Dam near Bonner. The average annual flow in this reach is 7,145 cfs. The middle Clark Fork River encompasses the river's mainstem and the St. Regis, lower Flathead, Thompson, and Jocko rivers. Major tributaries include the Bitterroot, St Regis, lower Flathead, and Thompson River. Thompson Falls Dam, built in 1916 on the mainstem Clark Fork, is an upstream passage barrier. Kerr Dam, built in 1938 on the lower Flathead River, prevents fish passage from the Clark Fork into the Flathead Lake system (Hansen and DosSantos 1997) (see Flathead River Basin discussion above). Milltown Dam, built in 1907 on the mainstem Clark Fork, prevents passage upstream to the upper Clark Fork drainage and the Blackfoot River.

The lower Flathead River is one of Montana's largest rivers, with a drainage area of 8,795 square miles and an annual discharge of 11,190 cfs (MBTSG 1996e). Flow in this portion of the Flathead River is regulated by Kerr Dam, located four miles downstream from the original outlet of Flathead Lake. From there, the river flows south and west for 72 miles to its confluence with the Clark Fork River near Paradise, Montana (DosSantos et al. 1988).

Milltown Dam is a run-of-the-river facility constructed just downstream from the confluence of the Blackfoot River and the Clark Fork River near Bonner. It is a hydroelectric facility that blocks fish passage and prevents bull trout from migrating to the upper Clark Fork River. Warm water temperatures in the river and blockage by the dam are major factors affecting bull trout distribution and habitat fragmentation (MBTSG 1996e). The dam owner is currently involved in re-licensing the dam, and the fisheries management plan which is being developed includes provisions for providing selective fish passage.

Historically, migratory bull trout were common in the middle Clark Fork system and there are many anecdotal reports of bull trout presence (Pratt and Huston 1993, MBTSG 1996e). Bull trout were common in the larger tributaries of the Clark Fork River above and below Missoula. Bull trout were commonly found in the Blackfoot and Bitterroot Rivers as well as smaller streams like Rattlesnake Creek, at Missoula. The Mountain Water Company Dam on Rattlesnake Creek blocks fish passage from the Clark Fork River into upper Rattlesnake Creek. Rattlesnake Creek is a site where bull trout, historically, were the most abundant fish caught in the creek. In 1960, bull trout made up 12.4 percent of the fish sampled in Rattlesnake Creek below the Missoula water supply, and above the water supply, the proportion of bull trout sampled was much greater (38.2 percent) (MBTSG 1996e). Currently, adult bull trout congregate annually below the dam in an attempt to migrate upstream. Above the dam, Rattlesnake Creek supports resident bull trout.

Bull trout are rare in the mainstem Clark Fork River between Milltown dam and the confluence of the Flathead River, comprising only 0.44 percent of the total number of trout sampled during 240 days of electrofishing in the 11-year period from 1983 and 1993. During electrofishing surveys of

the mainstem Clark Fork in the 1980s, a few bull trout were regularly captured; now, however, bull trout are rarely captured in the mainstem (MBTSG 1996e; pers. comm., R. Berg, MFWP 1997). Bull trout were the rarest species captured during electrofishing surveys of the lower Flathead River in the 1980s (17 individual bull trout captured over 4 years) (DosSantos et al. 1988). During four nights of electrofishing on the Clark Fork River over a 4-year period between Plains and Paradise, only one bull trout was captured (pers. comm., Huston). Juvenile bull trout have been caught in the lower Flathead River, indicating it is used for rearing (Hansen and DosSantos 1997). The most important spawning tributaries for migratory bull trout in this subpopulation appear to be Fish Creek and the West Fork Thompson, but migratory bull trout also spawn in St. Regis River, Trout Creek, Cedar Creek, and Petty Creek (MBTSG 1996e). No redd count data is available. Fishtrap Creek is also an important spawning tributary downstream from the confluence with the Flathead River.

Although there is little evidence available, limited data suggest that migratory bull trout are declining and rare at the present time in the middle Clark Fork (MBTSG 1996e), due to extreme habitat fragmentation (MBTSG 1996e). Fragmentation has resulted in numerous resident bull trout populations of moderate to low density (MBTSG 1996e). Currently, resident bull trout are found in the St. Regis and Jocko Rivers, and Fish, Trout, Cedar, Petty, Rattlesnake, Ninemile, Grant, Tamarack and Dry Creek drainages (MBTSG 1996e; Berg and Priest 1995; Hansen and DosSantos 1997).

Summary of Factors Affecting Bull Trout in the Middle Clark Fork River: Construction of four major hydroelectric dams in the mainstem Clark Fork River has highly fragmented the bull trout metapopulation that ranged from Lake Pend Oreille upstream into the headwaters of the Clark Fork (Pratt and Huston 1993). Cabinet Gorge Dam, built in 1952; Noxon Rapids Dam, built in 1958; Noxon Rapids Dam, built in 1958; Thompson Falls Dam, built in 1916; and Milltown Dam, built in 1907, are all upstream passage barriers to fish beginning downstream at Lake Pend Oreille. Milltown Dam, prevents passage upstream from the middle to the upper Clark Fork drainage and the Blackfoot River. Additionally, Kerr Dam, built in 1938 on the lower Flathead River, prevents fish passage from the Clark Fork into the Flathead Lake system. Also, water releases from the reservoirs above the dams may be from layers of the reservoir that are either too warm or too cold to provide adequate downstream water conditions for bull trout. These dams have fragmented the original bull trout population into isolated subpopulations, favoring the resident life history form over the migratory form. Noxon Rapids and Cabinet Gorge Dams are currently in the relicensing process. The Montana Bull trout Scientific Group ranked dams as a very high risk to bull trout restoration in the lower Clark Fork (MBTSG 1996f), middle Clark Fork (MBTSG 1996e), and upper Clark Fork (MBTSG 1995b) Rivers.

The most serious threat to bull trout restoration in the middle Clark Fork River is fragmentation of bull trout into isolated units. Because of this, most remaining bull trout subpopulations are at high risk of extinction, and the effects of other risk factors, such as mining, grazing, agricultural impacts on water quality and quantity, and introduced species are locally exacerbated. When isolated populations become extinct, the probability of recolonization is low; in addition, the high number of risk factors and the interactions between risk factors complicate restoration efforts. The decline of the migratory bull trout form also complicates restoration efforts, resulting in less

opportunity for recolonizing areas where bull trout have been extirpated (Rieman and McIntyre 1993). Furthermore, individuals that pass downstream over dams are lost from the upstream subpopulation, and although spawning habitat may still exist in these subpopulations, historic rearing habitats for migratory adults and subadults in the larger river system have been converted into reservoirs whose conditions are unsuitable for bull trout (MBTSG 1996a). All these factors decrease the long term viability of the remaining bull trout subpopulations (Rieman and McIntyre 1993).

Many miles of streams in the middle Clark Fork segment are water quality impaired because of mining (153 miles), forestry (238 miles), dams (see above), and agricultural impacts (MDHES 1994). Warm water temperatures in the river and the Milltown Dam impoundment are major factors affecting bull trout distribution and habitat fragmentation. Ninemile Creek drainage has had long term impacts from mining, logging, and agriculture that have caused extensive sedimentation (MBTSG 1996e). Numerous dams on smaller tributaries block passage or have created isolated, resident populations, such as Rattlesnake, Mission, and Post creeks (MBTSG 1996e). Historic mining occurred in many of the Middle Clark Fork tributaries. As a result, there are 153 miles of stream that are water quality impaired as a result of mining impacts (MDHES 1994).

Thompson Falls Reservoir is operated for peaking power, causing 4-foot daily water fluctuations, limiting its quality as bull trout habitat (MFWP 1997). In addition, Thompson Falls Reservoir is currently managed to produce a northern pike fishery with trophy pike; this factor will continue unless dam management changes to better benefit native salmonids as a result of dam relicensing (MFWP 1997).

Lower Clark Fork River Subpopulation: The lower Clark Fork River valley flows through sedimentary formations that was formed by flood flows from glacial Lake Missoula. Today, three hydroelectric dams occur within the lower Clark Fork River segment. Cabinet Gorge Dam, is just downstream from the Idaho/Montana border and is operated as a re-regulating facility for Noxon Rapids Dam. Noxon Rapids Dam inundates the Clark Fork River between the backwaters of the Cabinet Gorge Reservoir and the tailwaters of Thompson Falls Dam. Thompson Falls Dam is the upper boundary of the lower Clark Fork River drainage area.

Prior to hydroelectric development in the lower Clark Fork River drainage, migratory bull trout from the Clark Fork River and from lake Pend Oreille had access to tributary streams both within the lower Clark Fork River drainage and upstream of Thompson Falls Dam. Historically, the Clark Fork River was likely utilized as a migration corridor between its tributaries and Lake Pend Oreille. Few man-made barriers to fish movement existed in the 1800s, and historic accounts suggest that bull trout residing in Lake Pend Oreille utilized spawning streams, and could potentially exchange genetic material with other stocks, as far up the Clark Fork River as the Flathead Lake/River basin (PBTTAT 1998). Pratt and Huston (1993) estimated the historic population of migratory bull trout from Lake Pend Oreille may have exceeded 10,000 adfluvial bull trout spawners annually. Bull trout harvest from Lake Pend Oreille was estimated to be 5,000

fish in 1953 (shortly after construction of Cabinet Gorge Dam) lending support to a total estimate of 10,000 adults (PBTTAT 1998).

The construction of Thompson Falls Dam in 1913 prevented any potential migration of bull trout to the upstream portions of the Clark Fork River system (PBTTAT 1998). After 1913, the accessible watershed available to Lake Pend Oreille bull trout consisted of Lake Pend Oreille and its tributaries, the Pend Oreille River (beginning at the lake outlet) and its tributaries upstream of Albeni Falls, and the Clark Fork River and its tributaries upstream to Thompson Falls Dam. Besides the tributaries that flow directly into Lake Pend Oreille, adfluvial bull trout from Lake Pend Oreille are believed to have used 86 percent of the habitat in tributaries that entered the Clark Fork River below the present site of Thompson Falls Dam. After construction of Cabinet Gorge Dam blocked the Clark Fork River in 1952, the remaining watershed area available to bull trout was reduced by about 43 percent (excluding the Priest River/Lake system and the area downstream of Albeni Falls on the Pend Oreille River). Historically, lower Clark Fork River tributaries represented important spawning areas for migratory bull trout from Lake Pend Oreille, before and after, Thompson Falls Dam was constructed in 1913.

Streams originally used by spawning bull trout that are located in the Clark Fork River drainage between Cabinet Gorge Dam and Thompson Falls Dam (i.e., tributaries that are now inaccessible to Lake Pend Oreille bull trout because of the Clark Fork dams) included Elk Creek, Bull River, Pilgrim Creek, Government Creek, Stevens Creek, Swamp Creek, Marten Creek, Tuscor Creek, Vermilion River, Grave Creek, Mosquito Creek, and Prospect Creek (Pratt and Huston 1993). The estimated number of bull trout that historically (1949 and 1950) migrated to these streams from Lake Pend Oreille before construction of Cabinet Gorge Dam was estimated to be less than 2000. As the dams were built the migratory corridor was blocked and the shift from larger migratory bull trout populations to smaller more isolated migratory and resident populations occurred, and in turn, the likelihood of extinction increased. As indicated above, by the 1940s and 1950s the total lower Clark Fork River population was estimated to be less than 2,000. The catch rate for bull trout in 1955 was 0.17 fish/hr and often lower upstream from Cabinet Gorge Dam. These changes have occurred over a 40-year period (4 to 8 bull trout generations).

As stated above, construction of the Cabinet Gorge Dam in 1952, eliminated access for Lake Pend Oreille bull trout to a substantial portion of the remaining lower Clark Fork River tributaries. It also disrupted movement of migrating juvenile bull trout attempting to travel to Lake Pend Oreille for maturation to adulthood. Instead, some portion of these juvenile fish heading for Lake Pend Oreille were "residualized" in Cabinet Gorge Reservoir and matured there before returning to the tributary streams for spawning. Following construction of Noxon Rapids Dam in 1959, the remaining adult bull trout in Cabinet Gorge Reservoir were again prevented from reaching upstream tributaries above Noxon Rapids Dam and downstream migrating juveniles from those tributaries were forced to residualize in the newly formed Noxon Rapids Reservoir or to attempt downstream migration through or over the dams. In 1993, Pratt and Huston (1993) concluded that only small numbers of spawning bull trout exist in Cabinet Gorge and Noxon Reservoirs and that the populations are fragile.

Recent studies (License Application Volume V.H-2, V.H-3, V.H-7, and V.H-11) conducted from 1994 to 1996 by Avista Corporation (formerly Washington Water Power Company), FERC licensee for Cabinet Gorge Dam and Noxon Rapids Dam, have confirmed earlier investigations (Pratt and Houston 1993) concerning the small size and fragile nature of bull trout populations associated with the two reservoirs. Extensive sampling since 1993 has found almost no large bull trout (large fish size being an indication of an adfluvial life history) in the dams' reservoirs or their tributaries and evidence of spawning adfluvial fish is lacking. Observations and sampling at presumed bull trout spawning sites has revealed the presence of brown trout only, indicating that bull trout are no longer present or are possibly being replaced by the introduced brown trout. In reservoir tributary reaches accessible to migratory fish, bull trout were the least abundant trout species sampled. Total numbers of fish estimated for the tributaries sampled were 5,856 bull trout; 8,520 brown trout; 35,625 brook trout; and 69,543 westslope cutthroat trout. During this sampling period, 1994 to 1996, bull trout were found in only five tributary streams (Bull River, Rock Creek, Vermilion River, Grave Creek, and Prospect Creek). No bull trout were sampled in seven streams where they were likely present historically (Elk Creek, Pilgrim Creek, Government Creek, Stevens Creek, Swamp Creek, Martin Creek, or Tuscor Creek). In the streams where bull trout were collected, the small size of almost all sampled fish precluded determination of resident or adfluvial life history.

Based on the studies cited above, the Cabinet Gorge Dam and Noxon Rapids Dam licensee concluded, "it is now highly likely that many of the adfluvial bull trout populations that historically existed in the reservoir's tributary streams, and were presumed to be maintaining a remnant population, in fact no longer exist." Bull trout observed in the tributary streams were either small resident fish or juvenile fish remaining from the few spawning adfluvial individuals from the reservoirs. This conclusion agrees with that of Schrenk and Simonich (1998) that adfluvial bull trout in Cabinet Gorge Reservoir are at risk because of fragmented habitat, migration barriers, small available habitat areas, degraded habitat conditions, low predicted survival to emergence, hybridization with brook trout, and low population size. It is likely that adfluvial bull trout in Cabinet Gorge Reservoir do not represent a viable population.

Since dam construction, the bull trout catch during gill net surveys in the reservoirs (between 1960 and 1985) indicates that bull trout declined in Noxon Rapids reservoir and remained stable in Cabinet Gorge reservoir. As indicated above, recent surveys indicate that there are very few bull trout in the reservoirs and these fish are in a very fragile situation and susceptible to further population declines (MBTSG 1996f). Bull trout currently exist in both Noxon Rapids and Cabinet Gorge reservoirs and utilize tributary streams for spawning and rearing. Cabinet Gorge bull trout populations are supported primarily by two spawning streams (Rock Creek and the Bull River). Both drainages are designated as core areas, indicating that they are the strongest remaining bull trout populations in the system (MBTSG 1996f). Little current status information is available for the lower Clark Fork bull trout subpopulation. In the Bull River drainage, bull trout are present in the mainstem, North Fork, East Fork, and South Fork, and Copper Creek (MBTSG 1996f). In the mainstem Bull River in 1992 and 1993, 12 and 16 redds, respectively, were counted (Pratt and Huston 1993).

In Rock Creek, large fish, probably migratory, have been observed. However, no large redds have been located in Rock Creek in recent surveys, though smaller redds, presumably from the resident population, have been found (MBTSG 1996f). Sediment levels in Rock Creek are 40 percent fine sediments, which is already considered high enough to significantly reduce bull trout survival to emergence. Complicating matters, a new mine and mill complex is proposed in the Rock Creek drainage that will pose a high risk to bull trout in the drainage and, potentially, in downstream waters as well (MBTSG 1996f).

In Noxon Rapids Reservoir, the resident bull trout life form has generally replaced the migratory form that historically dominated this system (MBTSG 1996f). Historically, migratory bull trout were common in the lower Clark Fork drainage and there are many anecdotal reports of bull trout presence (Pratt and Huston 1993, MBTSG 1996f). Noxon Rapids reservoir has five tributaries that support migratory bull trout spawning and rearing. In 1993, a total of 41 redds were found in these tributaries (Pratt and Huston 1993). The highest redd counts were in the Vermillion River (24 redds) and Prospect Creek (9 redds); the three other streams each had 4 redds or less (Pratt and Huston 1993). As a result, the Vermillion and Prospect drainages were designated core areas for this subpopulation (MBTSG 1996f).

The Vermillion River watershed contains several areas of sensitive landtypes which are a chronic source of sediment. This has resulted in a large volume of bedload and reduced transport efficiency, with the result that a large delta has developed in Noxon Reservoir at the mouth of the Vermillion. Overall primary and secondary productivity in the system is low and the river has been listed by the Montana Department of Environmental Quality (MDEQ) as a Water Quality Limited Segment (WQLS). In addition to poor bedload transport efficiency, the Vermillion River contains a relatively small amount of large woody debris (LWD) and very little potential to recruit LWD in the future. This is due to the unstable, migrating channel that has moved a large percentage of the trees within the riparian zone. Little of the large woody material that enters the active channel is retained. Spawning habitat in the Vermillion is limited to isolated pockets of gravel behind stable debris or boulders and to the lower end of a narrow incised channel referred to as China Gorge. It appears that bull trout and some westslope cutthroat trout spawning occurs in a small area where a historic mine diversion tunnel discharges groundwater into the river; this is the most notable area where suitable spawning gravels exist in the mainstem Vermillion.

Bull trout use of Prospect Creek appears minimal at present because of poor instream habitat conditions and poor riparian zone conditions. Furthermore, in 1995 and 1996, flooding caused severe damage by washing out culverts and scouring road surfaces and bridge abutments. Channel aggradation occurred in several areas as well as severe bank erosion. Attempts to fix the problems with standard engineering techniques have failed. However, efforts are underway as part of a long-term restoration approach using natural channel design strategies to repair damaged aquatic habitat and riparian function in this system (pers. comm., P. Saffel, MFWP). Nevertheless, salmonids (bull trout and westslope cutthroat) are presently considered "unsuccessful" in Noxon Rapids Reservoir (MFWP 1997).

As part of the recent relicensing application and settlement agreement with Avista Corporation, extensive efforts and planning are now underway to provide fish passage at Cabinet Gorge and Noxon Rapids dams for upstream passage of bull trout, as well as other species. Eventually, Thompson Falls Dam is likely to have fish passage as well. With fish passage at these dams in the distant future, the connectivity of the lower Clark Fork system to Lake Pend Oreille should be restored and recovery of migratory bull trout in the area enhanced significantly.

Summary of Factors Affecting Bull Trout in the Lower Clark Fork River: In the lower Clark Fork River drainage, fragmentation of the historic migratory population is considered to be the highest risk to restoration. Fragmentation has resulted in smaller, more discrete population units with less tributary accessibility. The migratory component of these smaller units is at a high threat of extirpation due to their limited abundance and available range. Forestry practices in the lower Clark Fork have affected primary spawning streams and future logging activity is expected. The past effects of forestry, including road construction, continues to be a source of impaired water quality in tributaries in this subpopulation (MDHES 1994).

Other factors potentially affecting this bull trout subpopulation include a proposal for a large, underground copper/silver mine in the Rock Creek drainage, which is in the permitting process. Tailings from this mine would be stored at the confluence of Rock Creek and the Clark Fork (MBTSG 1996f). Rock Creek is one of only two core areas for this subpopulation identified by the MBTSG (1996f).

Sediment levels in the Bull River bull trout spawning areas as a result of past forestry activities exceed the levels known to decrease bull trout survival (Pratt and Huston 1993, MBTSG 1996f). Because nearly all migratory bull trout spawning for the lower Clark River subpopulation occurs in the Bull River, this greatly increases the vulnerability of this subpopulation (Pratt and Huston 1993).

Cabinet Gorge Reservoir is operated as a re-regulating reservoir with 4-foot daily water level fluctuations and a high flushing rate, which minimizes its quality as bull trout habitat (MFWP 1997). During construction of the Clark Fork dams, associated reservoirs were treated to eliminate fish so that "desirable" sport fish could be introduced (MBTSG 1996f, MFWP 1997). High water temperatures (70 °F) in Noxon Rapids Reservoir limits its use by bull trout (MBTSG 1996B), making it more suitable for introduced warm water fish, including bass (MFWP 1997). Introduced bass may conflict with bull trout (MFWP 1997). Noxon Rapids Reservoir now supports a strong introduced smallmouth bass (*Micropterus dolomieui*) and largemouth bass (*M. salmoides*) fishery (MFWP 1997). Smallmouth and largemouth bass are the management priority for Noxon Rapids Reservoir, unless management for more suitable bull trout habitat conditions are emphasized as a result of dam relicensing (MFWP 1997). The fishery management objective for Cabinet Gorge Reservoir is to enhance its bull trout population while managing the present bass fishery (MFWP 1997).

Poachers are known to target concentrations of bull trout in the Clark Fork system (Long 1997). However, bull trout fishing regulations have gotten progressively more restrictive in recent years, resulting in the closure of all waters to the taking of and/or intentional fishing for bull trout, except in Swan Lake. The mouths of some important bull trout spawning tributaries, including one in the lower Clark Fork drainage, have been closed to angling to protect bull trout in staging areas from June 1 to August 30 (MFWP 1996).

The MBTSG concluded that the extensive presence of introduced species (particularly in the lower Clark Fork) posed a high risk to bull trout (MBTSG 1996f). Many species of nonnative fish have been introduced throughout the Clark Fork system. Brook trout are found in all parts of the system. Bull trout-brook trout hybrids exist in the middle and upper Clark Fork systems (MBTSG 1995b, Hansen and DosSantos 1997). Watson and Hillman (1997) found an inverse relationship between bull trout occurrence and the presence of brook trout.

Westslope Cutthroat Trout

Lee et al. (1997) classified 436 of 541 (81 percent) subwatersheds in the Clark Fork River sub-basin as depressed, and acknowledge few strong populations are left in Montana. Principal tributaries of the Clark Fork River are Flint-Rock Creek, and the upper Clark Fork, Blackfoot (see WCT discussion below for this drainage), middle Clark Fork, Bitterroot (see WCT discussion below for this drainage), and lower Clark Fork rivers. Land ownership in the drainage is 55.8 percent USFS, 1.7 percent U.S. Bureau of Land Management, < 0.1 percent tribal, 4.7 percent State of Montana, and 37.8 percent private and other public entities (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a).

WCT are believed to have historically occupied all of the streams and lakes to which they had access in the Clark Fork River sub-basin (MTFWP, *in litt.* 1998 as cited in USDI 1999a). In the drainage, however, only 5,847 miles (35.1 percent) of the estimated 16,667 miles of historic stream habitat have been surveyed for WCT. Thus, WCT could occupy additional stream miles that have not yet been surveyed. Among those 5,847 surveyed stream miles, WCT have been documented in 5,166 miles of stream (88.4 percent). Those WCT stocks have various degrees of genetic purity or have not yet been tested genetically (USDI 1999a). Of the total linear amount of stream habitat known to be occupied by WCT in the Clark Fork River sub-basin, 57.5 percent lies on lands administered by federal agencies (USDI 1999a).

WCT stocks are strong or predicted strong in 79 HUCs, depressed or predicted depressed in 353 HUCs, and absent or predicted absent in the remaining 42 HUCs that collectively constitute the Clark Fork River sub-basin (USDI 1999a). Among the 5,847 miles of stream surveyed, stocks of genetically pure WCT occupy 1,330 miles (316 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 227 miles; and stocks that are < 90.0 percent pure occupy 208 miles (MTFWP, *in litt.* 1998 as cited in USDI 1999a). Westslope cutthroat trout stocks inhabiting 3,401 miles of stream (975 stream reaches) remain untested genetically (USDI 1999a). Among the 5,166 miles of stream occupied by WCT stocks, 1,099 of the stream miles have stocks that are

genetically pure and considered abundant; genetically pure stocks in the remaining 231 miles of stream are considered rare. Of the, 557 stream miles with WCT stocks that have genetic purity of 90 percent, fish in 1,262 miles of stream are considered abundant.

In the upper Clark Fork River sub-basin, stocks of genetically pure WCT occupy 224 miles (39 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 26 miles; stocks that are < 90.0 percent pure occupy 39 miles; and stocks in 290 miles of stream (84 stream reaches) remain untested genetically (Appendix Table 3; MTFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 579 miles of stream occupied by WCT stocks, 542 of the stream miles have stocks that are considered abundant; stocks in the remaining 37 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the upper Clark Fork River sub-basin, 28.8 percent lies on lands administered by federal agencies (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 10 HUCs; depressed or predicted depressed in 39 HUCs; and absent or predicted absent in the remaining 18 HUCs that collectively constitute the upper Clark Fork River sub-basin (USDI 1999a).

In the Flint-Rock Creek sub-basin stocks of genetically pure WCT occupy 144 miles (23 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 30 miles; stocks that are < 90.0 percent pure occupy 6 miles; and stocks in 449 miles of stream (125 stream reaches) remain untested genetically (Appendix Table 3; MTFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 629 miles of stream occupied by WCT stocks, 489 of the stream miles have stocks that are considered abundant; stocks in the remaining 140 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Flint-Rock Creek sub-basin, 57.9 percent lies on lands administered by federal agencies (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 28 HUCs; depressed or predicted depressed in 13 HUCs; and absent or predicted absent in the remaining 8 HUCs that collectively constitute the Flint-Rock Creek River sub-basin (USDI 1999a).

The middle Clark Fork River sub-basin, stocks of genetically pure WCT occupy 105 miles (21 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 28 miles; stocks that are < 90.0 percent pure occupy 32 miles; and stocks in 702 miles of stream (201 stream reaches) remain untested genetically (Appendix Table 3; MTFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 867 miles of stream occupied by WCT stocks, 479 of the stream miles have stocks that are considered abundant; stocks in the remaining 388 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the middle Clark Fork River sub-basin, 56.2 percent lies on lands administered by federal agencies (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 11 HUCs; depressed or predicted depressed in 55 HUCs; and absent or predicted absent in the remaining one HUC that collectively constitute the middle Clark Fork River sub-basin (USDI 1999a).

The lower Clark Fork River sub-basin, stocks of genetically pure WCT occupy 249 miles (58 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 31 miles; stocks that are < 90.0 percent pure occupy 19 miles; and stocks in 408 miles of stream (111 stream reaches) remain untested genetically (Appendix Table 3; MTFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 707 miles of stream occupied by WCT stocks, 474 of the stream miles have stocks that are considered abundant; stocks in the remaining 233 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the lower Clark Fork River sub-basin, 56.3 percent lies on lands administered by federal agencies (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 15 HUCs; depressed or predicted depressed in 83 HUCs; and absent or predicted absent in the remaining three HUCs that collectively constitute the lower Clark Fork River sub-basin (USDI 1999a).

In summary, WCT in the Clark Fork River sub-basin occur in about 1,291 tributaries or stream reaches that collectively encompass 5,166 linear miles of stream habitat, distributed among 6 watersheds (USDI 1999a). Of the total linear amount of stream habitat known to be occupied by WCT in the drainage, 57.5 percent lies on lands administered by federal agencies (USDI 1999a).

Summary of Factors Affecting the Species in the Clark Fork River Sub-basin (based on USDI 1999a): Major land-use activities in the Clark Fork River sub-basin that may adversely affect WCT include forestry practices, mining, livestock grazing and other agricultural practices, and urbanization. The MTDEQ lists 77 streams in the Clark Fork River sub-basin as being water-quality impaired as the result of forestry practices, 143 impaired by agricultural practices, 99 impaired by water withdrawals, 71 impaired by roads, and 73 impaired by mining (UDSI 1999). Many of these streams are impaired by more than one activity. Information on the possible occurrence of WCT in these streams is presently unavailable, however.

Angler harvest is closely regulated in the Clark Fork River sub-basin and is not considered a threat to WCT (MTFWP, *in litt.* 1999 as cited in USDI 1999a). In many waters in the sub-basin, fishing for WCT is restricted to catch-and-release. Existing regulatory mechanisms failed to prevent the illegal stocking of northern pike into the Clearwater River system. Predation on WCT by normative predatory fishes poses a threat to WCT in a few localized areas. The highly predacious northern pike, for example, was illegally introduced into the Clearwater River system (MBTSG 1995c). There are no other evident, inherent inadequacies in existing federal, state or local regulatory mechanisms that affect WCT in the drainage. However, effective implementation of the various regulatory mechanisms that potentially affect WCT depends largely upon the appropriation of adequate funding and, ultimately, commitment on the part of the management or regulatory agencies to fulfill their respective responsibilities. Where these responsibilities are not being fulfilled, WCT may be threatened by ongoing or planned, adverse changes in their habitat or by chronic, adverse effects that remain unabated.

In the Clark Fork River sub-basin, whirling disease has been detected in the Blackfoot River watershed, the Flint Creek-Rock Creek watershed, and the upper Clark Fork River watershed

(Gustafson 1996 as cited in USDI 1999a). Extensive research is being conducted to determine the distribution of whirling disease in Montana, the susceptibility of WCT (a close relative of rainbow trout) to whirling disease, and possible control measures. Research suggests that WCT in headwater streams will not be affected by whirling disease because these streams are not suitable for colonization by the intermediate host for the whirling disease organism. Moreover, current research suggests that, although the whirling disease organism may be present in streams, low levels of the organism are unlikely to result in deleterious infections in fish, including cutthroat trout. Consequently, whirling disease is not considered an important threat to extant WCT stocks in the Clark Fork River sub-basin.

Stocking of normative fish species in Clark Fork River sub-basin began in the 1890s. As a result, normative brook trout, brown trout and rainbow trout became established long ago in many streams and lakes throughout Montana (MTFWP, *in litt.* 1999 as cited in USDI 1999a). Although such stocking has not occurred in the drainage for more than two decades, the normative fishes that became established probably constitute the greatest contemporary threat to the maintenance and restoration of WCT in the drainage.

Many people in the Bitterroot River watershed are building private fish ponds on their property and stocking them with brook trout, leading to concern that these introduced fish could spread into sub-basin tributaries where they do not already exist (MBTSG 1995d). In addition, the genetic integrity of WCT can be threatened by interbreeding with normative rainbow trout and Yellowstone cutthroat trout (MTFWP, *in litt.* 1999 as cited in USDI 1999a).

Summary of Programs and Actions Addressing WCT Issues in Montana (based on USDI 1999a): Numerous management programs and other actions are being implemented to eliminate or ameliorate the adverse effects on WCT of past, present, and proposed land-management activities in Montana. On nonfederal lands in the state, several mechanisms are being implemented to protect WCT, their habitat, and other aquatic resources. Forestry "Best Management Practices" (BMP) are being implemented on Montana State Forests to maintain water quality and reduce sediment input; audits of forestry practices indicate a high degree of compliance and grazing BMPs have also been developed and are being implemented on state grazing lands.

Montana has several laws and regulations directed toward protection of aquatic habitats that, if properly applied and enforced, reduce threats to WCT throughout the range of the WCT. The Montana Stream Protection Act requires a permit for any project that may affect the natural and existing shape and form of any stream or its banks or tributaries; the Streamside Management Zone Law permits only selective logging and prohibits clear cutting and heavy equipment operation within 50 feet of any lake, stream, or other body of water; the Montana Natural Streambed and Land Preservation Act requires private, nongovernmental entities to obtain a permit for any activity that physically alters or modifies the bed or banks of a perennially flowing stream; and the Montana Pollutant Discharge Elimination System requires permits for all discharges to surface water or groundwater, including discharges related to construction, dewatering, suction dredges and placer mining. Before permits allowing activities covered under

these regulations are issued, applications are reviewed by MFWP, Montana Department of Natural Resources and Conservation, and the MDEQ. Recommendations to limit impacts to WCT and their habitat are mandated through the permitting process.

In 1997, the Montana Legislature passed House Bill 546, which strengthened the state's authority to develop Total Maximum Daily Loads (TMDLs) for Montana waters. Under this legislation, MDEQ is directed to identify impaired water bodies, identify the causes of impairment, and develop corrective actions. MDEQ's goal is to correct all impairments within the next 10 years. Such corrective actions will improve water quality in many streams and should result in enhancement of habitat for WCT.

Of the approximately 12,896 linear miles of stream occupied by WCT in Montana, 7,210 miles (55.9 percent) occur on federal lands (USDI 1999a). Among the nearly 42 million acres of land that constitute the watersheds occupied by WCT in Montana, 36.6 percent are administered by the USFS, 4.1 percent by the BLM, and 2.7 percent by the National Park Service and FWS . Many of the lakes that are habitat for WCT are in Glacier National Park, where National Park Service policies preclude modification of WCT habitat and introduction of normative species.

On lands administered by the USFS and BLM in the Columbia River basin, where 5,253 (72.9 percent) of the 7,210 stream miles occupied by WCT on federal lands in Montana occur, numerous management programs and other actions are being implemented to minimize or ameliorate the adverse effects on WCT of past, present, and proposed forestry practices. INFISH includes interim direction for riparian management objectives, standards and guidelines, and monitoring in the Columbia River basin. Among other things, INFISH requires that 300 foot buffers be maintained along all streams. INFISH standards, which can only be modified following a watershed analysis or site-specific evaluation, are being implemented on USFS and BLM lands to minimize or eliminate present or potential destruction of WCT habitat and other aquatic resources. Upon its completion, the ICBEMP will supercede INFISH and establish aquatic ecosystem management standards on these federal lands in the basin.

Additional land-use restrictions and protections that benefit WCT on Federal lands in Montana will result from the June 10, 1998, listing of bull trout in the Columbia River basin as a threatened species under the Act (63 FR 31647). Because the general distribution of bull trout overlaps that of WCT in the basin, section 7 of the Act is directed toward the protection of bull trout and their habitats will also afford benefits to WCT.

In addition to those administrative protections, the national forests in Montana reported a total of 234 projects directed toward the protection and restoration of WCT and their habitats on forest lands (Bosworth, *in litt.* 1998 as cited in USDI 1999a). Similarly, the MFWP reported about 500 projects (MTFWP, *in litt.* 1998 as cited in USDI 1999a) and the National Park Service, Yellowstone National Park, reported 12 projects (Finley, *in litt.* 1998 as cited in USDI 1999a), all directed toward the protection and restoration of WCT and their habitats.

Extensive research is being conducted to determine the distribution of whirling disease in Montana, the susceptibility of WCT to whirling disease, and possible means to control the disease.

MFWP has implemented policies and regulations to prevent the human transfer of potentially diseased fishes (or water that contains the protozoan that causes whirling disease) among streams and lakes (MTFWP, *in lift.* 1999 as cited in USDI 1999a).

Restoration activities underway as part of the Blackfoot Challenge, a cooperative endeavor between private landowners and public agencies to restore and conserve streams and riparian environments in the Blackfoot River valley, include removal offish-passage barriers; screening of irrigation diversions to prevent the loss offish to canals; and general improvement of instream fish habitat (MBTRT 1997). The Blackfoot Challenge also works to acquire conservation easements.

A Memorandum of Understanding and Conservation Agreement for WCT (MFWP 1999) was finalized in May, 1999 to expedite implementation of conservation measures in Montana. This agreement is a cooperative and collaborative effort among resource agencies, conservation and industry organizations, resource users, and private landowners for the purpose of incorporating established management goals and objectives for WCT into respective planning and budgeting processes within identified time frames. Per this agreement, the management goal for WCT in Montana is to ensure long-term self-sustaining persistence of the subspecies within each of the five major sub-basins (Clark Fork, Kootenai, Flathead, upper Missouri, and Saskatchewan), and to maintain the genetic diversity and life history strategies of the local populations. Reported in the agreement were the threats to the species as well as the conservation actions that can be applied within all or individual watersheds depending on site-specific causes of decline. Signatories to the agreement will address the threats, to the extent they exist, with management and restoration actions. The initial term of the agreement is for 5 years and if all signatories agree that at the end of the initial term significant progress has been made towards conservation of WCT, the agreement can be extended for an additional 5 years. The 1999 Montana Legislature passed a bill that provided $0.75 million to MFWP to implement the management plan for WCT, and to accomplish similar work with bull trout.

Blackfoot River Sub-basin

Plum Creek lands in the Blackfoot River planning area sub-basin consist of 1,479,429 acres. These are scattered throughout the sub-basin but are mostly situated in the central portion and western edge. Tier 1 watersheds in the Blackfoot River planning area sub-basin total 659,696 acres (approximately 45 percent of the drainage), of which 124,049 acres (about 8 percent of the drainage) are Plum Creek lands. Tier 2 lands total 819,733 acres (55 percent of the drainage), of which 166,578 acres (11 percent of the drainage) are owned by Plum Creek. One hundred seventy two miles of Key Migratory Rivers occur in the Blackfoot, of which 16 miles are on Plum Creek lands. Perennial streams on Plum Creek lands in the Blackfoot total 278 miles. Grazing leases on Plum Creek lands in the Blackfoot total 163,278 acres along 405 stream miles. Of these, 42,701 acres and 94 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 3,116 miles of roads occur on Plum Creek lands in the Flathead and another 301 miles are proposed.

The Blackfoot River flows from its headwaters approximately 133 miles to its confluence with the Clark Fork River near Bonner, Montana (Moore et al. 1991). It originates at the confluence of Beartrap and Anaconda creeks, southwest of Rogers Pass. The Blackfoot River has a drainage area of approximately 2300 square miles and average annual discharge is 1,578 cfs (MBTSG 1995c). Glacial activity strongly influenced the geology and topography of the upper Blackfoot River and its tributaries, where extensive deposits of glacial gravel outwashes and moraine drifts occur. Streamflows in the mainstem and some tributaries are strongly influenced by these glacial deposits. Tributaries frequently have intermittent sections due to the flowing through the glacial deposits (MBTSG 1995c).

Bull Trout

Mining for gold, silver, lead, and copper has had extensive impacts on aquatic ecosystems in the Blackfoot River drainage over the past century. Many mines exist in the western and southern portions of the sub-basin (MBTSG 1995c). Impacts from these mines has resulted in loss of aquatic habitat in past years, while contamination of waters from mine effluent continue to today (MBTSG 1995c). Toxic mining wastes moving downstream from the headwaters and degraded habitat in tributaries are considered leading causes that reduced the viability of the fishery in the Blackfoot river drainage. Most of the upper sub-basin's large tributaries and mainstem waters have been contaminated at one time or another by mine tailings, waste piles, or mine effluent. Concentration of sulfates are extremely high in the more acidic tributaries. Fish populations in the upper Blackfoot continue to be impacted by the washout of the Mike Horse tailings dam in 1975, which spilled contaminated tailings into the Blackfoot River (MBTSG 1995c). Both acidity and sulfate show downstream attenuation from the headwater sources in the Blackfoot River (MBTSG 1995c). Research in the Blackfoot drainage demonstrated that heavy metal contaminants released in the headwaters affect chemical trends, metal concentrations, metal bio-availability and fish populations a long distance from the contaminant source (Moore et al. 1991).

Currently, a proposal for a large open pit gold mine using cyanide heap leach processing is in the planning and permitting process. The project location is bordered by the upper Blackfoot River and the Landers Fork, which drains Copper Creek. Much of the ore body occurs below the water table and will require pumping of groundwater. Concern is high regarding the effects of this mine on the hydrology of the upper Blackfoot system and contamination risks (C. Cody, EPA *in litt.*, 1997).

In the Blackfoot River drainage, wide-spread canopy removal, alterations to riparian vegetation, and warm water irrigation returns have significantly warmed the historic temperature regime of the Blackfoot (MBTSG 1995c, Pierce et al. 1997). Probable causes of elevated temperatures are grazing in riparian zones, logging, and irrigation return flows (MBTSG 1995c).

Extensive logging has occurred in many Blackfoot drainages such that water quality impairment as a result of silvicultural practices has been noted in many drainages, including the North Fork of the Blackfoot (MDHES 1994). However, where the North Fork of the Blackfoot enters the

river's mainstem (river mile 54.1), the flow nearly doubles, bringing a cold-water influence that improves water quality and species richness, based on the increase in abundance of bull trout and westslope cutthroat trout below this confluence (MFWP 1997). The effects of past forestry practices in the Blackfoot River drainage include increased sediment in streams, increased peak flows, thermal modifications, loss of instream woody debris, and channel instability (MBTSG 1995c).

Impacts to water quality as a result of agricultural practices have also been observed in the Blackfoot River drainage, including 193 miles of the river's tributaries. Chronic dewatering has been found in 82.4 miles of 18 streams within the Blackfoot, and irrigation diversions are a high threat to the restoration of migratory bull trout in some Blackfoot waters, particularly the North Fork of the Blackfoot, Poorman Creek, and Nevada Creek (MBTSG 1995c). Depressed fisheries in the Nevada and Ovando Valleys can be attributed to poor water quality and poor habitat due to agriculture practices (MBTSG 1995c). Nevada Creek (river mile 67.8) has been identified as a primary source of nonpoint pollutants, delivering nitrates, phosphates, sediment, and elevated stream temperatures to the middle Blackfoot River (MFWP 1997).

Upstream passage of migratory bull trout between the middle and lower segments of Clark Fork River and the Blackfoot was severed in 1906 and 1907 by the construction of Milltown Dam on the mainstem Clark Fork immediately downstream of the confluence of the Blackfoot River (MBTSG 1995c, Pierce et al. 1997). Each spring concentrations of fish, including some bull trout, are observed at the base of Milltown Dam. It is presumed that these fish are attempting to move upstream past the dam (MBTSG 1995c). This run of-the-river hydroelectric facility is currently involved in relicensing by the Federal Energy Regulatory Commission. A fisheries mitigation plan is being developed as a component of this relicensing procedure, which includes provisions for selective fish passage (MBTSG 1995c).

In 1990, local landowners and state and federal agencies in the Blackfoot River valley initiated a cooperative effort to restore fisheries and riparian zones in the Blackfoot drainage. Known as the Blackfoot Challenge, this effort continues today. A bull trout subcommittee has been formed to provide advice on bull trout restoration in the Blackfoot River (MBTRT 1997). Through the Blackfoot Challenge, many stream and fishery restoration efforts have been accomplished to date, including repair of fish passage barriers and screen diversions and improvement of instream fish habitat (MBTRT 1997). Most of these restoration efforts has occurred in tributary streams to the middle reaches on the Blackfoot River. Completed restoration projects have occurred on 23 streams influencing over 200 stream miles, and monitoring results of these projects have shown increased spawning of bull trout and westslope cutthroat trout (MFWP 1997).

Blackfoot River Subpopulation: Bull trout were widely distributed in the Blackfoot River historically (Berg and Priest 1995 MBTSG 1995c). It is likely that there was migratory connectivity for bull trout between the Clark Fork River and the Blackfoot River. The Flathead Indians were reported to have camped near the mouth in order to catch bull trout. The connection between the two river systems was broken when Milltown dam was constructed in 1906. Each

spring there are concentrations of fish observed at the base of the dam and in 1992, two 30 inch bull trout were found in the sluiceway of the dam after it had been accidentally dewatered (MBTSG 1995c).

The Blackfoot River constitutes a single bull trout subpopulation. However, bull trout in Cooper's Lake may be a disjunct subpopulation (MBTSG 1995c). Bull trout occurrence is documented for numerous tributaries and lakes within the Blackfoot drainage prior to the 1970s (MBTSG 1995c, Platts et al. 1995). The Blackfoot River is one of the few drainages in Montana where fluvial bull trout are still the dominant life history form; both adfluvial and resident bull trout also occur in the drainage (Hillman and Chapman 1997, Pierce et al. 1997, Swanberg and Burns 1997). There are no major natural barriers that would have excluded bull trout from significant parts of the drainage.

Fluvial bull trout in the Blackfoot River system occur from the mainstem to the headwaters of larger tributaries. Present distribution is linked to larger tributaries draining the mountains north of the Blackfoot River, although several smaller tributaries in the Garnet Range to the south historically supported bull trout. Adfluvial bull trout occur in the Clearwater River and Cooper Lake drainages. Fluvial bull trout currently inhabit 420 stream miles or 22 percent of the total amount of perennial streams in the Blackfoot drainage (MFWP 1997).

In recent years there have been research efforts to study bull trout in the Blackfoot River system. The mainstem contains migratory bull trout. The abundance of these fish varies by reach. Generally, electrofishing data indicate that from the mouth of the Blackfoot to the North Fork of the Blackfoot River bull trout are considered uncommon. From the North Fork Blackfoot River to Poorman Creek bull trout are rare. From Poorman Creek to the Landers Fork, bull trout are expected but not verified, and from the Landers Fork to the headwaters, bull trout are rare.

The mainstem Blackfoot River is identified as nodal habitat in this area of the drainage (MBTSG 1995c). The MBTSG (1995c) identified several bull trout core areas in the Blackfoot River drainage which support the strongest remaining populations. These areas are the North Fork of the Blackfoot, Monture Creek, Copper Creek, Gold Creek, Placid Creek, Cottonwood Creek, the Clearwater River above Rainey Lake, Deer Creek, Belmont Creek, Landers Fork, Morrell Creek, and the East and West Forks of the Clearwater River. Other watersheds may be added as more information becomes available (MBTSG 1995c).

The current bull trout management objective, as stated in the 1990 MFWP's Blackfoot River Management Plan, is to increase the standing crop of adult bull trout larger than 5 lbs. to one fish per 1000 ft of stream. A key component of restoration for bull trout in the Blackfoot River is to maintain a self-reproducing migratory life form which has access to tributary streams and spawns in core watersheds. Specifically, a baseline of redd counts should be established in all drainages that presently support spawning migratory fish.

In the mainstem Blackfoot River below the North Fork, bull trout appear to be increasing since 1989, although numbers are still low. Lengthy bull trout migrations have occurred in the Blackfoot drainage. Tagged bull trout in the lower river have moved upstream to the North Fork, a distance of over 50 miles. Fish from the mainstem are also known to move into the Clearwater River system. The North Fork of the Blackfoot River and Monture Creek are the most important spawning streams in the drainage. Redd counts have increased in recent years (from 25 redds in 1991 to 49 redds in 1994), probably due to increased angling restrictions and/or improved habitat resulting from habitat restoration projects (MBTSG 1995c).

In the upper Blackfoot River, several streams are suspected to contain low numbers of bull trout, but the status of the species is unclear. Based on limited data, it appears that bull trout may have been completely lost from portions of the upper Blackfoot, but, on the other hand, bull trout may be increasing in other areas, particularly in the North Fork of the Blackfoot and Monture Creek.

In 1996, 198 redds were recorded drainage-wide with seventy percent of spawning occurring in just two streams, Monture Creek and the North Fork of the Blackfoot (Pierce et al. 1997). The most significant spawning streams in the Blackfoot drainage are Monture Creek, the North Fork, and Copper Creek (MBTSG 1995c, Hillman and Chapman 1997, Pierce et al. 1997, Swanberg and Burns 1997). Between 1988 and 1996, redd counts in Monture Creek increased from 10 to 65, and in the North Fork of the Blackfoot redd counts increased from 7 to 59 (Pierce et al. 1997). Because these two streams are located in close geographic proximity, the risk of a single catastrophic event affecting bull trout populations in both is high (Rieman and McIntyre 1993, Pierce et al. 1997).

Although redd counts from Monture Creek and the North Fork of the Blackfoot have increased, numbers of bull trout in most other tributaries are low. Based on historic records, bull trout are extirpated from eleven Blackfoot tributaries, including Elk Creek, Dry Creek, Keep Cool Creek, Grentier Creek, BearCreek, Blanchard Creek, Nevada Creek, and Dick Creek (Berg and Priest 1995, MBTSG 1995c, Pierce et al. 1997), and the Landers Fork no longer supports bull trout spawning (MBTSG 1995c). Throughout the drainage, bull trout are considered "uncommon" to "rare" (MBTSG 1995c). In 1996, bull trout densities in the Blackfoot River were described as "quite low" (0.00 to 0.37 per 100 square miles) (Hillman and Chapman 1997). From 1990 to 1996, densities in the lower Blackfoot have declined 43 percent from 1.4 to 0.8 bull trout per 1000 feet (Pierce et al. 1997). However, densities in the middle Blackfoot increased from 1.5 to 2.6 bull trout per 1000 feet between 1990 and 1996 (Pierce et al. 1997).

Although Copper Creek is considered important for bull trout, in 1996 bull trout density was low in this drainage, estimated at only 0.95/100 square miles (Hillman and Chapman 1997). In Copper Creek index reaches, redd counts have fluctuated between 19 and 25 since 1989 (Hillman and Chapman 1997). Copper Creek is one the few remaining streams within the Montana bull trout range that still supports a native fish assemblage.

The MFWP has observed lengthy migrations of bull trout in the Blackfoot River system. Tagged bull trout from the Johnstrud section of the Blackfoot River were found over 50 miles away in the North Fork of the Blackfoot. Bull trout in the Blackfoot River are known to move into the Clearwater River as well (MBTSG 1995c).

In general, surveys by MFWP have found that south flowing tributaries all contain bull trout, whereas north flowing tributaries do not, although some historical use of some north flowing streams has been noted (MBTSG 1995c). Spawning areas within tributaries are very localized and small, and appear to be strongly influenced by groundwater and used repeatedly year after year (MBTSG 1995c).

The Clearwater River tributary of the Blackfoot contains seven Lakes (the Salmon, Seeley, Inez, Alva, Rainy, Placid, and Clearwater); all are connected by the Clearwater River. Rainy Lake, Clearwater Lake, Placid Lake, and Seeley Lake still contain bull trout (MFWP 1997). However, connectivity is limited at the watershed scale primarily due to dams at Rainy Lake, Placid Lake, and a dam between Lake Inez and Seeley Lake. This limits distribution and abundance of fluvial and adfluvial forms of bull trout in the system. Habitat within the Clearwater drainage has been heavily impacted from timber harvest, roading construction, and recreation, resulting in fragmented habitat. Road densities are high in most of the drainage, the lowest being Morrell Creek at 2.73 miles/square mile and the highest being lower Placid Creek at 5.22 miles/square mile. In the upper Clearwater drainage system (above Rainey Lake), 16 of the 65 miles of road in the drainage are within 300 feet of a stream channel and close enough to have a major influence on either stream stability or sediment contribution (Lolo National Forest 2000). percent streams without canopy cover is moderate to high probably because of the characteristics of a wide, flat valley bottom dominated by shrub species (Lolo National Forest 2000). In these types of areas, sedimentation is increased, decreasing the quality of spawning habitat. In general, sedimentation is a concern in the watershed with modeling indicating a long-term sediment yield more than twice the natural yield as a result of the lingering effects of previous land management activities in the watershed (Lolo National Forest 2000).

The USFS (Lolo National Forest 2000) estimates that the Clearwater drainage has less than 50 adult fluvial bull trout based on the high number of tributaries and quality of spawning gravels. There are several lakes that provide good rearing habitat, but growth and survival is limited due to fish barriers and presence of exotic fish, as many as 20 different species. In Lake Inez, current bull trout densities have declined 80 percent from historic averages obtained from gillnetting data since the 1950s (pers. comm., R. Berg 1997). In Salmon Lake, despite intensive gillnetting, bull trout have not been caught in the past 4 years. Rainey Lake is believed to have the most abundant bull trout population in this group of lakes and may be recovering. Migration barriers exist below Rainey Lake, Lake Alva, and Lake Inez. Bull trout are known to collect at the barrier below Rainey Lake and maybe others as well. Discussions are underway about removing these barriers (MBTSG 1995c). In general, current data on these populations are limited.

The MBTSG (1995c) reports that bull trout status in the Blackfoot River drainage is precarious. Bull trout may be increasing in some portions of the drainage, whereas it appears that bull trout have been completely lost in recent years from other portions. Bull trout in the North Fork of the Blackfoot and Monture Creek areas appear to be increasing. However, the East Fork of the North Fork of the Blackfoot and Dick Creek have a few remnant bull trout but their presence has not been documented for years. Union Creek has been sampled extensively in recent years and no bull trout have been observed. The few remaining bull trout in Nevada Creek are found above Nevada Creek Reservoir, whereas downstream from the dam only one bull trout has been collected in recent years. Poorman Creek has very low numbers of bull trout, which are isolated due to natural dewatering from the mainstem Blackfoot River. Bull trout status from several other tributaries in the drainage is unknown.

Summary of Factors Affecting Bull Trout in the Blackfoot River Sub-basin: Milltown Dam blocks bull trout movement upstream from the lower Clark Fork River into the upper Clark Fork and Blackfoot drainages (MBTSG 1995c, Swanberg 1996). Bull trout that pass downstream over the dam are lost from the subpopulation (Swanberg 1996, Pierce et al. 1997). Smaller dams in Blackfoot River tributaries block upstream passage to upper Nevada Creek, Clearwater Lake, Rainy Lake, and Lake Inez (MBTSG 1995c). In the Blackfoot drainage, downstream migrants have been trapped in irrigation ditches and lost to the population (MBTSG 1995c, Swanberg 1996). Several diversions in the Blackfoot drainage have been renovated to provide passage and eliminate ditch entrainment (MBTRT 1997).

Mining and introduced species are the two predominant risks to bull trout restoration in the Blackfoot drainage (MBTSG 1995c). The MBTSG (1995c) ranked mining in the Blackfoot as a very high risk to bull trout restoration. Mining impacts include direct loss of habitat, particularly in the upper portions of the sub-basin, as well as water quality effects that pervade the system. The impacts of past mining activities persist and new mines that may be developed in the future may potentially lead to further losses of habitat and to increased water quality degradation. A large open pit gold mine with cyanide heap leach processing (the McDonald gold project) is being planned for the Lincoln area and is a serious concern among some groups.

The presence of introduced species in the Blackfoot drainage is identified as a high risk to bull trout through hybridization (brook trout), predation (brown trout), and possible competition (brook and brown trout) (MBTSG 1995c). Bull trout-brook trout hybrids have been observed in the Blackfoot drainage (Pierce et al. 1997). Watson and Hillman (1997) found an inverse relationship between bull trout occurrence and the presence of brook trout. Brown trout are commonly found in Blackfoot River tributary streams as well as in the mainstem. This is unlike other Montana river systems. Since habitat availability and quality have been reduced and since brook and brown trout habitat preferences overlap with bull trout, these processes/interactions may synergistically act to reduce carrying capacity for bull trout.

Northern pike have been illegally introduced into the Clearwater system, threatening all fish species in this system (MFWP 1997). The pike population has drastically increased in Salmon

Lake and Lake Inez and had a severe negative effect on bull trout in these lakes (pers. comm., R. Berg1997). Pike also occur in Seeley Lake and Alva Lakes, and are expected to increase and affect bull trout in Salmon Lake (pers. comm., R. Berg1997). Other nonnatives in these waters are laregemouth bass, rainbow trout, kokanee, and yellow perch (MFWP 1997). Restoration of bull trout will be the management emphasis in Rainy and Clearwater Lakes, where pike do not occur, while the rest of the lakes in this chain will be managed for both native trout and rainbow trout, kokanee, and largemouth bass (MFWP 1997).

Water temperatures in the mainstem Blackfoot frequently exceeded bull trout preferred temperature range 60 °F annually from 1994 to 1996, making availability of thermal refuges critical for bull trout conservation (Pierce et al. 1997). Crowding of bull trout in thermal refuges could expose the fish to added competition, stress, predation, and illegal harvest (Pierce et al. 1997). However, it appears that, in the Blackfoot, bull trout tend to migrate to colder waters before high temperatures occur (Swanberg 1996).

In the upper Blackfoot River, warm temperatures appear to be a major risk to bull trout. Elevated temperatures are found in Nevada Creek, Douglas Creek, Nevada Spring Creek, Cottonwood Creek, Willow Creek, Union Creek, Elk Creek, and Clearwater Creek. During the summer, the Blackfoot River is significantly warmer downstream of the confluence of Nevada Creek than upstream. Summer water temperatures in Nevada Creek and the Blackfoot River were significantly above levels considered optimal for bull trout (MBTSG 1995c). Probable causes of elevated temperatures are grazing in riparian zones, logging, and irrigation return flows. Rural residential development is of high concern locally in the Blackfoot drainage. Efforts to mitigate such impacts have been encouraged by the Blackfoot Challenge, which has been working to acquire conservation easements, among other projects (see above).

In the Nevada Creek drainage, agricultural practices have resulted in poor water quality through nutrient enrichment, sedimentation, dewatering, and increased water temperatures (MBTSG 1995c). Alteration of stream flows below Nevada Creek Reservoir have eliminated fish habitat through dewatering of the stream channel. McGuire (1991 as cited in MBTSG 1995c) found evidence of persistent nonpoint source pollution (nutrient enrichment, sedimentation, and elevated water temperatures) in the Blackfoot River below the confluence of Nevada Creek.

The effects of forest practices was considered a very high risk to bull trout restoration in the Blackfoot drainage (MBTSG 1995c). Historically, log drives in the Blackfoot mainstem and Clearwater River probably had significant impacts on aquatic habitat and were very damaging to fish and fish habitat at the time they occurred; such damage likely persists into the present. Many drainages in the Blackfoot River watershed have been extensively logged and suffer the effects of sedimentation. Current forest practices are more progressive, but risks to bull trout are still present as a result of past forestry practices, including poor existing road systems (MBTSG 1995c).

Poaching of bull trout has been documented in the Blackfoot (Swanberg 1996). Recent radio tagging of bull trout have shown that poaching still occurs as well as misidentification by anglers.

Recent environmental events may have been a factor in the decline of bull trout in the Blackfoot River system. Drought in the early 1990s increased water temperatures and fish losses during this time are apparent (Pierce et al. 1997). In February, 1996, substantial ice flows may have forced bull trout downstream over Milltown dam and scoured banks, degrading rearing habitat (Pierce et al. 1997).

A bull trout in the Landers Fork of the Blackfoot River froze to death after it was stranded in a shallow section of the stream above a portion of the Landers Fork that becomes naturally seasonally dewatered (Swanberg and Burns 1997). Bull trout movement in the upper Blackfoot is also seasonally limited, possibly concentrating fish and increasing vulnerability to catastrophic events and illegal fishing (Swanberg and Burns 1997).

Westslope Cutthroat Trout

In the Blackfoot River sub-basin, stocks of genetically pure WCT occupy 255 miles (60 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 59 miles; stocks that are <90.0 percent pure occupy 39 miles; and stocks in 666 miles of stream (170 stream reaches) remain untested genetically (Appendix Table 3; MTFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 1,019 miles of stream occupied by WCT stocks, 638 of the stream miles have stocks that are considered abundant; stocks in the remaining 381 miles of stream are considered rare. Of the total linear amount of stream habitat known to be occupied by WCT in the Blackfoot River sub-basin, 41.1 percent lies on lands administered by federal agencies (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in five HUCs; depressed or predicted depressed in 77 HUCs; and absent or predicted absent in the remaining 10 HUCs that collectively constitute the Blackfoot River sub-basin (USDI 1999a).

Factors Affecting WCT in the Blackfoot River Sub-basin: See also "*Summary of Factors Affecting the Species in the Clark Fork River Sub-basin.*" The MBTSG (1995c) ranked mining in the Blackfoot River watershed as a high risk to bull trout restoration and would likely rank as high risk for WCT as well. Mining of gold, silver, lead, and copper has occurred in Blackfoot River headwaters during the past century, and effluents from the mines continue to result in the loss of habitat for bull trout (MBTSG 1995c). Altogether, 153 miles of streams in the Middle Clark Fork River watershed are water-quality impaired because of mining (MDHES 1994).

Whirling disease has been detected in the Blackfoot River watershed (Gustafson 1996 as cited in USDI 1999a). Extensive research is being conducted to determine the distribution of whirling disease in Montana, the susceptibility of WCT (a close relative of rainbow trout) to whirling disease, and possible control measures.

Restoration activities underway as part of the Blackfoot Challenge, a cooperative endeavor between private landowners and public agencies to restore and conserve streams and riparian environments in the Blackfoot River valley, include removal offish-passage barriers; screening of

irrigation diversions to prevent the loss offish to canals; and general improvement of instream fish habitat (MBTRT 1997). The Blackfoot Challenge also works to acquire conservation easements.

Bitterroot River Sub-basin

Plum Creek lands in the Bitterroot River planning area sub-basin consist of 1,822,548 acres situated at the extreme northern end of the sub-basin. Tier 1 watersheds in the Bitterroot sub-basin total 106,286 acres (approximately 5 percent of the drainage), of which 19,220 acres (approximately 1 percent of the drainage) are on Plum Creek lands. Tier 2 lands total 1,716,262 acres (95 percent of the drainage), of which 61,379 acres (3 percent of the drainage) are owned by Plum Creek. No Key Migratory Rivers occur in the Bitterroot sub-basin, either on Plum Creek or other lands. Perennial streams on Plum Creek lands in the Bitterroot total 101 miles. Grazing leases on Plum Creek lands in this sub-basin total 42,050 acres along 132 stream miles. Of these, 10,043 acres and 33 stream miles occur in Tier 1 watersheds while the balance occurs on Tier 2 lands. A total of 1,181 miles of roads occur on Plum Creek lands in the Flathead and another 94 miles are proposed.

The Bitterroot River originates in the high peaks of the Sapphire and Bitterroot Mountains in western Montana. The East and West Forks of the Bitterroot join near the town of Connor and from there the mainstem flows north through the Bitterroot valley approximately 85 miles, entering the Clark Fork River near Missoula, Montana. The total area of the drainage is 2,814 square miles (MBTSG 1995d). The valley floor is predominantly irrigate crop and pasture land. The Bitterroot River has 27 tributaries on the west side and 12 on the east side. The approximate mean annual flow of the Bitterroot River in 1991 was 2,080 cfs measured near the mouth of the river.

Bull Trout

Historically, migratory bull trout were likely distributed throughout the Bitterroot drainage and used the river and all its major tributaries (MBTSG 1995d). There were no major natural barriers to fish migration that would have excluded bull trout from any significant portion of the drainage except natural waterfalls at higher elevations in tributary streams (MBTSG 1995d). Many reports document the presence of bull trout throughout the Bitterroot River system prior to the 1970s (Berg and Priest 1995, MBTSG 1995d). It is unknown whether migratory bull trout from Lake Pend Oreille historically used the Bitterroot River (MBTSG 1995d).

Currently, bull trout appear to be absent from the Bitterroot mainstem, or nearly so, from the mouth of the river near Missoula to Blodgett Creek. From Blodgett Creek to the East Fork of the Bitterroot, bull trout are rare, and in the upper reaches of the East and West Forks, some migratory bull trout still exist, but in low numbers. The bull trout life form most common in the Bitterroot River system today is resident fish that tend to live in higher elevation streams within USFS lands (Clancy 1993, MBTSG 1995d, Clancy 1996). The entire Bitterroot River is considered nodal habitat (MBTSG 1995d). Core areas are mostly major tributaries on both sides of the valley that contain the strongest remaining bull trout populations and are relatively undisturbed.

Bull trout in the Bitterroot River drainage now consist of numerous (perhaps 25 or more) resident subpopulations in headwater streams that are no longer connected to the Bitterroot mainstem (MBTSG 1995d, Clancy 1996). Nearly all of these resident populations contain less than 50 small individuals (less than 12 inches) (Clancy 1996; C. Clancy, MFWP, *in litt.*, 1997), and appear to be declining in number and distribution (MBTSG 1995d). In a study of the Bitterroot drainage, Rich (1996) concluded that where bull trout populations are highly fragmented in sub-basins without strong populations in main tributaries, they are likely at risk of stochastic extirpation.

Some creeks in the Bitterroot sub-basin in which resident bull trout subpopulations are known or thought to occur are Bass, Bear, Big, Burnt Fork, Bitterroot, Fred Burr, Gold, Kootenai, Lost Horse, Mill, One Horse, Railroad, Reimel, Roaring Lion, Sawtooth, Sleeping Child, South Fork Lolo, Sweathouse, Sweeney, Tincup, Tolan, Warm Springs, Watchtower, West Fork Lolo, and Willow (Berg and Priest 1995; MBTSG 1995d, Clancy 1996; C. Clancy, *in litt.*, 1997). Upper Warm Springs Creek supports some of the highest densities of resident bull trout in the drainage; from 1992 to 1995 the average was 87 individuals (Clancy 1996; C. Clancy, *in litt.* 1997). A few drainages, such as Skalkaho, upper East Fork Bitterroot, and upper West Fork Bitterroot, contain higher numbers of bull trout which migrate within these drainages, although each of these drainages is now isolated from the mainstem Bitterroot (MBTSG 1995d). Skalkaho and the upper East Fork Bitterroot are the strongest bull trout subpopulations remaining in the Bitterroot drainage.

Within the upper East Fork of the Bitterroot and its tributaries, bull trout are migratory. Bull trout numbers were considered "moderate" during 1992 and 1994 surveys in this area (Clancy 1996). During surveys from 1993 to 1995, two-thirds of the streams in the East Fork of the Bitterroot sub-basin contained bull trout (Rich 1996). Tributaries to the upper East Fork in which bull trout occur include Martin Creek, Moose Creek, Meadow Creek, and Swift Creek. In the upper East Fork, 41 bull trout were estimated in 1992 (C. Clancy, *in litt.*, 1997). Bull trout estimates in Martin Creek have been less than 20 from 1992 to 1995 (C. Clancy, *in litt.*, 1997). In Moose Creek, estimates from 1991 to 1994 ranged from 12 to 43 fish (C. Clancy, *in litt.* 1997). In Meadow Creek, estimates ranged from 21 to 87 fish between 1989 and 1996 (C. Clancy, *in litt.*, 1997). Meadow Creek seemed to demonstrate a declining trend in bull trout greater than 5 inches (Clancy 1996). In 1995, the Swift Creek estimate was 67 individuals (C. Clancy, *in litt.* 1997).

Skalkaho Creek and its tributaries have some of the highest bull trout densities in the Bitterroot drainage; these are located primarily in the upper reaches of the drainage (Clancy 1996). During surveys from 1993 to 1995, two-thirds of the streams in the Skalkaho sub-basin contained bull trout (Rich 1996). In index reaches in Skalkaho Creek, estimates ranged from 33 to 186 trout from 1990 to 1996 (C. Clancy, *in litt.*, 1997). The average for one of these reaches was 62 bull trout. In Daly Creek, 126 bull trout were estimated in 1989 (C. Clancy, *in litt.* 1997).

The West Fork of the Bitterroot River drainage, above Painted Rocks Dam, has low numbers of bull trout. These bull trout are primarily found in Slate Creek, where estimates from 1991 to 1993 ranged from 20 to 24 individuals (C. Clancy, *in litt.* 1997). Other tributaries that may contain bull trout include Blue Joint Creek, Hughes Creek, Johnson Creek, Overwhich Creek and Woods Creek. During surveys from 1993 to 1995, half the streams in the West Fork contained bull trout (Rich 1996).

Bitterroot National Forest (BNF) classifies watersheds into healthy, sensitive, and high risk, based on sediment yields from road construction and increased water yields and peak flows from timber harvest (Decker 1991 in MBTSG 1995d). About one-third of BNF streams were classified as healthy, one-third as sensitive, and one-third as high risk. Bull trout with estimable numbers of individuals (10 or more fish greater than 5 inches per 1000 feet) were found only in healthy or sensitive drainages (Clancy 1993). The effects of past forest practices, including road construction, continue to affect Bitterroot tributaries (MBTSG 1995d). Generally, bull trout numbers were higher where stream bottom materials were larger; bull trout populations tended to be low in areas with high amounts of fine sediments (Clancy 1993). In contrast, where brook trout were found, habitat conditions were characteristic of those that have been degraded by land use activities (Rich 1996). Eighty-five percent of the drainages classified as high risk supported brook trout (Clancy 1993).

Because bull trout in the Bitterroot watershed have lost their migratory form and have been fragmented into isolated resident subpopulations with low numbers of individuals and little to no genetic interchange, most of the Bitterroot subpopulations are considered at risk of stochastic extirpation. It is estimated that the probability of extinction of migratory bull trout will increase if there are less than 100 redds or 2,000 individuals in the migratory population (MBTSG 1995d). Therefore, the restoration goal recommended by the MBTSG (1995c) for the Bitterroot drainage is to establish a self-reproducing migratory population which spawns in tributary streams. Specifically, the MBTSG (1995c) recommends a preliminary goal of at least 100 redds or 2,000 individuals in the population over a 15-year period (three generations) with spawning distributed in all core watersheds. The reestablishment of connectivity between the Bitterroot River and its tributaries is considered imperative for the long-term survival of this species in this drainage.

Summary of Factors Affecting Bull Trout in the Bitterroot River Sub-basin: Tributaries of the Bitterroot River that contain populations of small, resident bull trout in the upper reaches are generally isolated from one another. Original connections between the Bitterroot mainstem and its tributaries have been severed by habitat degradation, dewatering, and other passage barriers. Tributaries on the east side of the valley tend to have more bull trout than the west side. Brown trout are common in the Bitterroot River and the lower end of tributary streams, and brook trout are common throughout many tributaries. The two highest risks to bull trout recovery in the Bitterroot system are the presence of introduced fish and dewatering of streams (MBTSG 1995d). Diversion dam barriers and effects of past and potential future forestry practices are also high risks.

The MBTSG (1995c) has identified dewatering of tributary streams in the Bitterroot as one of the highest risks to bull trout restoration. The mainstem Bitterroot and the lower reaches of many of its tributaries are chronically dewatered during the irrigation season by five major diversions and numerous small canals (Clancy 1993, MBTSG 1995d, Clancy 1996). Most large tributaries in the northern Bitterroot drainage are also diverted. Many headwater tributaries are diverted for irrigation during the summer, so that little streamflow is contributed to the mainstem river (Clancy 1996). Nearly 65 stream miles in at least 18 tributaries are chronically dewatered in the Bitterroot drainage, including the mainstem Bitterroot, Blodgett Creek, and Lolo Creek (MBTSG 1995d).

Some diversions on the mainstem Bitterroot may be fish passage barriers, or, alternately, downstream migrants can be trapped in irrigation ditches and lost from the population (MBTSG 1995d). Dewatering of streams has led to high mid-summer water temperatures that are likely to favor brook trout and brown trout, and this is probably one of the primary causes for loss of bull trout in the mainstem. Dewatering restricts the distribution and movement of bull trout by creating thermal and water quality barriers. Temperatures in the lower Bitterroot River and some tributaries meet or exceed 70 °F during the summer months (temperatures above 59 °F are thought to limit bull trout distribution). Besides dewatering, other probable causes of thermal problems include lack of riparian vegetation to provide shade, warm irrigation return flows, and warm water releases from irrigation reservoirs.

Water temperatures in numerous Bitterroot tributaries exceeded 59 °F in summer, especially lower in the drainages (Clancy 1996). This is evident in Sleeping Child Creek, the East Fork of the Bitterroot, Lick Creek, North Rye Creek, and Tincup Creek (Clancy 1996). The highest bull trout densities are found in the colder streams in the Bitterroot drainage (Clancy 1996). In the upper reaches of Skalkaho, during 3 years of monitoring (1993-1995), water temperatures did not exceed 59 °F, although at its confluence with the mainstem Bitterroot, temperatures exceeded 65 °F during 1995 (Clancy 1996). The two sites that seemed to support high bull trout densities in warm water temperatures are both above barriers, which likely prevented brook trout from accessing them (Clancy 1996). In 1994, drought exacerbated temperature conditions in the Bitterroot, causing many tributaries to exceed 59 °F (Clancy 1996).

The human population in the Bitterroot valley has been rapidly increasing, along with the associated rural residential development (MBTSG 1995d). Development increases pressure to alter stream and riparian habitats, resulting in streambank modification and destabilization, increased nutrient loads, and increased water temperature problems (MBTSG 1995d). The lower Bitterroot River is a major non-point source of nutrient pollution, primarily from sewage effluent and land development (EPA 1993 in MBTSG 1995d). Streambank modification and destabilization and municipal point source pollution have been identified as high risk to long-term aquatic ecosystem health (MBTSG 1995d). Within the Bitterroot, about 390 stream miles, including the mainstem, are impaired for beneficial uses of the water. Sources of impairment are mostly agriculture, silviculture, and resource extraction as well as land development, road and highway modification, and municipal wastewater effluent (MBTSG 1995d, MDHES 1994).

Severe overgrazing occurs in bottom streams of the Bitterroot valley, which is considered by the MBTSG (1995c) to be a very high risk to bull trout restoration. In Sweathouse Creek, there are numerous areas adjacent to the mainstem Bitterroot where grazing has damaged riparian areas and streambanks (Clancy 1996). Bull trout were only found in the upper portion of this drainage.

Painted Rocks Dam is a barrier to upstream fish passage in the West Fork of the Bitterroot; however, it also prevents nonnative trout from moving upstream (MBTSG 1995d).

Because bull trout in the Bitterroot River drainage are highly fragmented into small resident subpopulations, the risk from environmental events such as fire, flood, or drought are high (MBTSG 1995d). If a local population is extirpated as a result of an environmental event, there is little opportunity for recolonization because of the lack of connectivity among the resident subpopulations (MBTSG 1995d).

Introduced brook, brown, and rainbow trout are present in the Bitterroot drainage (Clancy 1996). The presence of these nonnatives may have been a factor in the fragmentation of bull trout range in the Bitterroot drainage by restricting migratory bull trout movements (Rich 1996). Bull trout-brook trout hybrids have been documented in at least nine Bitterroot tributaries (MBTSG 1995d), indicating that brook trout may be replacing bull trout in some streams (Clancy 1993). Rich (1996) found a strong negative correlation between brook trout presence and the presence of bull trout in Bitterroot River tributaries. However, brook trout and bull trout occurred together in only a small proportion of Bitterroot streams surveyed (9 of 112), and the most important factor influencing bull trout/brook trout distribution was differing habitat requirements, not competitive exclusion (Rich 1996).

Brook trout were found at lower elevations, in warmer water temperatures, and poorer watershed conditions than bull trout (Clancy 1993, Clancy 1996). Brook trout also tended to be found in locations that historically have had road access, which would have made stocking easier (Clancy 1993). Brook trout are not present in the upper East Fork of the Bitterroot and upper Skalkaho Creek, where the strongest bull trout subpopulations exist. However, Skalkaho Creek becomes dominated by brook and brown trout in its lower reaches (Clancy 1993). Many residents in the Bitterroot drainage are building private fish ponds on their properties and stocking them with brook trout, leading to concern that these introduced fish could spread into Bitterroot tributaries where they do not already exist (MBTSG 1995d).

Westslope Cutthroat Trout

The Bitterroot River sub-basin, stocks of genetically pure WCT occupy 353 miles (115 stream reaches); stocks that are 99.9 to 90.0 percent pure occupy 53 miles; stocks that are < 90.0 percent pure occupy 73 miles; and stocks in 886 miles of stream (284 stream reaches) remain untested genetically (Appendix Table 3; MTFWP, *in litt.* 1998 as cited in USDI 1999a). Among the total 1,365 miles of stream occupied by WCT stocks, 1,109 of the stream miles have stocks that are considered abundant; stocks in the remaining 256 miles of stream are considered rare. Of the total

linear amount of stream habitat known to be occupied by WCT in the Bitterroot River sub-basin, 67.7 percent lies on lands administered by federal agencies (Appendix Table 4; MTFWP, *in litt.* 1998 as cited in USDI 1999a). WCT stocks are strong or predicted strong in 10 HUCs; depressed or predicted depressed in 86 HUCs; and absent or predicted absent in the remaining two HUCs that collectively constitute the Bitterroot River sub-basin (USDI 1999a).

Summary of Factors Affecting WCT in the Bitterroot Sub-basin: See also *"Summary of Factors Affecting the Species in the Clark Fork River Sub-basin."* Most of the large tributaries in the northern region of the Bitterroot River watershed are diverted for irrigation (MBTSG 1995d). Nearly 65 miles of stream in the Bitterroot River and at least 18 of its tributaries experience chronic low-flow conditions during the irrigation season (MBTSG 1995d). Intensive livestock grazing, particularly in the Deerlodge valley, Flint Creek valley, and parts of the Rock Creek valley, has adversely affected water quality and fisheries habitat in those areas of the upper Clark Fork watershed (MBTSG 1995b).

The human population and associated rural residential development have been increasing rapidly in the Bitterroot Valley (MBTSG 1995d). Development can lead to alteration of stream and riparian habitats. The lower Bitterroot River is a major nonpoint source of nutrient pollution, primarily from sewage effluents and land development (EPA 1993 as cited in MBTSG 1995d).

Many people in the Bitterroot River watershed are building private fish ponds on their property and stocking them with brook trout, leading to concern that these introduced fish could spread into tributaries where they do not already exist (MBTSG 1995d). In addition, the genetic integrity of WCT can be threatened by interbreeding with normative rainbow trout and Yellowstone cutthroat trout (MTFWP, *in litt.* 1999 as cited in USDI 1999a).

Mountain Whitefish in the Action Area in Montana

Mountain whitefish are widely distributed and abundant in the action area. The mountain whitefish is considered abundant in all river drainages in Montana where it occurs on both sides of the continental divide and in all major streams adjacent to mountain ranges such as the Yellowstone, Missouri, Clark Fork, and Kootenai river systems (Brown 1971).

Mountain whitefish are abundant in the Kootenai River sub-basin and are commercially fished in this system. Mountain whitefish were the most abundant fish captured in electrofishing surveys in 1997 and 1998 in the mainstem of the Flathead River above Flathead Lake, and are also abundant in the South Fork of the Flathead River (per. comm., Mark Deleray, MFWP), although the South Fork is outside the action area. The Montana state record for mountain whitefish weighed 5.09 pounds and was caught in the Kootenai River (Montana Outdoors May/June 1999).

Pygmy Whitefish in the Action Area in Montana

In Montana, pygmy whitefish are known to occur in Bull Lake (and tributaries), Lake McDonald (and tributaries), Hungry Horse Reservoir, Flathead Lake, the Little Bitterroot River, and Ashley,

Swan, Cyclone, and Seely lakes (Brown 1971). From 1968 to 1971, extensive nettings showed mountain whitefish to be one of the most abundant fish in Flathead Lake, and were considered one of the most abundant small, primary carnivores and likely an important food source for the secondary carnivores such as lake trout and bull trout (Weisel et al. 1973). Total length of pygmy whitefish rarely exceeds 6 inches; however in Montana, a few specimens have reached 7.3 inches or greater. The Montana state record for pygmy whitefish was recently caught on February 23, 1999; it weighed 0.18 pounds, was 8 inches in length, and was caught in Ashley Lake (MFWP, Record Fish Report, 2/24/99).

Weisel et al. (1973) found that in late November and December large numbers of pygmy whitefish move from the deep water of Flathead Lake and congregate at the mouths of the Swan River and Flathead River before entering the river systems, presumably to spawn. Mountain whitefish are extremely wary of movement during spawning and will seek deep water when disturbed. Similarly to Lake Superior whitefish, a spawning run of pygmy whitefish is known to occur from Flathead Lake into Flathead River in late fall (pers. comm., Mark Deleray, MFWP). However, pygmy whitefish in the Flathead may spawn a month later than those in Lake Superior (Weisel et al. 1973).

Fredenberg (1998) hypothesized that in northwest Montana pygmy whitefish may have suffered severe ecological hardship as a result of the introduction of *Mysis relitca* (opposum shrimp). The presence of opposum shrimp in Flathead Lake has led to a cascading food web that affects the balance of the fish community in the lake. Actual impacts are unknown; however, recent gill net surveys in Flathead Lake indicate that pygmy whitefish are abundant and records of incidental catch support this conclusion (pers. comm., Mark Deleray, MFWP). More survey information is likely to be forthcoming for Flathead Lake pygmy whitefish. Given the lack of information on this species in western Montana, resource agencies generally agree that more surveys need to be conducted to determine trend, abundance, and distribution for this species.

Idaho

Plum Creek's draft NFHCP included lands in three drainages in the State of Idaho, the Lochsa River, Little North Fork of the Clearwater River, and upper St. Joe River. However, since release of the draft NFHCP to the public, Plum Creek has sold the lands in the North Fork of the Clearwater and the upper St. Joe to Crown Pacific Timber Company. Consequently, only Plum Creek lands in the Loshsa River sub-basin in Idaho are now covered by the NFHCP.

Lochsa River Sub-basin

Plum Creek lands in the Lochsa consist of 40,424 acres located in a checkerboard pattern at the headwaters of the drainage. Tier 1 watersheds in the overall drainage total 82,912 acres (approximately 11 percent of the drainage), of which 13,365 acres (2 percent of the drainage) are Plum Creek lands. Tier 2 lands total 674,010 acres (89 percent of the drainage), of which 26,896 acres (4 percent of the drainage) are owned by Plum Creek. Key Migratory Rivers in the Lochsa

drainage total 42 miles; 11 miles of these are on Plum Creek lands. Perennial streams on Plum Creek lands in the Lochsa total 47 miles. No grazing leases occur on Plum Creek lands in this drainage and there are no irrigation diversions. A total of 539 miles of roads occur on Plum Creek lands in the Lochsa and another 47 miles are proposed.

Drainages in the Lochsa sub-basin that include Plum Creek lands are the upper Lochsa River and Brushy Fork, Papoose, Crooked Fork, Colt Killed, and Walton creeks. These drainages are further discussed below.

Lochsa River: The Lochsa River sub-basin is comprised primarily of undeveloped forest land. Elevations in the Lochsa range from 1,400 feet at the mouth of the river to over 8,600 feet at its headwaters. The majority of the Lochsa drainage is USFS land managed by Clearwater National Forest. Plum Creek also owns portions of the Lochsa watershed at its upper end near the river's headwaters. Most of the Loshsa River mainstem is designated as a Wild and Scenic River under the Wild and Scenic Rivers Act, while two miles of the river above Powell and Colt Killed Creek have been determined as suitable for listing under this law but are not currently designated. About half the Lochsa watershed south of the mainstem is part of the Selway Bitterroot Wilderness Area.

Topography in the Lochsa watershed drainage consists of deeply incised stream channels with steep valley walls. Flatlands on the ridge tops and valley bottoms are typically small to nonexistent. These characteristics create a significant erosion potential, since soils on steep slopes are generally thin and unstable. Mass slumping and slides can occur following heavy winter rains or periods of rapid snow melt. Land management activities such as timber harvest and road building have the potential to contribute to these erosion patterns. Water quality in the mainstem Lochsa is generally excellent and supports most beneficial uses identified for the river (recreation, cold water biota, domestic water supply, and agricultural water supply) (Clearwater Basin Bull Trout Technical Advisory Team 1998). However, there are problems with salmonid spawning in portions of the watershed (see below).

The lower Lochsa has experienced heavy logging and fires, is lower in elevation, and has less snowpack than the upper sub-basin, all of which may contribute to higher average water temperatures. The Lochsa mainstem is listed on the IDEQ's list of water quality impaired stream segments under section 303(d) of the Clear Water Act because of water temperature factors (IDEQ 1999). Water temperatures in the upper Lochsa are generally in better condition. A review of water temperatures in the sub-basin by the Idaho Division of Environmental Quality (1999) concluded that summer water temperatures in the sub-basin are linked to natural conditions as well as man-made ones (such as air temperatures), and can exceed water quality standards even in watersheds that are unaffected by land management activities. Thus, elevated water temperatures in the Lochsa are likely due in part to natural factors and man-made factors such as removal of riparian vegetation.

Brushy Fork Creek: Brushy Fork Creek in the Lochsa is owned by Plum Creek and the USFS in a checkerboard ownership pattern. Spruce Creek and Twin Creek are tributaries of Brushy Fork Creek. A 12 meter high bedrock falls is located approximately 1 km downstream of the headwaters of Twin Creek, which limits its upstream fish distribution. A bedrock migration barrier exists on Spruce Creek approximately one mile upstream from its mouth. Although the barrier was modified in 1988, based on the apparent absence of anadromous fish above the barrier, and recent measurements of the plunge pool depth and fall height, the barrier may still pose an obstacle to upstream migration.

Several stream reaches in the Spruce Creek drainage are in a degraded condition because of sedimentation resulting from past and current land management activities (USFS 1999a). Roads were built in the valley bottom in the 1950s and 1960s to harvest trees affected by the spruce beetle infestation, and several riparian areas were logged. As a follow-up to the logging operations, large woody debris was removed from some stream reaches in the watershed, a practice that has been discontinued by the USFS. In an effort to decrease sediment loading in the drainage, a limited amount of restoration work was completed in Spruce Creek in 1994. Sediment, and its potential adverse impacts on fish production, is a major issue regarding future management of the Spruce Creek watershed (USFS 1999a). Large debris jams are present in the upper two reaches of Spruce Creek, some of which are remnant of past logging as indicated by chainsaw cuts. Beaver dams are also present in these reaches. Sediment has accumulated in the pools created by the debris jams and beaver dams, resulting in high cobble embeddedness values.

Papoose Creek: Papoose Creek is comprised of USFS lands and Plum Creek lands in a checkerboard ownership pattern. Papoose Creek and Squaw Creek were first entered by the USFS for timber harvest in the early 1950s in response to a spruce beetle epidemic. A road into each drainage was constructed, usually within the floodplain or riparian areas of the streams. The roads displaced riparian vegetation and are a constant source of sediment to the streams. Tributary roads within the drainages were later built in conjunction with timber sales. In the 1970s and 1980s, large segments of these streams were cleaned of instream large wood by well-intentioned biologists in an attempt to improve upstream fish passage and release sediment (USFS 1999a). Some restoration work occurred in the Lochsa in the 1980s, including placement of instream structures typical of that time (e.g., full spanning attached log weirs) and retrofit approaches to fish passage through impassable culverts. Road densities in the Squaw Creek and Papoose Creek watersheds are very high; this is currently being addressed by Clearwater National Forest through a road obliteration program (see Summary section below).

Crooked Fork Creek: Crooked Fork Creek, which combines with Colt Killed Creek to form the Lochsa River, is owned by the USFS and Plum Creek in a checkerboard ownership pattern. Stream condition in the upper Crooked Fork appears to be good. However, road densities in Shotgun and lower Boulder creeks are very high and need to be addressed (USFS 1999a). Road densities in upper Crooked Fork, Fox Creek, and upper Boulder Creek are relatively low (USFS 1999a).

Colt Killed Creek: The Colt Killed drainage is composed of a number of major drainages and subdrainages that vary in size and average annual discharge, including Storm Creek, Beaver Creek, and Savage Creek. The area has not been significantly developed, except for the Beaver Creek drainage. However, Savage Creek has been affected by the Elk Summit Road and Colt Killed Creek by the Colt Creek Road. Both roads were built under design specifications that do not meet the current standards and guidelines required for new road construction or reconstruction under PACFISH (USFS 1999a). Most streams in the drainage are considered supply limited, having more energy in an average flow year than is needed to move the existing sediment load.

Colt Killed, and its tributaries Storm Creek and Beaver Creek, were surveyed under contract by Clearwater Biostudies between 1994 and 1997. Instream large wood was frequent and cobble embeddedness was average in Colt Killed and Beaver creeks. Although embeddedness was low in Storm Creek, large instream wood was infrequent. Road densities within Colt Killed Creek are considered low (USFS 1999a). The highest road density in the watershed is within Beaver Creek, where road density is moderate. The uppermost portion of the Beaver Creek drainage was impacted by a large, stand replacing fire in 1919; in addition, since 1971 more than 26 percent of the watershed has been harvested. As a result, the mouth of Beaver Creek has a large deposit of alluvial material, with multiple channels, overflow channels, undercut banks, and large deposits of boulder and cobble sized material. Frequency of instream large wood is low throughout the drainage. In Storm Creek, no timber harvest or road construction has occurred. Storm Creek is a stable system. The high average flow keeps sediment from accumulating in the channel; consequently, cobble embeddedness is low to moderate (14 percent to 35 percent). Because of high energy flows and a high percentage of bedrock and boulder in the stream channel, the abundance of instream large wood is low, however.

Walton Creek: Walton Creek is owned in a checkerboard pattern by the USFS and Plum Creek. Management activities began in the Walton Creek watershed in 1934 with the construction of Road 360, the Elk Summit Road, and Road 362, the Tom Beal Road. Road 111 was built in 1971. These roads were constructed prior to the implementation of modern practices and therefore have delivered sediment to Walton Creek. In the early 1970s, an earth flow covered the Elk Summit Road in the Walton Creek Watershed. Sediment from this flow eroded into the stream. Walton Creek was surveyed in 1993; cobble embeddedness was estimated at 30 percent and sedimentation from past road construction was documented in the lower three kilometers of the creek (USFS 1999a). The quantity of large wood in the creek was rated as fair, and it is anticipated that an adequate supply of large wood will be available in future years, as standing trees along the stream were frequent (USFS 1999a).

Bull Trout

The status of bull trout in the Lochsa River sub-basin varies depending on location within the drainage, land management history, and biotic and abiotic conditions. Generally, the most important bull trout populations in the Lochsa occur within the upper portions of the drainage

upstream of Post Office Creek. Bull trout spawning and early rearing have been observed only in the upper Lochsa, specifically in Papoose Creek and tributaries, Squaw Creek, upper Crooked Fork (Hopeful, Boulder, Shotgun, and Fox creeks), Colt Killed Creek (Storm and Beaver creeks), Lake Creek, and Brushy Fork (Twin Creek) (Clearwater Basin Bull Trout Technical Advisory Team 1998; pers. comm., Pat Murphy, Clearwater National Forest). In the lower Lochsa, some drainages exhibit no bull trout presence (e.g., Pete King Creek, Deadman Creek, and Canyon Creek) while in other areas, including the river's mainstem, subadult and adult bull trout are observed but no spawning. Tributaries in the lower Lochsa where adult and subadult bull trout are known to occur include Coolwater, Fire, Fish, and possibly Boulder creeks (pers. comm., Pat Murphy, Clearwater National Forest).

The presence of brook trout, a bull trout competitor, is often an important factor in bull trout status. Fortunately, the Lochsa sub-basin has relatively few populations of brook trout, those that are known being primarily in Sponge Creek (a tributary of Lake Creek), Hoodoo Creek (a tributary of Colt Killed Creek), and Bimerick Creek, which flows into the Lochsa mainstem (pers. comm. Pat Murphy, Clearwater National Forest).

A review of bull trout status completed in 1994 for the Interior Columbia Basin Ecosystem Management Project (ICBEMP) described bull trout populations in the Lochsa Sub-basin as "strong" or "depressed," depending on the subwatershed. (USDA and USDI 1997). Bull trout have been documented in the Lochsa mainstem and its following tributaries: Weir, Post Office, Squaw, Papoose, Brushy Fork, lower Crooked Fork (below Brushy Fork), upper Crooked Fork (above Brushy Fork), Twin, Colt Killed (formerly White Sand), Indian Grave, Beaver, Storm, Walton, Warm Springs, Boulder, Fire, and Split creeks (Clearwater Basin Bull Trout Technical Advisory Team 1998). Bull trout spawning and early rearing in the Lochsa have been documented in Papoose Creek and tributaries, Squaw Creek, upper Crooked Fork (Hopeful, Boulder, Shotgun, and Fox creeks), Colt Killed Creek (Storm and Beaver creeks), Lake Creek, and Brushy Fork (Twin and Spruce creeks) (Clearwater Basin Bull Trout Technical Advisory Team 1998). Bull trout are also suspected to spawn in Walton Creek, and subadult and adult bull trout have been observed in the Lochsa River. Bull trout have not been recently documented in Pete King, Rye Patch Canyon, Deadman, Sherman, Bald Mountain, Holly, Lost, Wendover, Badger, Cold Storage, Lake, Stanley, Old Man, or Coolwater, creeks. The Lochsa sub-basin also provides habitat for Yellowstone cutthroat trout, golden trout, and brook trout, any of which may hybridize with bull trout.

Based on current information, bull trout appear to occur most frequently in the upper portions of the Lochsa sub-basin and less frequently in the lower portions. However, much of the information cited above is the result of Plum Creek presence/absence surveys, and equivalent survey efforts for bull trout spawning and early rearing in the balance of the Lochsa drainage is lacking (Clearwater Basin Bull Trout Technical Advisory Team 1998). This lack may soon be rectified, however, since Clearwater National Forest has recently initiated bull trout spawning/ early rearing habitat surveys on its lands in the Lochsa drainage.

The most concentrated known bull trout use in the Lochsa sub-basin occurs in Papoose Creek and Squaw Creek. Squaw Creek is inhabited by fluvial bull trout. Some of the most significant known fluvial bull trout habitat within the Lochsa drainage occurs in Squaw Creek; surveys have found the highest number of bull trout redd counts, some of the highest bull trout juvenile densities, and some of the cooler water temperatures in upper Lochsa River drainage here. The Squaw Creek drainage is managed entirely by the USFS. Papoose Creek is also inhabited by bull trout and has the potential to become a significant fluvial bull trout population (USFS 1999b). Bull trout are known to use Squaw Creek, Papoose Creek, and the West Fork of Papoose for spawning and early rearing. Adult and subadult bull trout may also use Papoose Creek as forage or refuge habitat, particularly when the water is cooler.

Doe Creek, a tributary to lower Squaw Creek, was surveyed by the USFS in 1995 and bull trout were observed (USFS 1999b). No bull trout were found in Parachute Creek, also a tributary of Papoose Creek, for unknown reasons since aquatic conditions appear to be suitable. This may be due to a culvert near the mouth of Parachute Creek. In the 1980s this barrier was treated through construction of a gabion weir downstream of the culvert, creating a pool at the culvert outlet and deeper water closer to the culvert. However, today water is beginning to cut around the gabion and the pool upstream of the gabion has filled somewhat with stream bedload. As a result fish passage during low flows is unlikely, passage during high flows is likely difficult even for adult fish, and is probably impossible for juvenile fish. Logging has been occurring in the Parachute Creek subwatershed since the 1950s.

In the upper Crooked Fork, including Hopeful, Shotgun, Boulder, and Fox creeks, bull trout have been documented, but more study is needed to determine the species' status and life history in this watershed; it is likely the bull trout population in the upper Crooked Fork is resident (USFS 1999b).

Bushy Fork Creek is known to be inhabited by bull trout. Westslope cutthroat trout have been observed upstream of the migration barrier (USFS 1999b), while westslope cutthroat trout and bull trout have been observed below the barrier (USFS 1999b). These bull trout were likely migrating upstream through Brushy Fork to spawn, but may also have been using Brushy Fork as foraging habitat. In surveys conducted in1993, four bull trout were observed above this barrier; two juvenile bull trout were found in the mainstem of Spruce Creek, and two juveniles in the lower reaches of the South Fork of Spruce Creek (Clearwater Biostudies 1994). The presence of the migration barrier suggests that these fish may represent a resident, genetically distinct bull trout population within the upper Spruce Creek watershed. However, extensive redd surveys in Spruce Creek during fall 1997 resulted in no observations of redds. Furthermore, more intensive bull trout surveys were conducted above the migration barrier in summer 1998 and no bull trout were observed (USFS 1999b). The Clearwater Basin Bull Trout Technical Advisory Team (1998) states that "based on the presence of an impassable falls in Lower Spruce Creek, below where the juveniles were observed, it is likely the Spruce Creek [bull trout] population exhibits a resident life history pattern. This population has an extremely low density or has been extirpated."

Twin Creek is inhabited by westslope cutthroat trout and bull trout. Bull trout are well distributed throughout the stream; a 22-inch long bull trout was observed in Twin Creek during 1994 fish surveys (Clearwater Biostudies 1994). At the time, it was believed this fluvial fish was staging to spawn in Twin Creek. However, bull trout redd counts performed in fall 1997 indicated the bull trout population in Twin Creek is likely a resident population and there were no signs of fluvial spawners. It is likely the fish observed in 1994 was in Twin Creek to forage on other fish. During the 1997 survey, three resident sized redds (average diameter 1 foot) and several adult bull trout were observed along the upper half of Twin Creek (USFS 1999b). Observing three redds during this survey, considered to be a low number, is a cause for concern, suggesting that the Twin Creek aquatic system has problems (USFS 1999b). However, future redd counts in Twin Creek will provide a better indication of the health of this population.

Colt Killed, and its tributaries Storm Creek and Beaver Creek, were surveyed under contract by Clearwater Biostudies between 1994 and 1997. Bull trout were observed in all three drainages (USFS 1999b). Recent reintroduction of chinook salmon to Colt Killed Creek has likely resulted in an increase of the prey base for bull trout. However, brook trout populations have been observed in tributaries of Colt Killed Creek, creating the potential for habitat competition or genetic intermixing with bull trout.

The first documented survey for bull trout redds occurred along Beaver Creek in 1997; two redds were observed (USFS 1999b). The small size of the redds and the presence of gradient barriers below their locations indicate that the Beaver Creek bull trout population may be resident; however, more study is needed to determine the status of this population. Bull trout have been observed in Storm Creek (USFS 1999b).
The Lake Creek tributary of the Lochsa River is entirely unroaded and is characterized by glaciated headwater lakes and steep slopes. Access to Lake Creek and its tributaries is restricted to a few primitive trails and a dirt airstrip adjacent to Fish Lake. When surveyed by Clearwater Biostudies, Lake Creek displayed a moderate number of primary pools, good stream bank stability, and cobble embeddedness of 30 percent (USFS 1999b). Large instream wood was at a low frequency (5.8 pieces/100m). Clearwater Biostudies documented the presence of westslope cutthroat trout, Snake River steelhead, Snake River chinook salmon, and brook trout within the drainage. An adfluvial population of bull trout were historically present in Fish Lake, but were not documented in this survey.

In summary, bull trout are distributed throughout much of the Lochsa sub-basin. However, bull trout spawning and early rearing occur only in the upper Lochsa, while, in the lower Lochsa and the Lochsa mainstem, only adult and subadult bull trout occur. Bull trout status is considered "strong" in only two creeks in the upper Lochsa (Squaw and Beaver creeks), and are absent from or are considered "depressed" in all other watersheds in the sub-basin. This is attributable to several natural and manmade factors but land management activities, including logging and road building, resulting in elevated water temperatures and sediment levels, are probably the primary responsible factors. However, aquatic conditions in the sub-basin are improving due to a number of restoration activities currently being undertaken by the USFS.

Westslope Cutthroat Trout

Westslope cutthroat trout are widely distributed in the Lochsa River sub-basin but in varying densities. Generally, WCT numbers are higher in the upper portions of the sub-basin than the lower portions. This distribution is similar to bull trout distribution in the Lochsa and is probably temperature related (pers. comm., Pat Murphy, Clearwater National Forest). Clearwater National Forest classifies streams that have fewer than two WSC that are at least 2 years of age per 100 meters of stream as "depressed," and streams that have more than two fish of this age class per 100 meters of stream as "strong." Streams that are considered "strong" for WCT include upper Crooked Fork, Post Office, Squaw, Canyon, Papoose, and Storm creeks, all of which are relatively high in the Lochsa sub-basin; streams that are considered "depressed" for WCT include lower Brushy Fork, lower Colt Killed, lower Crooked Fork, Deadman, and Bimerick creeks (pers. comm., Pat Murphy, Clearwater National Forest). This illustrates the pattern that the upper drainages in the Lochsa generally support higher densities of WCT than the lower drainages.

The Lochsa River, several of its tributaries, and several high mountain lakes in the sub-basin have been stocked with nonnative salmonids; species stocked include cutthroat trout of unspecified origin, Yellowstone cutthroat trout, and rainbow trout (steelhead, kamloops, Mt Lassen, Hayspur, and unspecified) (pers. comm., Dana Weigel, Nez Perce Tribe). According to IDFG records, rainbow trout were stocked annually in the Lochsa mainstem until 1990, and Crooked Fork, Walton, Squaw, Papoose, Pete King, Fish, and Canyon creeks have been stocked with hatchery rainbow trout. In addition, 30 lakes in the Lochsa sub-basin have been stocked with rainbow since 1968 and thirteen lakes in the sub-basin are still being stocked (pers. comm., Dana Weigel, Nez Perce Tribe). Fish Lake, however, has never been stocked.

To determine the effects of this stocking history, the Department of Fisheries Management of the Nez Perce Tribe is studying the genetic purity of WCT in the Lochsa sub-basin (pers. comm., Dana Weigel, Nez Perce Tribe). Twelve sites in the Lochsa were surveyed in 1998 and 20 sites were surveyed in 1999. Results from 1999 are still being analyzed, but preliminary 1998 results indicate that WCT in Crooked Fork Creek, Savage Creek, Rock Creek, Shotgun Creek, Twin Creek, Jay Creek, Wind Lakes Creek, Fox Creek, and Fish Lake are genetically pure (pers. comm., Dana Weigel, Nez Perce Tribe). WCT in Doe Creek, Papoose Creek, and Beaver Creek are introgressed, however, as a result of interbreeding with nonnative trout (pers. comm, Dana Weigel, Nez Perce Tribe).

Redband Trout

Two kinds of rainbow trout occur in Idaho's Lochsa River sub-basin–the anadromous steelhead form and a resident form. The FWS considers the resident form to be redband trout and this is the form that is covered by the NFHCP (i.e., is a "covered species"). However, it is not always clear from the literature where the two forms occur, respectively, in the Lochsa. A USFS status report of the Lochsa (USFS 1999b) describes numerous individual streams (e.g., Deadman, Pete King, Fish, Canyon, Lost, Indian Grave, Wendover, Papoose, Brushy Fork, Twin, and Storm creeks) as

containing "steelhead/rainbow," but whether this term refers to the anadromous form or resident form is unclear. Probably the term means that field surveyors were uncertain as to what form was present when the creeks were surveyed. Another area of confusion is in the definition of redband trout. The USFS considers only those rainbow trout that are geographically isolated from the anadromous form to be redbands, while the FWS considers any rainbow trout that is resident to be a redband, regardless of whether or not it is isolated from the anadromous form. Future survey work by the USFS and Plum Creek should clarify redband distribution in the Lochsa. For now, it is known that the resident redband form is present in the Lochsa, but its distribution is uncertain.

Mountain Whitefish

The Idaho Department of Fish and Game (IDFG) conducts mountain whitefish surveys annually throughout the Lochsa River sub-basin (pers. comm., Tim Cochanauer, IDFG). In this sub-basin, mountain whitefish occur primarily in the Lochsa mainstem and the larger tributaries of the watershed. They are considered abundant in the river's mainstem and are present in Brushy Fork, Crooked Fork, Fish, Squaw, Old Man, Warm Springs, and Colt Killed creeks (pers. comm., Pat Murphy, Clearwater National Forest; pers. comm.; Tim Cochanauer, IDFG). They also occur incidentally in the River's smaller tributaries. IDFG considers the mountain whitefish population in the Lochsa sub-basin to be "very healthy" (pers. comm., Tim Cochanauer, IDFG).

Pygmy Whitefish

In Idaho, pygmy whitefish are considered a species of concern. Pygmy whitefish are known to occur in Lake Pend Oreille and Priest Lake in Idaho (Simpson and Wallace 1978), though these lakes are outside the action area. No pygmy whitefish are known to occur in the Lochsa River sub-basin.

Anadromous Fish

Chinook salmon, steelhead, and Pacific lamprey constitute the anadromous fish populations in the Lochsa River sub-basin. Juvenile steelhead spend 2 to 3 years and juvenile chinook spend less than 1 year in their nursery areas in the Lochsa River prior to downstream migration. Adult salmon and steelhead generally spend 2 to 4 years in the Pacific Ocean before returning to the Lochsa River through the Columbia, Snake, and Clearwater river systems. Pacific lamprey larvae may spend 5 or more years in the Lochsa River in mud/detritus substrate before migrating to the ocean as adults.

The mainstem Lochsa River is 65 miles long and consists primarily of B2, B2c, B3c, and C3 channel types. Suitable anadromous spawning habitat in the mainstem is present, but additional spawning and rearing habitat is more common in the Lochsa tributaries. The more important anadromous spawning and rearing habitat Lochsa tributaries located either downstream of, or outside, Plum Creek property include: Pete King, Canyon, Deadman, Fish, Wier, Postoffice, Squaw, and Warm Springs creeks. Within the checkerboard ownership between Plum Creek and

the USFS in the Upper Lochsa River, the important anadromous streams include: Papoose, Crooked Fork, Colt Killed, Brushy Fork, Spruce, Twin, and Walton creeks.

Papoose Creek contains both steelhead and chinook salmon. Chinook salmon have been stocked by the Nez Perce Tribe. Spawning chinook have been observed in the West Fork, East Fork, and mainstem of Papoose Creek. Papoose Creek is also likely used as refuge habitat by juvenile salmonids in the spring to avoid high flows and ice scour in the Lochsa River. Chinook salmon redd counts made by the Nez Perce Tribe during 1992-1997 from the mouth to the Papoose forks ranged from 0 in 1994 to 45 in 1997. Also in1997, they counted an additional 12 redds in West Fork Papoose and 4 redds in East Fork Papoose (USFS 1999b).

Crooked Fork Creek has been cited as one of the most important anadromous salmonid producing streams in Idaho, with chinook salmon the most abundant fish species observed in the lower Crooked Fork during recent USFS surveys (Clearwater Biostudies 1994). The stream is part of a multiagency study on hatchery supplementation of chinook salmon stocks as a component of the proposed recovery plan for Snake River salmon. Russian and Swede creeks, two high gradient tributaries to Crooked Fork, were also found to contain rainbow/steelhead.

Colt Killed Creek (formerly White Sand Creek) is a fifth order stream that combines with Crooked Fork Creek to form the Lochsa River. Both chinook salmon and steelhead are found in this drainage. Colt Killed Creek is the largest and most important anadromous fisheries stream system on the Clearwater National Forest, providing 250 acres of anadromous spawning and rearing habitat. Chinook salmon were recently reintroduced to Colt Killed Creek (USFS 1999b). Only the lower-most portion of Colt Killed Creek contains Plum Creek property.

Brushy Fork Creek is a large fourth order stream tributary to Crooked Fork Creek. There is a natural barrier to migrating fish approximately10 miles upstream from its mouth, just upstream of the Spruce Creek confluence. Snake River steelhead and chinook salmon have been observed below the barrier, while Snake River steelhead have been introduced upstream of the migration barrier on Bushy Fork Creek (USFS 1999b). Spruce Creek, a major tributary of Brushy Fork, has a bedrock migration barrier approximately one mile upstream from its mouth. Within this one mile section, however, chinook salmon and steelhead are found. Although the barrier was modified in 1988, anadromous fish are apparently absent above the barrier. Twin Creek, another large tributary to Brushy Fork, is inhabited by Snake River steelhead; lower Twin Creek may also serve as juvenile chinook refuge habitat, particularly in the spring when Brushy Creek flows are high. Pack Creek, another tributary of Brushy Fork, contains steelhead, and probably also serves as chinook refuge habitat.

Walton Creek is a fourth order tributary of the Lochsa River. A chinook salmon satellite hatchery facility is located at the mouth of Walton Creek. This facility is used for trapping and holding returning adult chinook salmon, rearing salmon smolts, and releasing steelhead. It is owned by the U.S. Army Corps of Engineers and is operated by the IDFG with funding supplied by the FWS as part of the Lower Snake River Fish and Wildlife Compensation Plan. The source of water for the

facility is Walton Creek. The hatchery managers operate a weir which blocks upstream migration in Walton Creek at the hatchery. The weir trap operators have reported catching chinook salmon, cutthroat trout, and bull trout in the trap. They incorporate the caught chinook salmon into their hatchery, and release the cutthroat trout and bull trout upstream.

Summary of Factors Affecting Fisheries in the Lochsa River Sub-basin: Land management activities in the Lochsa River sub-basin include road building and maintenance, agriculture, mining, recreation, and forest management. Forest management activities in the Lochsa, both historical and current, include timber harvest, road building, tree thinning, fertilizing, and fire suppression.

Roads for timber harvest and fire control have been built in the Lochsa throughout most of this century. Intensive road building began in the 1950s and continued through the 1980s. Today, road density in the Lochsa averages 1.2 miles per square mile (IDEQ 1999). Most of these roads are dirt or gravel forest management and timber access roads managed by Clearwater National Forest, many of which contribute to elevated sediment levels in the basin's waterways as a result of erosion and runoff. Public roads include State Highway 12, which closely parallels the Lochsa River mainstem and Crooked Fork Creek along most of their lengths. he effects of Highway 12 include a decrease in the potential for large woody debris (LWD) input, decrease in the frequency of off channel habitat, and increase in access by anglers (Clearwater Basin Bull Trout Technical Advisory Team 1998). In addition, Highway 12 is a source of fine sediments in the winter as a result of road sanding and a potential source of hazardous materials contamination as a result of highway accidents. During the construction of Highway 12, the installation of impassable culverts, such as at Badger Creek, Cold Storage Creek, and perhaps others, has caused upstream migration barriers for resident and anadromous fish.

Agricultural activities are relatively few in the Lochsa drainage. Early grazing allotments were established throughout the upper stream sub-basins during the early 1900s and following wildfires that occurred in 1889, 1910, and 1919. Large numbers of sheep were grazed at that time, until natural plant succession decreased forage, making grazing infeasible. Currently, grazing in the Lochsa watershed is very limited. One grazing allotment, Eldorado Canyon Grazing Allotment, extends from the Lolo Creek drainage into the upper Pete King Creek drainage. Other allotments at Packer Meadows (upper Pack Creek) and Elk Meadows (upper Brushy Fork Creek) were terminated in the late 1970s. Grazing of pack and saddle stock by outfitters and the USFS occurs, but is short-term and site specific. No grazing leases occur on Plum Creek lands in the Lochsa.

Historical mining activities in the Lochsa drainage were relatively minor compared to other nearby areas (e.g., the North and South Forks of the Clearwater). Dredging has occurred in only one drainage (lower Peter King Creek) while hard rock mining has occurred in lower Canyon Creek, Pete King Creek, upper Papoose Creek, and upper Crooked Fork Creek. The dredge mining has resulted in visible impacts to instream conditions which are still evident; the hard rock mining, however, has had little effects on aquatic conditions. Mineral resources in the Lochsa area were

evaluated from 1990 through 1992 by the U.S. Bureau of Mines, Idaho Geologic Survey, and the U.S. Geological Survey as a part of the suitability study of public lands for wilderness designation. Their reports conclude that further prospecting is warranted in the area. Several aggregate sources are located within the watershed.

Timber harvest is a historical and ongoing land practice in the Lochsa. Large-scale commercial logging on USFS lands began in 1953 in response to a spruce bark beetle infestation. Prior to the establishment of the Idaho Forest Practices Act (IFPA) (approximately 1975), streams and riparian areas received little protection from timber harvest, skidding and processing activities. The legacy of these activities include streams with decreased LWD (from salvage logging and stream cleaning activities), reductions in recruitable LWD, and increased water temperatures (from harvest of riparian forests). These factors still affect fish habitat in some of the watershed. However, forest management activities since establishment of the IFPA have a much lesser impact on fish habitat. Also, Federal land managers have recently adopted PACFISH and INFISH management guidelines, which exceed Idaho's requirement for stream buffer width and were specifically designed to minimize potential impacts to fish (see Federal Land Management section above).

In late November and early December 1995 and December 1996, flooding occurred within the Lochsa watershed as a result of heavy rains falling on snow. This flooding negatively affected aquatic habitats within the drainage. For example, pre-flood cobble embeddedness in the Squaw Creek watershed ranged from 19 to 43 percent while post-flood embeddedness ranged from 35 to 46 percent (USFS 1999b). Pre-flood instream large wood ranged from 6.1 to 16.7 pieces per 100 meters of stream in Squaw Creek and post-flood instream wood ranged from 2.7 to 10.1 pieces per 100 meters of stream (USFS 1999b). In Papoose Creek, cobble embeddedness increased from 27 percent to 41 percent after the floods. These data indicate a shift toward larger cobbles, a decrease in spawning gravels (coarse and small gravel) and a reduction of LWD as a result of the 1995-1996 floods.

Sedimentation and temperature problems are significant issues in the Lochsa sub-basin. These problems apparently have their source both in natural conditions and in past land management practices. Natural conditions that may have affected bull trout numbers and distribution in the Lochsa include a number of major fires since the turn of the century, the 1995-1996 floods and geomorphic conditions in the sub-basin. Natural conditions can also combine with land management activities to exacerbate adverse aquatic effects. For example, about 20 percent of the Lochsa is classified as landslide prone, and 93 percent of this landslide prone area is within 150 feet of streams (IDEQ 1999). Clearwater National Forest documented that, during the 1995-1996 floods, 907 landslides occurred throughout the forest (IDEQ 1999) (though not all were within the Lochsa sub-basin). Of these, about two-thirds were related to land management activities; 12 percent were road-related, 12 percent were associated with timber harvest, and 29 percent were natural (IDEQ 1999).

Land management practices have also significantly affected aquatic habitats in some areas of the Lochsa. The Lochsa Face Biological Assessment (USFS 1998), for example, states that, "Past land management in some of the watersheds within the action area has left a legacy of unneeded, unstable, redundant roads across the landscape. These roads are a chronic source of sediment to streams and have the potential for mass failures." In addition to roads, logging activities themselves have resulted in increased erosion through loss of forest cover and soil disturbance, loss of riparian habitats, and other effects. Many creeks in the Lochsa exhibit water quality problems associated primarily with these land management practices–such as elevated sediment levels in streams, elevated water temperatures, and reduced structural diversity (e.g., reduced levels of LWD). In the lower Lochsa, sediment levels as well as water temperatures are known to be elevated in Pete King, Deadman, Canyon, Apgar, and Glade creeks (pers. comm., Pat Murphy, Clearwater National Forest). Portions of the upper Lochsa, where Plum Creek's and USFS lands occur, have also been affected. In the upper Lochsa, sediment levels are elevated in portions of Papoose, Squaw, Crooked Fork, Brushy Fork, Post Office, and Colt Killed creeks (pers. comm., Pat Murphy, Clearwater National Forest). Lands south of the Lochsa mainstem, however, are relatively unaffected by land management activities, since much of these occur in designated wilderness or roadless areas. Watersheds with all or most of the drainage inside wilderness or roadless areas include Fish Creek, Split Creek, Old Man Creek, and Fire Creek.

Water temperatures are also a problem in many areas of the sub-basin, and may account in part for the fact that relatively few bull trout occur in the lower Lochsa and that no spawning occurs there (pers. comm., Pat Murphy, Clearwater National Forest). Water temperature monitoring by the USFS (see below) shows that temperatures suitable for bull trout spawning and early rearing are being met or nearly met in many creeks in the upper Lochsa, including Squaw, Parachute, and Colt Killed creeks (pers. comm., Pat Murphy, Clearwater National Forest).

Instream structural diversity has also been affected by land management in the Lochsa. In a biological assessment for the Lochsa prepared by Clearwater National Forest, numerous creeks were rated for presence of LWD and pool frequency (USFS 1999b). Most creeks were rated "low" for presence of LWD, including Squaw, Papoose, Beaver, Parachute, Brushy Fork, Colt Killed, and Storm creeks; Crooked Fork and Fish creeks were rated as "moderate" for LWD and Indian Grave and Weir creeks were rated as "high" or "good" (USFS 1999b). A similar pattern is reported for pool frequency, including Squaw and Papoose creeks, rated as "low" (USFS 1999b). Some of these ratings are due to the 1995-1996 floods, which scoured some streams of much of their LWD loads; others are due to high energy streams which often flush wood downstream. However, in many cases, low levels of LWD is also due to the logging of riparian forests and a past USFS practice of removing LWD from streams (the practice has since been discontinued). However, there is also evidence of improving conditions for LWD presence. For example, in Doe Creek the presence of LWD shifted from 6.5 pieces per 100 meters of stream in 1984 to 7.8 pieces in 1995 (USFS 1999b). However, the amount of instream wood in Doe Creek was still low in 1995 compared to the average amount of instream wood in 288 unroaded drainages of the same channel type within Clearwater National Forest (10.1 pieces of wood/100 meters of stream) (Huntington 1995a).

In response to these problems, Clearwater National Forest has initiated a number of programs to increase water quality in the Lochsa. The Forest has maintained a temperature monitoring program in the Lochsa since 1990; in 1999, stream temperatures at 90 monitoring stations on 71 stream sites were monitored (pers. comm., Pat Murphy, Clearwater National Forest). Bedload (a measure of sedimentation) is also being monitored (IDEQ 1999). In 1997, the USFS completed a study of the 1995-1996 landslides in the Lochsa and made recommendations to reduce slides associated with forest management. In addition, since the mid 1980s Clearwater National Forest has initiated a number of projects in the Lochsa to improve aquatic conditions in the watershed, including shrubfield reforestation, riparian reforestation, and a road obliteration program. Also, minimal timber harvest has occurred within 100-150 feet of fish bearing streams in the Lochsa in the past 10 years, and none is planned in the future because of PACFISH and INFISH requirements. Little new road construction is currently occurring on USFS lands in the Lochsa. As a result of these efforts, recovery of aquatic conditions in the Lochsa is characterized as "positive but slow" (USFS 1999b). Recovery in some drainages (e.g., Pete King Creek, Squaw Creek, and Papoose Creek) to some extent was set back by effects of the 1995-1996 floods. However, improvements in overall aquatic conditions in the Lochsa should continue, provided logging and road building restrictions and restoration activities continue to be implemented.

Washington

Bull trout in Washington state are listed as threatened throughout the state. The action area in Washington State includes two geographic areas defined in the final listing rule (USDI 1998a) for the Columbia River DPS:

1. The Mid-Columbia River Geographical Area includes all tributaries upstream of the Snake River to the location of Chief Joseph Dam. The FWS identified 16 subpopulations in watersheds of 4 tributaries of the middle Columbia River which includes the Yakima, the Wenatchee, the Entiat, and the Methow Rivers. Most bull trout in the Mid-Columbia River area are isolated by dams or unsuitable habitat created by water diversions. The FWS considers 2 of the 16 subpopulations as strong and increasing or stable. The other 14 subpopulations are considered low in abundance, depressed, or unknown trends. The FWS considers 10 of the 16 subpopulations at risk of extirpation because of naturally occurring events due to isolation, single life-history form and spawning area, and low abundance. In spawning surveys conducted in the Wenatchee and the Methow River systems adfluvial and fluvial sized bull trout have been seen spawning with resident sized fish (pers. comm., Judy DeLaVergne, FWS). The FWS considers this isolated subpopulation to be at risk of stochastic extirpation.

2. The Lower Columbia Geographical Area includes all tributaries in Oregon and Washington downstream of the Snake River confluence near the town of Pasco, Washington. The FWS identified 20 subpopulations in watersheds of nine major tributaries of the lower Columbia River which includes the Lewis, the Willamette, the White Salmon, the Klickitat, the Hood, the Deschutes , the John Day, the Umatilla, and the Walla Walla

Rivers. Hydroelectric facilities and large expanses of unsuitable, fragmented habitat have isolated the 20 subpopulations in the lower Columbia area. Large dams, such as McNary, John Day, The Dalles, and Bonneville, separate four reaches of the lower Columbia River. Although fish may pass each facility in both upstream and downstream directions, the extent to which bull trout use the Columbia River is unknown. In addition, the nine major tributaries have numerous hydropower facilities, many of which do not provide upstream passage. Migratory bull trout are present in at least 13 of the 20 subpopulations in the lower Columbia River. Many migratory fish are adfluvial and inhabit reservoirs created by dams. The FWS considers 5 of the 20 subpopulations at risk of extirpation from naturally occurring events due to isolation, single life-history form, and low abundance.

Two lower Columbia River sub-basins within the action area, which are not listed as subpopulation watersheds by the FWS for bull trout and defined as outliers in the DEIS/NFHCP (1999), include the Cowlitz and the Kalama sub-basins.. Bull trout have been located in 1991 in the upper Cowlitz River and in 1998 in the upper Kalama River watersheds by WDFW fisheries personnel.

Westslope cutthroat trout in Washington are considered a species of concern throughout the action area on the east slopes of the Cascades. Redband trout populations in Washington are found throughout the Columbia River Basin, east of the Cascade Mountains. They are found in high mountain streams and in arid desert drainages.

For coastal cutthroat trout in Washington, the action area in the Lewis River sub-basin includes the Southwestern WA/Columbia River ESU which is proposed for listing as threatened..

For steelhead in Washington, the action area includes the Mid-Columbia evolutionarily significant unit (ESU) and the Lower Columbia ESU. Steelhead are listed as threatened in the both of the ESU's.

For salmon in Washington, the action area in the Lewis River sub-basin includes the chinook Lower Columbia River ESU which is listed as threatened and the coho Lower Columbia River/Southwest WA ESU as a candidate species.

Most of the baseline information below was derived from various USDA watershed analyses reports (USDA 1994a,b; USDA 1995a,b,c,d,e,f,; USDA 1996a,b;USDA 1997a,b,c,d,e,f,g), provincial watershed assessments (USDA 1997h,i), Aquatic Consultation Packages (USDA 1999b,c) and consultation products of the FWS (USDI 1999c,d,e,f,g). These are listed in the Literature Cited section.

Yakima River Basin

The Yakima River basin is about 4 million acres in size, with elevations ranging from 340 to 8,184 feet. Annual precipitation varies widely, from 91 inches annually at Snoqualmie Pass, to 7.9 inches

in the City of Yakima. Six lakes used as storage reservoirs have been constructed in the headwaters of the Yakima basin, including reservoirs in the Tieton River, affecting flows throughout the basin, including streams that flow through Plum Creek property. From 50 to 100 percent of the water delivered to the basin above the confluence of the Yakima and Naches Rivers is diverted for irrigation and hydropower during the irrigation season. The basin is 40 percent forested, 40 percent range land, 15 percent irrigated cropland, and the remainder includes lakes and all other uses.

Historically the Yakima River drainage supported spring chinook salmon, summer steelhead, coho salmon, bull trout, westslope cutthroat trout, and redband trout. Up until the turn of the 19th Century, anadromous fish were said to abound in the upper Yakima River (USFS 1999). The native coho salmon have been eliminated from the Yakima River, however the Yakama Indian Nation is trying to rebuild a coho fishery and have succeeded in having some returning coho in the last few years.

The principal drainages with Plum Creek ownership in the Yakima River basin include North and South Forks of Foundation Creek; North, Middle, South Forks of Ahtanum Creek and Reservation Creek in the Ahtanum Creek sub-basin; and the Tieton River, Oak Creek, and Cowiche Creek in the Naches River sub-basin. Plum Creek owns approximately 10,000 acres the Ahtanum Creek drainage, 10,000 acres in the Tieton River drainage, and several hundred acres in Cowiche and Oak creeks. The land is in a checkerboard pattern with adjacent lands owned principally by the USFS in the Tieton and Cowiche drainages, and by the Washington Department of Natural Resources and the Yakama Indian Nation in Ahtanum and Oak Creek drainages. Land use in the vicinity of Plum Creek property is principally forestry and grazing. These sub-basins with Plum Creek property are described below.

Interbreeding bull trout are believed to have been eliminated from the mainstream Yakima River (WDFW 1997). The 1998 Washington State Salmonid Stock Inventory Appendix for Bull trout and Dolly Varden (WDFW 1998) identifies the Yakima bull trout as a distinct stock based on their geographic, physical, and thermal isolation. Genetic characteristics are unknown. There are adfluvial, fluvial, and resident life histories present in the Yakima basin. It is possible that anadromous forms may have been present in the past (WDFW 1998). Bull trout were thought to have been extirpated in the lower Yakima River before the 1950s however, state biologists caught and released a 11 inch bull trout near Benton City. No known spawning areas have been located outside of Ahtanum Creek in the lower Yakima River although surveys have not been performed in many places. (pers. comm., Scott Craig, Richard Smith, FWS; Eric Anderson, Washington Department of Fish and Wildlife). Historically, bull trout distribution and abundance are believed to have been much greater throughout most of the Yakima River basin (WDFW 1997). Bull trout are now reduced to nine isolated stocks (of which all will be addressed below) these include: Yakima mainstem, Kachelus, Kachess, CleElum Lakes and North Fork Teanaway in the upper Yakima River and Bumping and Rimrock Lakes, Naches River, and Ahtanum Creek in tributaries to the lower Yakima River. Subpopulations are considered to be at critically low levels in the Yakima River basin (WDFW 1998) most likely due to disturbance in the lower watershed such as

dams, irrigation diversions, altered stream flows, development, roads, and stream temperatures. Currently it is unknown how the state identified bull trout stocks mix and migrate.

The FWS final listing rule for the bull trout in the Columbia River DPS described the Yakima River basin in the Mid-Columbia River Geographical Area with eight subpopulations. The action area for the Plum Creek NFHCP includes two of the Yakima River listed bull trout subpopulations, Naches River and Ahtanum Creek. While the upper Yakima River subpopulations are described as being outside of the NFHCP planning area, it will be described below as part of the action area. The importance of the upper Yakima subpopulations is unknown but the extent of migration and mixing of populations in the Yakima River could be important for the persistence of the species. The inclusion of the upper Yakima subpopulation is relevant for the discussion because interaction between the subpopulations could occur and there is movement of bull trout through Roza Dam, located just upstream of the Naches River, on the mainstem Yakima River.

Upper Yakima River (Yakima Mainstem, North Fork Teanaway, Cle Elum, Kachess, and Keechelus)

The upper Yakima watershed is mostly forest land while the lower watershed is mostly privately owned and has much development. It contains 12 subwatersheds and approximately 1,219 miles of stream. According to the USFS 1999 aquatic consultation package for the Yakima River basin, the watershed is about 198,186 acres in size. The upper Yakima watershed is contained within lands designated as the Snoqualmie Pass Adaptive Management Area by the NWFP. Approximately 50,326 acres are privately owned by Plum Creek and managed under their Cascades Habitat Conservation Plan. There are also approximately 14,465 acres that are Administratively Withdrawn and managed as Alpine Lakes Wilderness under the NWFP.

Major tributaries to the upper Yakima River are Kachess River, and Gold, Meadow, Cabin, Box Canyon, Gale, Mineral, Big, and Little creeks. The watershed has two major water storage reservoirs, Kachess and Keechelus Lakes. They are natural lakes with dams that were constructed in the early 1900s to increase storage capacity and regulate flow for irrigation. A smaller reservoir, Lake Easton, also is a water diversion structure for Kittitas County irrigation canals. Fish passage is provided around the Easton dam but Kachess and Keehelus dams block upstream migration and have isolated fish populations above the lakes.

The USFS 1996 Yakima River Watershed Analysis describes lands in the watershed as influenced by glacial activity with underlying landforms that are unstable with glacial troughs and glaciated mountain slopes that exhibit high debris slide and landslide hazards. Approximately 60 percent of the watershed is represented by these landforms. The analysis also determined that mass wasting was more likely to occur on the interbedded sandstones of the Naches formation, the Phyllites of the Easton Schist, and Lookout Mountain and Ohanapecosh Formations. The areas of concern for inner gorge failures are associated with riparian area logging, and are likely to occur in Big Creek and Cabin Creek subwatersheds. The watershed analysis noted that soils are generally shallow and coarse and susceptible to surface erosion. The areas having the highest risk of sediment erosion

from management are in Keechelus, Silver, Gold, Cabin, Big, Little, Mineral, Box, and Gates/Thetis drainages.

Bull Trout

The few bull trout found in the upper mainstem Yakima River, above Ellensburg, are either outmigrants from upper tributaries or have been flushed past either the Keechelus, Kachess, or Cle Elum dams (WDFW 1998). Most of the land Keechelus and Kachess Lakes both support isolated reproductive stocks of bull trout although they are small populations (USFS 1999). Keechelus Lake Dam, completed in 1914, impounded the existing lake and isolated resident bull trout from the remainder of the Yakima River (WDFW 1997). Chronically low redd counts from 1984 through 1996 (range 2 to 51, mean 14) indicate the stock is in critical condition (Anderson 1996; WDFW 1997; WDFW 1998). In both lakes spawning is limited to one stream, Gold Creek (Keechelus Lake) and Box Canyon (Kachess Lake). Run timing of the Keechleus Lake stock and the spawning population in the S.F. Tieton River in Rimrock Lake is distinct (WDFW 1998). Run timing of other Yakima River stocks is not distinct or is unknown from other Washington State bull trout.

Kachess Lake Dam, completed in 1905, impounded the existing lake and isolated bull trout from the remainder of the Yakima River (WDFW 1997). Presently, confirmed spawning is limited to Box Canyon Creek. Spawning may have also occurred in Rocky Run Creek. Mongillo (1992) identified Kachess Lake bull trout as an at-risk stock. Annual redd surveys between 1984 and 1996 indicate bull trout in Box Canyon may be near extirpation. Redd counts ranged from 0 to 11 with a mean of 4.5 (Anderson 1996; WDFW 1997; WDFW 1998). The FWS considers this isolated sub-population to be at risk of stochastic extirpation. Fluvial and adfluvial sized fish have been counted in 1998 and 1999 between May through July at Wells, Rocky reach, and Rock Islands Dams and have been observed in Wanapum Dam Pool (pers. comm., Richard Smith, FWS).

Cle Elum Watershed: The Cle Elum River watershed as described by the USFS in the 1999 CleElum watershed analysis, contains all the lands that drain into Cle Elum Lake above the dam. The watershed begins at the Deception Pass on the Cascade Crest and drains into the Yakima River just west of the town of Cle Elum. It contains approximately 144,547 acres and is oriented in a north-south direction. Construction of the Cle Elum reservoir occurred in 1933. Fish populations in the Cle Elum River, above the dam, are totally isolated, except for the possibility of some outmigration. Cle Elum Lake is an irrigation reservoir created as part of a larger system of reservoirs to provide water to the Kittitas and Yakima Valleys. Historically chinook salmon, coho salmon, sockeye salmon, and steelhead trout were found throughout the upper Cle Elum watershed. Currently remnant populations of chinook and steelhead exist below the dam.

Bull trout are believed to have been abundant historically but only remain as a remnant population both above and below the dam (USFS 1999). Bull trout occur in both Cle Elum and Waptus Lakes and River systems. The populations are severely depressed (USFS 1999). Cle Elum Lake

Dam, constructed in 1905, impounded the existing lake and isolated bull trout from the rest of the Yakima River (WDFW 1997). Waptus Lake, upstream of Cle Elum Lake, is also isolated from the Yakima River by the dam. Researchers have captured or observed only 20 bull trout in this subpopulation since 1990 (WDFW 1997). In 1996, three migratory bull trout were observed in the Cle Elum River about one mile above Salmon La Sac Campground (pers. comm., Scott Craig, FWS 1997). Very few bull trout appear in harvest records, and the status of this bull trout stock is unknown (Anderson 1996; WDFW 1997; WDFW 1998). The FWS considers this isolated subpopulation to be at risk of stochastic extirpation. The strongest populations are in the Waptus drainage but is threatened by an abundant brook trout population (USFS 1999).

Teanaway Watershed: The Teanaway River watershed is approximately 134,260 acres in size as described by the 1999 USFS Teanaway watershed analysis and aquatic consultation package for the upper Yakima sub-basin. The watershed is surrounded by the Wenatchee Mountains in the North, Teanaway Ridge on the east and by Cle Elum Ridge on the south and west. The West Fork, Middle Fork and North Fork form the Teanaway River which is oriented in a north to south direction. There are approximately 1,295 miles of stream in the watershed.

Stream surveys conducted in 1936 and discussed in the watershed analysis, are said to have found bull trout in the Middle Fork Teanaway and Beverly Creek on the North Fork was identified as the only tributary with bull trout. A resident stock of bull trout in the North Fork Teanaway River is isolated from the Yakima River by irrigation diversions and dewatering in the mainstem of the Teanaway River. The presence of this stock was reconfirmed in 1996 (Anderson 1996). Few bull trout have been documented in recent years and they are considered to be at critically low levels in the Teanaway River basin (WDFW 1997; WDFW 1998). Migratory access to the upper watershed above agriculture lands only occurs during high water yield years due to irrigation and water use. During 7 years of surveys involving multiple techniques, only 28 bull trout and two redds have been observed. The FWS considers this isolated subpopulation to be at risk of stochastic extirpation because of ongoing threats and low numbers. Brook trout do not seem to have developed a dominant presence in the watershed (WDFW 1998).

Swauk Creek Watershed: Swauk Creek is located in the Upper Yakima River and its confluence occurs at approximately 12 miles northwest of the town of Ellensburg. According to the 1996 USFS Swauk watershed analysis, it encompasses approximately 53,146 acres, of which 47,781 acres are National Forest lands. The headwaters are located at Teanaway Ridge to the west, Table Mountain to the east, and the Wenatchee Mountains to the North, with elevations ranging from 5361 feet to 6359 feet in the headwaters to 2,000 feet near the mouth. The upper third of the mainstem flows in a westerly direction while the lower watershed is oriented in a southerly direction to the Yakima River. Average annual precipitation ranges between 40 inches in the headwaters to 20 inches at the confluence with the Yakima River and falls mostly as snow.

Bull trout have not been found in recent surveys in the Swauk Creek watershed. They have been observed occasionally in lower Swauk Creek near the confluence with the Yakima River. Little is known about the historic range of bull trout in the Upper Yakima watershed especially in the

Swauk drainage. Few bull trout have been located in the basalt and sandstone geology typical in the Swauk Creek watershed.

Taenum-Manashtash Watersheds: The Taenum-Manashtash watershed is approximately 65,000 acres in size and is oriented in a west to east direction according to the USFS 1999 Taenum-Manashtash watershed analysis. It consists of two major stream systems which flow into the Yakima River at two locations. Taenum Creek is the more northern tributary and enters the Yakima River near the community of Thorp at 166.1 river miles. Manashtash Creek enters the Yakima River south of Taenum Creek, and south of the city of Ellensburg at 154.4 river miles. There are approximately 408 miles of stream in both watersheds.

According to the watershed analysis, in 1989 a Yakima Nation fish survey crew working in the North and South Forks of Taenum creeks collected and identified a dolly varden/bull trout. However surveys done in 1993 did not locate any bull trout. There is no habitat connectivity for migrating bull trout between Manashtash Creek and the Yakima River and bull trout have not been documented in the Manashtash watershed. Current surveys described in the watershed analysis including electrofishing and day and night snorkeling, done in 1990 and 1994, did not find bull trout in Manashtash Creek.

Westslope Cutthroat Trout

Cle Elum Watershed: Westslope cutthroat trout are widely distributed especially in the upper watershed. Introduction of nonnative rainbow and brook trout may have displaced westslope cutthroat from some historic habitat but their range may have been expanded through their stocking in high lakes. Westslope cutthroat trout that were planted were used from a native population in the Wenatchee River system from Twin Lakes in the Napeequa River drainage. These fish continue to be planted in high lakes in the watershed.

Teanaway Watershed: The 1999 USFS Teanaway watershed analysis discusses that westslope cutthroat are found throughout the Teanaway watershed and genetic analysis in Stafford Creek determined the fish to be native westslope. Steelhead populations are at critical levels and hatchery supplemental programs and improvements are occurring in the lower Yakima to improve smolt survival.

Swauk Creek Watershed: Westlsope cutthroat trout are found throughout the watershed but are concentrated in the headwaters streams. The watershed analysis describes that the distribution may be natural because there has been little stocking and the redband are native suggesting natural partitioning between westslope cutthroat and redband trout.
Taenum-Manashtash Watersheds: Westlsope cutthroat trout are distributed throughout the Taenum and Manashtash drainages and are found to be the most widely distributed species in the Taenum watershed. The watershed analysis describes that migration barriers are present and have existed since the early 1900s. Migratory cutthroat described in the watershed analysis, from the Yakima River, have not greatly influenced the resident life forms in these watersheds. Cutthroat trout have been planted within the watersheds.

Redband Trout

The Wenatchee National Forest expects that rainbow trout observed in the Yakima River systems are a combination of redband and coastal stocks which have developed because of state stocking programs and other unknown stocking of rainbow trout.

Cle Elum Watershed: Redband trout are native to the watershed and have likely been impacted by the introduction of nonnative rainbows and brook trout. The status of redband trout is not however known in this area.

Teanaway Watershed: Redband trout are considered to be the native rainbow trout in the Teanaway watershed. Genetic information referenced and used in the Teanaway Watershed Analysis and in Section 7 consultation by the US Forest Service, describes that both westslope cutthroat and redband rainbow trout exist in the Teanaway system. Genetic information found that there was mixing of both rainbow and westslope cutthroat genetics in the Teanaway watershed and that it may contain a natural hybrid zone for the two species of trout.

Swauk Creek Watershed: Salmonids present in the Swauk watershed includes redband trout. Redband trout are located throughout the watershed and have been found to be genetically pure redband and may be unique to the watershed (USFS 1999). Steelhead are known to utilize Swauk Creek up to Iron Creek and could likely utilize the system within the range of redband trout.

Taenum-Manashtash Watersheds: Redband/rainbow trout are abundant in the lower segments of Taenum Creek.

Anadromous Fish

The Yakima River basin historically supported sockeye salmon, spring, summer and fall runs of chinook salmon, coho salmon, and steelhead. Summer chinook salmon were extirpated in the 1970s (Waknitz et al. 1995). All coho salmon above Bonneville Dam are extinct except those spawning in the Hood River (Nehlsen et al. 1991), and sockeye that were once produced in several lakes, including Bumping, Kachess, Keechelus, and Cle Elum are extinct in the Yakima River Basin (SOAC 1998). Hatchery coho salmon have been stocked in Ahtanum Creek by the Yakama Indian Nation occasionally since the 1980s, and have been observed to spawn in the lower mile of Ahtanum Creek (WDNR 1997). Anadromous fish ESUs present today in the Yakima basin include Upper Columbia River fall-run chinook salmon, Mid-Columbia River spring chinook salmon and Mid-Columbia River steelhead. The Yakima basin is designated critical habitat for Middle Columbia River steelhead, which is listed as threatened.
Historically, production of chinook occurred throughout the basin, from small tributary streams to the lower mainstem (SOAC 1998). Spring chinook spawn in the American River, Naches River and tributaries, and mainstem Yakima (including the Cle Elum River) (Yakima River enhancement study 1991). Juveniles are found most commonly in the first river mile of tributaries. Natural stocks of spring chinook salmon in the Yakima River tributaries have increased by about 7 percent

annually since 1958, however increases in the upper Yakima River slowed to 3.5 percent from 1987 to 1996 and spring chinook in the Naches River decreased 9.7 percent in the same period (Myers et al. 1998). Spring chinook adult returns have ranged from 9,300 to 645 for the period 1986 to 1997 (SOAC 1998).

Fall chinook currently spawn in the lower Yakima River from Sunnyside Dam to the mouth, and in Marion Drain. Fall chinook salmon in the lower Yakima River are a composite of hatchery stocks, while those spawning in the Marion Drain may remnants of "native" Yakima River fish (Myers et al. 1998). Fall chinook of mixed origin in the Yakima basin have increased by 6.5 percent annually since 1950, with a 23 percent increase from 1983-1994 (Myers et al. 1998). Natural fall chinook in the Marion Drain had declines of -9.4 percent and -5.7 percent in the same periods, respectively (Myers et al. 1998). Returning adult fall chinook number in the 2,000-4,000 range.

Historically, steelhead were widely distributed in the Yakima River basin, spawning in streams of every size, from the mainstem Yakima River to small creeks with intermittent flow. Currently, steelhead production is much reduced, and is concentrated in Satus and Toppenish Creek in the lower Yakima basin. Scattered spawning occurs in the Naches River, in the upper Yakima River and the Teanaway River (SOAC 1998). The number of returning adult steelhead has varied in recent years from a low of 204 in 1980, to a high of 2,601 in 1987 (SOAC 1988) Steelhead had an annual increase of 14 percent from 1980 to1993 (Busby et al.1996).

Summary of Factors Affecting Fish Species: The baseline assessments described in this section are summaries adopted from the Wenatchee National Forest aquatic consultation packages for the upper Yakima, Naches, and Taenum/Manashtash sub-basin assessments and associated watershed analysis. The FWS/NMFS matrix indicators (UFWS/NMFS 1998) were used for the baseline assessments.

USFS Plum Creek Land Exchange fisheries BA (USDA 1999c) and USFS aquatic consultation package reported the upper Yakima River mainstem watershed to be functioning at unacceptable risk for all subpopulation characteristics (size, growth and survival, life history diversity and isolation, and persistence and genetic integrity) for steelhead and bull trout, stream temperature, physical barriers, LWD, pool frequency and quality, large pools, off-channel habitat, refugia (bull trout and steelhead), peak and base flows, road density and location, disturbance history, and riparian reserves. Population and habitat indicators found to be functioning at risk included growth and survival, life history diversity and isolation, and persistence and genetic integrity for cutthroat trout, sediment, chemical contaminants/nutrients (dissolved oxygen and pH), substrate embeddedness, off-channel habitat, refugia (cutthroat trout), width/depth ratios, streambank condition, floodplain connectivity, drainage network increase, and disturbance regime.

Conditions of the habitat and population indicators are related to dams on Lake Keechelus and Kaches (drawdown zones are sterile, dams prevent passage and cause isolation), altered hydrologic processes (dams and irrigation, roads, harvest,) mass wasting (60 percent of watershed

being in high debris /landslide hazard), timber harvest (historical harvest, at least 26 percent of forest is in a immature state, 56 percent immature if consider all Plum Creek lands harvested), roads (location and ~3.6 miles/sq. mile where Cabin, Keechleus, and mainstem Yakima have greater than 2.0 miles/sq. mile), recreation (developed and dispersed campsites and railheads), fire exclusion, and agriculture.

Baseline assessments of bull trout subpopulations in the Cle Elum subwatershed determined that population and habitat indicators were functioning at unacceptable risk for all subpopulation indicators (size, growth and survival, life history diversity and isolation, and persistence and genetic integrity) for bull trout, and physical barriers. Population and habitat indicators found to be functioning at risk included life history diversity and isolation and persistence and genetic integrity for cutthroat trout, stream temperatures, substrate embeddedness, LWS, pool frequency and quality, large pools, off-channel habitat, refugia, width/depth ratios (lower Cle Elum River), streambank condition, floodplain connectivity, peak and base flows, road density and location, disturbance history, riparian reserves, and disturbance regime. Conditions of the indicators are related to the dam on the Cle Elum Lake, (the change in the flow regime as well as it being a physical barrier), timber harvest in subwatersheds (~33 percent is in an immature state), recreation on the floodplain (developed campsites, dispersed campsite locations in riparian areas, off-road vehicle use in Fortune Creek), roads (location, density in riparian areas and the subwatersheds ranges up to 3.9 miles/sq. mile), grazing (sheep and cows historically, sheep currently), and mining (historical hard rock and placer mining, currently no new large scale mines).

Baseline assessments of bull trout subpopulations in the Teanaway subwatershed determined that population and habitat indicators were functioning at unacceptable risk for all subpopulation characters (size, growth and survival, life history diversity and isolation, and persistence and genetic integrity) for steelhead and bull trout, stream temperatures (lower Teanaway), physical barriers, LWD, refugia (steelhead and bull trout), floodplain connectivity (lower Teanaway), peak and base flows, disturbance history, riparian reserves (lower Teanaway), and disturbance regime. Population and habitat indicators found to be functioning at risk included life history diversity and isolation (cutthroat trout), stream temperatures (upper Teanaway), sediment (lower Teanaway), pool frequency and quality, large pools, off-channel habitat, refugia (cutthroat trout), width/depth ratio (mainstem and N. Fork Teanaway), streambank condition, floodplain connectivity (upper Teanaway), drainage network increase, and riparian reserves (upper Teanaway). Conditions of the indicators are related to impacts that include: timber harvest (log drives at the turn of the century, 38 percent of the stands are in a immature state, riparian harvest), roads (locations, number of system roads on both private and National Forest is a concern), grazing (grazed up to 1996 in Stafford Creek, 1993 Boise Cascade allotment and 1996 USFS allotments are not in use), recreation (dispersed trails and campsite use, off-road vehicle use and stream crossings, developed sites in riparian reserves), fire exclusion, and altered hydrologic processes.

The Swauk subwatershed (upstream of First Creek) baseline assessments determined that population and habitat indicators were functioning at unacceptable risk for all subpopulation indicators (size, growth and survival, life history diversity and isolation, and persistence and

genetic integrity) for bull trout and steelhead, stream temperature, sediment, physical barriers, substrate embeddedness, LWD, pool frequency and quality, off-channel habitat, refugia (Swauk mainstem), width/depth ratios, streambank condition, floodplain connectivity, road density and location, riparian reserves, and disturbance regime. Population and habitat indicators found to be functioning at risk included life history diversity and isolation and persistence and genetic integrity for cutthroat trout, contaminants and nutrients, large pools, increase in drainage network, and disturbance history. Conditions of the indicators are related to such impacts as roads (State Highway 97, ~20 percent of the watershed is compacted due to roads, skid trails, and dispersed roads, road density ranges between 2.2 and 6.3 in the watershed and 1.4-11.9 miles/sq. mile in riparian reserves, culverts/barriers), timber harvest (Iron, Medicine, Hovey and Upper Swauk have a concern for increased peak flows), mining (historic dredging, diking and confinement of channels and use of mercury, current placer mining and dredging), grazing (historically horses and sheep, currently sheep), fire exclusion (grazing reduced fuels, man reduced fire starts, and ~60 percent in the dry forest type in the subwatershed is classified as dense), recreation (past off road vehicle use, developed camping, dispersed camping and user built trails), and irrigation diversions/instream barriers (Boulder, First, Williams, and Mill creeks).

Baseline assessments for the Taenum subwatershed determined that population and habitat indicators were functioning at unacceptable risk for all subpopulation characteristics (bull trout and steelhead), temperature, substrate, LWD (Taenum mainstem and N. Fork Taenum Creek), refugia (bull trout and steelhead), peak and base flows, drainage network increase, road density and location, and disturbance history. Population and habitat indicators found to be functioning at risk included growth and survival (cutthroat trout), persistence (cutthroat trout), sediment, LWD (S. Fork Taenum Creek), pool quality and large pools, off-channel habitat, refugia (cutthroat trout), streambank condition, floodplain connectivity, riparian reserves, and disturbance regime. The FWS considers the Taenum baseline conditions to apply to the Manashtash baseline according to the USFWS Plum Creek Land Exchange biological opinion, as they have similar management patterns and watershed disturbances. Conditions of the population and habitat indicators are related to impacts that include irrigation diversions both unscreened and as instream and flow barriers) timber harvest (with 20 percent of the stands in an immature condition on National Forest lands and 30 percent and greater were immature on private lands), grazing (both sheep and cattle since 1850s and still including ½ of the watershed by the 1960s), dispersed recreation, roads (with riparian road densities in both watersheds ranging between 5.57-1.5), and fire exclusion. Particularly roads located in the floodplains and increases in the drainage network has increased impacts as evidenced in 1975, 1977, and 1990 floods disturbances. Streams within these watersheds are listed on the 303(d) lists for Washington State. Instream sediment measurement are high in many stream reaches of the watersheds.

Irrigation withdrawals have a dominant effect on fish habitat throughout the Yakima River basin. Pre-irrigation system maps show that the channel system in the basin was much more complex with myriad side channels and dense riparian vegetation. Reservoirs now regulate most of the winter and spring runoff, reducing the frequency of overbank flows, and reducing natural recharge of the flood plain that historically sustained summer flows and moderated water temperatures

(SOAC 1998). Certain reaches in both the upper and lower Yakima River do not comply with Washington State Department of Ecology (WDOE) standards for temperature, fecal coliform, sediment, and pesticide residue violations, and have been placed on the Section 303(d) list of the Clean Water Act. Turbidity and phosphorus have also been detected at concentrations that may affect aquatic life. The National Water Quality Assessment Program conducted a survey in 1990, which indicated that the ecological health in the lower Yakima River and some tributaries was impaired (Cuffney et al., 1997).

Yakima irrigation facilities are operated to protect incubating spring chinook eggs and alevins in the upper Yakima River Basin. according to the SOAC (1998) report, the operation is known as "flip-flop," and is implemented as follows: Through early September, water is released primarily from reservoirs on the Yakima arm (Keechelus, Kachess, and Cle Elum) with minimal releases from Naches arm reservoirs (Rimrock and Bumping). On or near September 10, releases are shifted from reservoirs on the Yakima arm to reservoirs on the Naches arm. The purpose of this flow manipulation is to maintain irrigation water supply while protecting incubating spring chinook eggs and alevins in the upper River between the town of Easton and the Teanaway River (river mile 203.5 to 176.1). The shift in flows force spring chinook in the Yakima River to construct their redds in locations that require lower flows, thus allowing continued irrigation without eliminating chinook redds.

Ahtanum Creek Sub-basin

This assessment of baseline conditions includes information which is summarized from the Washington State Department of Natural Resources (WDNR) 1997/98 Ahtanum watershed analysis and the full document has more specific details. The description of this baseline will include a description of the Cowiche and Reynolds creeks in the Cowiche watershed analysis unit (WAU), lower Ahtanum and Foundation Creek in the Foundation WAU, and Middle and North Forks of Ahtanum Creek or Darland Mountain WAU. A portion of the NFHCP covered lands occurs within these watersheds, and they all are similar in size, aspect, and watershed processes. The effects of the project within each WAU would be expected to be similar.

The Ahtanum watersheds are characterized by east-west trending rounded or flat-topped ridges and deep, steep-walled canyons with narrow or broad flat-valley bottoms that cut into the eastern foothills of the Cascade Mountains. in Yakima County, Washington. Cowiche Creek joins the Naches River approximately three miles above the confluence with the Yakima River, and Ahtanum Creek joins the Yakima River near Union Gap (approximately 8 miles downstream of the mouth of the Naches River). Within these watersheds, approximately 47 percent of the area is in State ownership, 39 percent is held by commercial timber companies (primarily Plum Creek and Boise Cascade Corporation), 6 percent is owned by Ahtanum Irrigation District, and 8 percent is mixed private ownership.

Bull Trout

Ahtanum Creek bull trout have been identified as a distinct stock based on their geographic location by WDFW (1998). Mainly resident sized bull trout are known to occur in the Middle and North Forks of Ahtanum creeks. It is likely that bull trout spawning occurs in the South Fork Ahtanum but redd counts have not been conducted there yet (WDFW 1998). Other life history forms (fluvial or anadromous) may have been maintained throughout the forest before the development of unscreened and unladdered irrigation diversions and dams in the mainstem Ahtanum. The Ahtanum bull trout are thought to have risen from the native fluvial/resident life history forms that occurred throughout the Yakima River basin. Ahtanum Creek bull trout are now isolated from fish in the lower Yakima River due to thermal barriers and total dewatering of the lower Ahtanum Creek at 19.7 river miles at the Wapato Irrigation Diversion by water withdrawals (WDFW 1998). WDFW maintains a recreational harvest prohibition for bull trout stocks in these watersheds in 1992 and a total fishing closure on parts of North Fork Ahtanum and Shellneck Creek (tributary to NF Ahtanum). Recent spawning surveys indicate that the numbers of bull trout appear very low and that there may be other spawning populations in unsurveyed streams in the watersheds (pers. comm, Eric Anderson, Washington Department of Fish and Wildlife).

WDFW indicates a critical status for the South Fork Cowiche and Reynolds Creek appear to provide areas conducive to bull trout spawning and rearing, but no bull trout have been located in these drainages with spot-check electrofishing. However, the WDFW (1998) bull trout stock assessment says that in the early 1970s there is some information that indicates bull trout were present in Cowiche Creek. There has been extensive stocking of eastern brook trout in the lower mainstem of Cowiche Creek which may have affected bull trout persistence.

Westslope Cutthroat Trout

Where nonnative rainbow trout have been introduced, hybridization with westslope cutthroat trout is widespread (Behnke and Zarn 1976; Rieman and Apperson 1989). Therefore, the true distribution and status of the original genotypes is questionable. However, it is likely that westslope cutthroat trout continue to exist in isolated populations within the Ahtanum Creek sub-basin.

Redband Trout

The long history of stocking rainbow trout within the Columbia River basin, and the proclivity for redband and rainbow trout to hybridize, make the true distribution and status of the original genotypes questionable. In general, introgressed redband trout are found in mid-elevation streams. Upper reaches and headwater areas appear to maintain the native redband trout (Behnke 1999). Therefore, it is likely that *O.m.garidneri* continues to exist in isolated populations within the Ahtanum Creek sub-basin.

Mountain Whitefish

Although specific information is lacking, it is likely that mountain whitefish occur within the Ahtanum Creek Sub-basin.

Coastal Cutthroat Trout, Coastal Rainbow Trout, and Pygmy Whitefish

These species are not known to naturally occur in the Ahtanum Creek Sub-basin.

Anadromous Fish

Water diversions (impassable diversion dams and low flows) severely limit the potential use of Ahtanum Creek by anadromous fish, allowing only a narrow window for fish to enter the stream in the fall, and to migrate elsewhere before the stream is de-watered in mid-July. It appears from the literature that Ahtanum Creek is used very little by anadromous fish, but use could improve dramatically if the irrigation problems were corrected. The timing of spawning and migration potentially allows steelhead and coho to use Ahtanum Creek for spawning, while chinook salmon are largely precluded from using the stream because spawning coincides with dewatering. Fast et al. (1991) did not observe juvenile spring chinook salmon in any Yakima River tributaries below Roza Dam in the summer, but found them during the winter in Wenas, Wide Hollow and Ahtanum creeks, and in Wanity Slough. This seasonal distribution pattern was attributed to summer dewatering and excessive stream temperatures. Chinook salmon are reported to use the lower 3 miles of Ahtanum Creek for rearing and migration, and coho salmon are reported to use the lower 17 miles for spawning and rearing (Table 1 below, fish distribution). The StreamNet fish distribution database indicates that steelhead use the mainstem of Ahtanum Creek, and the North, South and Middle Forks (Table 1 below, fish distribution). The Ahtanum Watershed Analysis (WDNR 1997) states that anadromous fish are precluded from using the North Fork Ahtanum Creek due to passage barriers. In a report, by BPA (1990) steelhead were reported to be in the Ahtanum Creek drainage upstream from the town of Tampico in the summer, but not below. Differences in reported fish distribution are possibly due to different seasons when surveys occurred, or due to improvements that have increased fish utilization since earlier studies were completed. Although there is not complete agreement in reported anadromous fish distributions, all the literature reviewed indicates that suitable anadromous fish habitat is severely reduced by irrigation facilities and withdraws, and that anadromous fish numbers are depressed as a result. Neither coastal rainbow trout or coastal cutthroat trout exist in the Athanum Creek sub-basin.

Factors Affecting Fish in Ahtanum Creek: The predominant land uses in the Ahtanum Creek sub-basin includes forestry, livestock grazing, irrigation and water conveyance, and recreation. The largest factor affecting anadromous fish are diversion dams that are impassable, unscreened ditches, and agricultural irrigation that causes total dewatering of the mainstem Ahtanum Creek below RM 19.6 from July 10 to mid-October (BPA 1990). The Ahtanum Creek sub-basin is unusable by anadromous fish during much of the year. If passage barriers were removed, the North and Middle Forks of Ahtanum Creek and several other tributary streams could probably

support anadromous fish, although these areas are far from pristine. In the upper forested portion of the drainage (North, Middle, and South Forks of Ahtanum Creek) sedimentation and reduced vegetative cover from cattle grazing, logging, and roads in riparian areas have caused habitat degradation, that would likely be rated in the FWS/NMFS matrix indicators for sediment, riparian connectivity, and subpopulation indicators as "functioning at risk" or "not properly functioning." The WDFW bull trout stock assessment (WDFW 1998), and the Ahtanum Watershed Analysis (WDNR 1997), discuss numerous problems such as overgrazing, off-road vehicle traffic use, intensive agriculture use along shorelines, development of shorelines and floodplains, excessive timber harvest in the upper watersheds and excessive road densities.

Naches River Sub-basin (including lower Tieton River)

The Naches River is a tributary to the lower Yakima River with a watershed of 74,000 acres. The Naches River enters the Yakima river just north of the town of Yakima. Major tributaries to the Naches River include the Little Naches River, American River, Bumping River, Rattlesnake Creek, Tieton River, and Cowiche Creek. Plum Creek lands are located in upper portions of the Tieton, Cowiche, and Oak Creek drainages.

Approximately 11 percent of the watershed is private ownership (checkerboard lands) of which most is harvested. The NWFP designated 36 percent as matrix, 12 percent and Late Successional Reserve, 38 percent as a Managed Late Successional Area, and that it is a Key Watershed. The Naches watershed is within the Naches Mountains geologic subsection including basalt, pyroclastic material, sedimentary, crystalline, and weak metamorphic bedrock. The principal landform in the watershed is the structurally controlled volcanic/pyroclastic mountain slope landform. This landform is susceptible to surface erosion, localized landslides, or deep seated landslides, especially at the contact zone between fine material and competent basalt or crystalline bedrock. These slope failures often slide into the valley floor confining and damming the stream channels. Streams are continuing to readjust to this confinement by down-cutting and undercutting toe slopes of the slides creating unstable conditions. These conditions contribute to natural input of high levels of sediment.

The Tieton River is the largest tributary in the lower Naches River, entering west of the town of Naches. It encompasses approximately 115,296 acres of which 10,067 acres are owned by Plum Creek. Other landowners with large holdings include Boise Cascade Corporation, and the Washington Department of Natural Resources. Flows in the Tieton River are controlled by releases from the Rimrock Dam, located in the headwaters of the Tieton River. The area above Rimrock Dam, is 3 percent private land ownership, and 93 percent is Federal. Forty-five percent of the Federal lands are designated Wilderness, 34 percent are Late Successional Reserves, 12 percent is Matrix, and 2 percent is within the Managed Late Successional Reserve. Below Rimrock Dam, approximately 20 percent of the watershed is privately owned, 24 percent is within the Lost Lake Managed Late Successional Area, 45 percent is managed as Matrix, and 10 percent is designated Wilderness.

Bull Trout

Naches Watershed: The Naches River bull trout subpopulation resides in the lower Yakima River system and consists of the Naches River mainstem and it's tributaries (Little Naches, American River, lower Bumping River, Rattlesnake Creek, and lower Tieton River, excluding the watersheds above Rimrock and Bumping Dams. Rimrock Lake bull trout subpopulation includes all of the upper Tieton River above the dam and Rimrock Lake. Bumping Lake bull trout subpopulation includes all of the upper Bumping River above the dam and Bumping Lake.

According to the 1998 WDFW bull trout stock assessment, bull trout in the Naches River, originated from native fluvial/resident forms. The smaller resident bull trout inhabit smaller headwater tributaries and larger fluvial fish inhabit mainstem systems and spawn in the smaller tributaries. More recently, fluvial and adfluvial sized bull trout have been seen spawning lower in the mainstems of rivers (pers. comm., Judy De La Vergne, FWS). There is some overlap but the degree of genetic exchange between the two life histories is unknown. The Naches stock as identified by WDFW (1998) is composed of fish from the Tieton River (below Rimrock Dam), Rattlesnake creek, American River, Little Naches River, Bumping River (below Bumping Lake dam), and smaller tributaries of these streams. Smaller tributaries currently inhabited by bull trout include: Dog, Hindoo, Little Wildcat and North Fork Rattle Snake creeks (Rattlesnake Creek drainage), Crow (Little Naches River drainage), and Creek, Kettle, Timber and Union creeks (American River drainage) and the USFS caught a single bull trout in Milk and Oak creeks.

The Naches River stock of resident and fluvial bull trout is isolated because of the Tieton and Bumping Lake Dams upstream and by irrigation diversion dams downstream causing dewatering, entrapment, seasonal thermal barriers, and mortality (Anderson 1996). Bull trout abundance is low in the Naches River subpopulation. Recent spawning has been documented in reaches of Rattlesnake Creek and American River (64 redds total in 1996). WDFW (1998) considers the status of this stock critical based on low spawning escapement. Spawning may be more widespread than documented because of abundant suitable habitat in the watershed. In 1992 fishing for bull trout was prohibited and beginning in 1998 there was a total fishing closure on the upper section of Union Creek to protect spawning and early rearing bull trout (WDFW 1998).

Little Naches Watershed and Bumping/American Watershed: Bull trout reside in the Little Naches, a 5th field tributary that joins the Bumping River to form the Naches River. The lower one mile of Bumping River, above Bumping Lake, provides bull trout spawning habitat. Bumping Lake is the location of the Bumping Lake bull trout subpopulation which may have originated from a native adfluvial life history before construction of the Bumping Lake Dam. Fluvial/resident forms are present as well and currently inhabit streams below the dam. Deep Creek is the only tributary of Bumping Lake where bull trout spawning is observed and juveniles probably rear for several years before migrating to Bumping Lake. Union Creek, a tributary to the American River and surrounding stream area adjacent to the American River provide spawning habitat for bull trout.

Rattlesnake Watershed: A significant population of bull trout use Rattlesnake Creek, a 5th field tributary to the Naches River, as a migration corridor where known spawning occurs in the William O. Douglas wilderness. Four adult bull trout were identified in snorkel surveys in 1996, in North Fork Rattlesnake Creek

Tieton Watershed: The Tieton River is the largest tributary in the lower Naches River. Most of the bull trout use occurs in the upper Tieton Watershed. The watershed above Rimrock Dam is the location of the Rimrock Lake subpopulation of bull trout, which originated from a native fluvial/resident life history form that occurred in the Tieton River. WDFW considers this stock a separate stock based on its physical and geographic isolation above the Dam. After construction of the dam this stock adapted to an adfluvial type of life history. Bull trout have been seen occasionally in Clear Lake and in the mainstem upper Tieton River. Adults are seen in Indian Creek and South Fork Tieton River (Bear, Short, Dirty, Grey, Spruce, and Corral creeks) and in the North Fork below Clear Lake Dam although spawning has not been observed below Clear Lake. Adult bull trout are found in the lower Tieton River but no spawning has been documented. There was one bull trout found in Oak Creek in electrofishing surveys in 1999 by USFS fisheries crews. The 1999 USFS aquatic consultation package for the Naches River sub-basin mentions that adult fish seen in the lower Tieton River may be migrating fish from the Naches River population.

As a result of Rimrock Dam, the Tieton River has two separate flow regimes and is managed as two river systems by the USFS, referred to the upper Tieton and the lower Tieton watersheds. Rimrock Lake is a Bureau of Reclamation project on the upper Tieton River, and supplying irrigation water to the Yakima Valley. Anadromous and resident fish habitat and populations are impacted by the altered flow regime released from Rimrock Lake. The current flow regime has been designated to protect downstream spring chinook spawning while providing irrigation water to the Yakima Valley. The resultant flows are opposite or "flip flopped" from original flows. Runoff water is held in Rimrock Lake while most irrigation flows are released from the other upper Yakima Reservoirs. In late summer, flows are stored in the upper Yakima reservoirs and released from Rimrock Lake. This flow regime results in poor fish habitat conditions for most fish species, including bull trout, in the Tieton River downstream of the dams and adjacent to the reservoir.

Westslope Cutthroat Trout

Where nonnative rainbow trout have been introduced, hybridization with westslope cutthroat trout is widespread (Behnke and Zarn 1976; Rieman and Apperson 1989). Therefore, the true distribution and status of the original genotypes is questionable. However, it is likely that westslope cutthroat trout continue to exist in isolated populations within the Naches River sub-basin.

Redband Trout

The long history of stocking rainbow trout within the Columbia River basin, and the proclivity for redband and rainbow trout to hybridize, make the true distribution and status of the original genotypes questionable. In general, introgressed redband trout are found in mid-elevation streams. Upper reaches and headwater areas appear to maintain the native redband trout (Behnke 1999). Therefore, it is likely that *O.m.garidneri* continues to exist in isolated populations within the Naches River sub-basin.

Mountain Whitefish

Although specific information is lacking, it is likely that mountain whitefish occur within the Naches River Sub-basin.

Coastal Cutthroat Trout, Coastal Rainbow Trout, and Pygmy Whitefish

These species are not known to naturally occur in the Naches River sub-basin, including the lower Tieton River sub-basin

Anadromous Fish

According to the USFS Naches Watershed Analysis (USFS 1999c) steelhead spawn in the sub-basin between January and May. It is believed that the native resident redband trout populations and steelhead may be one population exhibiting resident and anadromous life histories. The WDFW 1992 considers steelhead in the Yakima, Naches, Wenatchee, and Entiat sub-basins to be depressed (WDFW 1992). According to the watershed analysis, outmigration of steelhead smolts from the Naches River was monitored at the Wapatox Diversion from 1985 to1987 and it was found that the Naches system was producing approximately 10 percent of the smolts found in the Yakima basin by the Yakama Indian Nation in 1990 and that approximately 40 percent of the Yakima River steelhead run returns to the Naches River (USFS 1999c). Little is known about the distribution of steelhead in the Naches sub-basin other than they are spawning and rearing somewhere in the mainstem Naches, Little Naches, Rattlesnake, American, and Bumping Rivers. The watershed analysis lists significant steelhead sub-watersheds for the Naches including: the Little Naches and lower Rattlesnake Creek.

Factors Affecting Fish in the Naches River: The baseline assessment for the Naches River (USFS 1999c) determined that population and habitat indicators in the Naches River mainstem watershed were functioning at unacceptable conditions for growth and survival (not for cutthroat) and life history/diversity/and isolation (bull trout only), temperature (mainstem Naches River, Gold Creek, and N. Fork Nile), physical barriers (Swamp, Orr, and Gold creeks), large woody debris (mainstem Naches River and L. Fork Rock Creek), pool frequency/quality (mainstem Naches River), off-channel habitat (mainstem Naches River, and Orr Creek), refugia (bull trout only), streambank condition (mainstem Naches), floodplain connectivity (mainstem Naches River and

Orr Creek), road density and location, disturbance regime, riparian reserves (mainstem Naches River), and disturbance regime.

The indicators identified as functioning at risk included: subpopulation size (for bull trout and steelhead only), growth and survival (cutthroat only), life history/diversity/and isolation (steelhead and cutthroat only), persistence and genetic integrity, temperature (tributaries), sediment, substrate embeddedness, pool frequency and quality (tributaries), large pools (mainstem Naches River), off-channel habitat (Rock and Gold creeks), refugia (steelhead and cutthroat only), channel width/depth ratios (mainstem Naches River), floodplain connectivity (Rock and Gold creeks), peak and base flows, and riparian reserves (tributaries). Timber harvest (72 percent of National Forest is harvested), roads (30 percent within 300 feet of streams and Rock, Gold, Milk, and Orr creeks; mainstem floodplains are cutoff; and there are barriers at crossings on Swamp, Orr creeks), grazing, and recreation (riparian camping, highest miles of trail are in the mainstem watershed, and off road vehicle use) and fire exclusion (high risk of catastrophic fire) are some of the biggest impacts affecting aquatic resources in the Naches River watershed. Stream temperatures are elevated in Gold Creek and N. Fork Nile Creek due to past riparian harvest due to timber harvest. The location of State Highway 410 causes a barrier at Gold Creek. The dams in the watershed and poor conditions of the migratory corridor are the impacting fish populations in the Naches River mainstem.

Rimrock Reservoir is a Bureau of Reclamation project on the upper Tieton River, and supplying irrigation water to the Yakima Valley. Rimrock Dam completely prevents upstream fish passage. Fish populations above Rimrock Dam are isolated from the rest of the Naches system although there may be some downstream migration of redband trout, cutthroat trout, and bull trout. The Dam was finished in 1924 and is 319 feet high with a water storage capacity of 198,000 acre-feet. Clear Lake is a second reservoir formed at the confluence of Clear Creek and the North Fork Tieton River. It is approximately one-half mile upstream of Rimrock Reservoir. There is a recently constructed fish ladder on the dam at Clear Lake to provide passage for bull trout. The flows through the ladder are surface flows and may be too warm to entice bull trout. Anadromous and resident fish habitat and populations are affected by the altered flow regime released from Rimrock Lake, which are managed under the "flip-flop" scenario described previously.

Stocking of nonnative trout and salmon throughout the Tieton River and its tributaries has further impacted native fish. Brook trout and nonnative rainbow have been stocked throughout the watershed and kokanee salmon and other nonnative fish are stocked to provide a sport fishery in Rimrock Lake (kokanee are probably an important forage species for bull trout).

Table 1. Anadromous fish distribution in the Yakima River drainage. Data from StreamNet database (StreamNet 2000).

Subbasin	Stream	Species	Primary Use	Area Found (River Miles)
Ahtanum Creek	Ahtanum Creek	spring chinook	rearing, migration	0 - 2.9
		steelhead	spawning, rearing	0.5 - 21.9
		coho salmon	spawning, rearing	0.5 - 17.6
	South Fork Ahtanum Creek	steelhead	spawning, rearing	0 - 5.8
	Foundation Creek	steelhead	migration	0 - 0.8
	Middle Fork Ahtanum Creek	steelhead	migration	0 - 0.9
	North Fork Ahtanum Creek	steelhead	spawning, rearing	0 - 9.2
		steelhead	migration	9.2 - 13.3
Naches River	Cowiche Creek	spring chinook	rearing, migration	0.7 - 4.6
		steelhead	spawning, rearing	0 - 7.2
		coho salmon	spawning, rearing	0.1 - 7.2
	South Fork Cowiche	steelhead	spawning, rearing	0 - 17.4
	Oak Creek (trib. to Tieton River)	spring chinook	migration	0 - 2.9
		steelhead	spawning, rearing	0 - 8.7
	Tieton River	spring chinook	migration	0 - 2.3
		steelhead	spawning, rearing	0 - 21.3

Lewis River Sub-basin

The Lewis River watershed includes two large drainages, the North Fork and East Fork, which converge 3.5 miles from the Columbia River. The Lewis River watershed drains an area of about 1,050 square miles. Elevations range from10 feet at the Columbia River to 12,000 feet at Mount Adams. The majority of the drainage is forested, and timber harvest, recreation, and residential development are the principal uses. The headwaters originate on the southern flanks of Mount St. Helens and Mount Adams. The main stem of the river (North Fork) has three major dams, Swift Reservoir (RM 48), Yale Reservoir (RM 34), and Merwin Lake (RM 20). Upstream fish passage is completely blocked 20 miles from the mouth of the Lewis River by the 240 foot high Merwin Dam. Human population densities are generally low within the basin. There is scattered residential

development with only a few small communities (Cougar, Chelatchie, and Amboy) in the upper basin. The largest urban population center, the City of Woodland, lies near the mouth of the river.

The Lewis River drainage contains designated critical habitat for lower Columbia River steelhead, lower Columbia River chinook salmon, and Columbia River chum salmon. The upstream boundary of the critical habitat for steelhead and chinook salmon includes areas above Mayfield Dam due to the fact that these species are trapped and moved into areas above the dams, while the upstream boundary for chum salmon ends at Merwin Dam. The drainage also supports the Lower Columbia River/Southwest Washington coho salmon ESU that is not listed.

The North Fork Lewis River headwaters extend to the flanks of Mount Adams and Mount St. Helens. Glacial runoff contributes to the flow in the Lewis River, but rainfall provides the most significant contribution. The basin above Merwin Dam is 189.41 square miles, with approximately 45 percent Federal land, owned mostly by the USFS. Principal land uses include forestry, recreational, and residential development. Recreational demand for use of the reservoirs and National Forest is large and growing.. The majority of the Lewis River basin is forested, with vegetation typical of the western hemlock vegetation zone. A large portion of the North Fork Lewis River basin is managed as commercial forest and, as such, is undeveloped except for logging roads. Average road density is 4.48 miles per square mile. Approximately 30 square miles of the upper basin was denuded by the May 18, 1980 eruption of Mount St. Helens.

The major tributaries in the Lewis River drainage below Merwin Dam include the East Fork Lewis River, Johnson Creek, and Cedar Creek. Stream Flows in the North Fork Lewis River are regulated by the Merwin Dam. The majority of lands below Merwin Dam are private and road densities average 4.96 miles per square mile. The lower 12 miles of the mainstem and North Fork Lewis River flow through a wide, flat valley that is used principally as cropland, and is protected from flooding by dikes. The valley begins to narrow upstream for the next 8 miles, forming a canyon that begins near the confluence of Cedar Creek, and continues to Merwin Dam. The lower 11 miles are influenced by tidal backwaters of the Columbia River. Within this area, the flow is sluggish and the sediments are generally composed of sand, silts, and clays typical of lower flood plains.

Bull Trout

The FWS identified two subpopulations of bull trout in the Lewis River watershed, both within the North Fork: one subpopulation in Yale Reservoir and one in Swift Reservoir (USDI 1999b). As of 1997, only migratory (adfluvial) bull trout have been identified in these reservoirs (WDFW 1997). The North Fork Lewis River is segregated by three dams: Merwin, Yale, and Swift (from downstream to upstream). These dams do not allow upstream passage. Limited downstream passage over these dams is assumed based on observed adult bull trout in Merwin Reservoir, the furthest downstream reservoir. Because no known spawning sites are accessible to bull trout in Merwin Reservoir, these fish are not considered a subpopulation. As of 1997, only migratory (adfluvial) bull trout have been identified in these reservoirs (WDFW 1997). Bull trout currently

occupy 22.1 km (11.9 mi) of the mainstem North Fork Lewis River including identified spawning tributaries in Pine, Rush and Cougar creeks (GPNF 1995a). Although Platts et al. (1995) concluded that insufficient information existed to determine the status and trends of bull trout in Swift and Yale reservoirs, WDFW (1997;1998) considers the subpopulations to be depressed due to "chronically low abundance." Spawning ground surveys conducted since 1988 for the Yale Reservoir subpopulation indicate an annual escapement in Cougar Creek of 22 fish (range 7 to 37). The status of the Yale Reservoir subpopulation is considered to be depressed with an unknown trend (USDI 1999b).

The Swift Reservoir subpopulation spawns in Pine and Rush creeks (WDFW 1997). Radiotelemetry studies conducted on bull trout in Swift Reservoir indicate that migrating adults use both Rush and Pine creeks with no evidence of reproductive isolation. Bull trout distribution is limited to the lower 1.6 km (1.0 mi) of Rush Creek due to an impassable falls, and the expansion of bull trout range within other tributaries in the upper watershed is thought to be limited by unsuitable temperature regimes (Faler and Bair 1996). From 1994 through 1996, an estimate of 101, 246, and 282 adult bull trout, respectively, migrated into Rush and Pine creeks (GPNF 1995a; WDFW 1997). Unlike the Yale Reservoir subpopulation, bull trout in Swift Reservoir have a larger spawning area and connectivity between spawning grounds (Pine and Rush creeks), which may buffer this subpopulation against stochastic events. For example, after the 1980 eruption of Mount St. Helens when habitat throughout the Pine Creek drainage was severely altered (Faler and Bair 1996), migratory bull trout from Swift Reservoir subsequently recolonized Pine Creek. The status of the Swift Reservoir subpopulation is considered to be depressed with a stable trend (USDI 1999b).

Muddy River Watershed: The Muddy River watershed is a 5th field watershed located in the Lewis River sub-basin upstream of Swift Reservoir. While no bull trout have been captured or officially documented within the watershed, it is probable that a portion of the extant Swift Reservoir adfluvial subpopulation may utilize portions of the Muddy River watershed containing suitable habitat.

Middle Lewis Watershed: The Middle Lewis River Watershed (102,093 acres) is a 5th field watershed located in the Lewis River Basin. This 5th field watershed encompasses the Lewis River and its tributaries near the upstream end of Swift Reservoir near the Muddy River confluence northeast to Alec Creek. At this time, all of the sixth-field watersheds within the Middle Lewis River are included in the area for bull trout consultation analysis. A known bull trout population occurs in Rush Creek. These are adfluvial bull trout from the extant Swift Reservoir sub-population

Lower Lewis Watershed: The Lewis River is dammed at three locations forming three successive impoundments: Lake Merwin, Yale Lake, and Swift Reservoir (from downstream to upstream). None of these impoundment facilities currently provide fish passage. A portion of Yale Lake and all of Swift Reservoir occur within the lower Lewis 5th field watershed. This 5th field watershed encompasses immediate tributaries flowing directly from the north and south sides of Swift

Reservoir and north side of upper Yale Lake. At this time, only nine 6th-field watersheds within the lower Lewis River are included in the area for bull trout consultation.

Bull trout populations occur in both Pine and Cougar creeks. Bull trout occurring within Pine Creek come from the Swift Reservoir adfluvial sub-population. Bull trout occupying Cougar Creek are disconnected from the Pine Creek population due to lack of fish passage facilities at Swift Dam. The Cougar Creek population come from the adfluvial sub-population present in Yale Reservoir, predominantly from fish spilling over Swift Dam (pers. comm., John Weinheimer, WDFW; Spruell et al. 1998).

Spawning ground surveys conducted in the Yale Reservoir since 1988 indicate an annual escapement in Cougar Creek of 22 fish (range 7 to 37). The status of the Yale Reservoir subpopulation is considered to be depressed with an unknown trend (WDFW 1998). The Swift Reservoir subpopulation spawns in Pine and Rush creeks (WDFW 1997). Radiotelemetry studies conducted on bull trout in Swift Reservoir indicate that migrating adults use both Rush and Pine creeks with no evidence of reproductive isolation. Bull trout distribution is limited to the lower 1.6 km (1.0 mi) of Rush Creek due to impassable falls. Expansion of bull trout range within other tributaries in the upper watershed is thought to be limited by unsuitable temperature regimes (Faler and Bair 1996). An estimated 101, 246, and 282 adult bull trout migrated into Rush and Pine creeks from 1994 through 1996, respectively (USDA 1995; WDFW 1997). Unlike the Yale Reservoir subpopulation, bull trout in Swift Reservoir have a larger spawning area and connectivity between spawning grounds (Pine and Rush creeks). This connectivity may buffer the subpopulation against stochastic events. For example, migratory bull trout from Swift Reservoir subsequently recolonized Pine Creek after the 1980 eruption of Mount St. Helens severely altered habitat throughout the Pine Creek drainage (Faler and Bair 1996). Juvenile bull trout were captured on two occasions by electroshocking on an unnamed right bank tributary of Pine Creek in the exchange parcel (USDI 1999b). The status of the Swift Reservoir subpopulation is considered to be depressed but slowly rebuilding (WDFW 1998).

Mountain Whitefish

Mountain whitefish are distributed throughout the Lewis River watershed, occupying streams and lakes in the summer and wintering in large pools in winter. In terms of large woody debris (LWD), stream surveys indicate that about 90 percent of streams in the upper Lewis River are lacking for this habitat feature. About 52-69 percent of the same streams are rated as poor relative to the pools per mile indicator (GPNF 1995; GPNF 1995a). Both of these indicators are likely influenced by the absence of mature or old growth western red cedar, Douglas, fir, and western hemlock.

Westslope Cutthroat Trout, Redband Trout, and Pygmy Whitefish

These species are not known to naturally occur in the Lewis River watershed.

Coastal Cutthroat Trout

Specific data on the abundance and status of populations of coastal cutthroat trout in the Lewis River watershed are not available. The overall status of the Lewis River coastal cutthroat trout stocks are unknown, but likely to be depressed (WDFW 1999). Anadromous forms only exist below Merwin Dam on the North Fork Lewis River, and likely in the East Fork Lewis River. Above Merwin Dam resident, fluvial, and adfluvial populations exist. Westslope cutthroat trout have been introduced into the watershed, and WDFW historically released hatchery-origin anadromous cutthroat trout as smolts into the mainstem North Fork Lewis River (WDFW 1999).

Both anadromous and fluvial forms of coastal cutthroat trout in this watershed have been affected by the establishment and operation of hydropower projects. The most apparent impact of hydropower projects are their adverse effects on migratory fish. The three projects on the Lewis River (Swift, Merwin and Yale)do not have facilities designed for passing fish, either upstream or downstream. Without fish ladders or other mechanisms to pass fish upstream, migratory fluvial and anadromous coastal cutthroat trout are limited in their potential geographical range for pursuing foraging and spawning activities. Without downstream bypass systems, migratory fish are relegated to passing projects via spill or through power generating turbines. Once passing downstream of a project without upstream passage facilities, fish are excluded from returning to their natal streams. For example, the hydropower projects on the Lewis River have been identified as major habitat limiting factors (Washington State Conservation Commission 2000), and are likely to have destroyed a significant portion of cutthroat spawning areas (WDFW 1999), as well as blocking anadromous fish access to the upper watershed.

Hatchery releases of coastal cutthroat trout in the Lewis River occurred in 1997. These fish were likely from either the Beaver Creek hatchery stock or from native Cowlitz River stocks (WDFW 1997 *in* NMFS 1999). The existence or extent of genetic and ecological implications from these nonnative introductions are unknown.

Coastal Rainbow Trout

Specific information on the distribution and status of coastal rainbow trout (*Oncorhynchus mykiss irideus*) in Washington is scarce. As indicated previously in this document, this situation is exacerbated by numerous introductions of both native and nonnative stocks of rainbow trout in lakes and streams of the northwest and other factors. With consideration of these caveats, "rainbow trout" have been observed in the Lewis River watershed (USFS 1995). Specific information on distribution and abundance of rainbow trout is poorly documented, but they have been identified in West, Chinook, Boulder, Pin and Tillicum creeks (FWS and USFS internal files, 2000).

Anadromous Fish

The Lewis River drainage includes designated critical habitat that includes all historically accessible reaches of the Lewis River, upstream to the Merwin Dam for Lower Columbia River

steelhead and chinook salmon, and Columbia River chum salmon (FR 65 7764, February 16, 2000). Hatchery stocks of Lower Columbia River spring and fall chinook salmon are not listed (FR 64 14315, March 24, 1999), but are considered part of the Lower Columbia River ESU. All progeny of naturally-spawning hatchery chinook in the Lewis River drainage, however, are listed, even though the parental stock is not. The Lewis River is in the range of the Lower Columbia/Southwest Washington coho salmon ESU, which is a candidate species.

Anadromous fish historically occupied portions of the Lewis River and tributaries more than 60 miles upstream, to the slopes of Mount Adams. Nearly 80 percent of the historic anadromous fish habitat in the Lewis River drainage was eliminated by the construction of Merwin Dam at RM 20. The majority of spawning and rearing habitat for anadromous fish in the Lewis River drainage is now in Cedar Creek and its tributaries. The majority of lands owned by Plum Creek are upstream from Merwin Dam, however Plum Creek owns a few small parcels within several miles of the North Fork Lewis River, below Merwin Dam. The parcels below Merwin Dam include approximately 320 acres in the headwaters of Houghton Creek, 300 acres in Colvin Creek, and 150 acres in Husky Creek. Based on the distribution map in Wade (2000a), salmon are not known or presumed to occur in these watersheds, but steelhead are known to occur in the lower reaches of Houghton and Colvin creeks, several miles downstream from Plum Creek property. Plum Creek does not own lands in the Cedar Creek or East Fork Lewis River drainages.

Spring Chinook

Historically, spring chinook were the predominant salmon species in the Lewis River. Spring chinook salmon occurred well-above the Merwin Dam before it blocked upstream passage. Merwin Dam virtually eliminated the natural run of spring chinook in the Lewis drainage. Spring chinook presently occupy the mainstem Lewis River to Merwin Dam, and the mainstem of the Cedar River upstream to the town of Amboy. Nearly all of the spawning in Lewis River occurs in a 4-mile reach from Merwin Dam, downstream to the Lewis River hatchery. Hatchery programs for spring chinook were established in1959 to supplement the population. Spring Chinook salmon in the Lewis River are believed to be a composite of the Cowlitz River spring-run chinook salmon stock and other Lower Columbia and Willamette River stocks (Meyers et al. 1998). Natural spawning escapement from 1980-1991 has averaged 2,194, and ranged from 345 to 6,939 individuals. Only occasional stray spring chinook return to the East Fork Lewis.

Fall Chinook

Fall chinook spawn in the North Fork Lewis River in the 4 mile reach below Merwin Dam, which is about half of the area that was historically available prior to construction of the Merwin Dam. Fall chinook spawning in the East Fork Lewis River occurs in the area from Lucia Falls down to below Daybreak Park near RM 6.2. The Lewis River and East Fork Lewis River fall run chinook are the only stocks of chinook to be of native origin and predominantly natural production (Meyers et.al. 1988). Since the early 1900s, natural fall chinook populations have been stable or increasing in the Lewis River, without significant hatchery influence. The North Fork Lewis River

fall chinook represent about 80 percent to 85 percent of the wild fall chinook returning to the Lower Columbia River (WDF, 1990). Spawning escapements from the North Fork Lewis River from 1967-1991 averaged 12,976, and ranged from 4,199 to 22,977 individuals. Spawning escapements from the East Fork Lewis River from 1967-1991 averaged 598, and ranged from 157 to 2,354 individuals.

Summer Steelhead

Summer historically occurred throughout the Lewis River drainage, but construction of Merwin Dam blocked anadromous fish passage to approximately 80 percent of the useable spawning and rearing habitat within the North Fork Lewis watershed. Passage was also blocked by a mill dam on Cedar Creek until the dam was removed in 1946. Spawning now occurs throughout most of Cedar Creek and throughout most of the East Fork Lewis River drainage. Few steelhead were reported to have ascended Sunset Falls on the East Fork Lewis River before it was notched in 1982 to facilitate fish passage. Now approximately 12 percent of the observed spawning in the East Fork occurs in the headwaters above Sunset Falls and in the upper tributaries.

Summer steelhead stocks are considered by WDFW to be "depressed" due to chronically low escapements and loss of habitat above the dams. Summer steelhead in the East Fork Lewis River are primarily from nonnative hatchery origin, with some natural spawning. Historically, an average of approximately 90,000 summer-run steelhead smolts were released annually into the East Fork Lewis River system, although current stocking is around 40,000 smolts.
The wild stock of North Fork summer steelhead account for less than 7 percent of the total North Fork run size. Total escapement of summer steelhead to the Lewis River between 1925 and 1933 was estimated to be 4,000 fish, while the average run size 1963 to1967 was estimated to be 6,150.

Winter Steelhead

Wild steelhead production in the North Fork Lewis River has diminished from historic potential due to loss of habitat from the Merwin Dam. The majority of spawning and rearing habitat for winter steelhead in the Lewis River drainage is in the East Fork and tributaries. As partial mitigation for the lost spawning and rearing habitat from Merwin Dam, state hatcheries began planting winter steelhead smolts in 1954. The Lewis River winter steelhead stocks are now composed of both wild and hatchery stocks. Approximately half of the adult winter steelhead returns in the East Fork, and 6 percent in the North Fork Lewis River are wild fish. The winter-run steelhead stocks in both the East and North Lewis Rivers are identified as depressed by the WDFW.

Coho

Historically, the Lewis River system had abundant wild coho that occurred as far as 60 miles upstream. The Lewis River in 1949 was considered one of the most important coho producers in

the Columbia Basin. In 1951, WDFW estimated that 15,000 coho entered the Lewis River system to spawn, with 10,000 entering the North Fork and 5,000 the East Fork. Virtually all coho in the Lewis watershed are from hatchery production, but a few returning fish successfully use natural habitat. Cedar Creek is the most extensively used tributary in the North Fork Lewis River drainage; with coho traveling 15 miles into tributaries such as the North and South Forks of Chelatchie Creek. Coho in the North Fork Lewis are considered depressed based on a long-term decline in escapement. Coho occur it the East Fork Lewis River up to Lucia Falls (RM 21.3). The recent status of coho in the East Fork Lewis River drainage is unknown because of incomplete and inconsistent survey data, but is likely depressed.

Chum

Chum salmon spawn in the lower reaches of both the mainstem North Fork and East Fork Lewis River. Estimated escapement in 1951 was 3,000 adult spawners, and by 1973 numbers declined to a few hundred fish in both the Lewis and Kalama River drainages. Spawning was concentrated in side channels and upwelling areas in the lower 6 miles of the East Fork Lewis River. Chum salmon were observed in the North Fork Lewis River, downstream of Merwin Dam, in the 1950s, and a few adult chum are still observed each year, in recent years. About 45 juvenile chum were captured during seining operations in 1998, indicating that at least a small amount of natural production occurs in the North Fork Lewis River drainage.

Summary of Factors Affecting Fisheries in the Lewis River Sub-basin: Freshwater habitat within the Lewis River watershed has declined in quality due to 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 Mount St. Helens (WDFW 1999). Limiting factors (i.e., 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 (e.g., high erosion rates, 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 USFS (USFS 1996) confirm the WSCC limiting factors conclusions. In addressing key habitat attributes for salmonids, the USFS 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: 1) levels of LWD are reduced in quantity; 2) pool frequency is reduced; 3) stream temperatures are elevated; 4) aquatic habitat is fragmented, and 5) sediment levels are elevated.

The lower Lewis watershed bull trout subpopulation was determined in the USFS Plum Creek Land Exchange BA to be functioning at unacceptable risk because of population numbers, growth rates, survival rates, diversity, isolation, persistence, genetic integrity, temperature, LWD, refugia,

change in peak/base flows (Pine Creek only; rest of watershed is functioning only "at risk"), road density and location, inadequate riparian reserves, disturbance history, and disturbance regime.

The majority of spawning and rearing habitat for anadromous fish below Merwin Dam is in Cedar Creek and its tributaries. Major factors limiting habitat within Cedar Creek include elevated water temperatures, low summer flows, and spawning gravels cemented with fine sediments. Water releases from Merwin Dam are managed to support native fall chinook downstream of the dams, but the flows do not provide as well for the needs of other species of anadromous fish. Most of the lower 7 miles of the Lewis River is diked for flood protection, eliminating a large portion of potential juvenile rearing and overwintering habitat in the lower reaches of the river. Upstream from RM 7 to RM 15, many areas of the river have been rip-rapped, but a portion of the off-channel areas and wetlands are still functioning. Most of the riparian areas in the Lewis River drainage tributaries are in "fair" to "poor" condition due to past harvest, grazing and residential development that has generally left the stands in early seral stages or created stands dominated by deciduous trees. LWD abundance is "poor" in most areas within the drainage due to extensive logging within riparian areas, past efforts to clear the streams of LWD, and the lack of LWD recruitment from areas above the dams.

Numerous fish passage barriers are present in tributaries below Merwin Dam. A culvert under the Lewis River Highway blocks upstream fish passage in Johnson Creek, and a dam that is no longer in use completely blocks passage of all fish species in Colvin Creek. Plum Creek owns land in headwaters of both of these streams.

Spawning gravels in the North Fork Lewis River below Merwin reservoir are in good condition due to the effects of the dam trapping fine sediment. Fine sediments were noted in spawning gravels throughout many parts of Cedar Creek and its tributaries.

Water temperature in the mainstem of the North Fork is moderated by releases from Merwin dam and is generally cool. Cedar Creek experiences high water temperatures during the summer, and sometimes exceeds lethal temperatures for salmonids (73.4 to 77 °F). Various land use activities that contribute to temperature problems in Cedar Creek include agriculture and grazing, water withdrawals, surface runoff, and loss of riparian vegetation from residential development and timber harvest, and the construction of illegal dams and diversions on tributaries to Cedar Creek.

See Wade (2000a) for additional details.

Kalama River Sub-basin (Outlier)

The Kalama River drainage flows 44.5 miles, from Mount St. Helens to the Columbia River. Elevation ranges from 10 feet at the Columbia River to 8,000 feet on Mount St. Helens. The climate is maritime, with mild, cool, wet winters and dry, warm summers. Average annual precipitation ranges from 45 inches near Woodland to over 140 inches near Mount Adams, with snowfall dominating at higher elevations. The underlying geology is composed of volcanic

materials, and much of the landscape is influenced by Mount St. Helens' volcanic activity. Eruptions occur at intervals of 100 to 400 years, with the most recent major eruption occurring in. Mudflows from volcanic eruptions traveled down many of the Kalama basin's drainages, leaving deposits that are easily eroded. The potential for mass wasting is extremely high in the upper portions of the Kalama River and some of its tributaries, where volcanic deposits and steep slopes are typical. Most of the drainage is forested, and approximately 96 percent is owned and managed by private timber companies. Road density averages 5.75 miles/square mile. The uppermost portion of the drainage is Federal land administered by the Gifford Pinchot National Forest and Mount St. Helens National Volcanic Monument. The only urban area in the Kalama drainage is the town of Kalama near the mouth of the river.

The gradient of the Kalama River along the lower 8 miles is flat to moderate. Tidal influences extend upstream approximately 3 miles, and creates a shallow bar at the mouth of the river that inhibits fish passage at low tide. At RM 10, there is a concrete barrier dam and fish ladder at the Kalama Falls that traps most returning fish and only steelhead and excess spring chinook are passed above the lower falls by the WDFW. At RM 35 an impassable falls blocks all anadromous passage. Many of the tributaries to the Kalama have steep gradients, with only the lower portions of the streams accessible to anadromous fish.

The Kalama drainage is designated critical habitat for Lower Columbia River steelhead, Lower Columbia River chinook salmon, and Columbia River chum salmon. The drainage also supports the Lower Columbia River/Southwest Washington coho salmon ESU that is not listed.

Bull Trout

In the late summer of 1998 a bull trout was caught by a WDFW employee, experienced in fish identification, doing hook and line fish surveys from the Kalama Springs downstream. It was caught within one mile of Kalama Springs, above the dam and was about 14 inches long. There are no known fish migration barriers upstream of Kalama Falls. Suitable temperatures for bull trout exist in the north and east forks of Fossil Creek due to the influence of springs. Other instream habitat factors and riparian conditions are generally poor. However, given the potential of suitable habitat conditions, the inadequacy of existing surveys (WDFW 1998; Lucas 1999), the sighting and size of the bull trout caught in 1998, the FWS considers resident and fluvial bull trout are to be present upstream of Kalama Falls.

Coastal Cutthroat Trout

Coastal cutthroat trout are found throughout the Kalama River basin, including Elk, Wolf, Summers, Langdon, Owl, and Schoolhouse creeks, and in the mainstem Kalama River (WDFW 1999). Past logging practices have severely affected riparian cover, pool habitat, water temperatures, sedimentation, and flow regimes (WDFW 1999). Erosion rates in the basin have been high since the 1980 eruption of Mount St. Helens. Road construction in the basin has also affected erosion rates. Six of eight sub-watersheds show peak flow increases of more than ten

percent, while five sub-watersheds have greater than a 40 percent increase in the channel network due to roads and ditches. Stream surveys indicate that about 40 percent of streams are rated as poor for LWD, with 61 percent rated as poor for pools per mile of stream (GPNF 1996a). Significant culvert passage problems and disconnection of the mainstem river from the floodplain have also been identified as habitat limiting factors (Washington State Conservation Commission 2000). Introduced exotic fish include brown and brook trout (GPNF 1996a). The WDFW (1999) has classified the Kalama River coastal cutthroat trout stock as depressed.

Coastal Rainbow Trout

Rainbow trout are found throughout the Kalama River basin, but records of stocking are incomplete and it is not know what proportion of the populations are naturally occurring (GPNF 1996a). Many of the factors that affect coastal cutthroat trout are likely to similarly affect coastal rainbow trout.

Mountain Whitefish

Although specific information is lacking, it is likely that mountain whitefish occur within the Kalama River basin.

Westslope Cutthroat Trout, Redband Trout, and Pygmy Whitefish

These species are not known to naturally occur in the Kalama River watershed.

Anadromous fish

The Kalama River drainage is designated critical habitat for Lower Columbia River steelhead and chinook salmon, and Columbia River chum salmon (FR 65 7764, February 16, 2000). Hatchery stocks of Lower Columbia River spring and fall chinook salmon are not listed (FR 64 14315, March 24, 1999), but are considered part of the Lower Columbia River ESU. All progeny of naturally-spawning hatchery chinook in the Kalama River drainage, however, are listed, even though the parental stock is not. The Kalama River is in the range of part of the Lower Columbia/Southwest Washington coho salmon ESU, which is a candidate species.

The 8 miles of the mainstem Kalama River downstream from Lower Kalama Falls provides the entire available spawning habitat for fall chinook and chum salmon in the Kalama drainage. Winter steelhead historically depended almost entirely on this same area, including tributaries, for spawning and rearing habitat. Industrial, residential, and hatchery development has reduced the abundance and quality of habitat below the falls. Winter steelhead are released above the lower falls, consequently, the most important spawning habitat for winter steelhead is now in the upper mainstem Kalama River from RM 10 to RM 35. Key spawning and rearing areas for summer steelhead are found in Gobar Creek, Wildhorse Creek, North Fork Kalama, Langdon Creek, and Lakeview Peak Creek. The tributaries below Lower Kalama Falls provide the most important

spawning and rearing habitat for coho salmon. Natural coho production within the basin is likely limited by the availability of off-channel rearing and over-wintering habitat which has been reduced through dikes, levees, and other developments in the flood plain.

Spring Chinook

Spring chinook are found in the mainstem Kalama River from the mouth to Kalama Falls. Spring chinook salmon are indigenous to the Kalama system, but are now believed to be a composite of the Cowlitz River spring-run chinook salmon stock and other Lower Columbia and Willamette River stocks (Meyers et al. 1998). The majority of adult returns are from hatchery releases. In years with excess hatchery fish, chinook are released upstream of the upper hatchery, allowing access all the way to the upper falls. Spring chinook escapement from 1980-1991 averaged 602, with a range of 0 to 2,892 adults. Spawning occurs between the lower Kalama Hatchery (RM 4.8) and the Kalama Falls Hatchery (RM 10). Based on the fish distribution map in Wade (2000a), spring chinook salmon are not known to occur in streams on Plum Creek property in the Kalama River basin, but Plum Creek owns properties in tributaries to the Kalama River that could potentially be used for rearing near the mouths, several miles downstream from Plum Creek lands.

Fall Chinook

Fall chinook in the Kalama River system were once in sufficient numbers to support a trapping and canning operation near the mouth. Natural production of fall chinook in the has declined from historic levels and has been replaced by hatchery supplementation dating back as far as 1895. Natural spawning escapements from 1967 to1991 averaged 6,448, and ranged from 1,259 to 24,549. The mainstem Kalama River between lower Kalama Falls and RM 2.4 provides the entire available spawning habitat for fall chinook in the Kalama drainage. The distribution of fall chinook salmon is limited to the lower 5 miles of the river, up to the lower Kalama Falls. Plum Creek owns a small tract of land less than two miles from the Lower Falls, while the remainder of their property is more than 10 miles upstream from areas where fall chinook occur.

Steelhead

Steelhead are the most widely distributed anadromous fish in the Kalama River drainage, and historically were distributed throughout the drainage up to Kalama Falls at RM 35. Steelhead occupy the mainstem Kalama River from the mouth to headwaters of the North Fork Kalama River and they are found in the larger tributaries such as Wildhorse, Gobar Arnold, and Jacks creeks. According to the distribution map from, Plum Creek lands in the North Fork Kalama River and Jacks Creek include headwater streams in the vicinity of areas presumed or known to be occupied by steelhead, and they are known to occur on Plum Creek property in portions of Arnold Creek. Summer steelhead are thought to be the only salmonids to regularly move upstream from the lower Kalama Falls (RM 10) before the construction of a fishway in 1936. Winter steelhead were believed to be confined below the lower falls in most years.

The Kalama River drainage is thought to have limited natural production potential for steelhead, because there are few tributaries where steelhead spawn, and the tributaries where spawning occurs are short and high gradient. The Kalama River drainage historically had moderate numbers of winter and summer steelhead, probably due to the limited production potential. Steelhead numbers observed prior to the 1950s are similar to numbers observed today, suggesting that steelhead numbers in the Kalama River have been relatively stable in recent decades. There has been a large hatchery influence on stock composition and population size of Kalama River steelhead for more than 50 years. Populations of Kalama River winter steelhead are generally meeting WDF escapement goals, while summer steelhead are not.

Coho

The distribution of coho salmon is limited to the lower 10 miles of the Kalama River, up to the Lower Kalama Falls. Coho salmon were historically confined to the area below Kalama Falls (RM 10) until a fish ladder was constructed in 1936. Upstream passage at the Kalama Falls is controlled by WDF, and under current direction, coho are not passed above the falls. Plum Creek owns a small tract of land less than two miles from the Lower Falls, while the remainder of their property is more than 10 miles upstream from areas where fall chinook occur. The Kalama River coho stock status is depressed due to chronically low production. Natural spawning is presumed to be low, and juvenile production is believed to be below stream potential. The NMFS estimated there may be only about 100 post-December spawning coho salmon in lower Columbia River tributaries in the entire state of Washington (Johnson et al. 1991), compared to 3,000 fish estimated in the Kalama River alone in 1951 (Wade 2000a).

Chum

The potential distribution of chum salmon is limited to the lower 10 miles of the river, up to the Lower Kalama Falls. There is about 8 miles of potential spawning habitat in the mainstem Kalama extending downstream from Lower Kalama Falls. Chum salmon numbers in the Lower Columbia River are extremely low, and information on chum salmon numbers in the Kalama is unavailable. Chum salmon returns were described as almost nonexistent. Plum Creek owns a small tract of land less than 2 miles from the Lower Falls, while the remainder of their property is more than 10 miles upstream from areas where chum salmon occur.

Factors Affecting Fish in the Kalama River Drainage: Commercial forestry is the dominant land use affecting fish habitat in the Kalama River drainage. From the 1960s through the early 1980s, almost the entire watershed, including the riparian zones, was logged, most of the instream LWD debris was removed, and an extensive system of roads was constructed. Logging around and through streams, the use of splash dams to transport logs, poor road construction, and impassable culverts reduced or eliminated anadromous fish from many streams. Timber harvest in the 1970s and early 1980s contributed to excessive peak flows and high sediment loads. As a result, fish habitat quality is generally poor. Excess deposition of fine sediment was a identified as a limiting factor from field surveys in most of Arnold, Wildhorse, Gobar, and Bear creeks, and the mainstem

Kalama. Coarse sediments have accumulated at the mouths of many tributaries and fine sediments have embedded spawning substrates in areas of the mainstem Kalama. A wide and shallow bar has grown at the mouth of the Kalama River, and created hazards from predation, elevated water temperature, and barriers to migration. Coarse sediments deposited at stream mouths obstruct fish passage and limit rearing habitat during low flows, while deposition of fine sediment in spawning gravels is associated with reduce survival of eggs.

There is a general lack of LWD throughout the Kalama Basin. From Jacks Creek (RM 24.6) to the upper falls (RM 35), there was a fair amount of LWD in the mainstem tied up in log jams, but it is not distributed throughout the basin. The potential for future recruitment of LWD is poor almost throughout the Kalama River basin due to past logging that has left over 88 percent of the riparian habitat in early seral stages of development. There will be minimal future potential for large wood recruitment in most of the Kalama Basin for at least the next 100 years.

The lower mainstem Kalama has good quality, deep pools and good pool to riffle ratios, while the quality and availability of pools vary in the tributaries. Substrate conditions in the mainstem Kalama below the lower falls are believed to contain patches of fair to good spawning gravels. Water quality in the lower 10 miles of the Kalama River is considered impaired (303(d) listed) due to elevated water temperature. Extensive industrial and residential development has occurred in the lower 2 miles of the Kalama, especially to the west of Interstate-5. Most of the lower river has been channelized and diked to facilitate development of the historic flood plain, resulting in the degradation or loss of rearing and over-wintering habitat for juvenile coho that are naturally in short supply.

Culverts, thermal barriers, small dams, and flow obstructions that potentially block anadromous habitat for steelhead, coho, or chinook were mapped by. Impassable culverts were noted in Wildhorse Creek, Bear Creek (tributary to Gobar Creek), Schoolhouse Creek, and Bybee Creek, and in two unnamed tributaries near the mouth of the Kalama River. There is a natural barrier at lower Kalama River Falls, an abandoned dam at lower Kalama Fish Hatchery, and large gravel deposits causing flows to become subsurface near the mouths of Langdon Creek, North Fork Kalama River, Jacks Creek and Wold Creek.

A large portion of the Kalama River drainage contains soils with high erosion potential and natural slope instability. February 1996 flooding triggered at least 39 new slides in the Kalama River basin. The drainage is slowly recovering from past logging impacts, and turbidity afer rainfalls is noticeably reduced from levels observed in the1970s. The recovery of riparian areas from past logging activities, coupled with improved road designs and practices is attributed by to improvements in sediment delivery to stream systems. However, chronic inputs of fine sediments to the river can be expected to continue due to high road densities in the drainage.

In summary, freshwater habitat within the Kalama River watershed has been negatively affected by many of the same human-induced factors as in the adjacent basins, including timber harvest,

road building, mining, agriculture, hatchery introductions, and rural development. See Wade (2000a) for additional details.

Cowlitz River Sub-basin (Outliers)

Bull Trout

Upper Cowlitz River Watershed: The upper Cowlitz River watershed is a 5th field watershed and is designated by the USFS as including lands located between the towns of Randle and Packwood, Washington with the lower boundary of this watershed near Davis Creek. Bull trout have not been located in the upper Cowlitz watershed analysis area according to the 1999 Gifford Pinchot National Forest Bull Trout consultation baseline, although this is currently under review due to a bull trout caught in the Cispus Watershed (refer to the discussion below). Suitable habitat may exist for bull trout based on stream temperatures and lack of survey information in Glacier and Jordon Creek in upper Johnson subwatershed and in wilderness streams. Any bull trout potentially located below Mayfield Dam would not be affected by such things as temperature and sediment due to the buffering of the dams on Mayfield and Riffe Lakes.

Cispus River Watershed: The Cispus River is a tributary to the Cowlitz River with its confluence at approximately 90 river miles. Bull trout have been located in the Cispus River Watershed in Yellow Jacket Creek, near the Cispus Learning Center, which is a tributary to the Cispus River. There is one positive sighting from July 1991, by a WDFW employee trained in fish identification. The bull trout caught was healthy looking and was about 6 to 8 inches long (pers. comm., Judy De La Vergne, FWS). The FWS considers bull trout present in the upper Cowlitz/Cispus watershed.

Middle Cowlitz Watershed: This watershed is a 5th field watershed that encompasses 84,432 acres near the town of Randle, Washington. The middle Cowlitz watershed extends west from Cunningham Creek to the town of Randle and southwest to the Cispus River. The northern portion of the Cowlitz River watershed originates from the southern slopes of Mount Rainier in the National Park and the southern portion of the watershed flows from the western slopes of Johnson Peak at 7,487 feet in elevation in the Goat Rocks Wilderness.

Bull trout have not been documented in the middle Cowlitz River sub-basin According to the USFS and Plum Creek Timber Company Land Exchange BA and the Gifford Pinchot National Forest consultation baseline, the middle Cowlitz watershed does not provide suitable bull trout habitat based on 10 years of stream surveys. The absence of bull trout is thought to be due to unsuitable stream temperatures throughout the watershed. Brook trout do exist in Silver Creek.

Toutle River Sub-basin: The Toutle River is a relatively small watershed that occupies the lower Cowlitz River sub-basin. The 1997 USFS Toutle River watershed analysis describes the upper Toutle watershed being 109,557 acres with 73,302 aces of National Forest and 36,255 acres of privately owned lands. There are nine subwatersheds within the upper Toutle watershed that drain

the northern slopes of Mount St. Helens and the lands to the west. These subwatersheds include: Green River, Falls, Miners, Tadedollar, Coldwater, Grizzly, Castle, Studebaker, and Coldspring creeks, the upper Toutle River, and smaller unnamed tributaries.

No bull trout have been located within the Toutle River system. Pre and post eruption information taken from creel census, anecdotal information, electro-shocking, angling from 1936 to 1941, continuous fish trap data, USFS, and WDFW, has not produced any evidence that bull trout reside in the Toutle watershed.

Coastal Cutthroat Trout

The Cowlitz River ecosystem has been degraded by hydroelectric development, road building, timber harvesting, agriculture and rural development. The construction of Mayfield and Mossyrock dams in the 1960s eliminated natural anadromous fish access (WDFW 1999), although recently attempts to truck portions of anadromous runs around dams that are not equipped with ladders have been implemented. This 40-year exclusion of the anadromous form of coastal cutthroat trout from the North Riffe Lake River sub-basin means that only fluvial and/or resident populations are currently evident, and WDFW (1999) classifies the Cowlitz stock complex of coastal cutthroat trout as depressed.

Resident and fluvial populations of coastal cutthroat trout have been identified throughout the Cowlitz River watershed above Mayfield and Mossyrock dams (WDFW 1999), including the Cispus River and it's tributaries (Gifford Pinchot National Forest 1996), and the upper Cowlitz River (WDFW 1999; Gifford Pinchot National Forest 1998) . The presence of introduced exotics (e.g., westslope cutthroat trout, brook trout, rainbow trout of unknown origin; Gifford Pinchot National Forest 1996) is another problematic factor affecting these populations.

Resident and fluvial populations of coastal cutthroat trout have been identified in various streams and lakes throughout the Toutle River watershed, including Blue, Silver, and Coldwater lakes, Castle, Coldspring, Coldwater, Elk, and Falls streams, the mainstem, North, and South Forks of the Toutle River, and the Green River (GPNF 1997; WDFW 1999). The WDFW (1999) classifies the Toutle coastal cutthroat trout stock as depressed based on chronically low escapement.

Coastal Rainbow Trout

Because of nonnative stocking, isolation of steelhead above dams, and other factors as discussed above, details on the overall presence and status of coastal rainbow trout in this sub-basin are lacking. "Rainbow" trout have been observed in the Cowlitz River watershed in Smith, Jordan, Carlton, and Summit creeks, Clear Fork, and in the Ohanapecosh River (FWS and USFS internal files, 2000; Gifford Pinchot National Forest 1998). Steelhead historically inhabited the lower Cispus River (tributary to the Cowlitz River) watershed (Bryant 1949 *in* Gifford Pinchot National Forest 1996). "Rainbow" trout were once stocked in the basin, and some remnant populations (of unknown origin) remain. Other exotics such as brook trout and westslope cutthroat trout have

also been stocked in this watershed (Gifford Pinchot National Forest 1996). "Rainbow" trout have been observed in the Toutle River watershed in Coldwater, Lower Venus, and Spirit lakes, and in Castle, Coldspring, Coldwater, Disappointment, Elk, Green, Maratta, and Miner's creeks, among others, and the North Fork of the Toutle River (GPNF 1997). The status of coastal rainbow trout populations in the Toutle River watershed is unknown.

Mountain Whitefish

Broad based surveys (e.g., watershed analyses; Gifford Pinchot National Forest 1996) often do not sample for other than salmon and trout species, and do not distinguish between native and planted stocks. Consequently, little is known about mountain whitefish status and distribution in this watershed, except that they are known to occur (BPA 1993 *in* Gifford Pinchot National Forest 1996). Although specific information is lacking, it is likely that mountain whitefish occur within the Cowlitz River sub-basin.

Westslope Cutthroat Trout, Redband Trout, and Pygmy Whitefish

These species are not known to naturally occur in the Cowlitz River sub-basin.

Anadromous Fish [summarized from Wade (2000b), except where noted by citations]

The Cowlitz River drainage includes designated critical habitat that includes all historically accessible reaches, upstream to the Mayfield Dam for Columbia River chum salmon (FR 65 7764, February 16, 2000). Natural passage of adult salmon and steelhead is blocked by the Mayfield Dam. Critical habitat for Lower Columbia River steelhead and chinook salmon include areas above Mayfield Dam because listed chinook and steelhead are trapped and moved above the dam (FR 65 7764, February 16, 2000). Hatchery stocks of Lower Columbia River spring and fall chinook salmon are not listed (FR 64 14315, March 24, 1999), but are considered part of the Lower Columbia River ESU. All progeny of naturally-spawning hatchery chinook in the Cowlitz River drainage, however, are listed, even though the parental stock is not. The Cowlitz River is in the range of the Lower Columbia/Southwest Washington coho salmon ESU, which is a candidate species.

The Cowlitz River supports winter and summer steelhead, coastal cutthroat, fall and spring chinook, coho, and chum salmon. The Cowlitz River may be the most intensively-fished sub-basin by the sport-fishery in the state. It has been the top winter steelhead river in Washington, and is also popular for summer steelhead, for spring and fall chinook, and coho. The loss of anadromous fish habitat above the Mayfield Dam is partially mitigated by trucking anadromous fish around the dams. From 1974 to 1980, spring chinook, coho, and steelhead adults were trucked above the Mayfield Dam to the Tilton River, and above Mossyrock to the Cowlitz River, to provide sport fishing opportunities. This practice was suspended from 1981 to 1991 due to detection of a virus in winter steelhead, and resumed in 1994. The current practice is to trap and haul native winter steelhead, coho, and coastal cutthroat to the Mayfield/Tilton, Upper Cowlitz, and Cispus sub-

basin. Out-migrating juveniles from above the Cowlitz Falls Dam are collected at the Cowlitz Falls Fish Facility and are trucked below Barrier Dam. Out-migrants from the Tilton and Mayfield sub-basin are passed downstream in a flume.

Plum Creek owns 15,216 acres of lands in the Tilton River drainage and other smaller tributaries that drain into Riffe Lake; and there are less than 200 acres in the headwaters of the South Fork Toutle River. The Tilton River historically was a minor producer of spring chinook salmon (around 2 percent of the Cowlitz population), and Steelhead are trucked to portions of the Tilton River for release.

The Toutle River was one of the most popular steelhead fishing streams in the state of Washington before the 1980 eruption of Mount St. Helens. The eruption dramatically reduced fish populations in portions of the Toutle River drainage. In good return years, the Cowlitz attracts immense angler effort for spring chinook. Both the Cowlitz and Toutle attracted considerable angler effort for fall chinook and coho (WDW 1990). Plum Creek owns less than 200 acres in the headwaters of the South Fork Toutle River in the Bear Creek and Trouble Creek drainages.

Spring Chinook

Historically, spring chinook were abundant in the Cowlitz River drainage, and nearly all of the spring chinook spawning occurred in the Cowlitz and Cispus Rivers, above the present-day Mayfield Dam. In 1948, an estimated 32,490 adult spring chinook were produced annually in the upper Cowlitz River, with an estimated spawning escapement of 9,000 fish above the dam site. In the early 1950s (before construction of the Mayfield Dam), the estimated annual spawning escapement had dropped to 10,900 spring chinook, with a distribution estimated to be 400 fish in the upper Toutle River, 200 fish in the Tilton River, 8,100 in the Cispus River, and 1,700 in the upper Cowlitz. Spring chinook were not found in the Tilton after about 1950.

Spring chinook in the Cowlitz River are a hatchery stock of mixed origin, and very few individuals are produced from natural spawning. Most of the natural spawning on the Cowlitz River occurs in an 8-mile reach between the Cowlitz Salmon and Trout hatcheries. The Cowlitz Salmon Hatchery mitigation goal is to return 17,300 spring chinook adults to the hatchery each year. Between 1983 and 1992, the average annual escapement to the hatchery and Cowlitz River was 11,573, and has ranged from 6,417 to 18,302 individuals. Current stocking practices include trucking adults above the Cowlitz Falls Dam, and collecting juveniles at Cowlitz Falls Fish Collection Facility that are trucked to areas below Barrier Dam. Cowlitz River spring chinook is considered depressed due to low escapements that from 1980 to1991 averaged 389 fish, ranging from 90 to 1,116.

In the early 1950s, annual spawning escapement was estimated to be 400 fish in the upper Toutle River. The estimated return in 1990 was 164 fish. The Toutle Hatchery produced spring chinook from 1967 until 1980, when it was destroyed by the Mount St. Helens mudflows. Most Toutle spring chinook were reared in Deer Springs Pond, which was destroyed in the winter of 1981 to 1982 when a temporary flood-control dam was breached. The primary management objective for

the Toutle River is to produce 500 fish for sport harvest, requiring a return of 1,697 fish and a total production of 2,976 fish.

Fall Chinook

Historically, fall chinook spawning occurred in all the major tributaries to the Cowlitz, several of the smaller tributaries, as well as the main river. The Cowlitz River fall chinook natural spawners are a mixed stock of composite production that is dominated by hatchery-produced fish. In 1987, naturally-spawning fish comprised just over ten percent of adult returns. Fall chinook are considered depressed by WDFW due to a decline in natural spawning escapements that averaged 6,778 between 1967 to1991, and dropped to 2,600 fish between 1992 and 2000. In 1948, the WDF and WDG estimated that the upper Cowlitz River produced 63,612 adult fall chinook annually. Roughly half of the fall chinook run from1950 to 1961 originated above Mayfield Dam, and more than one quarter of the spawning grounds are now inundated by Mayfield and Mossyrock reservoirs. Most of the spawning today takes place between the Kelso Bridge and the Cowlitz Salmon Hatchery (more than 15 miles downstream from Mayfield Dam). Fall chinook have been passed upstream in varying numbers, but since 1980, only a small number of jacks have been passed upstream due to the inability to achieve hatchery spawning needs. Between 1983 and 1992, the average annual escapement to the hatchery and Cowlitz River was 11,666 and ranged from 3,778 to 20,071 individuals. Natural spawning escapements from 1967 to1991 averaged 6,778, and ranged from 2,450 to 23,345 (SASSI 93).

The estimated annual escapement of fall chinook in the Toutle River and its tributaries in the early 1950s was 6,500. An estimated 80 percent of the total Toutle River fall chinook run spawned in the lower five miles of the mainstem Toutle (WDF 1951). Spawning areas in the mainstem Toutle, North Fork, and Green rivers were destroyed by the 1980 eruption of Mount St. Helens. South Fork Toutle River fall chinook currently spawn in the mainstem from river mile 2.6 to the mouth. Fall chinook natural spawners are an unknown stock of composite production. Fall chinook are considered depressed and show signs of a long-term negative trend. Natural spawning escapements from 1967 to 1979 averaged 257 and ranged from 42 to 578. Post eruption escapements in 1980 and 1981 were zero and 81 fish, respectively. Spawning ground counts were suspended until 1991, when the escapement was 33 fish (WDF et al. 1993).

Coho

Cowlitz River coho are a mixed stock of composite production, and most coho in the Cowlitz River basin are of hatchery origin. Of the 4,635 naturally-spawning coho in the Cowlitz in 1985, an estimated 91 percent were hatchery smolt releases, and hatchery fingerling releases could account for the remaining naturally-spawning fish. Most of the natural spawning takes place in Olequa Creek, with smaller numbers in about a dozen larger tributaries to the Cowlitz River below Mayfield Dam. About a third of the coho were estimated to have come from above Mayfield Dam in 1948, increasing to 77 percent around the time that Mayfield Dam was constructed. Coho experienced a rapid population decline from 1948 to the early 1950s, dropping

by more than 50 percent. Between 1983 and 1992, the average annual escapement to the hatchery and Cowlitz River was 28,572, and has ranged from 13,009 fish in 1990 to 54,685 fish. Current coho stocks are considered depressed. Coho are managed to provide a sport fishery. Current stocking practices include trucking adults to the Tilton River, and collecting juveniles at the Cowlitz Falls Fish Collection Facility and trucking them to areas below Barrier Dam.

Coho were historically abundant in the Toutle River drainage, and were present throughout the watershed. Historically, they spawned in all accessible tributaries, including the South Fork Toutle River and its tributaries. Some of the South Fork Toutle River spawning areas were destroyed by the1980 eruption of Mount St. Helens. Naturally spawning coho in the Toutle River drainage are of unknown stock of composite production, but currently spawn in all accessible tributaries. Naturally spawning escapement estimates are not available. Current coho stocks are considered depressed and show signs of a long-term negative trend. A number of tributaries to the South Fork Toutle River have good production potential such as Johnson, Studebaker, Disappointment, and Herrington creeks.

Steelhead

Approximately 80 percent of the historic winter steelhead spawning and rearing areas were in the mainstem Cowlitz and in the Tilton and Ohanapecosh rivers, which are no longer accessible. Prior to 1981, an annual average of 3,466 steelhead were trucked into the Tilton River to provide a sport fishery, and a few fish spawned naturally in the river. The sport catch was only 6 percent of the transported adults, and the remaining fish moved out of the Tilton River. Transport of adult steelhead to the Tilton River was resumed in 1996, and continues today. The steelhead population in the Cowlitz River is managed to produce a similar number of adult returns that were observed in the early 1960s, which averaged around 11,000 fish at the Mayfield fish collection facility. As part of the WDFW/Tacoma City Light mitigation agreement, WDFW is managing for 750,000 smolts, which are to provide a return of 22,000 adults and a sports catch of 15,400 fish. Naturally-spawning winter steelhead are a mixed stock of wild production, with hatchery spawners averaging approximately 92 percent. Most of the natural spawning takes place in Olequa, Ostrander, Salmon, Arkansas, Delameter, and Monahan creeks, which are unaffected by activities on Plum Creek land. In 1990, it was estimated that naturally-spawning steelhead below Barrier Dam were less than two percent of the total run. The stock is considered depressed based on chronically low returns.

Historical production estimates are unavailable for winter steelhead in the Toutle River drainage.. Currently, most winter steelhead spawning occurs in the mainstem Toutle River. The South Fork Toutle winter steelhead are a mixed of wild production. Current winter steelhead stocks are considered healthy, based on escapement goals. Estimated spawning escapements from1984 through 1992 averaged 1,381, and ranged from 752 to 2,222. The escapement goal of 1,058 was exceeded 6 of the 9 years. The mean escapement from 1991 to 1996 was estimated to be 893 fish. An estimated 17 percent of the run during these years were hatchery fish. A total of 30,000

summer steelhead smolts have been annually stocked into the South Fork Toutle River for sport fishing.

Chum Salmon

Chum salmon are found in extremely low numbers and little data is available on their historical abundance and life history in the Cowlitz River drainage. The Cowlitz River had a total estimated escapement of 1,000 chum in the early 1950s. A run of adult chum was observed 15 miles upstream from the Mayfield dam site prior to any impoundments on the Cowlitz. Between 1961 and 1966, the Mayfield fish-passage facility only reported collecting two adult chum. Twelve chum were collected and transported over Mayfield Dam from September 16 through December 22, 1961. Probable spawning areas were identified in 1951 in the following tributaries; Coweeman and Toutle Rivers, Ostrander, Arkansas, Salmon, Olequa, and Lacamas creeks. Chum were reported in 1973 to be present in Monahan, Delameter, Baxter, and North Fork Arkansas creeks, and the North and South Forks of the Toutle River. Recent WDFW observations report chum salmon in the headwaters of Lacamas Creek Detailed records describing the number of chum captured each year have not been kept, but typically, less than ten adults are collected in an average year at the Cowlitz Salmon Hatchery.

Chum salmon were reported to be present in the South Fork Toutle River in 1973. See the discussion above for chum salmon in the Cowlitz River.

Summary of Factors Affecting Fisheries in the Cowlitz River Watershed: Freshwater habitat within the Cowlitz River watershed in general, including the North Riffe Lake River sub-basin, has been negatively affected by many of the same human-induced factors as in the Lewis River sub-basin, including hydropower, timber harvest, road building, mining, agriculture, hatchery introductions, and rural development (WDFW 1999;Gifford Pinchot National Forest 1996), as well as natural factors such as the deposition of ash and pumice from periodic eruption of Mount St. Helens (Gifford Pinchot National Forest 1996).

The largest factor affecting anadromous fish in the Cowlitz River drainage is the loss of access to historic spawning habitat that existed above Mayfield Dam. Mayfield, Mossyrock, and Cowlitz Falls dams form complete barriers to natural upstream migration and inhibit downstream migration. Over 300 miles of formerly productive habitat is either inaccessible or inundated by the reservoirs. The loss of fish passage is partially offset by trucking adults upstream and from juvenile releases. In addition to effects of the dams, fish habitat is impaired from agriculture, forestry, and other land uses. Limiting factors include low LWD abundance, poor riparian conditions, high water temperatures in portions of the drainage, low flows, increased peak flows, loss of historic off-channel and floodplain habitat from diking and hardening the channels. Drastic losses of fish production from the lower Cowlitz, downstream of the Toutle River, are attributed to changes to the river channel as a result of dredging, diking, and straightening

Freshwater habitat within the Toutle River watershed has been negatively affected by the 1980 eruption of Mount St. Helens, urbanization, recreational activities, timber harvest, and elevated road densities in two sub-basins. The result of these, and possibly other factors, is that LWD levels are low in about 15 percent of Toutle River watershed streams, pool frequency is low in about 20 percent of streams, elevated peak stream flows exist in many sub-basins, riparian habitat is in early successional stages, and aquatic habitat is fragmented due to road and culvert-related effects (GPNF 1997; WDFW 1999). The presence of introduced exotics (e.g., brook trout, rainbow trout of unknown origin, brown trout; GPNF 1997) is another problematic factor affecting native fish.

There are no significant barriers to fish migration in the South Fork Toutle River, and tributaries are generally accessible to anadromous fish. The largest factors affecting fish habitat in the Toutle River is the deposition of materials from the eruption of Mount St. Helens in 1980, and high road densities. From the volcanic eruption in 1980, mudflows and tephra deposits filled many of the river valleys and flood capacity was significantly reduced. Within 1 year after the eruption of Mount St. Helens, over 20 million cubic yards of sediment had been dredged from the river and placed mainly within the floodplain and adjacent wetlands. The lower Toutle River now meanders through a wide shallow valley with an aggraded channel and dredge spoils essentially forming dikes along its banks. A number of habitat constraints that limit production of anadromous fish include limited floodplain, off-channel, and pool habitat, high width-to-depth ratios and poor riparian conditions that contribute to elevated stream temperatures, lack of instream cover and LWD, and unstable substrate conditions. Hydrologic immaturity and high road densities contribute to increased peak flows and channel instability. High road densities and numerous stream adjacent roads also contribute excessive amounts of fine sediment to stream channels.

Pygmy Whitefish in the State of Washington

In eastern Washington, pygmy whitefish are present in Diamond Lake near Spokane and Lake Roosevelt, as well as nine other lakes, most of which are near Cle Elum, Chelan, and the northern Idaho border (Hallock and Mongillo 1998). These areas are also outside the action area for this biological opinion.

The State of Washington is currently reviewing the status of the pygmy whitefish to determine whether it should be moved from a species of concern to a sensitive species, a classification reflecting greater vulnerability to threats to its survival. 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 232-12-297, Section 2.6).

Summary of Factors: Like other native salmonid covered species addressed in this Opinion, pygmy whitefish prefer cool, clean water for spawning and rearing, and clean gravels for spawning, in both lakes and streams. Therefore, the factors discussed above that have contributed

to declines of the other covered species may also affect pygmy whitefish populations. In summary, little is known about the abundance and ecology of pygmy whitefish, and more work is need to determine distribution parameters more precisely. However, as stated above, the known distribution of this species is extremely limited within the action area. Pygmy whitefish have no Federal status. It is uncertain whether isolation of the species makes its persistence in the action area at risk.

Appendix B

Overview of the Effects of Forest, Road, and Range Management on Fish Habitat

Land management activities can alter processes that create and maintain riparian and aquatic habitats, often resulting in reductions of habitat complexity and the diversity of aquatic species (Elmore and Beschta 1987; USDA et al. 1993; USDA and USDI 1994). Forest management activities such as road building and timber harvest (felling, yarding, skidding, landing, and silviculture) has been suggested as the single greatest threat to watersheds and aquatic species (Anderson 1988 citing a report of the Montana State Water Quality Bureau). Forestry practices in riparian areas have been identified as a high risk factor in all bull trout restoration/conservation areas in Montana (MBTSG 1998). In watersheds containing bull trout, changes in habitat features associated with reductions in habitat complexity include decreases in large woody debris, pool quality, channel stability, substrate quality, groundwater inflows, and suitable habitat to serve as corridors between habitat patches (MBTSG 1998).

Bull trout populations have been negatively impacted by past and current forest-management practices, and most populations continue to experience the negative effects from these land-use practices and related activities. The results of over a century of logging in bull trout habitat include the obvious effects, such as of clear cuts and poorly situated roads, and the more latent effects, such as an increase in landslide potential in highly impacted watersheds. The latter is illustrated by the approximately 2,300 land slides that occurred on national forest lands in the Clearwater and Spokane river sub-basins during high runoff events in 1995 and 1996, and that were correlated with high logging road density (L. McLaud, Idaho Conservation League, *in litt.* 1997; R. Patten, Panhandle National Forest, *in litt.* 1997). The same runoff events also triggered an estimated 2,000 land slides on adjacent non-Federal timber lands in the Clearwater River basin (McLaud, Idaho Conservation League, *in litt.* 1997). In general, streams in the most degraded category generally do not support bull trout populations because of stream morphology changes, increased cobble embeddedness, and high summer temperatures–all of which result in part from the effects of past and present forest practices.

Bull trout spawning and rearing is correlated with streams not subject to past timber harvest (Brown 1992). Timber harvest activities were responsible in the decline and isolation of bull trout in Pataha Creek, Washington (WDFW 1997), a tributary in the Tucannon River drainage. In the North Fork Boise River sub-basin, Idaho, the majority of bull trout spawning and rearing habitat for the Arrowrock Reservoir subpopulation exists in the roadless headwaters of the Crooked, Bear, and North Fork Boise Rivers (USDA 1994).

The long-lasting effects of past timber management activities on aquatic habitats is illustrated by conditions in the 1,270 mi^2 South Fork of the Salmon River watershed, Idaho. This watershed was first logged in the 1940s and logging activity peaked in 1961 (Chapman et al. 1991).

Sedimentation in the South Fork of the Salmon River increased approximately 350 percent above pre-logging levels (Chapman et al. 1991), and resident and anadromous salmonids, including bull trout were virtually extirpated. Despite a 25-year logging moratorium in this watershed, fish habitat still has not returned to pre-logging quality, and salmon production has not recovered (Chapman et al. 1991).

A relationship between forest management, watershed conditions, aquatic habitat degradation, and loss of occupied bull trout range has also been documented in the Spokane River sub-basin, Idaho. Streambed aggradation and loss of pool habitat are attributed to forest management and associated roads in the sub-basin (G. Kappesser, Panhandle National Forest, *in litt.* 1993). The loss of pool habitat has been correlated to reductions in bull trout range and abundance in managed watersheds (Cross and Everest 1995).

The USFS has classified watersheds in the Bitterroot National Forest, Montana, into three categories: "healthy, sensitive, and high risk," based on sediment yield as a result of road construction and increased water yield and peak flow as a result of timber harvest (Decker 1991 *in* MBTSG 1995a). About one third of all watersheds were assigned to each of the three categories. Bull trout with estimable numbers were found only in watersheds rated as "healthy" or "sensitive" (Clancy 1993). The effects of past forest practices, including road construction, continue to affect Bitterroot tributaries (MBTSG 1995a). Generally, bull trout numbers were higher where stream substrates were larger, but numbers tended to be lower in areas high in fine sediments (Clancy 1993). In contrast, habitat where brook trout, an introduced, non-native species that competes and hybridizes with bull trout, were found were characteristic of areas degraded by land use activities (Rich 1996). Eighty-five percent of the drainages classified as "high risk" supported brook trout (Clancy 1993).

Extensive logging activity has impaired water quality in many tributaries of the Blackfoot River, Montana, including the North Fork of the Blackfoot River (MDHES 1994). Wide-spread canopy removal, alterations to riparian vegetation, and water irrigation returns have increased the historic temperature regimes of the Blackfoot River (MBTSG 1995b; Pierce et al. 1997). Water temperatures in the mainstem Blackfoot frequently exceeded the bull trout preferred range of 60 °F (15 °C) in 1994, 1995 and 1996, making coldwater refuges during this time a critical factor for bull trout (Pierce et al. 1997). The effects of forest practices was considered a limitation to bull trout restoration in the Blackfoot River drainage (MBTSG 1995b).

Timber management is the dominant land use in the Kootenai River watershed, Montana, where extensive road construction to support forestry activities exists throughout the watershed. Many reaches of streams in the Kootenai drainage have impaired water quality as a result of silviculture activities (MDHES 1994). Furthermore, as a result of salvage logging in 1996, the number of timber sales and clearcuts have substantially increased over the past 3 years (Kootenai National Forest 1997).

Past forest practices, including road construction, log skidding, riparian harvest, clearcutting, and splash dams, are considered a cause in the historic decline of bull trout in the Flathead Lake basin and have limited bull trout restoration opportunities in the area (MBTSG 1995c). This sub-basin supports over 30 bull trout subpopulations in wilderness areas, national parks, national forests, and private lands–an indication of the degree of habitat fragmentation. Because bull trout are sensitive to habitat and water quality degradation, Fraley and Shepard (1989) considered timber harvest and road construction in both the North and Middle Forks of the Flathead River drainages to be threats to bull trout spawning and rearing habitat. Although forest practices have improved, effects of past activities still affect bull trout since the existing road systems continue to erode, cause sedimentation, and increase water yield to streams. Silvicultural activities have contributed to 202 miles in 17 streams being classified as water quality impaired in the Flathead basin (MDHES 1994).

Forest management activities (other than timber harvest) can have effects on soil erosion and soil productivity that are much greater than natural conditions, and these can lead to increases in erosion and runoff (Elliot et al. 1999). Such activities include tree planting, site preparation, prescribed burning, timber harvest, stand maintenance, forest nurseries, and seed orchards, as well as associated activities, including logging road construction and maintenance and gravel quarrying for roads. Effects of timber harvest and road management on sediment delivery and other key habitat features important to native fish are described in more detail below.

The cutting and felling of trees by itself does not cause significant erosion, but the effect of removing large amounts of vegetation can lead to greater erosion rates so that the total erosion from timber harvest may approach that from roads (Elliot et al. 1999). Not all hillside surface erosion reaches stream channels, but conduits such as roads, ditches, and skid trails increase this probability, particularly if buffer strips are not left between treated areas and stream channels (Chamberlin et al. 1991). The potential for surface erosion is directly related to the amount of bare compacted soil exposed to rain and runoff, and timber harvesting tends to compact the soil (Chamberlin et al. 1991). Skidding logs to landing sites compacts and scarifies the soil. Skid trails are responsible for most of the erosion on timber harvest units because of the removal or disturbance of the surface humic layer (Elliot et al. 1999) and the reduced infiltration rates as a result of compaction of the forest soil (Everest et al. 1987).

Forest practices during site preparation, harvest, yarding, and other activities that utilize heavy equipment increase soil compaction which may increase splash erosion and channelized runoff (Spencer et al. 1996). The effects of compaction is especially important because of the long-term consequence (on the scale of decades and centuries) of the hydrologic characteristics of soils and the site productivity of second growth forests (Everest et al. 1987). Compaction can occur with a single pass of logging equipment across a site. Tractor logging creates relatively large areas of bare and compacted ground that interrupts subsurface channel networks formed by decomposed root systems. This results in reduced access and capacity of these subsurface channels causing soil slumps and increased surface erosion during forest management activities.

The role of the protective surface residue layer on the forest floor is critical in controlling erosion (Elliot et al. 1999). Loss or disturbance of this litter and duff layer through mechanical means can significantly increase erosion. Further, the decomposing root system reduces infiltration capacity resulting in increased runoff with the potential for increased sediment delivery to stream channels. In addition, compaction has been associated with reduced soil productivity; decreases in microbial populations; and reduced root growth, height and timber volume (Elliot et al. 1999).

Site preparation consists of clearing slash and competing vegetation and exposing adequate mineral soil for subsequent tree planting or natural regeneration. This is accomplished using one or more techniques, such as tractors or excavators, tree planting hoes, and broadcast burns (described below). The extent of site preparation has been reduced over the last few years in the forest industry because of specific environmental concerns, particularly the practices of broadcast burning and scarification of large areas.

As indicated above, use of some types of equipment for site preparation can increase compaction and cause erosion. Use of tractor piling and burning can cause extensive compaction, as opposed to broadcast burning with essentially no associated equipment use and compaction (Everest et al. 1987). Pile locations can increase the risk of hillslope erosion and mass wasting, especially on erodible soils. Burning of slash or broadcast burning may result in fire escaping into the forest, riparian zone, CMZ, or inner gorge with the chance that soil horizons may be damaged within the burn area. After fires have been contained, there remains a risk that smoldering wood persisting under snow can reignite the following season.

In conclusion, forest practices that adversely affect native fish and their habitat are primarily timber extraction and road construction, especially where these activities affect riparian areas. These activities, when conducted without adequate protective measures, alter native fish habitat by increasing sedimentation, reducing habitat complexity, increasing water temperature, and promoting channel instability. Although certain forest practices have been prohibited or altered in recent years to improve protection of aquatic habitats, the consequences of past activities continue to affect native fish and their habitat. For example, within the Columbia River population segment of the bull trout, approximately 74 percent of bull trout subpopulations are threatened by forest practices. However, the NFHCP is intended to change past forest practices by providing a new set of forest management actions designed to reduce or eliminate adverse effects to the structure and function of the riparian zone and aquatic habitat.

Livestock grazing in riparian areas is a controversial issue because the effects of grazing on fish populations is not well understood (Platts 1991; Mosley et al. 1997; Rinne 1999). Although extensive information exists on the direct effects of grazing on certain components of fish habitat and stream condition, the effects of grazing (i.e. of grazing induced habitat alterations) on the fish themselves is less easily demonstrated (Rinne 1999). Also, less information is available on the relationship between grazing and fish populations in forested environments compared to open rangeland environments.

Riparian areas are often grazed more heavily than upland areas because the terrain is flatter and water, shade, and more succulent vegetation is available (Platts 1991). There appears, however, to be wide consensus that livestock grazing has adversely affected riparian areas throughout the western United States (Platts 1979, 1991). In the Pacific Northwest, grazing within aquatic ecosystems has amplified and/or initiated instability within stream corridors, and overgrazing has led to reductions in soil structure, soil compaction, and damage and loss of vegetative cover (Quigley and Arbelbide 1997).

In general, grazed watersheds compared to ungrazed watersheds exhibit higher sediment levels, unstable streambanks, higher summertime water temperatures, fewer undercut banks, decreased vegetative cover, modified channel morphology, and sometimes an increase in harmful bacteria generated from livestock waste (Quigley and Arbelbide 1997). Species composition of stream-side vegetation can be altered by livestock grazing, as can vegetation productivity and associated fire regimes (Quigley and Arbelbide 1997). These changes to naturally-occurring stream system processes and associated riparian structure and functions have been implicated in the decline of salmonid abundance (Platts 1991). However, the effects of grazing on salmonid populations is directly related to how grazing is managed, in that well-managed grazing can be compatible with healthy, functioning riparian ecosystems (Mosley et al. 1997; Ehrhart and Hansen 1997; Ehrhart and Hansen 1998).

In summary, numerous studies have shown that improper livestock grazing can damage streams and degrade fish habitat (see review by Platts 1991). Streambank trampling by livestock, by itself, or in concert with a reduction in riparian vegetation can lead to channel widening, channel downcutting (or aggregation), and decreased streambank stability. When streams are downcut and local water tables are lowered, riparian vegetation can be further reduced or eliminated. Channel widening can cause increased levels of fine sediment on stream bottoms, and increased stream temperatures (Meehan and Platts 1978).

Stream Temperature

In general, salmonids, behaviorally and physiologically, have adapted to the very complex temperature situations found in natural stream systems. Fish can seek out localized cold-water sources such as deep stratified pools and areas with upwelling groundwater (Bilby 1984) or they can become inactive (Beschta et al. 1987). Growth and activity of fish increase with temperature up to some optimum and then decrease as the optimum is exceeded, provided food supply is not limiting. As temperature drops, fish may move long distances to find suitable winter habitat.

It is well established that water temperature is a critical habitat characteristic for bull trout. Water temperature can affect production, limit bull trout distribution and exacerbate habitat fragmentation (Rieman and McIntyre 1993; Fraley and Sheppard 1989). Bull trout are found primarily in colder streams and prefer colder water temperatures than other salmonids (McMahon et al. 1998; McCullough 1999; Rieman and Chandler 1999). Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed.

Goetz (1989) surmised that optimum water temperatures for rearing juvenile bull trout is about 44-46 °F. Juvenile bull trout were found to select the coldest water available in a plunge pool (63 FR 31647) and in the North Fork of the Malheur River, Oregon adult bull trout were found at the mouths of coldwater tributaries only when water temperatures exceeded 70 °F (Buckman et al. 1992). Frissell (1999) inferred the thermal regime, either during summer or winter, is the proximate habitat factor limiting bull trout distribution and abundance. Although adult bull trout do occur in streams that warm to 68-70 °F, these temperatures likely approach the upper limit of desired rearing and holding conditions for these fish. Consequently, environmental stress probably becomes more of a factor as water temperature increases. In a laboratory setting, McMahon et al. (1998) found optimum bull trout growth occurred between 53.6 °F and 60.8 °F, and that the upper incipient lethal temperature for bull trout was 69.8 °F.

Forest practices affect bull trout through a variety of impacts to watershed structural conditions and functional capacity. The primary pathways for negative impacts are through altering stream temperature patterns, hydrologic and sediment regimes, and reducing channel complexity, as well as the structural features that maintain channel complexity. Potential adverse effects also include introduction of pollutants (fuels, fertilizers, pesticides, and herbicides) into watercourses while conducting timber harvest, site preparation, and stand maintenance activities.

Bull trout require colder water temperatures than most salmonids and these requirements vary according to life cycle stages. Timber harvest has the potential to affect stream temperatures primarily through reducing streamside canopy levels. The potential for riparian vegetation to mediate stream temperatures is greatest for small to intermediate size streams and diminishes as streams increase in size lower in the floodplain (Spence et al. 1996). Generally, small and intermediate streams represent the majority of total aggregate stream length within a watershed (Chamberlain et al. 1991). Given these relationships, maintaining adequate canopy conditions on small and medium sized streams (including intermittent streams) is necessary to avoid altering natural temperature regimes.

Groundwater entering streams (especially small streams) may be an important determinant of stream temperatures (Spence et al. 1996) or may provide localized thermal refugia in larger stream systems. Where groundwater flows originate above the neutral zone (generally, 52 to 59 feet below the surface) groundwater temperatures will vary seasonally, as influenced by air temperature patterns (Spence et al. 1996). Timber harvest in upland areas exposes the soil surface to greater amounts of solar radiation than under forested conditions (Carlson and Groot 1997), elevating daytime temperatures of both air and soil (Fleming et al. 1998; Buckley et al. 1998, Morecroft et al. 1998) and increasing diurnal temperature fluctuations (Carlson and Groot 1997). Relationships between shallow source groundwater flows and air and soil temperatures indicate that harvest activities in upland areas may increase stream temperatures via increasing temperature of shallow groundwater inflows. Other pathways for harvest actions to influence stream temperature include changing the volume and timing of peak flows, elevating suspended sediment levels, and altering channel characteristics (Chamberlain et al. 1991; Spence et al. 1996; USDA and USDI 1998a).

Although it has not been well documented and studied to date, in a western Washington stream temperature was found to increase after clearcutting and that stream temperatures warmed at distances of 590 feet into adjacent, forested buffer strips through down-slope advection of heated groundwater (Brosofske et al. 1997 *in* Frissell 1999). The temperature increases of the surface water, despite the full shade of uncut riparian buffers, may have been due to the transfer of heat from increased soil temperatures after logging to the shallow groundwater associated with those soils (Frissell 1999). The link between loss of surface cover and warming of groundwater has been long established; however, it apparently is a neglected factor with respect to land management practices and protection of native fish. Protection of groundwater-surface water linkages could be crucial to the matter of bull trout recovery, and presumably, native fish in general (Frissell 1999). More rigorous research is needed to address this issue.

Timber harvest in riparian zones, particularly the area adjacent to stream margins, can remove shading allowing greater sunlight penetration, surface water warming, and winter ice formation (Beschta et al. 1987; Chamberlain et al. 1991). The temperature increase in a stream is directly proportional to the area exposed to sunlight and inversely proportional to the volume of water in the stream. The effect of canopy removal on stream temperatures is greatest for small streams and diminishes as streams get wider (Sugden et al. 1998). Consequently, small streams respond faster to changes in canopy cover than larger streams (Sugden et al. 1998). During winter, riparian vegetation can moderate stream temperatures and prevent excessive stream cooling. In the absence of riparian vegetation, stream margins may freeze too rapidly or too extensively creating "anchor ice," a condition in which ice melds to gravel and soil and mechanically uplifts during subsequent thaws. Bank erosion and inputs of sediment may follow this stream condition (Swanston 1991).

Although canopy cover has been shown to be a dominant factor influencing water temperature, Sugden et al. (1998) state that no studies have been done that examine the effects of riparian timber harvest on changes in stream temperature under current forest practice regulations. These authors conducted an initial investigation to address this question as it applies to Montana and Idaho forest practice regulations. They sampled ten sites along 600-foot perennial stream segments that were harvested on both sides of the stream according to state regulations. Results of the study indicated mean canopy cover before harvest was 67 percent, after harvest was 62 percent, and canopy cover changes ranged from 0 to 13 percentage points. Using their temperature modeling convention, the average impact on stream temperature from harvesting in these areas would be less than 1 °C. They surmised that further research would be needed to strengthen understanding of these relationships.

In 1998, Plum Creek conducted a study in Idaho in which they examined effects of canopy cover removal after harvest compared to adjacent unharvested "reference" reaches upstream or downstream of the treated reach (DEIS/NFHCP 1999). The results indicated no significant difference in stream canopy cover between treated and reference reaches, which suggested that pre-harvest canopy cover over the stream was relatively unaffected. In addition, a watershed analysis conducted by Plum Creek in Goat Creek and Piper Creek watersheds in the Swan River

valley in Montana determined that six recent timber harvests (since 1992) had met the more stringent shading requirements of the State of Washington and that these watersheds did not show significant temperature increases based on continuous monitoring data (Resource Assessment Team 1996). Data from the canopy closure information showed that most stream segments in the Montana watersheds were in compliance with Washington standards. However, even though the Washington shading requirements appeared to be satisfied in the Swan River Valley, ground water upwelling produces a confounding effect in this area and may have more of a controlling influence on stream temperature than canopy cover. More research will be needed on the relationship between temperature and canopy closure to ascertain the validity of Washington requirements for use in intermountain forests.

Chen et al. (1995) suggested that daytime and nighttime temperatures range more in areas where logging has altered streamside cover. He reported that nighttime temperatures decrease and daytime temperatures increase in these situations, which implies that wider air temperature fluctuations could negatively affect fish survival and health (Thomas et al. 1986; Sullivan 1990) found that air temperature had a stronger influence on stream temperature than shade, and that shade alone may not maintain stream temperatures. Maintenance of groundwater and air temperature may be necessary. Chen et al. (1995) and Sullivan (1990) observed elevated maximum air temperatures at stand margins which indicated that changes in air temperatures in riparian stands can have an affect on stream temperatures and riparian buffer widths may be inadequate if they do not maintain appropriate air temperatures.

Headwater streams can be either perennial or intermittent, fish-bearing or non-fish-bearing, and connected or not connected by surface flow to downstream systems. Little investigation of the effect of timber harvest adjacent to headwater streams and the resultant temperature effect of this action on temperature regimes in downstream reaches has occurred. It is known that temperature increases in small headwater streams can increase the temperature regimes in downstream reaches, but the magnitude of the effect depends on the relative temperature increase and amount of exposed streamflow (Beschta et al. 1987). Extensive exposed reaches without buffer strips in headwater streams can be expected cumulatively to have a downstream thermal effect. Beschta et al. (1987) report that exposed small headwater streams draining clearcuts can lead to substantial diurnal temperature fluctuations. They suggest leaving buffer strips as an effective means to moderate temperature changes.

Caldwell et al. (1991) found that small streams are very responsive to localized conditions and are influenced by air temperature and shading characteristics, groundwater flow and water temperature, and elevation. Caldwell (1991) reported water temperatures from small tributaries entering larger streams had minimal influence on downstream water temperature. Stream temperatures equilibrate with downstream conditions and the influence from headwater stream temperature increases, generally extends only about 500 feet. However, this study has been criticized in that it was not designed appropriately; assumptions were "demonstrably unfounded"; and that the conclusion that stream temperature equilibration takes place over 500 feet is

groundless. Using Caldwell's data, when analyzed appropriately, shows equilibration would take place over a distance of 3,600 feet (American Fisheries Society and the Society for Ecological Restoration 2000).

To limit downstream temperature effects, Sugden et al. (1998) suggested that thermal management zones that retain sufficient levels of shading on the order of 500 feet could be established in the lower reaches of small streams. These management zones would strengthen levels of shading where standard forest practice regulations are insufficient. As indicated above however, whether a 500 foot thermal management zone is adequate to equilibrate stream temperatures in small streams is debatable.

Johnson and Ryba (1992) concluded that buffer widths greater than 100 feet provide the same level of shade protection as an old-growth forest. Others have also suggested that buffers greater than 100 feet provide adequate shade to stream systems (Murphy 1995; Beschta et al. 1987). The Resource Assessment Team (1996) observed that effective shade protection to the stream was provided from trees from zero to 77 feet from the bank in the Swan Valley in Montana. The FEMAT report (USDA Forest Service et al. 1993) suggested that for 100 percent effectiveness in shading a buffer distance of about .75 tree height from the stream channel is needed, which is typically greater than 100 feet. As an interim measure until specific watershed analyses are done, the FEMAT approach establishes 300-foot buffers (two site potential tree heights) in which no harvest activities are allowed. This "one-size-fits-all" prescriptive approach for Federal lands has been criticized because it has no functional scientific basis (O'Laughlin and Belt 1995).

There is good agreement in the literature that riparian buffers are needed to retain shade function and to moderate stream temperature, but little agreement exists concerning buffer size needed or concerning what specific timber harvest activities within those buffers are compatible with fish. This uncertainty has led some agencies to establish conservative buffer widths (e.g., the FEMAT recommendation described above). On the other hand, variable-width buffers offer greater flexibility, but with the disadvantage that a variable format can be more cumbersome and costly to administer (O'Laughlin and Belt 1995). The answer is probably somewhere in between. Greater protection should be afforded to those areas that are most important to native fish and more flexibility allowed in areas that are less critical.

However, the effectiveness of a buffer may be diminished when the riparian vegetation community is exposed to disturbance, either through natural means or manmade disturbance. For example, physical alteration of the vegetative structure at the upland/riparian interface may influence the various functions provided by the buffer, either directly or indirectly. Timber harvest on the outer edge of a riparian buffer may expose the buffer area to increased light and wind. The interior microclimate of the riparian forest may be affected by reduction in relative humidity, more variable air temperatures, and increased wind-throw and tree breakage (Murphy 1995). Increased light penetration promotes shrub development which in turn reduces herbaceous cover and tree regeneration resulting in a shrub dominated community (Hibbs 1991). Thus, buffer zones may need to be wider to maintain interior microclimate conditions (USDA Forest Service et al. 1993)

and to ensure the long-term viability of riparian functions (Cederholm 1994). Width of buffer zones, timber harvest within buffer zones, and fixed or variable width buffer zones are the three main issues in designing buffers (Belt et al. 1992). These issues remain unresolved.

Livestock grazing can affect nearly all components of aquatic ecosystems. Improper grazing can lead to a reduction in vegetative canopy cover bordering or overhanging a stream. This can increase summer water temperatures by increasing direct solar radiation, and decrease winter water temperatures accelerating anchor ice formation (MBTSG 1998). Willow cover in an ungrazed area of a livestock exclosure was found to provide 75 percent more shade to the stream than was found in an adjacent grazed area where willows were less abundant (Platts 1991). Browsing of native riparian shrubs, if not limited to moderate utilization, may die off or be replaced with more browse tolerant non-native plant species. Some willow species cannot reproduce under heavy browsing. First-year willow seedlings can be very sensitive to browsing because of their shallow root system and be killed when livestock pull these plants from the ground or trample them (Kovalchik and Elmore 1992). Heavy browsing of riparian trees and shrubs can lead to changes in the composition of the riparian vegetative community (Mosley et al. 1997). Boggs and Weaver (1992) observed that on relatively ungrazed sites that undergo moderate grazing, the riparian understory of a mature cottonwood forest can change from a diverse, dense shrub layer of various mesic shrubs and willows to a nearly impenetrable understory of wood rose (*Rosa woodsii)* and western snowberry (*Symphoriocarpus occidentalis)*; and under heavy grazing the shrubs may be eliminated and the stand converted to a herbaceous understory dominated by a single species such as Kentucky bluegrass (*Poa pratensis)*. Livestock grazing has also been identified as one of the major factors contributing to declines in upland forest health by helping accelerate the trend of western forests toward denser, smaller trees and to species that are more dominated by fire-sensitive species (Belsky and Blumenthal 1997).

Grazing cattle improperly in riparian zones can lead to decreased vigor of trees, shrubs, forbs and grasses. Livestock are a major cause of this condition because they tend to concentrate in riparian zones for the high-quality forage and water availability. Skovlin (1984) reported that improper grazing in riparian zones can result in: 1) reduction in plant vigor of herbaceous and browse species (trees and shrubs) which, in turn, can lower production and alter composition; and 2) increased trampling; which can waste available forage and compact soils to further reduce productivity. Protracted heavy grazing can cause elimination of shrubs and trees (Maloney et al. 1999). Of further interest is that the dominant vegetation type in the watershed can have a significant influence on stream temperature. For example, lower stream temperatures were found in a western larch/Douglas fir and spruce/fir ecosystem compared to a ponderosa pine and mountain meadow ecosystem; and intermediate stream temperatures were observed in a lodgepole pine forest (Maloney et al. 1999).

It's commonly understood that when streamside vegetation is altered or removed, directly or indirectly through decreased productivity, summer water temperatures increase. Water temperatures rise because of increased exposure to solar radiation (Gibbons and Salo 1973). In addition, the range of diurnal temperature fluctuations may increase, which is undesirable for

native fish (Bowers et al. 1979). Platts (1991) found that, in general, summer water temperatures are higher for streams in grazed areas compared to ungrazed areas, and therefore salmonid populations are reduced. Streamside vegetation is essential in providing shade that keeps temperatures from reaching levels that are lethal to salmonids.

The importance of streamside cover to fish is well-documented. Trees and shrubs provide shade, one of the most important regulators of temperature in small streams, and shade removal can increase temperatures significantly. Meehan et al. (1969) found that removing streamside forest vegetation in southeast Alaska increased the maximum temperature by 90 °F. Temperatures were reduced by 12 °F where a nonforested stream meandered through 400 feet of mixed shrub and forest cover (Skovlin 1984). Skovlin (1984) suggested that restoring streamside shade could reduce temperatures by 6 to 12 °F, depending on stream conditions and temperatures. Streams with greater than 75 percent stream shade maintained acceptable stream temperature levels for rainbow trout and chinook salmon, with lowest temperatures found in streams within ungrazed watersheds (Maloney et al. 1999).

Sedimentation

Surface erosion and mass wasting are the two major forms in which fine sediment is delivered to stream systems on forested landscapes (Swanston 1991, Cedarholm et al. 1981, Everest et al. 1987). When excessive levels of fine or coarse sediments are deposited or suspended in streams survival and production of salmonids can be adversely affected. As deposition of fine sediments in salmonid spawning habitat increases, mortality of embryos, alevins, and fry increases (Chamberlain et al. 1991).

It has been well established that high levels of deposited sediments in spawning gravels (12 to 20 percent, typically) can increase mortality of salmonid eggs and alevins by reducing waterflow through spawning gravel, which can suffocate eggs, and by preventing fry from emerging from the gravel. Levels of fine sediment in streambed gravels has been negatively correlated with salmonid embryo survival (Cedarholm et al. 1981; Tappel and Bjornn 1983) and the quality of juvenile rearing habitat (Bjornn et al. 1977). Weaver and Fraley (1991a) observed an inverse relationship between the percentage of fine sediment in substrates and survival to emergence of bull trout embryos. Entombment was the major mortality factor in these tests. Densities of juvenile bull trout were found to be lower in areas of high sediment levels and cobble embeddedness (MBTSG 1998). Because of their close association with the substrate, juvenile bull trout distribution and rearing capacity are affected by sediment accumulations (Baxter and McPhail 1997). Pools, which are an important habitat feature for cover and security for bull trout and other salmonids, may also be lost due to increased levels of sediment (Megahan 1982).

Increases in suspended sediment can affect salmonids in several ways. Fish may avoid high concentrations of suspended sediments altogether (Hicks et al. 1991). Harvey and Lisle (1998) reported that high concentrations of suspended sediment can affect survival, growth, and behavior of stream biota. Slight elevations in suspended sediment may reduce feeding efficiency and growth

rates of some salmonids. At lower concentrations of suspended sediment fish may decrease feeding and at higher concentrations may cease feeding completely (Sigler et al. 1984). Even temporary spikes of suspended sediment may negatively effect salmonid behavior and may be lethal (Hicks et al. 1991). In addition, social behavior may be altered by suspended sediment (Berg and Northcote 1985). Suspended sediment may alter food supply by decreasing abundance and availability of aquatic insects; however, the precise thresholds of fine sediment in suspension or in deposits that result in harmful effects to benthic invertebrates is difficult to characterize (Chapman and McLeod 1987).

Noggle (1978) reported that extremely high concentrations of suspended sediments can cause fish mortality through gill abrasion. Furthermore, he observed that feeding rates of coho salmon decreased when turbidity levels reached certain thresholds. Turbidity is usually a near-linear function of suspended sediment such that as turbidity increases concentration of suspended sediment increases in proportion (Denman and Bauer 1999). Coho salmon were observed avoiding excessive turbidity levels when less turbid water was easily accessible (Bisson and Bilby 1982). Also, coho salmon were noted to increase their tendency to migrate when reared in turbid water (Sigler and Bjornn 1979). Sigler and Bjornn (1980) observed an inability of smaller coho fry reared in turbid water to compete for food and space with their larger cohorts reared in clear water.

Forest roads and timber harvest operations in uplands and in riparian areas can have variable effects on sediment production and on sediment delivery to stream systems (Everest et al. 1987, Chamberlin et al. 1991). Road construction, use, and maintenance, and tree-felling, log hauling and skidding, construction of landings, slash disposal, site preparation, and equipment staging and operations are all potential sources of fine sediment and are activities that diminish the ability of forest soils to resist surface erosion. Accelerated surface erosion and increased levels of sedimentation may decrease following the initial disturbance, but can remain above natural levels for many years (Spencer 1991; Swanston 1991). In general, logged slopes contribute sediment to streams based on the amount of exposed soils to rainfall and runoff. The rate of sediment delivery to stream channels is determined by slope steepness and distance to the stream channel (Quigley and Arbelbide 1997).

Roads are considered the main cause of accelerated surface erosion in forests across the western U.S. (Harr and Nichols 1993) and contribute more sediment to streams than any other land use activity (Gibbons and Salo 1973; Quigley and Arbelbide 1997). Roads are recognized as a long-term, chronic source of sediment affecting streams (Belt et al. 1992; Swanston 1991; Furniss et al. 1991; MBTSG 1998). Historically, roads have adversely affected salmonid habitat by increasing in-stream sediment loads, altering the morphology of stream channels, destabilizing streambanks, modifying drainage networks, creating barriers to movement, and increasing the potential for chemical pollution of the aquatic ecosystem (Furniss et al. 1991). Roads can cause serious degradation of salmonid habitats in streams if poorly planned, designed, located, constructed, and maintained (Furniss et al. 1991; Quigley and Arbelbide 1997; MBTSG 1998). Roads alter the natural sediment and hydrologic patterns by altering hillslope drainage patterns, which affect

sediment transport and deposition, and by altering the timing and magnitude of peak flows and stream discharge (Furniss et al. 1991; Megahan 1972).

Construction of road networks can greatly accelerate and lead to long-lasting erosion rates within a watershed (MBTSG 1998; Beschta 1978; Reid and Dunne 1984; Swanston and Swanson 1976). Elements that lead to these effects include poor road location and surface drainage, undersized culverts, generation of sidecast materials, and inadequate road maintenance practices (Quigley and Arbelbide 1997). Road surface erosion is particularly affected by traffic, which increases sediment yields substantially (Reid and Dunne 1984). Other important factors affecting road surface erosion include condition of the road surface, timing of when roads are used in relation to rainfall, road prism moisture content, location of the road relative to watercourses, methods used to construct the road, and steepness of the terrain on which the road is located.

Processes initiated or affected by roads include landslides, road surface erosion, secondary surface erosion (landslide scars exposed to rain splash), gullying, debris torrents, debris flows, slumps, and earthflows (Swanston 1991). Forest roads can substantially increase the frequency of mass soil movements in steep watersheds by several to hundreds of times depending on site variables (Everest et al. 1987; Furniss et al. 1991). Jenson and Finn (1966) observed that sedimentation is directly proportional to road mileage in granitic areas. Swanston and Swanson (1976) estimated that debris torrents in managed forests in Oregon occurred at rates of 41 and 4.5 times greater than rates in unmanaged forests as a result of forest roads and clearcuts. Similarly, Morrison (1975) found rates of debris torrents to be 13 and 8.8 times greater in forests with roads and clearcuts than in forests without them. Furniss et al. (1991) reported that sediment produced from roads greatly exceeds sediment produced from forests and clearcuts. In many locations, poorly-designed roads have been shown to have a larger effect on sedimentation than hillslope landslides or surface erosion (Kelsey 1980; Best et al. 1995; Wu and Swanston 1980; Swanson et al. 1987; Ziemer et al. 1996). Furniss et al. (1991) reported that road location is the most important factor in construction of roads because it affects more site variables like slope steepness, soil stability, bedrock structure, and presence of subsurface water and will determine the extent of surface failure.

Roads and related ditch networks are often connected to streams via surface flowpaths, providing a direct conduit for the sediment. Ground disturbance from road blading, particularly where the road is immediately adjacent to streams, and at intermittent and perennial stream crossings, can result in elevated sediment levels. The amount of sediment delivered continuously to streams may temporarily increase as bare soil is exposed as a result of blading and when ditch-roughness features (which store and route sediment) are removed. Ditch maintenance is another source of sediment which can increase erosion within the ditch. Sediment yield from road segments with freshly graded ditches is five to seven times greater than the yield from segments with vegetated ditches (Elliot and Tysdal 1999).

Road crossing across streams can restrict channel geometry and prevent or interfere with migration of adult and juvenile salmonids (Furniss et al. 1991). Crossings can also be a source of

sedimentation, especially if they fail or become plugged with debris, causing debris torrents and significant cumulative impacts downstream (Furniss et al. 1991; Murphy 1995). In fact, Furniss et al. (1991) considered stream crossings (culverts primarily) as dams that are designed to fail and that the failure will be substantial for most crossings. Furthermore, whether a crossing fails is less important than how it fails, meaning that failure is often catastrophic causing extensive local scour and deposition and downstream erosion that could last for years.

Culverts and bridges associated with forest roads pose the greatest risk to streams that support salmonids. Three types of problems can occur at stream crossings with culverts: 1) fish are blocked or impeded from migration due to improper installation of the pipe; 2) peak flows are not properly accommodated due to undersizing of the pipe; and 3) drainage is poor near the crossing because of poor road design. Bridges pose fewer problems and are preferred because they usually cause less channel modification than culverts and can ensure fish passage (Furniss et al. 1991). However, if a bridge crossing is not located and designed properly, it too can be a source of sediment and a point of hydrologic alteration, which can cause downstream channel-altering processes detrimental to fish habitat.

Impediment or delay in fish migration is often the result of culvert hydraulics, which create water velocity barriers, depth barriers, and/or vertical jump barriers. Fluvial and adfluvial fish movements occur at certain times of the year that can be critical for survival. For example, in the Blackfoot River in Montana there appears to be a run of juvenile bull trout in mid-summer (July/August) into smaller streams presumably for thermal refuge (Pierce et al. 1997). Culverts installed with a perched outlet can create a vertical jump, resulting in a fish passage barrier or obstacle at various flows, for some species and life stages. Culvert designs should not create a vertical jump, but instead be placed on the average natural stream gradient. Often the water velocity within the pipe is more of a limiting factor that the vertical jump itself. Velocity of water through the pipe can exceed the swimming speed capability of fish. Culvert designs should incorporate the lowest maximum average water velocity for the weakest-swimming fish requiring passage, which is often determined by that which allows juvenile fish to pass safely (Furniss et al. 1991; Bates 1997; Bell 1990). To avoid delay due to water depth, culvert design should be based on timing of fluvial and adfluvial fish movements and life stages and to accommodate the natural hydrograph and a minimum water depth. Recommended water depths on the Lolo National Forest in July and August when it appears that large, adult bull trout have migrated, is four inches to provide for the juvenile run of bull trout (Hendrickson 2000).

When a culvert is plugged by debris or is overtopped by high flows, streams associated with these structures can be diverted, can contribute to road failure, and can cause sedimentation (Murphy 1995). Although proper design and location of these structures can minimize the risk of structural failure, any crossing structure is almost certain to fail if it is not maintained or removed when a road is abandoned (USDA Forest Service et al. 1993; Murphy 1995). Nevertheless, even proper culvert design and location is not secure against failure. For culverts designed for a 25-year flood, there is an 80 percent probability of failure over a 50-year period; for culverts designed for a 100-year flood, there is a 40 percent probability of failure over a 50-year period (USDA Forest

Service et al. 1993). The effects of such a failure on salmonid habitat will depend on when it occurs, what the stream failure is associated with, antecedent weather conditions, and the number of salmonids using the affected stream system.

Drainage near a stream crossing, whether a culvert or bridge, is important. It has been assumed that 100 percent of the sediment carried by road ditches which discharge into streams at stream crossings will be delivered to the stream (Washington State Forest Practices Board 1997). Miller et al. (1995) observed that when runoff was discharged directly to stream channels 50 percent of the deposited sediment and 100 percent of the suspended sediment reached the stream, in contrast to only 1 percent of road sediment reaching the stream channel when runoff was directed to the forest floor. At least 10 percent sediment delivery can be expected when culvert outflow occurs within 200 feet of a stream, so hydrologic decoupling would only be possible for portions of the road located more than 200 feet from a stream (Washington State Forest Practices Board 1997).

Conceivably the most important mitigation measure related to sediment delivery from road erosion to streams depends on the location of the road with respect to the stream. The closer the road to the stream the more the mitigation should focus on the road ditch or traveled way (Elliot and Tysdal 1999). Some have observed that sediments discharged from the road do not reach streams due to the filtering and sediment trapping effects of intervening buffer strips (Megahan and Ketcheson 1996; Washington Forest Practices Board 1997; Ketcheson and Megahan 1996).

Particularly near stream crossings, the length of road ditch discharging sediment directly to the stream should be limited to short distances through location of intervening relief drainage structures such as broad-based dips, relief drain culverts, water bars, or other appropriate drainage structures that direct runoff onto the forest floor or through vegetated filter strips. Treatments of channels located below roads that are insloped or have culverts or waterbars could include lining the channel with rock or similar materials, establishing vegetation, or installing control structures, but these measures may be ineffective during severe runoffs and more expensive than directing excess runoff onto the forest floor (Elliot and Tysdal 1999). Relief culverts inside ditches near streams should be located as close as possible to the stream crossing so sediment drains off before reaching the stream. The addition of these road drainage structures may eliminate 25 to 85 percent of road sediment delivered to the stream (McGreer et al. 1998).

Habitat alterations as a result of roads and stream crossings can adversely affect all life stages of salmonids as well as many activities including migration, spawning, incubation, emergence, and rearing (Quigley and Arbelbide 1997). Cederholm et al. (1981) reported that the percentage of fine sediments in spawning gravels increased above natural levels when more than 2.5 percent of a basin area was covered by roads. In some Flathead River drainage watersheds in Montana, old secondary roads were found to act like first order streams that increased the drainage density of the watershed and resulted in increased water yields and channel instability in downstream bull trout spawning and rearing areas (MBTSG 1998).

In addition to roads, nearly all other forest activities disturb soil to some degree. Timber harvest involves log hauling, tree felling, brush removal, thinning, yarding, slash disposal, and site preparation for replanting, all of which are potential sources of fine sediment pollution (Murphy 1995). These activities occurring in riparian zones and upland areas are often responsible for increased rates of erosion and sedimentation (Chamberlain et al. 1991). Timber harvest can substantially increase sediment delivery to streams through surface erosion and mass wasting events. Generally, the amount of sediment logged slopes contribute to a stream depends on the extent of bare compacted soils that are exposed to rainfall and runoff (Quigley and Arbelbide 1997). The rate of sediment delivery is also related to slope steepness and the proximity of the activity to the stream channel.

The loss of protective vegetative crown cover as a result of logging can increase splash erosion (erosion caused by raindrops detaching soil particles), reduce slope stability, and alter runoff patterns. Increased water and sediment yields can accelerate bank erosion of stream channels and cause increased mass wasting, bedload deposition, channel braiding, and channel instability (MBTSG 1998). After harvest, root strength of stumps declines, often leading to slumps, landslides, and surface erosion (USDA Forest Service et al. 1993; Thomas et al. 1993). Riparian tree roots provide bank stability. Streambank sloughing, lateral channel migration during floods, and channel erosion often increases if those trees are removed, leading to sediment load increases and loss of overhanging banks and pools, which are important habitat for rearing salmonids (Murphy 1995). Harvesting hillslopes near headwater streams has been implicated to prolong increases in sediment delivery by altering groundwater concentrations and temperatures. Following harvest of the hillslope, the increase in the area of saturated overland flow combined with decay of the soil macrostructure provided by roots can result in increased incidence of surface erosion at channel heads and near-channel hillslopes, increased soil creep, and/or increased sapping and pipe failure erosion (Frissell 1999). Increases in sediment delivery can destabilize channel morphology, outpacing the ability of the stream to transport sediment through the system.

Some yarding activities, such as tractor yarding, can cause extensive soil disturbance and compaction that can increase splash erosion and channelize overland flow. If this occurs within riparian areas, the potential for fine sediment delivery to streams significantly increases. Cable yarding and helicopter systems that suspend logs usually cause less soil disturbance (Murphy 1995). Site preparation and other actions which result in loss of the protective humic layer can also increase the potential for surface erosion (Hicks et al. 1991). Furthermore, effects of compaction and disruption of the top soil layer can reduce soil permeability and productivity.

Relatively large amounts of mass wasting is typically associated with roads; however, lesser amounts of mass wasting is associated with clear-cuts as roots of cut trees die and the soil they retain is lost. Many small landslides occur on clearcut slopes as root strength is lost within 2 to10 years after trees have been cut (Murphy 1995). Therefore, areas of large clearcuts or numerous smaller clearcuts over a large area can be a significant source of sedimentation, which makes this form of erosion a substantial source of sediment in salmonid streams (Swanston 1991).

In summary, it is apparent that a direct effect of timber harvest and road construction is an increase in sediment delivery to streams. Indirect effects of timber harvest and road building activities on streams include increased stream flow and an associated increase in water temperature. Erosion potential and accelerated sediment delivery is increased by reduction in vegetation, compaction of soils and disruption of natural surface and subsurface drainage patterns. Generally logged slopes contribute sediment to streams based on the amount of bare compacted soils that are exposed to rainfall and runoff. Slope steepness and proximity to channels determine the rate of sediment delivery. Road reconstruction activities include activities such as blading, culvert replacement, ditch cleaning, and road stabilization. Temporary road construction and obliteration also affects sedimentation rates and surface water and streamflow regimes (Lee et al. 1997).

Overgrazing by livestock and its effects on salmonids has been identified as a major problem on western rangelands for decades (Platts 1981). Beschuta et al. (1991) concluded that livestock grazing represents the land–use most damaging to riparian vegetation. Further, elimination of grazing from the riparian zone may be needed to restore streamside vegetation, and fencing is the most effective means of improving riverine habitat in order to restore or maintain salmonid production (Beschuta et al. 1991). Behnke and Zarn (1976) reported the influence of livestock grazing on headwater habitat could be devastating to native threatened and endangered species, and indicated that destabilization of streambanks by trampling with consequent siltation of streambeds as the major factor. However, less is known about grazing impacts in riparian forest environments which may be more resilient than rangeland riparian zones. Also, there is evidence that livestock grazing practices can be employed that will protect stream fisheries (Platts 1982, Rinne 1999).

Livestock grazing can affect streambank stability by trampling and removal of streamside vegetation (Waters 1995). Large sections of unstable streambanks indicate an absence of appropriate vegetation in the right amount and type. Vegetation provides soil-binding root mats that protect streambanks by reducing water velocity along the stream edge and providing a means of trapping sediments and nutrients (Platts 1991). However, high stocking rates are a particular problem and can lead to increased sediment production and deterioration of channel stability. Trampling and hoof slide causes sloughing of streambanks and accelerates bank erosion (MBTSG 1998; Platts 1991). In severe cases, streambanks may collapse causing soil to enter directly into the stream. The longer cattle have access to a stream reach, the more likely streambank deterioration will occur (Mosley et al. 1997). Fall grazing systems studies in southwestern Montana indicate that 21 days of grazing maintained riparian areas in good condition compared to 37 days of grazing, which did not (Myers 1989). Dufour (1993) found that a 30 percent utilization standard for degraded riparian areas appeared to be adequate for riparian recovery and bank stability, but reported the best protective measure for streambanks was exclusion, particularly in sensitive areas of salmonid spawning and rearing habitats.

Large Woody Debris

Large woody debris, or LWD, is one of the most important components of stream habitat for fish populations, of stream hydrology, and of stream channel morphology. The importance of LWD varies within watersheds, within individual streams, and within individual areas or reaches of streams. For more than 100 years wood was removed from stream channels in the United States to facilitate boat traffic, floating of logs or log drives downstream, for protection of property, bridges, and roadways, and for improving fish migrations (Spence et al. 1996).

Woody debris occurs in the aquatic environment in multiple sizes, as single pieces, or as complex jams within the floodplain, with in the channel migration zone (CMZ), and within the immediate stream channel. Literature suggests that there are distinctive spatial patterns of LWD, pools, gravel bars, and forested islands that form in association with particular wood jam types (Abbe and Montgomery 1996). Certain LWD, termed "key members" or key pieces, initiate the formation of stable bars and meander jams that alter the local flow hydraulics and the spatial characteristics of scour and deposition leading to pool and bar formation (Abbe and Montgomery 1996). Individual jams can be very stable helping to provide refugia for forest patch or stand development (Abbe and Montgomery 1996). A literature review of definitions of large woody debris reveals that many different terms are used when speaking about woody debris including: coarse woody debris, large woody debris, woody debris, organic debris, coarse organic debris, large organic debris, dead organic matter, etc. These definitions come with different size distinctions and other discussions about how and where to measure woody debris. The reader needs to be cautious when applying wood counts because of the high range of natural variability and sampling errors that exist (Overton et al. 1995). Generally, LWD that is surveyed includes those pieces between 10 cm diameter at breast height (dbh) and larger. Some authors split pieces of wood into different size classes and others include only key pieces of wood. Key pieces of wood usually includes sizes greater than 24 inches dbh on the west side of the Cascade Mountains and 12 inches dbh on the east side of the Cascade Mountains and inland Columbia River Basin It is important to note that different sizes of wood respond differently in the stream channel and on the floodplain creating very different types of fish and aquatic habitat.

The size and species or type of wood determines the abilities of the wood to perform the functions above. In general the larger the size of LWD, the greater its stability in the stream and coniferous trees exhibit greater longevity in the stream than deciduous trees (Spence et al. 1996; Bilby and Ward 1989). Some studies in western Washington suggest that the diameter, length, and volume of pieces of wood were greater in mid-order streams than in low order streams in other words, as the width of the stream increases so does the diameter, length and volume of LWD (Bilby and Ward, 1989). Generally, LWD is large enough to span the entire channel, forming a longitudinal profile that creates the formation of plunge pools and increases pool habitat complexity, reduces stream gradients, and increases stream depth for important for overwinter habitat and cover.

Wood enters streams either directly from riparian areas or from hillslopes or upland areas to influence aquatic systems as described in FEMAT (USDA et al. 1993). Both conifer and deciduous tree vegetation located in both the uplands and riparian areas can become LWD in aquatic ecosystems. FEMAT refers to Thomas et al. (1993) and discusses that effectiveness of upland forest to deliver large wood to the riparian areas and stream channel, is naturally expected to decline at distances greater than one tree height from the stand edge (USDA et al. 1993). The introduction of wood from riparian areas occurs from the toppling of trees as they die, are knocked down, or are undercut by streamflow and stream debris (Spence et al. 1996). The introduction of wood from hillslopes occurs from windstorms, mass slope failures, and debris and ice torrents (Spence et al. 1996; Keller and Swansen 1978). Wood is also introduced into streams from snow avalanches and ice loading (Keller and Swansen 1978).

Large woody debris influences fish habitat and floodplain and stream channel morphology through coarse sediment and particulate matter storage, increases habitat diversity and complexity, and maintains flow heterogeneity (Spence et al. 1996; Bilby 1981). LWD provides long-term nutrient storage and substrate for aquatic invertebrates (Spence et al. 1996). It moderates flow disturbances and increases retention of water and nutrients and facilitating biological processing (Spence et al. 1996). Hicks et al. (1991) refers to Bustard and Narver (1975), Tschaplinski and Hartman (1983), Murphy et al. (1986), and Hartman and Brown (1987) and discusses that the abundance of salmonids is often closely linked to the abundance of woody debris, particularly in winter. LWD provides refugia for aquatic organisms during high and low flow events (Spence et al. 1996) and creates a diversity of hydraulic gradients while increasing microhabitat complexity supporting the coexistence of multi-species salmonid communities (Hicks et al. 1991). LWD retains gravels behind logs creating spawning areas for fish that are essential for spawning salmonids (Benda and Sias 1998). Larger debris dams retain fine sediment, acting similar to a filter, reducing the rate of sediment transport downstream, which could degrade spawning habitat (Spence et al. 1996). Pools (lateral, scour, plunge, backwater, pocket) formed in association with wood provide for complex habitat and function as rearing and feeding areas for fish in the summer and as critical low-velocity and thermal refuge in the winter (Benda and Sias 1998; Bisson et al. 1982). Large deep pools in many areas of the Columbia River Basin have been reduced by about 58 percent on National Forests and by about 80 percent on private lands in the Pacific Northwest according to Sedell and Everest (1991) as referenced in FEMAT (USDA et al. 1993). FEMAT describes this reduction in pools as being related to the loss of pool-forming structures such as LWD and refers to Bryant (1980) and Sullivan et al. (1987). Wood formed pools may also provide an avenue for flow regimes that enhance stream temperatures. Pools force or plunge water down into the substrates to percolate into the hyporheic zone. Once flows enter the hyporheic zone beneath the substrate it may be cooled and may reenter the surface flow as a spring or a seep. This source of cool water seems to be important for spawning bull trout and other salmonids. Pool tail outs, undercuts areas beneath logs, and areas along pool edges where gravels have been deposited because of the pool formation associated with woody debris, are important spawning areas for bull trout. The importance of these pools and woody debris jams for bull trout is high because adfluvial /fluvial bull trout are know to migrate long distances, from larger river systems and lakes to use these types of habitats. These pools and woody debris jams

are used for spawning habitat in the upper reaches of mainstem rivers and smaller tributaries in both low and high gradients. In the long-term the loss of LWD in the stream channel reduces the retention of spawning gravels, the frequency of pools, the habitat complexity necessary for cover and productivity and the structure necessary for natural energy dissipation to maintain stream channel function.

In terms of forest management, practices that affect both upland and riparian areas have the potential to directly and indirectly affect aquatic habitat and in particular LWD. The manipulation of vegetation and soils that could potentially become LWD or could produce future LWD on the floodplain, or in the stream channel have historically been affected by forest practices.

Forest practices directly influence vegetation within a watershed by the removal of trees during harvest, thinning, salvage; through manipulations of understory and ground vegetation to promote growth and vigor of desired species by burning or mechanical or chemical treatments (Spence et al. 1996). Forest vegetation is indirectly affected by changes in site conditions following harvest such as changes in microclimate, soil moisture and stability, ground cover, and susceptibility to erosion (Spence et al. 1996; Beschta et al. 1995). Soil compaction by ground-based equipment can reduce infiltration of water, thereby inhibiting seedling or established vegetation growth (Spence et al. 1996). Tree roots can die after logging and subsurface spaces can become compacted or filled with sediment, which also reduces infiltration of water and aeration in the soils thereby leading to changes in vegetation and species composition (Spence et al. 1996). The magnitude of vegetation change and the succession of vegetation following logging depend on the type and degree of disturbance (Spence et al. 1996).

Upland practices can effect surface erosion, mass wasting, hydrologic processes and nutrient dynamics, all of which contribute to altering levels of LWD on the floodplain and in the stream channel. These effects are greatest in the years immediately following logging because the degree of devegetation and soil disturbance is highest then (Spence et al. 1996). Different types of harvest schedules can affect the watershed processes by controlling the frequency of disturbance to the watershed area and the amounts of LWD delivered to the floodplain and stream channels. Harvest schedules typically range from 45-100 years in western Washington , Oregon, and California with some shorter rotations becoming more common and on average, longer rotations east of the Cascade Mountain Crest because of the drier climate conditions (Spence et al. 1996). Spence et al. refers to Frissell (1991) with a discussion indicating that longer harvest rotations can decrease the time that the landscape is disturbed and reduces the probability that catastrophic events will reduce the affects to current and future levels of LWD.

Forest stand harvest is discussed as using even-aged and un-even aged harvest methods, including clearcutting which has been the dominant harvest method in the Pacific Northwest (Spence et al. 1996; USDA et al. 1993). Current harvest methodology is tending to move away from even-age and clearcutting practices. Clearcutting is potentially more disruptive of natural watershed processes because all vegetation is removed and soils are highly disturbed. This can have more effects on levels of current and future LWD through delivery mechanisms such as mass wasting,

erosion of streambank vegetation, soil compaction, changes of vegetation species, etc. Selective harvest methods which leave larger older trees standing for structural retention or a set of wind tolerant trees for a rotation or more can maintain LWD levels by minimizing disturbances to soils such as compaction and minimizing effects to hydrologic processes such as mass wasting (Spence et al. 1996). In some cases drawbacks of selective harvest for the landowner include increased harvest cost, increased road densities, and growth of a less desirable tree species (Spence et al. 1996).

The removal or yarding of logs from harvested areas can cause compacted soils and soils prone to erosion or overland flows which can lead to increased mass wasting, erosion, and loss of potential future LWD. Generally ground-based operations using tracked or rubber tire skidders result in the greatest degree of compaction and area affected. Spence et al. (1996) discusses that compaction usually occurs within the first few passes of heavy equipment and when soils are moist and that designation of skid trails and skidding in either the dry season or over snow can minimize effects. Yarding systems can cause water to channel and cause erosion downslope, which can facilitate mass wasting and cause disturbances to the stream channel and current and future LWD. Skyline and helicopter yarding can both partially or fully suspend logs reducing impact to soils and minimizing compaction, and reduce the needs for roads and ground-based equipment (Spence et al. 1996). The location of landing areas for logs that are yarded can have effects on slope stability, soils, hydrologic regimes, and water quality all of which can lead to changed conditions for vegetative species and LWD. Location of landings so that they are not on slopes prone to erosion or mass wasting, so that they are located without sidecasting and construction on top of debris piles, and so that they are away from stream channel, can minimize effects to LWD.

Regeneration of vegetation or tree stands involves site preparation that includes removing logging debris, reducing shrubs, and preparing the soil for planting through such techniques as burning slash, mechanical clearing, use of mechanical augers for planting and hand scalping of which all can generate effect on current and future LWD. The effects of a high fire intensity burn can create hydrophobic conditions increasing the conditions for surface runoff and mass wasting which can affect current and future levels of LWD. Low intensity burns generally cause minimal soil damage and leave some organic debris in the soils and maintain root systems that sprout within a few weeks after a burn of this type . Mechanical equipment can have greater effects on soils and hydrologic processes because the equipment must travel over the site (Spence et al. 1996). Thinning and pruning activities are used to maintain tree stands and can result in additional soil compaction but using designated skid trails and roads reduces potential effects. Planting of single species, planting levels, and even-aged management can influence levels of LWD and the type of LWD for future recruitment to the floodplain and the stream channel. Natural levels and native species can minimize effects on LWD and aquatic habitat complexity.

Logging roads are primary sources of chronic erosion and trigger points of mass failures and the greater the road densities in a watershed the higher the probability of altering hydrologic processes (Spence et al. 1996) and current and future levels of LWD. Road construction including: cut and fill activities, poor construction of fills and road beds, and the alteration of

surface and subsurface water movement can accelerate earthflows, debris avalanches and debris torrents by destroying the stabilizing influence of vegetative cover and altering the hydrologic regime of the site by interrupting the balanced strength-stress relationships that exist under natural conditions (Swanston and Swanson 1976). Bull trout are described by the Mid-Columbia River Basin Project or ICBEMP (USDA and USDI 1997) as having reduced populations in areas where road densities are greater than approximately 1.0 miles per square mile. Major effects of roads on streams produced by debris flows is severe disturbance of the stream channel, including removal or rearrangement of all material in some stream segments and deposition of sediment and wood in others (Jones et al. 2000). Roads located on slopes prone to erosion can increase the chances of mass failures and the loss of future LWD, placement in valley bottoms can imped the natural channel migration across a floodplain and reduce potential future LWD inputs, and creek crossings are sites of bank erosion and channel constrictions which increase the risk of losing current and future LWD (Spence et al. 1996). Aquatic habitat complexity is lost or reduced when levels of LWD decreases. Trombulak (2000) refers to Trafela (1987) and relates that road location and construction can directly cause damage to trees that is visible up to 30 meters from the road and can contribute to the decline of up to 30 percent in forest productivity per rotation due to damaged trees. This mortality of trees in association with the cutting of safety hazard trees can effect upslope and riparian vegetative stands and depending upon the road location can effect LWD levels. However, locating roads in valley bottoms may be more preferable when upper slopes are prone to mass erosion and instability. Locating roads on ridge tops and on dry soils will reduce erosion and risk of mass failures. By ensuring adequate and natural drainage patterns, not concentrating runoff, avoiding discharge of water on unstable slopes, and designing culverts and bridges to accommodate extreme flood events the effects to the aquatic ecosystem can be minimized (Spence et al. 1996). Closure of roads in the form of full and partial decommissioning which includes partial to full recontouring of road surfaces to the resemble natural topography, has been reported as being effective in controlling erosion and restoring natural hydrologic processes including LWD. Road conditions surveys can help to identify problem areas and areas where multiple techniques may need to be used to be effective. Short-term erosion may occur until vegetation growth occurs on the closed roads and can be additive in effects with other forest activities, especially road building. Improper decommissioning where water gets trapped in furrows can lead to increased erosion, rilling, and mass failures. Scheduling road closures and road building to minimize effects of erosion and mass failures can reduce impacts to current and future LWD.

The practice of using buffers along streams is widely used to reduce impacts from logging and other forest activities on aquatic habitat complexity including LWD. Buffers will insure to some degree, that LWD levels remain on the floodplain and in the stream channels. The widths of the buffers vary and depend on the aquatic processes that are to be maintained. In the past buffers have been designated using valley width and sideslope gradients, from the wetted channel edges, from the average high flow channel, from the bankful channel, and more recently from the edges of the channel migration zone (CMZ). Stream channel or riparian buffers may vary because of the topography including slope, geology, precipitation levels and forms, and vegetative species. FEMAT or USDA et al. (1993) identifies variable size buffers and establishes buffers based on

stream types and can be adjusted with watershed analysis and the demonstration of meeting aquatic conservation strategy objectives. FEMAT also describes that the effects of riparian vegetation on streams decrease with increasing distance from the stream banks and that the effectiveness of floodplain forests and forests along constrained channels to deliver large wood is low at distance greater than approximately one tree height away from the channel. The amount of disturbances allowed within these buffers varies from none to a multitude of practices, which leads one to wonder why the term buffer is applied to them. Generally, there are equipment limitations, harvest and yarding limitations, site preparation limitations, and road building limitations within these buffers. Where riparian areas have been already altered by human activity, the long-term prospects for recovery of large conifers may be limited without active manipulation of riparian vegetation (Spence et al. 1996). Many streams in second growth forests have become progressively debris-impoverished following logging to the edge of the channel and young riparian stands do not produce sufficient debris of the proper size and quality to replace materials lost (Hicks et al. 1991). Such things as pruning, thinning, burning, and planting may be necessary for improved conditions in riparian areas to increase current and future LWD for floodplain and stream channel complexity. Long-term and future LWD can be enhanced with riparian buffers adjacent to year round channels as well as, headwater and intermittent channels, and are used to minimize mass failures and maintain a steady flow of LWD, as described by Cummins et al. (1994) and Spence et al. (1996).

At a landscape level, forest practices have resulted in substantial changes of species and age composition of western forests to stands that are managed as even aged, single species (Spence et al. 1996). Natural forests typically are composed of a mosaic of patches in different states of ecological succession (Spence et al. 1996). Bisson et al. (1987) as referred by Spence et al. (1996) discusses that riparian forests and LWD have been affected in areas where rapid growth of deciduous tress and shrubs has precluded coniferous species after harvest. For example, west of the Cascade Mountains there are large stands of deciduous trees especially in riparian areas, where very large conifers once grew. LWD produced by deciduous trees tends to be smaller, more mobile, and shorter lived in streams when compared to conifers. Literature reviewed and Spence et al. (1996) describes that removal of downed wood in riparian areas may affect re-establishment of some conifers, such as western hemlock and spruce because they rely heavily on decomposed nursery logs elevated above the forest floor. Large wood on the ground is mentioned as an important habitat component in riparian areas in FEMAT (USDA et al. 1993). A reduced supply of LWD decreases channel stability and eventually leads to loss of instream cover and pool habitat available for fish and fish seem to abandon streams and reaches that are lacking large wood or complex habitat features (Spence et al. 1996). Hicks et al. (1991) describes case studies by Bisson and Sedell (1984), Bryant (1980), Toews and Moore (1982), Lestelle and Cederholm (1984), Dolloff (1986), and Elliott (1986), where the removal of woody debris had immediate effects on salmonid populations because of declines in channel stability, reduction in pools and pool quality, enlarged riffles, and the overall reduction in the quality of fish habitat and fish communities.

The cumulative effect of forest practices has been a reduction in the complexity of stream macro- and microhabitats. Substantial decreases in the number of large, deep pools in river systems west of the Cascades Mountains have been documented in FEMAT (1993) and similar declines in pool frequency in river basins of eastern Oregon and Washington are described by McIntosh et al. (1994) as due to the lack reduction of LWD from wood removal programs and riparian timber harvests. Hicks et al. (1991) describes the changes in the distribution and abundance of LWD in streams as being among the most important long-term effects of forest management on fish habitat in Western North America. Hicks et al. (1991) discusses that overall trends include the reduction in the frequency of large pieces of LWD, stable debris in streams, concentrations of large accumulations; and the loss of important sources of new woody materials for stream channels as noted by Bisson et al. (1987). Hicks et al. (1991) refers to Sedell and Luchessa (1982), Narver (1971), and Rothacher and Glazebrook (1968) when describing these trends as having been accelerated by stream channelization, by debris removal for navigation for upstream fish migration, and for reduction of property damage during floods.

Grazing is practiced on forested lands throughout the Columbia River Basin and it represents the second most dominant land use in the Pacific Northwest following timber harvest (Spence et al. 1996). Heavy grazing around the turn of the century and continued grazing today causes widespread effects on upland and riparian vegetation (Spence et al. 1996). Loss of riparian vegetation from livestock grazing generally leads to wider stream channels and greater instability of stream channels due to loss of root strength and structure. Large woody debris is affected by continued compaction of soils in riparian areas, trampling of riparian vegetation, grazing of coniferous and deciduous trees, and streambank or channel erosion.

Grazing has created changes in species composition where Spence et al. (1996) describes that plants in upland areas have shifted from native perennial species to annual grasses and weedy species and gives an example by Johnson et al. (1994) where east of the Cascade Mountains upland sites have shifted from plant associations of Idaho fescue to tarweed, gumweed, and noxious weeds. Particularly important are riparian areas because livestock tend to migrate or congregate in these areas. Spence et al. (1996) continues to describe the replacement of riparian area vegetation such as willow, aspen, sedge, rush, and native grasses by annual grasses or sagebrush as due to historic and continued grazing. Discussions by Spence et al. (1996) mention that Elmore and Beschta (1987), Platts (1991), and Elmore (1992) indicate that recovery of grasses, willows, and other woody species can occur within a few years when grazing pressure is reduced or eliminated but that restoration of fully functioning riparian areas including older forests will take considerable time. Grazing pastures have also been maintained by removing woody shrubs and trees with tractors, using chemical treatments, and suppressing natural fire.

Livestock grazing can affect vegetation primarily through browsing and trampling, however in areas where livestock congregate, feces can bury vegetative species causing them die. Livestock can compact damp riparian soils, which inhibits seed germination, cause water to run off the surface, there by lowering the moisture content of the soils and the persistence of riparian species (Spence et al. 1996). The riparian soil surface contains a crust or "cryptogamic crust" of mosses,

algae, and lichens that cover soils between and among plants according to Fleischner (1994) and described by Spence et al. (1996) in which livestock trample and break the crust. Spence et al. (1996) mentions that Anderson et al. (1982) found that the recovery of these crusts take up to 18 years in ungrazed exclosures in Utah. Elimination of the "cryptogamic crusts" may alter nutrient cycling and can reduce the availability of nitrogen for plant growth, potentially affecting plant biomass and LWD (Spence et al. 1996).

The trampling and compaction of soils associated with livestock grazing can lead to stream downcutting and the invasion of water intolerant species. The water intolerant species of vegetation do not have the same root strengths to keep streambanks from eroding and to capture LWD so channel changes may occur at increased rates causing increased erosion and a reduction of LWD. The downcutting of the channel reduces or eliminates the floodplain width thereby reducing a potentially important mechanism for seed dispersal of woody plants and potential dispersal of LWD (Spence et al. 1996). The downcutting also alters the hydrologic regime. Altered hydrologic regimes can cause increases in nitrate-nitrogen concentration which can be readily transported by subsurface flows to the stream channels causing an increase in turbidity, algal growth, and oxygen depletion (Spence et al. 1996). Depending on the redox potential of the soils increased levels of modified or reduced forms of manganese, iron, and sulfur which can be toxic to plants can alter competitive interactions between plants changing the riparian plant communities and species available for LWD (Spence et al. 1996).

Cattle and sheep tend to select riparian areas because riparian areas have water, shade and cooler temperatures, food, and cover from the weather. In mountainous terrain the preference of riparian areas may be related to hillslope gradient or available access to the water and seeps. The FWS and Washington State Department of Fisheries biologists have observed cattle in and adjacent to higher gradient streams, where some streams or reaches had minimal access at tributary junctions, during bull trout spawning periods. Spence et al. (1996) offers some examples including: one, where 24 to 47 percent of the cattle in two pastures were found in riparian areas which included only 3 to 5 percent of their available pasture; and two, where 81 percent of the herbaceous biomass removed by livestock occurred in riparian meadows which accounted for only one to two percent of the available pasture. Direct and indirect effects of livestock grazing can be minimized with range riders, fence exclosures, pasture rotations, timing restrictions, removal from heavily damaged pastures, and removal in areas where cumulative effects of grazing will negatively affect other forest management activities, including restoration activities such as road obliteration, riparian planting, and streambank restoration.

Refer to the Stream Temperature, Sedimentation, and Channel Morphology sections in the "Overview of effects of forest, roads, and range management on fish habitat" section of this document for further discussions that can augment the overview of forest, road, and range management effects on LWD.

Water Quantity and Quality

Water quantity (hydrologic regime) and water quality (physical and chemical constituents) are important components of aquatic habitats (USDA and USDI 1997). The principal influence resource managers of federally-administered lands have on the health of aquatic ecosystems is through the management of water quantity and quality. The USDA and USDI (1997) reported that at a broad scale within the Interior Columbia River Basin (east of the Cascades' crest), water quantity (surface water volume and flow) has been affected by road construction and vegetation changes associated with silvicultural practices, livestock grazing, and agriculture. These activities also can affect water quality by contributing to increased sediment loads, water temperatures, and nutrient and contaminant levels. The FWS (1998a) reported that within the Columbia River Basin, many subpopulations of the Columbia River Distinct Population Segment of bull trout are threatened by impaired water quality. Changes in water quantity and quality resulting from forest, road, and range management practices can potentially adversely affect fish habitat. Soil and site disturbances from timber harvest activities can cause changes in water quantity and quality and potentially the modification and destruction of aquatic habitats (Quigley and Arbelbide 1997).

Many of the same adverse effects on water quantity and quality can result from improper forest, road, and range management practices. These effects can consequently cause the alteration and degradation of aquatic and riparian habitat for resident and anadromous native salmonids, as well as non-salmonids. These changes can negatively affect fish migration, spawning, incubation, emergence, and rearing success through various factors, such as increased peak flows, channel scour, changes in seasonal base flows, and the presence of contaminants (USDI and USDA 1997, Quigley and Arbelbide 1997). Relationships among changes in the hydrologic regime of a stream, effects on channel morphology, and the consequent suitability of aquatic habitat are discussed further in the following Channel Morphology section of this document.

Timber harvest activities can alter relationships among water infiltration, soil moisture storage, groundwater recharge, evapotranspiration, surface runoff, and stream flows. Depending on vegetation characteristics, the extent and intensity of timber harvest, and the amount of soil disturbance and compaction, hydrologic effects resulting from past forest land management activities can last 3 to 4 decades or more (USDA and USDI 1997). In general, the higher the level of disturbance in headwater areas, the greater the risk of hydrologic impact during high-flow events (DEIS/NFHCP 1999).

Chamberlin et al. (1991) discussed how forest management activities can influence components of the hydrologic cycle and some of the consequent effects on salmonid habitats. In discussing regional variations in streamflow response, the authors stated that, in general, forest management activities influence salmonid habitats when they cause changes in the normal regional streamflow pattern at the extremes. In other words, forest management activities influence salmonid habitats by increasing or decreasing the normal levels or occurrences of very high (peak) or very low (base) flows. Chamberlin et al. (1991) also provided the following broad generalizations regarding the effects of timber harvest activities on water balance:

- Harvesting activities (e.g., road-building, falling, yarding, and burning) can affect watershed hydrology and streamflow much more than other management activities (e.g., planting and thinning).
- Clearcutting causes increased snow deposition in the openings and earlier and quicker snowmelt. These effects can continue for several decades until stands are similar to the surrounding forest.
- Compared to unlogged areas harvested areas contain wetter soils during periods of evapotranspiration, higher groundwater levels, and potentially more late-summer runoff. These effects can continue for 3 to 5 years until new root systems become established.
- Road systems, skid trails, and landings accelerate slope runoff, concentrate drainage downslope, and can increase soil water content.

The amount of discharge in a stream affects the amount salmonid habitat available seasonally. Timber harvest and building roads can affect streamflow by altering water availability to streams and the extent of alteration depends on the timber harvest method and extent of trees removed from the logged area (Palmisano et al. 1993). Changes can occur to base flows (low flows), peak flows, and water in yield in a watershed (Spence et al. 1996). A major concern are the changes in low flow or base flow which typically increases after timber harvest. Although increased base flows can benefit salmonids by maintaining higher water levels, benefits can be short-lived as vegetation recovers and flows decrease below preharvest levels because rapidly growing trees use more water than mature trees (Hicks et al. 1991). Decreased base flows, especially at critical low-flow periods in late summer, can diminish available fish habitat and increase stream temperatures (Chamberlain et al. 1991; Murphy 1995).

In general, peak flows increase after timber harvest because water is routed more quickly to streams (Chamberlain et al. 1991; Murphy 1995; Beschta et al. 1995). Several studies have shown increases in peak flows of 10-200 percent while other studies have indicated no change (Spence et al. 1996). In those areas where there were increases in peak flows, water delivery was thought to have increased from rain-on-snow events of the transient snow zone where the vegetation removal occurred (Harr 1986). Troendle and King (1985) observed that peak snow melt flows averaged 20 percent greater after a forest was logged in small patches. Timber stands opened by harvesting are subject to stronger winds thus increasing the melt rate, particularly in clear-cuts. Twenty-two percent more water flowed from a recent clear-cut than an adjacent old-growth Douglas-fir stand during a 2-year rain-on-snow event (Berris and Harr 1987), and a 13.7 percent increase in peak winter flows was observed after only 19.2 percent of a watershed in British Columbia was clear-cut (Golding 1987 as cited in Chamberlain et al. 1991). Although studies have shown increases in the size of peak flows after timber harvest, the effects are variable and not well-documented; nevertheless fish habitat can be affected in areas where peak flows increase (Chamberlain et al. 1991; Spence et al. 1996) resulting in channel changes such as channel scour killing incubating eggs (Murphy 1995) and in pool volume and pool frequency (Sullivan et al. 1987) which can displace juvenile salmonids from winter cover (Tschaplinski and Hartman 1983).

Further, peak flow increases have been demonstrated in watersheds where road densities are high (Harr et al. 1975).

Water yield can increase following logging, but the extent of increase depends on the forest vegetation removed, climatic conditions, and the percentage of land area harvested and roaded. In general, the increase in water yield is directly proportional to the area harvested (Spence et al. 1996). Small patch cuts probably result in less water yield than large clear-cuts, and selective thinning or selective harvest may also have minimal impact on water yield (Beschta et al. 1995). Bosch and Hewlett (1982, as cited in Spence et al. 1996) after reviewing over 90 studies that water yield usually increases after 20-30 percent of the watershed has been harvested. These effects may persist until revegetation recovery approaches which can take 30 to 40 years assuming no further disturbance (Spence et al. 1996). Higher yields in logged watersheds can occur in the spring in snow-dominated systems and in rain-dominated systems the greatest flows can occur in the fall with the onset of fall rains (Spence et al. 1996).

As discussed previously, hydrologic and sediment regimes can be altered by vegetation removal, site disturbance, and soil compaction associated with timber harvest (USDA and USDI 1998a). The nature and magnitude of these changes is mediated by local climatic, geologic, and topographic characteristics as well as revegetation patterns (Spence et al. 1996). Harvest and site preparation that disturbs soils such as tractor skidding, cable yarding, burning and scalping, or scarification alter the ability of soils to accept water, increasing the potential for overland flow, and altering normal pathways for water entry to streams (Chamberlain et al. 1991). Canopy removal also alters the amount (Troendle and Olsen 1993), frequency, and intensity of precipitation delivery to forest floors. These disturbances may also lead to increased amounts of sediment introduced into streams and mobilization of sediments within the stream channel, mediated again by local conditions.

Roads can alter both subsurface and surface water flows, which, in turn, may alter both peak and base stream flows (USDC 1997; Jones and Grant 1996). Furniss et al. (1991) reported the primary negative affects of roads on streams are sedimentation and stream channel changes, but that other adverse effects can include changes in rainfall-runoff relationships, hillslope drainage, and possibly chemical contamination. Roads can affect hydrologic regimes by interrupting hillslope drainage patterns, which can alter the magnitude and timing of peak flows and change base flows of streams (Quigley and Arbelbide 1997). However, several authors report there is some uncertainty regarding the exact effects of forest roads on the size and timing of peak flows (Jones and Grant 1996; Thomas and Megahan 1998). The impermeable surfaces of roads and their cutbanks and ditches can result in less water infiltration and more surface runoff. Roadcuts also can intercept subsurface flow and direct it to stream channels (USDA and USDI 1997). In addition, roads can cause changes in the watershed area of small streams, the timing of water yields to channels, and consequently the hydrologic behavior of small streams (Furniss et al. 1991).

The construction, use, and maintenance of forest roads has been shown to be a primary source of sediment impacts in developed watersheds (USDA and USDI 1998a; also, see preceding section on Sedimentation). Lee et al. (1997) noted that although improvements in road construction and logging methods can reduce sediment delivery to streams, sedimentation increases are unavoidable even when utilizing the most cautious logging and construction methods. The FWS (1998a) reported in the final Biological Opinion that bull trout are very sensitive to sediment increases, hydrologic alterations, and impacts to stream structure and function imposed by extensive road networks and high road densities. Roads also are conduits for a host of related impacts, such as noxious weed introductions, illegal transplants of predatory or competing non-native fishes, increased harvest pressure and potential for poaching, dispersed recreation impacts, and potential introduction of toxicants from spills and roadside application of herbicides.

As stated above, even the most cautious road construction methods are likely to yield some degree of impact. Lee et al. (1997) noted that even though the threshold of negative response of streams and watersheds to road-induced sedimentation and hydrologic modification is not well known, an overall pattern related to road densities can be identified. They found a significant correlation between bull trout status classification and geometric mean road density ($p=0.0001$), while Quigley and Arbelbide (1997) found the correlation to be negative. Bull trout were indicated as being absent at geometric mean road densities at or above 1.31 miles of road per square mile (mi./mi.^{2}), depressed at or above 0.67 mi./mi.2, and strong at or above 0.18 mi./mi.^{2} (Lee et al. 1997). Correlation between bull trout status classification and geometric mean road density was significant ($p=0.0001$) and negative for the arithmetic mean of upstream road density, with bull trout being absent at a mean road density of 1.71 mi./mi.^{2}, depressed at 1.36 mi./mi.^{2}, and strong at 0.45 mi./mi.^{2} (Lee et al. 1997).

However, these road density analyses and effects of road density on bull trout have been questioned. Hicks (pers. comm., Plum Creek Timber Company, June 2, 1998) noted several weaknesses in the above-referenced analysis, including assumptions made, estimates of road densities, and subjective ratings regarding the "health" of bull trout populations. He addressed the applicability of road/ density as a proximal predictor of bull trout density or habitat quality. Regression analysis was performed on 16 years of redd count data from nine drainages in the Swan Valley. Hicks analyzed road density and density of streams deemed important to bull trout based upon geomorphological conditions. None of the regressions comparing road density with bull trout population indicators were significant. The only regressions that were significant were those that compared stream guilds with bull trout density indicators. Hicks concluded that any relationship that may be suggested between road density and bull trout density is neither statistically relevant nor predictive in explaining bull trout "health." He further concluded that the proximal effects of roads (e.g., sediment) on bull trout habitat can be better addressed by assessing road design, drainage conditions, and implementation of best management practices, than by addressing road density alone.

McGreer et al. (1998) reached a similar conclusion in their review of an analysis correlating increased road density with declines in four anadromous salmonid species. They examined the

Columbia River Basin Ecosystem Management Project Assessment of Ecosystem Components in the Interior Columbia River Basin (Quigley and Alberbide 1997). McGreer et al. (1998) found this work relied on simplified assumptions, dismissed many other factors of decline, and ignored specific cause and effects of road design, location, construction, and maintenance.

Chamberlin et al. (1991) reported the primary water quality constituents that may be influenced by timber harvesting are temperature, suspended sediment, dissolved oxygen, and nutrients. These same constituents can be directly or indirectly affected by road and range management practices, as well. The potential effects of forest, road, and range management practices on water temperatures and stream sedimentation, and the resultant effects on salmonid habitat, were discussed in detail earlier in this document under the headings Stream Temperature and Sedimentation. Chamberlin et al. (1991) noted that for dissolved oxygen, concentrations in intergravel spaces may be reduced if deposits of fine sediment restrict the flow of water through the streambed, potentially adversely affecting incubating or pre-emergent individuals. Dissolved oxygen levels in the water column also can be depressed during extreme low-flow periods, especially during warm summer months, and adversely affect aquatic organisms.

Chamberlin et al. (1991) reported that concentrations of inorganic nutrients (e.g. nitrogen and phosphorus) may increase in streams following logging, but usually only for short periods and by moderate amounts. In nutrient-limited streams, large algal blooms triggered by the release of the limiting nutrient into the water column can potentially harm salmonid production if algal remnants settle into intergravel spaces and their decay reduces dissolved oxygen levels (Chamberlin et al. 1991). Runoff contaminated by livestock wastes also can contribute to high instream nutrient levels and algal blooms (see below).

Overgrazing by livestock can damage, reduce, or eliminate vegetative cover, reduce soil structure, and increase soil compaction, thereby contributing to an increased rate and erosive force of surface runoff (Quigley and Arbelbide 1997). Soil compaction in both upland and riparian areas caused by livestock trampling can increase overland erosion and alter runoff patterns, which can contribute to stream channel instability, reduced streamflow late in the season, and poor infiltration rates (MBTSG 1998; Mosley et al. 1997). Compacted soils will cause water to move laterally over the land surface and potentially cause increased erosion and sediment delivery to the stream. In addition, compacted soil can inhibit the development of effective root structures for vegetation, which could ultimately lead to reduced plant vigor and changes in species composition. Soil compaction also may result in reduced soil moisture and increased soil temperatures, which can negatively affect plant vigor and groundwater temperatures, which, in turn, can greatly modify stream temperatures (Mosley et al. 1997).

Hydrologic functions associated with riparian areas that can be affected by livestock grazing include water filtration, water storage, and groundwater recharge. Platts (1991) stated that livestock grazing can alter water column characteristics by causing increases in water temperature, nutrients, and suspended sediment, and by causing changes in streamflow volume and timing. Several studies have compared fish abundance in stream reaches grazed and ungrazed

by cattle and concluded that heavily grazed sites degrade fish habitat and reduce the vitality of fish populations. Platt (1991) summarized 21 studies, most of which showed that improved habitat conditions resulted when grazing was prohibited from the vicinity of streams. Platts (1991) summarized that, generally, salmonid populations in streams passing through grazed areas are reduced compared to ungrazed areas because of more fine sediment in stream channels, more unstable and fewer undercut stream banks, and higher summer water temperatures.

Livestock use of stream crossings and watering areas, which are often located in reaches used for spawning, can directly impact fish survival (MBTSG 1998). Livestock use of these areas exposes fish redds and incubating eggs to direct mortality by trampling or by dislodging and exposing eggs. Indirect effects of livestock use may result from adult salmonids being harassed off of spawning redds. The more this happens, the less likely successful spawning will occur. However, interruption of spawning behavior, if temporary and infrequent, may not impede redd construction and spawning behavior.

Livestock grazing in riparian areas can result in the loading of surface water with fecal coliform bacteria , which can be significant (Mosley et al. 1997; Quigley and Arbelbide 1997; Platts 1989, 1991). As reported in Mosley et al. (1997), fecal coliform counts increased five to ten fold over ungrazed areas in several western states. The intensity of grazing or stocking rates often determines whether water quality standards for fecal coliform counts are violated. However, some investigators report that the amount of time cattle have access to a stream may influence bacterial concentration more than stocking rate. Violation of water quality standards could indicate presence of pathogens such as salmonella. Mosley et al. (1997) reported that investigators have observed survival of fecal coliform in feces for at least 18 weeks, long after cattle may be removed. Some studies have shown that fecal bacteria collect and proliferate in bottom sediments of streams; disturbance of stream bottom materials, either because of animal traffic or storm events, can resuspend fecal bacteria to the degree that concentrations can reach 2.4 to 110 times background levels (as reported in Mosley et al. 1997).

Water quality and anadromous and resident fish species can be adversely affected by the accidental introduction of forest chemicals and petroleum products to drainages during forest, road, and range management activities. Norris et al. (1991) discussed the potential effects on water quality of forest chemicals, which they categorize as pesticides, fertilizers, and fire retardants. Pesticides are grouped according to the type of pest they are intended to control (e.g., herbicides, insecticides, fungicides, rodenticides, etc.), with fewer than 10 pesticides receiving substantial use in forestry. Fertilizers are applied annually to a relatively small portion of commercial forest land, often where soils are nitrogen- or phosphorus-deficient. Application of fire retardants usually increases the concentration of ammonia (nitrogen) in stream waters. Lee et al. (1997) reported that agricultural herbicides and fertilizers may persist and occur in groundwater samples.

Norris et al. (1991) reported that, depending on various factors, the use of forest chemicals can result in both direct and indirect effects, or no effects, on salmonids and their habitats. For a direct

effect to occur, the organism and chemical must come in physical contact via water, food, or sediment. The chemical must then be taken up by the organism and migrate to the site of biochemical action in an active form and at a high enough concentration to cause a biological effect. Indirect effects are caused by a chemically induced-modification of habitat. Indirect effects may include insecticide-induced decreases in the instream food supply (aquatic insect biomass) for salmonids, and herbicide-induced reductions in riparian cover, shade, and associated terrestrial insects.

Processes by which forest chemicals can enter surface waters include direct application, drift from nearby application areas, and mobilization of chemicals in dry stream channels during storms following application. Norris et al. (1991) added that the potential for chemical entry intro streams can be minimized and, therefore, the likelihood for direct toxic effects on stream organisms can be reduced by the following:

- selecting and orienting spray units to avoid streams
- paying attention to the details of the application to avoid drift and direct application to surface water
- using buffer strips along streams

Norris et al. (1991) added that indirect effects from applying forest chemicals may be more likely to occur than direct effects. Furniss et al. (1991) reported that wherever roads are near streams or road drainages enter streams, a potential chemical-spill hazard exists. Chemicals used to suppress dust, control or fertilize roadside vegetation, and stabilize or deice road surfaces also can enter streams directly or be transported by runoff. There is similar potential for adversely affecting water quality, aquatic habitat, and aquatic organisms because of possible spills and leaks of petrochemical products (fuels, lubricants, hydraulic fluids) along roads or at activity sites near drainages.

Water quantity and quality, and subsequently fish habitat, also can be affected by the presence of irrigation diversions and storage reservoirs. Lee et al. (1997) reported that stream flow alterations from dams and irrigation diversions can degrade aquatic integrity for resident and anadromous native salmonids. For example, certain drainages in the action area, such as the Yakima River Basin and to a lesser extent, the Lewis River and Cowlitz River sub-basins in Washington, have a large number of irrigation diversions and storage reservoirs. Potential effects associated with diversions include the delivery to streams of agricultural chemicals and silt present in irrigation return flows; diversion of water from streams, making streams unusable at certain times of the year for certain life stages of fish; reduction in a stream's capacity to transport sediment; and exacerbation of water temperature problems because of low stream flows. Potential effects associated with reservoirs used to store irrigation waters are the creation of stream flows that are much high than natural when water is being released from reservoirs and much lower than natural when reservoirs are being filled. As a result, fish spawning, migration, and rearing can be disrupted by either high flow or low flow. These same effects on bull trout were also discussed by the FWS (1998a) in the final Biological Opinion for that species.

Changes in the distribution of native salmonids can be affected, in part, by functions and processes directly or indirectly related to changes in water quantity and quality. Henjum et al. (1994) in ICBEMP (1997) reported that on National Forests in the Upper Columbia River Basin east of the Cascade crest in Oregon and Washington, where summer air temperatures are generally much higher than 80 °F, many streams have lost their capability to support cold water species of fish. Stream temperatures are affected by reduced stream-side shading, disrupted surface flows, reduced stream flows, elevated sediment levels, and morphological shifts in stream channels. Additionally, sediment loads that exceed background levels can fill pools, silt spawning gravels, decrease channel stability, and modify channel morphology, negatively affecting the suitability of habitat for salmonids beyond temperature concerns (Beschta et al. 1987; Everest et al. 1987; MBTSG 1998; Swanson et al. 1987). Bull trout are especially sensitive to hydrologic alterations due primarily to the extended period of time (220+ days) from egg deposition to fry emergence spent within the streambed (FWS 1998a). Hydrologic changes that alter normal bedload movement and scour and fill patterns can excavate or bury redds, exposing eggs to stream flow, and trapping or crushing eggs or fry. Increasing levels of fine sediments affect developing eggs by filling interstitial spaces within stream substrate, reducing or eliminating water flow through the redd, supply of oxygen to developing eggs, and removal of waste products, and may be sufficient to reduce or eliminate the ability of juvenile fish to emerge from the redd (FWS 1998a). Rieman and McIntyre (1993) reported that activities influencing normal stream flow patterns and the frequency of extreme flow events that impact stream substrates are important factors in population dynamics. They stated that maintaining bull trout habitat requires flow and stream channel stability.

Most streams, rivers, and lakes in the NFHCP area have water quality that currently meets state standards. About 8 to 12 percent of stream miles in the area are currently water quality limited, either by temperature (3 to 6 percent), nutrients (0 to 4 percent), sediment/siltation/turbidity (9 to10 percent), or flow impairment (3 to 6 percent) (Lee et al. 1997). There are 42 reaches of 303(d) listed streams in the NFHCP area, all in Montana, that have been assigned a TMDL priority of high, moderate, or low. High priority has been assigned 5 of the 42 reaches, primarily because of mining-related water quality impairment. TMDL priority is moderate in 8 of the reaches and low in 28 of the reaches, reflecting agricultural, silviculture, mining, and/or highway and road related effects. TMDL priority has not been assigned in one reach (DEIS/NFHCP 1999). Reaches of certain drainages in 6 of the 15 NFHCP action area sub-basins have impaired water quality conditions that may threaten some subpopulations of bull trout (FWS 1998a).

Plum Creek activities that could potentially have an effect on water quality include silvicultural and related practices such as tree planting, site preparation, prescribed burning, timber harvest, and stand maintenance, retrieval of forest products other than timber, construction of electronic sites, other land use (e.g., development), operation of manufacturing mills, fish habitat restoration, cattle grazing, and road management, including gravel quarrying for road construction, logging road construction, and logging road maintenance. Plum Creek will not receive incidental take authorization for use of forest chemicals under the NFHCP and permit. Point source water

discharges resulting from activities in the covered lands in the NFHCP area are limited to forest products manufacturing sites located in Columbia Falls, Kalispell, Fortine, and Pablo, Montana. Monitoring is and will continue to occur to ensure that discharges from these sites conform to specified limits, which are regulated under State water quality discharge permits.

Channel Morphology

Stream channel morphology is often described in terms of width/depth ratio related to bank full stage cross-section (Rosgen 1996). Studies of watershed function have confirmed that changes in bankful channel dimensions correspond to changes in the magnitude and frequency of bankful discharge. These changes in bankful discharge can and do result from activities such as; forest clear cutting, vegetation conversion, roads, over-grazing, and other watershed changes (Rosgen 1996).

Channel condition and dynamics indicators which are generally considered to be functioning appropriately are: having an average wetted width/maximum depth ratio in scour pools in a reach of ≤ 10; >80 percent of any reach has $\geq$90 percent stability; and off-channel areas are frequently hydrologically linked to main channel with overbank flows that occur and maintain wetland function, riparian vegetation and succession (FWS 1998a).

In streams, channel morphology is largely influenced by geomorphic setting and riparian vegetation (Sullivan et al. 1987 cited in Murphy 1995), and by climate (Leopold 1994) such as the frequency of rain and snow. Other factors influencing channel width/morphology are changes in sediment and streamflow regime, channelization, changes in riparian vegetation that can influence bank characteristics, and solid structures, such as LWD, bedrock, and boulders (Murphy 1995; Rosgen 1996). Structurally diverse streams in watersheds unmodified by human activity typically have a great deal of buffering capacity to moderate the effects of floods on channel patterns and bed configuration (Cross and Everest 1995).

Off channel areas need to be hydrologically linked to the main channel, and overbank flows need to occur to maintain wetland function , riparian vegetation, and succession. Streambanks need to be maintained with riparian vegetation to ensure stability and minimize sediment input. Intact off channel areas that are functioning properly help dissipate the energy of water during high flow events and provide additional shoreline habitat at higher flows that can be used by bull trout.

Habitat components representative of stream channels where channel morphology is considered stable and complex are: large and diverse pools; large woody debris; overhanging vegetation; undercut banks; cobble and boulder substrate; water depth and turbulence; aquatic vegetation; diverse stream margins; side channels; groundwater-surface water linkages; and connectivity (Graham et al. 1981; Pratt 1984; Hoelscher and Bjornn 1989; Goetz 1991; Pratt 1992; Murphy 1995).

Bull trout are known to be associated with large pools, consisting of a wide range of water depths, velocities, substrates, and cover (Watson and Hillman 1997). Large woody debris in streams enhances the quality of habitat for salmonids and contributes to channel stability (Bisson et al. 1987). It creates pools and undercut banks, deflects streamflow, retains sediment, stabilizes the stream channel, increases hydraulic complexity, and improves feeding opportunities (Murphy 1995). By forming pools and retaining sediment, LWD also helps maintain water levels in small streams during periods of low stream flow (Lisle 1986 cited in Murphy 1995). Cover is a component of habitat complexity used by bull trout at all life-history stages.

Bull trout show strong affinity for stream bottoms and a preference for deep pools of cold water streams, lakes and reservoirs (Goetz 1989). Because of this strong association with the stream bottom throughout their life history, they can be adversely affected by human activities that directly or indirectly change substrate composition and channel stability. Cobble or fist-size stones provide the most favorable streambed habitat for stream algae and invertebrates, in turn influencing the amount of benthic biomass available to sustain various fish species (Goldeman and Horne 1983). Stream channels that are either lacking cobble size substrate, have elevated cobble embeddedness, or are unstable in nature (shift or scour), generally will have less abundant aquatic insects and will have decreased species diversity.

Groundwater-surface water linkages have also been shown to be important habitat components for bull trout. These important groundwater sources can be diminished to rare or widely separated in disturbed systems where channel morphology has been simplified (Frissell 1996 in Frissell 1999). Bull trout spawning areas have been shown to be associated with zones of strong groundwater upwelling in Swan sub-basin streams and the Metolius River (Baxter 1997 in Frissell 1999; Goetz 1997 in Frissell 1999). As indicated below under "refugia", these groundwater upwelling sources are also important as early rearing and wintering habitat, and sometimes are critical as localized thermal refugia (Frissell 1999).

Bull trout are a wide-ranging species with different habitat requirements at specific life history stages (MBTSG 1998). Migratory corridors provide the necessary connection between bull trout spawning, juvenile rearing, sub-adult rearing, and adult over-wintering and foraging areas (Rieman and McIntyre 1993). Disruption of migratory corridors can increase stress, reduce growth and survival, and potentially lead to the loss of the migratory life-history types (Rieman and McIntyre 1993). In general, it is necessary to provide bull trout access to a large, connected, high quality, freshwater habitat that includes cool temperature, deep pools, large wood, low substrate embeddedness, unimpaired flow regime and channel floodplain interactions.

Watershed disruption is a factor that has played a role in the decline of bull trout. Changes in or disruptions of watershed processes likely to influence characteristics of stream channels are also likely to influence the dynamics and persistence of bull trout populations. Bull trout are more strongly associated with the habitat characteristics of stable stream channels of only lightly disturbed sub-basins (Brown 1992; Clancy 1993; Cross and Everest 1995; Dambacher and others, in press; Huntington 1995b; Ratliff and Howell 1992).

It is well understood that many land use practices can directly or indirectly promote a more simplified channel morphology. As channels are simplified, connectivity of surface waters with the floodplain and hyporheic zone is lost (Stanford and Ward 1992; Stanford and Ward 1993; Ward 1993, all in Frissell 1999). Deforestation of floodplain surfaces for agriculture, timber harvest, and transportation systems permanently decouple many of the key physical processes responsible for maintaining natural channel complexity (Stanford and Ward 1992 in Frissell 1999).

Land management activities can alter processes that create and maintain riparian and aquatic habitats, often resulting in reductions of habitat complexity and the diversity of aquatic species (Elmore and Beschta 1987; USDA et al. 1993). In watersheds containing bull trout, changes in habitat features associated with reductions in habitat complexity and functional capacity include decreases in: LWD; pool quality; channel stability; substrate quality; groundwater inflows; and suitable habitat serving as corridors between habitat patches (e.g., resulting from increases in water temperature [MBTSG 1998]).

The magnitude and behavior of groundwater and flow exchange processes can be altered by human land use activities. Sedimentation appears to play an important role in decoupling this exchange, especially when chronic increases in fine sediment are experienced (Brunke and Gonser 1997 in Frissell 1999). It is possible for fine sediment to seal downwelling sites that could in turn reduce upwelling at discrete points many hundreds or thousands of meters down valley (Frissell 1999). Frissell (1999) states "it is almost certain that accompanying surficial morphological simplification is a proportional reduction of groundwater-surface water exchange, reduced areal incidence or magnitude of upwelling, and loss of thermal refugia".

Sedimentation also reduces pool depth, alters substrate composition, reduces interstitial space, and causes channels to braid (Rieman and McIntyre 1993 citing others). Impoundments and diversions have altered natural sediment transport processes, causing deposition of fine sediments in slackwater areas, reducing flushing of sediments through moderation of extreme flows, and decreasing recruitment of coarse material (including spawning gravels) downstream of the obstruction (Spence et al. 1996).

Forest management activities, including timber extraction and road building, affect stream habitats by altering recruitment of large woody debris, erosion and sedimentation rates, runoff patterns, the magnitude of peak and low flows, and annual water yield (Cacek 1989; Furniss et al. 1991; Wissmar et al. 1994; Spence et al. 1996). Activities that promote excessive substrate movement lower bull trout production by increasing egg and juvenile mortality, and reduce or eliminate habitat important to later life-history stages, such as when pools are filled with substrates (Shepard et al. 1984; Fraley and Shepard 1989; Brown 1992). The length and timing of bull trout egg incubation and juvenile development (typically more than 200 days during winter and spring) and the strong association of juvenile fish with stream substrate make bull trout vulnerable to changes in peak flows and timing that affect channels and substrate (Shepard et al. 1984; Goetz 1989; Pratt 1992).

Logging and road building in riparian zones reduce stream shading and widen stream channels, allowing greater sunlight penetration, surface water warming, and winter anchor ice formation which may cause bank erosion and sediment inputs (Swanston 1991; Beschta et al. 1987; Chamberlain et al. 1991). Logging in riparian areas reduces recruitment of large woody debris, thereby reducing stream habitat complexity. Loss of riparian vegetation destabilizes streambanks and increases erosion and sediment delivery to streams. Road construction that involves channelizing streams may cause reduced habitat complexity and increased sediment delivery.

Another important product of forest cover removal is increased microclimate and soil temperature extremes (Viereck et al. 1993; Bosofske et al. 1997, both in Frissell 1999). These changes increase the incidence of soil freeze-thaw episodes that promote both soil creep and bank wasting (Duijsings 1985; Kirkby and Carson 1972, both in Frissell 1999).

Floods or high flows have also been altered by land management (USDA and USDI 1997). Roads and clear cutting forested areas tend to magnify the effects of floods, leading to higher flows, erosion and bedload that scour channels (Furniss et al. 1991; McIntosh et al. 1994; USDA and USDI 1997), and degrade bull trout habitat (Henjum et al. 1994). Erosion from road landslides increases bedload to high stream flows over bedload levels without roads (Furniss et al. 1991). Increased bedload exacerbates the scouring effect of high water, increasing channel instability, leading to a loss of habitat diversity, especially pools (Henjum et al. 1994; McIntosh et al. 1994). Bull trout eggs and fry in the gravels during the scouring likely survive at lower rates (Henjum et al. 1994).

Large pools have been lost in many tributaries of the Columbia River in the past 50 years (Sedell and Everest 1991; McIntosh et al. 1994; U.S. Forest Service 1996). Overall, there has been a 58 percent reduction in the number of large, deep pools in resurveyed streams in National Forests within the range of the northern spotted owl in western and eastern Washington (USDA et al. 1993). A similar trend is apparent on private lands in coastal Oregon where large, deep pools decreased by 80 percent (USDA et al. 1993). In western Washington, Bisson and Sedell (1984), reported a similar loss of pools in sub-basins with moderate to intensive levels of timber harvest. Historical grazing practices in eastern Oregon have contributed to degraded riparian zones with reduced summer flows in streams, unstable and eroding stream banks, and reduced productivity of fish and wildlife (Elmore and Beschta 1987). Reduction of wood in stream channels, either from present or past activities, generally reduces pool frequency, quality, and channel complexity (Bisson et al. 1987; House and Boehne 1987; Spence et al. 1996). Road construction and timber harvest on unstable slopes can result in the loss of pools due to mass wasting and sedimentation (Janda et al. 1975; Morrison 1975; Swanson and Dyrness 1975; Ziemer and Swanston 1977; Betcha 1978; Ketcheson and Froehlich 1978; Marion 1981; Swanson et al. 1981; Coats 1987; Kelsey et al. 1981; Madej 1984; Nolan and Marron 1985; Grant and Wolff 1991).

Channel morphology can also be altered by improper livestock grazing. Decreased pool volume and quality, increased channel width, and loss of undercut banks are habitat components affected by removal of streamside vegetation and streambank erosion. Stream width normally increases

when subjected to heavy grazing and normally decreases when livestock are removed. Platts (1981) observed reduced water velocities (i.e. increased stream width and lower water tables) in a stream subjected to heavy grazing. Clifton (1989) reported that stream depths were maximum through ungrazed portions of the study area and that over a 50-year period without grazing, a 94 percent reduction in channel cross section area occurred. In streams passing through grazed areas water surface area increased and water depth decreased according to one study (Platt 1991). Platt (1991) reported that when domestic livestock are removed from watersheds, various studies have shown stream reductions ranging from 10 percent to 400 percent.

Livestock grazing can promote incised channels, reduced pool frequency, increased soil erosion, and altered water quality (Platts 1981; Kauffman and Krueger 1984; Henjum et al. 1994; Overton et al. 1993). These effects increase summer water temperatures, promote formation of anchor ice in winter, and increase sediment into spawning and rearing habitats. Overall, cover for bull trout is reduced and occupied bull trout habitat is negatively affected by livestock grazing (Howell and Buchanan 1992; Mullan et al. 1992; Platts et al. 1993; R. Uberuaga, Payette National Forest, *in litt.* 1993; Henjum et al. 1994; MBTSG 1995a,b,c; USDA and USDI 1996,1997).

Irrigation diversions, culverts, and degraded mainstem habitats have eliminated or seriously depressed migratory bull trout, effectively isolating resident subpopulations in headwater tributaries (Brown 1992; Ratliff and Howell 1992; Rieman and McIntyre 1993; Thurow et al. 1997). Loss of suitable habitat through watershed disturbance may also increase the distance between suitable or refuge habitats and strong subpopulations, thus reducing the likelihood of effective dispersal (Frissell et al. 1993).

Activities that influence the normal patterns of stream flow and the frequency of extreme flow events that impact substrates are anticipated to be important factors in population dynamics (Rieman and McIntyre 1993). With overwinter incubation and a close tie to the substrate, embryos and juveniles may be particularly vulnerable to flooding and channel scour associated with the rain-on-snow events common in some parts of the range within the belt geography of northern Idaho and northwestern Montana (Rieman and McIntyre 1993). Channel dewatering tied to low flows and bed aggradation has also blocked access for spawning fish resulting in year-class failures (Weaver 1992).

Overall, there is a lack of connectivity among subpopulations. Isolating mechanisms that have resulted in the loss of migratory bull trout (Rieman and McIntyre 1993) include, physical passage blockages at mainstem impoundments that have isolated whole sub-basins (Brown 1992; Pratt and Houston 1993; Rieman and McIntyre 1995), water diversions preventing spawners access to formerly suitable habitat, and thermal passage barriers at both tributary and mainstem scales. Intervening areas of poor habitat quality may also limit dispersal of resident forms.

Consequently, activities such as those described above have compromised channel morphology resulting in many bull trout subpopulations to be confined to smaller headwater streams that have been minimally affected by human caused habitat alterations. Small, isolated subpopulations are

more likely than larger subpopulations to go extinct over long time scales due to stochastic events (e.g., landslides, catastrophic fires, and floods). Further isolation of subpopulations in shrinking habitat will probably lead to increasing rates of extirpation not proportional to the simple loss of habitat area (Lee et al. 1997). As subpopulations become fragmented and isolated, local extinctions become permanent, making the extirpation of other subpopulations more likely (Rieman and McIntyre 1993). Meffe and Carrol (1994) cautioned against managing for unnaturally small populations, and urge that gene flow among historically connected populations should continue at historical rates.

Maintaining bull trout habitat requires stream channel and flow stability (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997; Watson and Hillman 1997; MBTSG 1998). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period and channel instability may decrease survival of eggs and young juveniles in the gravel during winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Houston 1993).

Complex aquatic habitats are necessary to accommodate the diverse needs of various salmonid species (Murphy 1995; Spence et al. 1996). Complex habitats not only provide salmonids with critical habitat for all life-history stages in freshwater, but provide refuges from environmental variability (e.g., extreme flows) and stochastic events (e.g., catastrophic fires), buffering populations from the effects of environmental perturbations (Sedell et al. 1990; Rieman and McIntyre 1993). Because most bull trout spend their entire life in freshwater, they are more sensitive to habitat disturbance than anadromous salmonids (Balon 1980; Rieman and McIntyre 1993). Bull trout are strongly associated with various components of habitat complexity, including cover, LWD, side channels, undercut banks, boulders, pools, and interstitial spaces in coarse substrate (Rieman and McIntyre 1993; Jakober 1995; MBTSG 1998).

For spawning, bull trout prefer loose, clean gravels and cobbles located at runs or tails of pools (McPhail and Murrey 1979; Fraley and Shepard 1989; Baxter and McPhail 1996). Due to the bull trout's extended residency in the gravel (220+ days from egg deposition to emergence), eggs, alevins, and fry are highly vulnerable to bedload movements and deposition of fine sediments. Unembedded substrate provides an important cover element for juvenile bull trout, especially in areas lacking other forms of cover (Goetz 1989; Pratt 1992; Baxter and McPhail 1996; Thurow 1997). Juvenile bull trout densities decrease with increasing embeddedness of substrate (Shepard et al. 1984; Enk 1985; Pratt 1992).

Young bull trout are closely associated with stream channel substrates. Incubation occurs over a prolonged period through the winter. Juvenile fish are found in close association with the bottom of the channel, often using substrate for cover (Fraley and Shepard 1989; Oliver 1979; Pratt 1984; Shepard and others 1984b). The association with substrate appears more important for bull trout than for other species (Nakano and others 1992; Pratt 1984). The extended tie to substrate and

the presence of embryos and alevins in substrate during winter and spring suggests that highly variable stream flows, bed load movements, and channel instability will influence the survival of young bull trout (Goetz 1989; Weaver 1985). Low habitat complexity, the frequency of bed load scour, and the frequency of low flows (which may cause freezing within the substrate) may be aggravated by watershed disruption and problems of channel instability in many bull trout streams (Elwood and Waters 1969; Seegrist and Gard 1972; Wickett 1958).al. 1Cover is another important component of habitat complexity that is used by bull trout at all life-history stages. Cover can include woody debris, overhanging vegetation, undercut banks, cobble and boulder substrate, water depth and turbulence, and aquatic vegetation (Graham et al. 1981; Pratt 1984; Hoelscher and Bjornn 1989; Goetz 1991; Pratt 1992; Murphy 1995). Larger adult bull trout tend to utilize deep water habitats such as pools or deep runs for security. When these habitats are lost or reduced in complexity, bull trout face greater risks of predation, harvest, and poaching. Because larger bull trout are more fecund than smaller fish, their contribution to a population may be disproportionate to their abundance. Loss of larger fish from habitat perturbations and collateral mechanisms, lowers the potential growth rate of a population and makes it more vulnerable to other factors.

Other life history features of bull trout make them particularly sensitive to activities directly or indirectly affecting stream channel integrity and natural flow patterns (MBTSG 1998). Examples of these life history features and their association with habitat complexity are: extensive spawning and overwintering migrations of adult bull trout, which require a large network of suitable freshwater habitat with migratory corridors; use of deep pools by both adults and juveniles for cover and thermal refuge; selection of redd sites by adults in low gradient reaches and in areas of groundwater influence (pers. comm., C. Baxter, University of Montana); lower gradient sites sometimes located adjacent to channel roughness elements (LWD and boulders) within stream reaches having overall moderate to steep grades; basin wide connectivity as sub-adult bull trout (migratory life-forms) tend to seek a broad range of areas for forage and cool water refugia. As much as half of present bull trout habitat is bordered by non-Federal lands. Migratory corridors link seasonal habitats for all bull trout life- history forms. For example, in Montana, migratory bull trout make extensive migrations in the Flathead River system (Fraley and Shepard 1989) and resident bull trout move to overwinter in downstream pools in tributaries of the Bitterroot River (Jakober 1995). The ability to migrate is important to the persistence of local bull trout subpopulations (Rieman and McIntyre 1993; M. Gilpin, University of California, *in litt.* 1997; Rieman et al. in press).

All biota in streams are influenced by unidirectional current. The greater the discharge and current that a stream experiences is of great importance since it controls the physical structure of the streambed and the amount of suspended material that is transported (Goldman and Horne 1983). When channel morphology/complexity is diminished, greater levels of streambed disturbance can be experienced during high flow events resulting in negative impacts to benthic biota. In turn affecting bull trout at all life-stages and other native salmonids through the loss of food sources.

Populations are likely to be most sensitive to changes that occur in headwater areas encompassing critical spawning and rearing habitat and remnant resident populations. The upstream head of steep channels and other steep hill slope areas are common initiation sites of debris slides and debris flows (Dietrich and Dunne 1978; Grant et al. 1990; Selby 1993). Headwater riparian areas need to be protected, so that adequate materials contributing to complex habitat downstream would be available when debris slides and flows occur (USDA et al. 1993).

Past land management methods such as log drives, splash dams, and stream clean-up activities undertaken to expedite the transport of timber products have had long lasting effects to stream channel function. Activities such as these occurred in many mid and lower channel reaches and have diminished cover through reductions in riparian vegetation and associated decreases in woody debris recruitment, declines in pool size and frequency, and declines in shrub lands (Narver 1971; Sedell and Luchessa 1982; Bisson and Sedell 1984; NMFS 1991; Sedell et al. 1991; Lee et al. 1997).

The observed differences in relative abundance of habitat types in reference watersheds and managed watersheds suggests that in managed watersheds, sediment scoured from heavily roaded and harvested headwater channels aggregates in lower channel reaches (Cross and Everest 1995). This type of aggradation has been shown to form seasonal migration barriers (both upstream and downstream) to adult bull trout in tributaries to Pend Oreille Lake. In addition non-forest roads degrade salmonid habitat by creating flow constraints in ephemeral, intermittent, and perennial channels by increasing erosion and sedimentation; creating passage barriers; channelization; and reducing riparian vegetation (Furniss et al. 1991; Ketcheson and Megahan 1996).

Lower elevation channel reaches historically constituted some of the most important habitats for maturing and overwintering fluvial bull trout. These habitats are more easily developed and have been exceedingly degraded by human activities, resulting in fragmented, isolated local bull trout populations (Rieman and McIntyre 1993; MBTSG 1998). Open migratory corridors, both within and among tributary streams, large rivers, and lake systems are critical for maintaining bull trout populations (MBTSG 1998).

Historically bull trout populations were well connected throughout the Columbia River basin. Habitat available to bull trout has been fragmented, and in may cases populations have been isolated entirely. Dams have isolated whole sub-basins throughout the Columbia River basin (see for example, Brown 1992; Kanda and other, in press; Pratt and Houston 1993; Rieman and McIntyre 1995). Irrigation diversions, culverts, and degraded mainstem habitats have eliminated or seriously depressed migratory life histories effectively isolating resident populations in headwater tributaries (Brown 1992; Montana Bull Trout Scientific Committee, in preparation; Ratliff and Howell 1992; Rieman and McIntyre 1993).

Movement is important to the persistence and interaction of local populations within the larger subpopulations (Rieman and McIntyre 1993). Movement of individuals allows for the full expression of life history forms and survival strategies (Rieman and Clayton 1997). Furthermore,

within the Columbia River basin, bull trout persistence will require improved connectivity among the 141 subpopulations that are not historically isolated by natural barriers or that are not currently at risk of invasion by non-native species. Enhanced connectivity for migratory life forms within bull trout subpopulations is needed to encourage population refounding and to allow gene transfer at historical rates.

Passage Barriers

Overall, in the sub-basins within the action area there is a general lack of connectivity among subpopulations of native fish (Quigley and Arbelbide 1997). Isolating mechanisms that have resulted in the loss of migratory bull trout (Rieman and McIntyre 1993) include, physical passage blockages at mainstem impoundments that have isolated whole sub-basins (Brown 1992; Pratt and Houston 1993; Rieman and McIntyre 1995), water diversions preventing spawners access to formerly suitable habitat, poorly designed culvert installations at forest road crossings that block upstream migrations into spawning and rearing tributaries, and thermal passage barriers at both tributary and mainstem scales.

Habitat fragmentation and the subsequent isolation of bull trout subpopulations is a key factor in the current threatened status of bull trout. Many bull trout subpopulations are currently confined to smaller headwater streams that have been minimally affected by human caused habitat alterations. Small, isolated subpopulations are more likely than larger subpopulations to go extinct over long time scales due to stochastic events (e.g., landslides, catastrophic fires, and floods).

Movement is also believed to be important to the persistence and interaction of local populations within the larger subpopulations (Rieman and McIntyre 1993). Movement of individuals allows for the full expression of life history forms and survival strategies (Rieman and McIntyre 1993). Enhanced connectivity for migratory life forms within bull trout subpopulations is needed to encourage population refounding and to allow gene transfer at historical rates.

Fish usually move upstream to spawn, but they also move to feed, hide and find better habitat as conditions in a stream change over time. Juvenile fish (sexually immature fish) tend to move downstream, but this is not always the case when they are moving in response to unfavorable habitat conditions such as increased stream temperature or fall migrations into overwintering areas. On temperature-sensitive streams, juvenile fish will move upstream if known sources of cool water exist within that system. Juvenile salmon are known to migrate upstream from main stem areas and into small tributary streams, or "off-channel" habitats to overwinter. Adult bull trout are known to move into smaller, colder tributaries from mainstem river systems during the summer in response to increasing river temperatures.

Migratory corridors provide the necessary connection between bull trout spawning, juvenile rearing, sub-adult rearing, and adult over-wintering and foraging areas (Rieman and McIntyre 1993). Disruption of migratory corridors can increase stress, reduce growth and survival, and potentially lead to the loss of the migratory life-history types (Rieman and McIntyre 1993). In

general, it is necessary to provide bull trout access to a large, connected, high quality, freshwater habitat that includes cool temperature, deep pools, large wood, low substrate embeddedness, unimpaired flow regime and channel floodplain interactions.

Culverts, irrigation diversions, and degraded mainstem habitats have eliminated or seriously depressed migratory bull trout, effectively isolating resident subpopulations in headwater tributaries (Brown 1992; Ratliff and Howell 1992; Rieman and McIntyre 1993; Thurow et al. 1997). Loss of suitable habitat through watershed disturbance may also increase the distance between suitable or refuge habitats and strong subpopulations, thus reducing the likelihood of effective dispersal (Frissell et al. 1993).

Forest roads frequently cross streams which typically involve culverts or bridges. Bridges are preferred because they usually cause less physical habitat disturbance of the stream channel than culverts and generally provide better fish passage (Furniss et al. 1991). Poorly designed and installed culverts can act as barriers to migratory and resident fish movements. Barriers at road crossings can be caused by impassable outfalls at culvert exits, excessive water velocity, insufficient water depth in culverts, disorienting turbulent flow patterns, lack of resting pools below culverts, or a combination of these conditions (Furniss et al. 1991). As indicated below, it is apparent that fish passage problems at culverts is an extensive problem in western Montana, on some National Forest lands and some private timber lands as well.

Fish movements may be blocked fully for all fish species and age classes, or fish movements may be impeded fully or partially for certain species and/or age classes depending on the type and timing of the obstruction or barrier. Generally, culverts can impede passage in three different ways: water velocity barriers, depth barriers and/or vertical jump barriers (Bell 1991; Bates 1997; Barber and Downs 1996). Different species and sizes of fish have different swimming abilities. Healthy adult fish swim more strongly than juvenile fish and can pass upstream through a culvert with less difficulty. If the culvert is too long, a fish may become exhausted while attempting to swim all the way through. If the velocity of water in the culvert is too great, a fish will not be able to swim fast enough to overcome it (Bell 1991).

Because the swimming capabilities of most salmonids are known, this information should be considered when designing safe fish passage through culverts (Everest, F.H., N.B. Armantrout [and others] 1985). The value to be used in culvert design should be based on the lowest maximum average water velocity for the weakest-swimming fish requiring passage. In many situations this will be determined by the requirement to safely pass juvenile fish (Bell 1991).

As part of a total maximum daily load (TMDL) assessment, an inspection of potential fish passage for adult westslope cutthroat trout at culverts was conducted in the upper Lolo Creek watershed on the Lolo National Forest (pers. comm., Joe Hoffman and Shane Hendrickson, Lolo National Forest). Field assessments were conducted in the fall of 1999 and culvert flows were modeled in January 2000 using the Forest Service's FishXing program (referenced on the internet at www.stream.fs.fed.us.fishxing). The 32 culverts analyzed all had velocity barrier problems for fish

passage when average velocities were used. When factoring the culvert wall friction (roughness), the situation improved somewhat. Even so, the model predicted less than five of the 32 culverts would pass fish successfully.

As reported in the DEIS/NFHCP (1999), 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 NFHCP covered lands. 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 more precise follow-up evaluation by a fish biologist.

In western Montana, fluvial westslope cutthroat trout are migrating during peak spring flows, usually during May and June. This migration is influenced by water temperature. Resident cutthroat trout have shorter migrating distances than bull trout and will move in relation to spawning, temperature, and winter habitat. Fluvial bull trout migrations are similar to the fluvial westslope cutthroat trout but move primarily on the descending limb of the hydrograph, during the months of June and July. There also appears to be a mid-summer (July/August) run of juvenile bull trout into smaller streams. This secondary migration is believed to be driven by increasing water temperatures within mainstem rivers (USFS memo dated January 6, 2000, between the Forest Fish Biologist and Forest Hydrologist, Lolo National Forest).

Based on the migration and spawning timing, it is recommended that passage for westslope cutthroat trout and bull trout be accounted for during May, June, July, and August on the Lolo National Forest in western Montana (USFS memo dated January 6, 2000, between the Forest Fish Biologist and Forest Hydrologist, Lolo National Forest). Resident fish may be moving at other times of the year, but typically if fluvial migration is provided, resident fish can pass through the culverts as well. At times where flow depths are not sufficient, typically resident fish are holding in pools or between rib formations, and are not moving around anyway. There is concern if a stream does not have overhead tree cover and winter icing becomes a problem that cutthroat can not migrate down to larger waters during the winter. However, if culverts have stream substrates through them, or simulated substrates, they will mimic stream conditions and cutthroat trout should be able to move downstream through the culvert. (USFS memo dated January 6, 2000, between the Forest Fish Biologist and Forest Hydrologist, Lolo National Forest).

Impediment or delay in fish migration often is the result of culvert hydraulics. (Washington Department of Fish and Wildlife 1999). Washington Department of Fish and Wildlife (1999) recommends that the culvert design allow for passage 90 percent of the time during the migration of target species and appropriate age class. Meehan (1991) recommends not providing passage during 5 percent of the year when flows are at their greatest and Baker and Votapka, P.E. (1990, as cited in Meehan 1991) imply that migration delays should not exceed 3 days.

Studies on these swimming speeds have been done for various fish species, mostly anadromous fish. Fish have three basic swimming speeds: cruising, sustained, and dart or burst speeds (Bell 1991; Baker and Votapka, 1990, as cited in Meehan 1991; Everest, F.H., N.B. Armantrout [and others] 1985). Recommendations on the Lolo National Forest in western Montana for culvert design flows for bull trout and WCT are as follows: 1) culvert lengths less than 60 feet, 4.0 feet per second (fps) design flow; 2) 60-99 culvert lengths, 3.0 fps design flow; and 3) 99-198 culvert lengths, 2.0 fps design flows (USFS memo dated January 6, 2000, between the Forest Fish Biologist and Forest Hydrologist, Lolo National Forest).

Minimum water depth is a difficulty that is limited to those structures that have no natural streambed or simulated streambed. The Washington Department of Fish and Wildlife (1999) recommends a minimum depth of 8 inches and Oregon Department of Transportation (1998) recommend a minimum depth of 9.6 inches, based on anadromous fish studies. Based on resident and fluvial bull trout and cutthroat trout having a smaller size than the typical anadromous fish, a 6 inch minimum flow is being recommended for the Lolo National Forest for migratory cutthroat and bull trout during May and June. In July and August when it appears that large, adult bull trout have migrated, depth can be 4 inches to provide for the juvenile run of bull trout (USFS memo dated January 6, 2000, between the Forest Fish Biologist and Forest Hydrologist, Lolo National Forest).

Culverts that are installed with a perched outlet or culverts that cause erosion at the outlet due to inadequate sizing often are characterized by increased pipe velocities which cause scour and a perched condition. This in turn can lead to a vertical barrier. On the Lolo National Forest it is recommended to design new culverts without a vertical jump by placing the culvert on the average natural stream gradient. Also recommended is that existing culverts should be assessed to determine if the water velocity within the pipe is more of a limiting factor that the vertical jump itself. Culverts that are designed for adequate flow, and for bedload and debris passage, and installed on a natural stream gradient would be expected to eliminate the vertical jump problem (USFS memo dated January 6, 2000, between the Forest Fish Biologist and Forest Hydrologist, Lolo National Forest).

In the Bitterroot River sub-basin in Montana, water diversions have virtually eliminated migratory bull trout (Rieman and McIntyre 1993). Diversion dams for irrigation withdrawal of water from forest streams and rivers often impede migration of adult fish or cause juveniles to be diverted into irrigation ditches (Spence et al. 1996). Juveniles, subadults, and adult native salmonid fish are often lost through entrainment at unscreened diversions or impingement on poorly designed screens. The diversion dam structure which often spans the entire channel can create vertical drops that may be an impassable barrier to fish (MBTSG 1998).

Irrigation water withdrawals can affect both the total volume of water available to fish and the seasonal distribution of flow. Most direct diversions from streams and rivers occur from spring through fall which results in reduced summer flows for fish movements. Lower water levels may concentrate fish, which potentially increases predation and competition for food and space.

Reduced water volume and velocities can cause increased water temperatures which may become excessively warm and delay or impede migrations and fish movement into suitable habitat. Irrigation has contributed to the extirpation of salmon and steelhead from many small streams in the Salmon National Forest due in large part to inadequate streamflows as a result of irrigation (Keifenheim 1992).

In western Montana, reductions in flows below irrigation diversions can create seasonal passage barriers for bull trout (MBTSG 1998). Adult bull trout may be blocked from entering into spawning tributary streams during late summer which is a time when reduced stream discharge rates can create thermal barriers to migration. Furthermore, downstream migrating juveniles tend to follow stream margins and commonly get entrained at diversion headgates because they are located along the stream perimeter. Ditches often divert the majority of water from streams and may resemble off-channel habitat which may attract fish into the irrigation ditch (MBTSG 1998). A self-cleaning fish screen at a headgate on the Blackfoot River has proven to stop entrainment of bull trout and has indicated that placement of screens on all headgates below spawning areas in the drainage would eliminate this loss of bull trout (Swanberg 1997).

Refugia

Refugia or refuge habitat for bull trout and other native salmonid fish species is embedded in metapopulation theory and concept. Metapopulation theory suggests that regional populations of a species may persist in variable environments as collections of local populations interacting through dispersal movements (Reiman and Dunham 1999). This concept appears to apply well to salmonid populations that are at risk and is likely common among many species of stream fishes. Well-distributed and interconnected populations of bull trout and other salmonid fishes across the landscape are required to maintain their long-term productivity and survival (Reiman and McIntyre 1993; Rieman et al. 1993). This strategy appears to be highly successful where habitats are capable of supporting strong and significant local subpopulations that are well-distributed and connected for all life stages and life forms. Should a natural disturbance event occur (e.g., fire), these areas where habitats remain undisturbed to act as local refuges can aid recolonization of the disturbed area. However, if refugia habitat is inadequate in terms of size, quality, number, and/or connectivity to maintain all life stages and life forms, the affected fish species are vulnerable to regional extinction (MBTSG 1998).

Habitat fragmentation and the subsequent isolation of bull trout subpopulations is a key factor in the current threatened status of bull trout in Columbia River sub-basins (Lee et al. 1997; Rieman et al. 1997). Many bull trout subpopulations are currently confined to smaller headwater streams that have been minimally affected by human caused habitat alterations. Small, isolated subpopulations of bull trout and other native salmonids are more likely than larger subpopulations to go extinct over long time scales due to stochastic events (e.g., landslides, catastrophic fires, and floods). Further isolation of subpopulations in shrinking habitat are likely to lead to increasing rates of extirpation not proportional to the simple loss of habitat area (Lee et al. 1997). Even with no further habitat loss, extirpation may be likely for many remaining isolated subpopulations (Lee

et al. 1997; Rieman et al. 1997). As subpopulations become fragmented and isolated, local extinctions become permanent, making the extirpation of other subpopulations more likely (Rieman and McIntyre 1993).

Overall, there is likely a lack of connectivity among subpopulations of bull trout and other covered species within the action area of the NFHCP. Migratory corridors provide the necessary connection between bull trout spawning, juvenile rearing, sub-adult rearing, and adult over-wintering and foraging areas (Rieman and McIntyre 1993). Disruption of migratory corridors can increase stress, reduce growth and survival, and potentially lead to the loss of the migratory life-history types (Rieman and McIntyre 1993). In general, it is necessary to provide bull trout and other native salmonids access to a large, connected, high quality, freshwater habitat that includes cool temperature, deep pools, large wood, low substrate embeddedness, unimpaired flow regime and channel floodplain interactions. Therefore, movement of individuals is essential to the persistence and interaction of local populations in order to allow for the full expression of life history forms and survival strategies (Rieman and Clayton 1997).

Habitat fragmentation can cause metapopulation systems to shift to smaller, more isolated units. Barriers such as water diversions, dams, impassable culverts, and dewatered reaches limit or exclude the number of individual fish that can emigrate to spawning and rearing areas. More subtle adverse effects that reduce effective movement of bull trout among refuge habitat within a sub-basin are due to hostile habitat conditions which can increase exposure to predators. Additionally, poor habitat conditions may increase stress or mortality resulting from blockage to thermal refuge habitat. Local refuges provide a protective mechanism against in that where refuges for fish exist in close proximity to a depopulated burned area, recolonization can occur rapidly (MBTSG 1998; Reiman et al. 1995). Reiman et al. (1995) found that bull trout and redband trout were greatly reduced in some stream reaches after an intense burn on the Boise National Forest, but rapidly recolonized the affected reaches.

It is well known that the loss of the migratory life form of bull trout and WCT, and of other salmonid species, has been due to the seriously limited or complete elimination of connecting corridors for dispersal (Reiman and McIntyre 1993; Reiman and Apperson 1989; MBTSG 1998; McIntyre and Reiman 1995). In these cases, refuge habitats become isolated in a system due to lack of connectivity, or due to poor quality interspersed habitats that become limiting for movement among subpopulations so that refounding or support for lost subpopulations is diminished.

Not as obvious as the hydrologic and hydraulic connectivity are other factors such as between surface and subsurface flows. Extensive valley floodplains with alluvial deposits and groundwater flows like those in the Swan Valley in Montana are extremely important to incubation of bull trout eggs where the upwelling of groundwater affects incubation temperatures and reduces the probability that embryos will become dewatered and/or freeze (Weaver and Fraley 1991b). Habitats influenced by groundwater inflows can be critical thermal refugia for riverine bull trout when river temperatures warm in the summer and when overwintering in deep pool habitat in

winter (MBTSG 1998). Floodplains having hydraulic connectivity within channels can support flowing groundwater (hyporheic) habitats and serve as refugia for macroinvertebrate communities (Quigley and Arbelbide 1997).

Movement and migration in tributary streams by bull trout and other native salmonids is in response to developmental and seasonal habitat requirements. Bull trout in the Flathead lake and river system move great distances (155 miles) among lakes, rivers, and tributary streams in response to spawning, rearing, and adult habitat needs (MBTSG 1998). Bull trout commonly make long-distance annual or seasonal movements among various riverine habitats searching for foraging opportunities and refuge from warm, low-water conditions in mid-summer and ice in winter (MBTSG 1998). Swanberg (1997) observed a pattern of seasonal movement by adult and subadult bull trout in the Blackfoot River sub-basin in Montana in response to local changes in thermal and hydrologic patterns in the river and its tributaries. Juvenile bull trout outmigrate from natal tributaries from June through August in the Flathead River system in Montana (Fraley and Sheppard 1989), but juvenile movements may occur at other times of the year (MBTSG 1998). Downstream migration provides more opportunity to access denser forage, find improved protection from avian and terrestrial predators, and alleviate intraspecific competition in rearing areas. Juvenile bull trout are also known to move within natal streams, probably in response to changing habitat and foraging requirements (MBTSG 1998).

As indicated above in the Environmental Baseline section, the Services presume that the baseline conditions for most watersheds within the action area are at some level of risk regarding the function of refugia habitat for bull trout and other native salmonids. This premise is based on information in the FWS's final rule for listing the Columbia River distinct population segment (DPS) which identified 141 isolated bull trout subpopulations within the range of the bull trout in the Columbia River basin. In addition, status reviews of bull trout in 12 sub-basins in Montana indicated that barriers were a major threat and in some sub-basins such as the Blackfoot and Bitterroot rivers, lack of connectivity due to barriers like diversions, culverts, excessive stream temperatures, and dams was a very high risk to restoration and recovery. Further, Quigley and Arbelbide (1997) suggested that the extensive heavily managed landscapes throughout the Columbia River basin has contributed to the fragmentation and simplification of most watersheds and that most watersheds are compromised, particularly in terms of persistence of local populations of native fish in light of catastrophic events. It is apparent that open corridors, both within and among tributary streams, mainstem rivers, and lake systems are critical for bull trout and other native salmonids to locate refugia habitat and ultimately maintain viable populations.

To protect bull trout refugia, the FWS recommends the following (FWS 1998c):

1. Avoid activities or their negative effects that would further fragment habitat, reduce habitat patch size, or further isolate remaining bull trout subpopulations;
2. Maintain or improve connectivity among occupied habitats and refugia by removing human-caused physical, thermal, and chemical barriers within and among isolated subpopulations in areas not at risk of invasion by non-native species (e.g., introduced brook trout, lake trout);

3. Improve connectivity among occupied habitats and refugia by providing both upstream and downstream passage of bull trout migrants at mainstem hydroelectric and flood control projects.

Forest, road, and range management activities can influence the function of refugia habitats for native fish mainly through interruption of hydrologic connections and habitat degradation. As previously mentioned in the fish passage section, culverts and diversion dams can block or impede fish movement thereby precluding dispersal to refuge habitats. Forest practices such as timber harvest and road management can increase fine and coarse sediment, modify channel morphology, alter streamflow, and change stream temperature and light regime (Hicks et al. 1991). A single effect if large enough, or the cumulative effect of these actions may result in habitat degradation such as filling of pools and channel widening to the level where stream temperature increases cause thermal barriers to fish movement. Similarly, poor grazing practices can lead to habitat degradation and thermal barriers (i.e., loss of connectivity), particularly where riparian vegetation needed to provide shade was removed by livestock and livestock trampling caused accelerated streambank erosion (Bowers et al. 1979).

APPENDIX C

SUMMARY OF THE NFHCP'S ROAD AND UPLAND SEDIMENT REDUCTION COMMITMENTS

- Plum Creek will maintain or increase the current high level of state regulated BMP compliance for roads and upland forest activities in all three states. In Montana, where BMPs are voluntary, Plum Creek will mandatorily comply with the BMPs as if there were state law.

- Plum Creek will design and construct new roads to "enhanced" BMP standards which exceed existing state rules and BMPs. The enhanced standards for new roads and upgrades for old roads are summarized below and explained in more detail in Appendix R-1 and R-3, respectively, in the DEIS/NFHCP:

  - Where road grades slope toward stream crossings, Plum Creek will install derivable drain dips and/or ditch relief pipes at the nearest practicable location to streams with an adequate filtration zone in order to minimize sediment delivery to streams.
  - Road fills over stream crossings will be grass seeded and straw-mulched concurrent with construction. Other road cuts and fills on newly constructed roads will be seeded within one operating season. The tread on native-surface roads will also be grass seeded within one operating season following construction unless the road will be used for hauling within 2 years of construction.
  - Slash filter windrows or a suitable alternative will be installed at the toe of all fill slopes that are within 50 feet of streams.
  - Fills at culvert inlets on stream crossings (culverts greater than or equal to 24-inch-diameter) will be well-armored with rock.
  - In Montana and Idaho, culvert installations will be designed to accommodate at least the 50-year peak flood as determined by U.S. Geological Survey flood magnitude prediction procedures. In Washington, culverts will be sized for 100-year events.
  - Where roads are located on highly erodible soils (as defined in Appendix R-1 of the DEIS/NFHCP, the road tread over stream crossings will be rocked. Soil maps will be provided to foresters.
  - New roads proposed on slopes >70 percent will require assessment of unstable features and where found a new road location will be contemplated, and if a new location is not feasible, a geotechnical evaluation will be done and ways to minimize risk identified.
  - Road cross-drainage will be provided frequently enough to control road tread erosion. On active native surfaced roads, drainage features will be located to not exceed 300 feet (and will not exceed 400 feet) along the centerline, and on highly erodible soils or steep grades >8 percent, this spacing will be reduced from the specifications above.

- Road clearing limits will be minimized where roads cross streams.
- Where seeps or springs are discovered during road construction, drainage features will be installed that pass accumulated surface water across the road prism and return it to the forest floor as close to the point of origin as reasonably practicable.
- Roads located in CMZs will be constructed with minimum fill depths, and include drainage features at all active channels.
- Stream crossing culvert installations must be designed to accommodate fish passage on fish-bearing streams. (see Appendix R-6).
- For each new mile of road Plum Creek constructs in the action area, at least 2 miles of existing road in that planning area sub-basin will be upgraded or abandoned prior to, or concurrent with, new construction. This requirement will no longer apply after all roads on the NFHCP covered lands have been upgraded in a given planning area sub-basin.. BMPs may be improved during the term of the permit through the adaptive management pathway.

- Plum Creek will track the status of road conditions in the action area using a road database layer that quantifies BMP status of road segments. The roads in the database designated with a BMP status are those for which Plum Creek has complete or shared management responsibility. They include private access roads off Plum Creek land that Plum Creek uses and manages, such as federally cost-shared roads. The designation of BMP status for inclusion in the database would be field verified. The database layer for BMP status would be operational within six months of the issuance of the incidental take permit (ITP), and would be updated annually.

- Plum Creek will inspect roads to determine their BMP status and condition and the results will be included in the annual update of the road database. Phantom roads discovered during the inspection process will be identified, mapped, inspected, and added to the database. Surplus roads will be identified at this time. The entire road system in the action area will have been inspected by the end of year 5 of the NFHCP. The road condition report (RCR) will contain the enhanced BMP specifications for new roads and for old road upgrades. The RCR will determine the BMP status for a road segment Where road problems are identified on jointly managed roads or are observed on adjacent lands, information will be communicated so that other landowners can participate in road system improvement.

- Plum Creek will upgrade old roads to "enhanced" BMP standards described above. Two priority categories are established for the purpose of focusing conservation: 1) all roads in high priority watersheds will be upgraded by the end of 2010; and 2) all roads in the remainder of the action area will be upgraded by the end of 2015. The high priority watersheds will be identified based on mutual agreement between Plum Creek and the Services, but will not exceed 20 percent of action area roads. Upgrading of remaining watersheds will be generally prioritized based on the following conservation guidance: 1) Tier 1 watersheds; 2) watersheds important to specific covered species; and 3) watersheds

with higher road densities. Plum Creek will incorporate the requests of cost-share road partners in road upgrades per this commitment. Furthermore, Plum Creek will seek participation under existing cost-share agreements to achieve targets set forth under this commitment. Deadlines listed above can be extended where necessary to cooperate with adjacent landowners that share responsibility for a given road segment. Where the water quality impact of upgrading an old road would exceed the conservation benefit, upgrading will be postponed until the road is needed for forest management activities. These roads will not be included in the normal upgrade schedule. Annual progress will be measured using the BMP status layer in the road database.

BMP enhancements and clarifications for old road upgrades are described in Appendix R-3 of the DEIS/NFHCP, and are summarized as follows:

- Where road grades slope toward stream crossings, derivable drain dips and/or ditch relief pipes will be located at the nearest practicable location to streams with an adequate filtration zone in order to minimize sediment delivery to streams.
- Road cross-drainage will be provided frequently enough to control road tread erosion. On active native surfaced roads, drainage features will be located to not exceed 300 feet (and will not exceed 400 feet) along the centerline, and on highly erodible soils or steep grades >8 percent, this spacing will be reduced from the specifications above.
- In Montana and Idaho, culvert installations will be designed to accommodate at least the 50-year peak flood as determined by U.S. Geological Survey flood magnitude prediction procedures. In Washington, culverts will be sized for 100-year events.
- When the outlet of road drainage features are too close to streams for effective forest-floor filtration, supplemental sediment filtration will be provided (such as slash filter windrows, straw-bales, silt fences, etc.) and/or drainage feature spacing will be decreased to minimize sediment delivery. Where this cannot be effectively done, the road segment will be re-categorized as a "hot spot" for special treatment (see below).
- For stream-adjacent/parallel roads or where there is a high density of stream crossings, simple/inexpensive re-location will be utilized in addition to (or in lieu of) road drainage improvements where possible. When inexpensive re-location is not possible and drainage improvements will not greatly reduce sedimentation impacts, the road segment will be categorized as a "hot spot" for special treatment (see below).
- Where upgrading or road use exposes bare mineral soil, disturbed areas will be grass seeded during appropriate sol moisture conditions before the end of the current operating season.

- Plum Creek will identify legacy road system "hot spots" by the end of year 5, and develop and implement a site specific management plan for each. A "legacy road" is one that has

lingering negative effects from past management activities. Hot spots are generally characterized as situations where the risk of waiting for routine BMP upgrades is unacceptable or standard technical solutions for upgrade of old roads would inadequately address the hazard. The following conditions will be designated as hot spots: 1) fish passage barriers; 2) roads located where impacts cannot be remedied by implementation of procedures for upgrade of old roads; 3) erosion gullies more than 6 inches deep in road surfaces that lead directly to streams; 4) perched road fills that are at imminent risk of landsliding; 5) washed-out culverts; 6) stream crossing culverts that are too short and leading to fillslope instability and sediment delivery to streams, and 7) any other situation where forester common sense dictates a hot spot designation is warranted. Hot Spots may also include non-road-related problems related to forestry or harvest activities discovered through the normal course of business, such as sediment delivery to streams from skid trails and landslides. This mitigation measure is intended to implement site-specific management plans for hot spots on an accelerated schedule. Exceptions may occur where complex legacy situations from past actions warrant an economic analysis and the seeking of partners to cost-share repairs.

- Surplus roads will be identified through road condition inspections, hot spot management planning, and during the course of routine forestry activities. All surplus roads will be abandoned. Specifications that determine when a road may be considered abandoned are detailed in Appendix R-7 of the DEIS/NFHCP. Abandonment will be performed concurrently with the upgrade of adjacent road systems. If the road also has been identified as a hot spot, treatment will be accelerated. If the road has been identified as accessing a poaching area, it will be abandoned within 2 years following its identification. Surplus roads will be identified on the road database so that the abandonment task can be effectively managed. Plum Creek will report the number of miles of road abandoned annually and will keep a record of the location of those abandoned roads so that they can be monitored to see if the desired results are being achieved.

- Plum Creek will periodically re-inspect roads that have been constructed to or upgraded to enhanced BMP standards and will perform any maintenance necessary to preserve BMP function. Re-inspection will occur on an as-needed basis with maximum re-inspection intervals as follows: 1) high priority watersheds, the maximum road re-inspection interval will be 5 years; and 2) for all other project roads, the maximum re-inspection interval will be 7 years except in all watersheds regardless of priority where road segments contain no stream crossings or are physically closed to vehicular traffic. In these cases the maximum re-inspection interval will be 10 years. Aerial reconnaissance will be conducted following 25-year flood (or greater) to identify new or unanticipated road maintenance needs. In addition, sediment will not be directly discharged to streams during road maintenance activities. Maintenance activities will be conducted so that the road is not progressively widened over time or the integrity of the road standard is not otherwise diminished. Where Plum Creek has sole ownership and discretion over road use, post harvest road maintenance will be performed. Where log truck use of roads is not anticipated for 15

years or longer, roads will be "put to sleep" to minimize the need for repeated maintenance and reduce the risk to water quality while still allowing administrative use if necessary.

- Plum Creek will perform road sediment delivery analyses (RSDAs) on select watersheds in the action area to quantify sediment delivery to streams. This includes preparing RSDAs for three third or fourth order watersheds per year for the first 10 years of the NFHCP. Plum Creek will select watersheds with priority given to: 1) Tier 1 watersheds; 2) watersheds of concern for other covered species; 3) watersheds with highly erodible soil types; 4) watersheds with streams listed as impaired under the Clean Water Act; and 5) watersheds studied as part of the NFHCP Adaptive Management plan (see Adaptive Management section below). RSDAs will be used to determine if sediment delivery from roads is being effectively minimized, and inform the "continuous improvement" implementation monitoring portion of the Adaptive Management implementation framework. RSDAs will form a basis for evaluating the instream response of reducing fine sediment delivery to streams under the Adaptive Management strategy incorporated in the NFHCP.

- Plum Creek will work with state fish and game departments to develop a road management plan aimed to reduce bull trout and other native salmonid mortality resulting from poaching on or adjacent to Plum Creek land. This will be incorporated into the overall road management planning of each Plum Creek management unit. The plan will involve road vehicle access closures to eliminate easy access to historic and high risk poaching sites on or adjacent to Plum Creek land. It will create cooperative agreements with agencies to facilitate enforcement of poaching at these high-risk sites. Roads identified for closure will also be evaluated to see if they are also surplus. If they are, they will be abandoned in accordance with the NFHCP measures within 2 years of identification.

- Plum Creek will use road restrictions to minimize impacts on the road system that may affect native fish populations by: 1) limiting public vehicular use on newly constructed roads unless agreements with neighboring landowners require the road be kept open; and 2) restricting public use on existing roads to minimize sediment delivery in the action area. Road restrictions will be tracked using a road database layer. Plum Creek will reserve the discretion to place the appropriate road restriction on existing roads using one of these four categories: 1) open roads with no restrictions on road use; 2) closed roads where road use is restricted year-round to all motorized vehicles (except snowmobiles) by using a physical barrier; 3) restricting year-round use with a gate with use restricted to authorized administrative use only; and 4) restricting use to seasonal periods where a road is gated and use is restricted for a portion of the year.

APPENDIX D

The Habitat Approach

Implementation of Section 7 of the Endangered Species Act for
Actions Affecting the Habitat of Pacific Anadromous Salmonids

Prepared by the National Marine Fisheries Service
Northwest Region
Habitat Conservation and Protected Resources Divisions
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I. Purpose

This document describes the analytic process and principles that the National Marine Fisheries Service (NMFS) Northwest Region (NWR) applies when conducting ESA § 7 consultations on actions affecting freshwater salmon[1] habitat.

II. Background

Section 7 of the Endangered Species Act[2] (ESA) requires Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of their critical habitat.[3] Federal agencies must consult with National Marine Fisheries Service (NMFS) regarding the effects of their actions on certain listed species.[4] The NMFS evaluates the effects of proposed Federal actions on listed salmon by applying the standards of § 7(a)(2) of the ESA as interpreted through joint NMFS and U.S. Fish and Wildlife Service (FWS) regulations and policies.[5] When NMFS issues a biological opinion, it uses the best scientific and commercial data available to determine whether a proposed Federal action is likely to (1) jeopardize the continued existence of a listed species, or (2) destroy or adversely modify the designated critical habitat of a listed species.[6]

The Services' ESA implementing regulations define "jeopardize the continued existence of" to mean: "...to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species."[7] Section 7(a)(2)'s requirement that Federal agencies avoid jeopardizing the continued existence of listed species is often referred to as the "jeopardy standard."[8] The ESA likewise requires that Federal agencies refrain from adversely modifying designated critical habitat.[9] The Services' ESA implementing regulations define the term "destruction or adverse modification" of critical habitat to mean:

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[1] For purposes of brevity and clarity, this document will use the word "salmon" to mean all those anadromous salmonid fishes occurring in, and native to, Pacific Ocean drainages of the United States – including anadromous forms of cutthroat and steelhead trouts, and not including salmonids occurring in Atlantic Ocean and Great Lakes drainages.

[2] 16 USC §§ 1531 *et seq.*

[3] 16 USC § 1536(a)(2) (1988).

[4] A 1974 Memorandum of Understanding between NMFS and FWS establishes that NMFS retains ESA jurisdiction over fish species that spend a majority of their lives in the marine environment, including salmon. *See* Memorandum of Understanding Between the U.S. Fish and Wildlife Service, United States Department of Interior, and the National Oceanic and Atmospheric Administration, United States Department of Commerce, Regarding Jurisdictional Responsibilities and Listing Procedures under the Endangered Species Act of 1973 (1974).

[5] *See* U.S. Fish and Wildlife Service and National Marine Fisheries Service., *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.* U.S. Government Printing Office, Washington, D.C. (1998).

[6] 16 USC § 1536(a)(2) (1988).

[7] 50 CFR § 402.02 (1999).

[8] *See* M.J. Bean and M.J. Rowland, *The Evolution of National Wildlife Law. Third Edition.* Praeger Publishers, Westport, Connecticut, pp. 240, 253 & 260 (1997).

[9] 16 USC § 15536(a)(2) (1988).

> . . . a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical.[10]

A species is listed as endangered if it is in danger of extinction throughout all or a significant portion of its range.[11] A species is listed as threatened if it is likely to become endangered within the foreseeable future.[12] Listing a species under the ESA therefore reflects a concern for a species' continued existence—the concern is immediate for endangered species and less immediate, but still real, for threatened species. The purpose of the ESA is to provide a means whereby the ecosystems upon which listed species depend may be conserved, such that the species no longer require the protections of the ESA and can be delisted.[13] This constitutes "recovery" under the ESA.[14] Recovery, then, represents a state in which there are no serious concerns for the survival of the species.[15]

Impeding a species' progress toward recovery exposes it to additional risk, and so reduces its likelihood of survival. Therefore, in order for an action to not "appreciably reduce" the likelihood of survival, it must not prevent or appreciably delay recovery. Salmon survival in the wild depends upon the proper functioning of certain ecosystem processes, including habitat formation and maintenance. Restoring functional habitats depends largely on allowing natural processes to increase their ecological function, while at the same time removing adverse impacts of current practices.[16] Along these lines, the courts have recognized that no bright line exists in the ESA regarding the concepts of survival and recovery.[17] Likewise, available scientific information concerning habitat processes and salmon population viability indicates no practical differences exist between the degree of function essential for long-term survival and that necessary to achieve recovery.[18]

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[10] 50 CFR § 402.02 (1999).

[11] 16 USC § 1532(6) (1988).

[12] 16 USC § 1532(20) (1988).

[13] *See, e.g.*, 16 USC § 1532(3) (1988) (defining the term "conserve"); 16 USC § 1531 (b)(1988) (stating the purpose of the ESA).

[14] *See, e.g.*, 16 USC § 1533(f)(1) (1988) (describing the purpose of recovery plans).

[15] NMFS, *Memorandum from R.S. Waples, NMFS, to the Record* (1997).

[16] Stouder et al., *Pacific Salmon and Their Ecosystems: Status and Future Options*, Chapman and Hall, New York, New York (1997).

[17] *Idaho Department of Fish and Game v. NMFS*, 850 F.Supp. 886 (D. OR 1994) (discussing NMFS' biological opinion concerning the Federal Columbia River Hydropower System).

[18] *See* 51 Fed. Reg. 19,926 (1982). In the preamble to the § 7 consultation regulations, the Services recognized that in some cases, no distinction between survival and recovery my exist, stating "If survival is jeopardized, recovery is also jeopardized...it is difficult to draw clear-cut distinctions" [between survival and recovery].

III. Organization of Endangered Species Act § 7 Analyses

In conducting analyses of habitat-altering actions under § 7 of the ESA, NMFS uses the following steps: (1) Consider the status and biological requirements of the affected species; (2) evaluate the relevance of the environmental baseline in the action area to the species' current status; (3) determine the effects of the proposed or continuing action on the species; (4) consider cumulative effects; (5) determine whether the proposed action, in light of the above factors, is likely to appreciably reduce the likelihood of species survival in the wild or adversely modify its critical habitat. If jeopardy or adverse modification is found, NMFS must identify reasonable and prudent alternatives to the action if they exist.

The analytical framework described above is consistent with the Services' joint ESA § 7 Consultation Handbook[19] and builds upon the Handbook framework to better reflect the scientific and practical realities of salmon conservation and management on the West Coast. Below we describe this analytical framework in detail.

A. Describe the Affected Species' Status and Define its Biological Requirements.

1. Identify the Affected Species and Describe its Status

The first step in conducting this analysis is to identify listed species, and when known, populations of listed species, that may be affected by the proposed action. Under the ESA, a taxonomic species may be defined as a "distinct population segment."[20] The NMFS has established a policy that describes such "distinct population segments" as Evolutionarily Significant Units (ESUs).[21] An ESU is a population or group of populations that is substantially reproductively isolated from other conspecific populations and represents an important component in the evolutionary legacy of the species.[22] In implementing the ESA, NMFS has established ESUs as the listing unit for salmon under its jurisdiction. Therefore, for purposes of jeopardy determinations, NMFS considers whether a proposed action will jeopardize the continued existence of the affected ESU or adversely modify its critical habitat.[23]

When affected species and populations have been identified, NMFS considers the relative status of the listed species, as well as the status of populations in the action area. This may include parameters of abundance, distribution, and trends in both. Various sources of information exist to define species and population status. The final rule listing the species or designating its

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[19] *See* FWS and NMFS, *supra* note 5.

[20] 16 USC § 1532(16) (1988).

[21] *See* 56 Fed. Reg. 58,618 (1991).

[22] R.S. Waples, *Definition of "Species" Under the Endangered Species Act: Application to Pacific Salmon*, National Marine Fisheries Service (1991).

[23] NMFS has recognized that in many cases ESUs contain a significant amount of genetic and life history diversity. Such diversity is represented by independent salmon populations that may inhabit river basins or major sub-basins within ESUs. In light of the importance of protecting the biological diversity represented by these populations, NMFS considers the effects of proposed actions on identifiable, independent salmon populations in judging whether a proposed action is likely to jeopardize the ESU as a whole.

critical habitat is a good example of this type of information. Species' status reviews and factors for decline reports may also provide relevant information for this section. When completed, recovery plans and associated reports will provide a basis for determining species status in the action area.

2. Define the Affected Species' Biological Requirements

The listed species' biological requirements may be described in a number of different ways. For example, they can be expressed in terms of population viability using such variables as a ratio of recruits to spawners, a survival rate for a given life stage (or set of life stages), a positive population trend, or a threshold population size. Biological requirements may also be described as the habitat conditions necessary to ensure the species' continued existence (*i.e.*, functional habitats) and these can be expressed in terms of physical, chemical, and biological parameters. The manner in which these requirements are described varies according to the nature of the action under consultation and its likely effects on the species.

However species' biological requirements are expressed—whether in terms of population variables or habitat components—it is important to remember that there is a strong causal link between the two: actions that affect habitat have the potential to affect population abundance, productivity, and diversity; these effects are particularly noticeable when populations are at low levels—as they are now in every listed ESU. The importance of this relationship is highlighted by the fact that freshwater habitat degradation is identified as a factor of decline in every salmon listing on the West Coast.[24]

Habitat-altering actions continue to affect salmon population viability, frequently in a negative manner.[25] However, it is often difficult to quantify the effects of a given habitat action in terms of its impact on biological requirements for individual salmon (whether in the action area or outside of it). Thus it follows that while it is often possible to draw an accurate picture of a species' rangewide status—and in fact doing so is a critical consideration in any jeopardy analysis—it is difficult to determine how that status may be affected by a given habitat-altering action. Given the current state of the science, usually the best that can be done is to determine the effects an action has on a given habitat component and, since there is a direct relationship between habitat condition and population viability, extrapolate to the impacts on the species as a whole. Thus, by examining the effects a given action has on the habitat portion of a species' biological requirements, NMFS has a gauge of how that action will affect the population variables that constitute the rest of a species' biological requirements and, ultimately, how the action will affect the species' current and future health.

Ideally, reliable scientific information on a species' biological requirements would exist at both the population and the ESU levels, and effects on habitat should be readily quantifiable in terms of population impacts. In the absence of such information, NMFS' analyses must rely on generally applicable scientific research that one may reasonably extrapolate to the action area and

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[24] *See, e.g.*, 57 Fed. Reg. 14,653 (April 22, 1992) (Snake River spring/summer and fall chinook); 62 Fed. Reg. 24,588 (May 6, 1997) (Southern Oregon/Northern California coho); 63 Fed. Reg. 13,347 (March 18, 1998) (Lower Columbia River and Central Valley steelhead).

[25] *See* NMFS, *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (MPI) (1996).

to the population(s) in question. Therefore, for actions that affect freshwater habitat, NMFS usually defines the biological requirements in terms of a concept called properly functioning condition (PFC). Properly functioning condition is the sustained presence of natural[26] habitat-forming processes in a watershed (*e.g.*, riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation. PFC, then, constitutes the habitat component of a species' biological requirements. The indicators of PFC vary between different landscapes based on unique physiographic and geologic features. For example, aquatic habitats on timberlands in glacial mountain valleys are controlled by natural processes operating at different scales and rates than are habitats on low-elevation coastal rivers.

In the PFC framework, baseline environmental conditions are described as "properly functioning," "at risk," or "not properly functioning." If a proposed action would be likely to impair[27] properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat toward PFC, it will usually be found likely to jeopardize the continued existence of the species or adversely modify its critical habitat or both, depending upon the specific considerations of the analysis. Such considerations may include for example, the species' status, the condition of the environmental baseline, the particular reasons for listing the species, any new threats that have arisen since listing, and the quality of the available information.

Since lotic[28] habitats are inherently dynamic, PFC is defined by the persistence of natural processes that maintain habitat productivity at a level sufficient to ensure long-term survival. Although the indicators used to assess functioning condition may entail instantaneous measurements, they are chosen, using the best available science, to detect the health of underlying processes, not static characteristics. "Best available science" advances through time; this advance allows PFC indicators to be refined, new threats to be assessed, and species status and trends to be better understood. The PFC concept includes a recognition that natural patterns of habitat disturbance will continue to occur. For example, floods, landslides, wind damage, and wildfires will result in spatial and temporal variability in habitat characteristics, as will anthropogenic perturbations.

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[26] The word "natural" in this definition is not intended to imply "pristine," nor does the best available science lead us to believe that only pristine wilderness will support salmon. The best available science does lead us to believe that the level of habitat function necessary for the long-term survival of salmon (PFC) is most reliably and efficiently recovered and maintained by simply eliminating anthropogenic impairments, and does not usually require artificial restoration. *See* Rhodes et. al., *A Coarse Screening Process for Potential Application in ESA Consultations.* Columbia River Inter-Tribal Fish Commission, Portland, Oregon, pp. 59-61, (1994); National Research Council, *Upstream: Salmon and Society in the Pacific Northwest. National Research Council*, National Academy Press, Washington, D.C., p. 201 (1996).

[27] In this document, to "impair" habitat means to reduce habitat condition to the extent that it does not fully support long-term salmon survival and therefore "impaired habitat" is that which does not perform that full support function. Note that "impair" and "impaired" are not intended to signify any and all reduction in habitat condition.

[28] Running water.

B. Evaluate the Relevance of the Environmental Baseline in the Action Area to the Species' Current Status.

The environmental baseline represents the current basal set of conditions to which the effects of the proposed or continuing action would be added. It "includes the past and present impacts of all Federal, State, or private activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early § 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process."[29]

The environmental baseline does not include any future discretionary Federal activities (that have not yet undergone ESA consultation) in the action area. The species' current status is described in relation to the risks presented by the continuing effects of all previous actions and resource commitments that are not subject to further exercise of Federal discretion. For a new project, the environmental baseline consists of the conditions in the action area that exist before the proposed action begins. For an ongoing Federal action, those effects of the action resulting from past unalterable resource commitments are included in the baseline, and those effects that would be caused by the continuance of the proposed action are then analyzed for determination of effects.

The reason for determining the species' status under the environmental baseline (without the effects of the proposed or continuing action) is to better understand the relative significance of the effects of the action upon the species' likelihood of survival and chances for recovery. Thus if the species' status is poor and the baseline is degraded at the time of consultation, it is more likely that any additional adverse effects caused by the proposed or continuing action will be significant.

The implementing regulations specify that the environmental baseline of the area potentially affected by the proposed action should be used in making the jeopardy determination. Consequently, delineating the action area for the proposed or continuing action is one of the first steps in identifying the environmental baseline. For the lotic environs typical of salmon habitat-related consultations, a watershed or sub-basin geographic unit (and its downstream environs) is usually a logical action area designation. Most habitat effects are carried downstream readily, and many travel upstream as well (*e.g.*, channel downcutting). Moreover, watershed divides provide clear boundaries for analyzing the cumulative effects of multiple independent actions.[30]

C. Determine the Effects of the Action on the Species.

In this step of the analysis, NMFS examines the likely effects of the proposed action on the species and its habitat within the context of the its current status and existing environmental baseline. The analysis also includes an analysis of both direct and indirect effects of the action. "Indirect effects" are those that are caused by the action and are later in time but are still

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[29] *See* 50 CFR § 402.02 (1999) (definition of "effects of the action"). Action area is defined by the consultation regulations (50 CFR 402.02) as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action."

[30] National Research Council, *Upstream: Salmon and Society in the Pacific Northwest. National Research Council*, National Academy Press, Washington, D.C., pp. 34, 213 & 359 (1996).

reasonably certain to occur. They include effects on species or critical habitat of future activities that are induced by the action subject to consultation and that occur after the action is completed. The analysis also takes into account direct and indirect effects of actions that are interrelated or interdependent with the proposed action. "Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration.

NMFS may use either or both of two independent techniques in assessing the impact of a proposed action. First, NMFS may consider the impact in terms of how many listed salmon will be killed or injured during a particular life stage and gauge the effects of that take's effects on population size and viability. Alternatively, NMFS may consider the impact on the species' freshwater habitat requirements, such as water temperature, substrate composition, dissolved gas levels, structural elements, etc. This second technique is especially useful for habitat-related analyses because, while many cause and effect relationships between habitat quality and population viability are well known,[31] they do not lend themselves to meaningful quantification in terms of fish numbers. Consequently, while this second technique does not directly assess the effects of actions on population condition, it indirectly considers this issue by evaluating existing habitat conditions in light of habitat conditions known to be conducive to salmon conservation.

Though there is more than one valid analytical framework for determining effects, NMFS usually uses a matrix of pathways and indicators to determine whether proposed actions would further damage impaired habitat or retard the progress of impaired habitat toward properly functioning condition. For the purpose of guiding Federal action agencies in making effects determinations, NMFS has developed and distributed a document detailing this method.[32] This document is discussed in more detail below. The levels of effects, or effects determinations, are defined[33] as:

> **"No effect."** Literally no effect whatsoever. No probability of any effect. The action is determined to have "no effect" if there are no proposed or listed salmon and no proposed or designated critical habitat in the action area or downstream from it. This effects determination is the responsibility of the action agency to make and does not require NMFS review.
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> **"May affect, not likely to adversely affect."** Insignificant, discountable, or beneficial effects. The effect level is determined to be "may affect, not likely to adversely affect" if the proposed action does not have the potential to hinder attainment of relevant properly functioning indicators and has a negligible (extremely low) probability of taking proposed or listed salmon or resulting in the destruction or adverse modification of their habitat. An insignificant effect relates to the size of the impact and should never reach the scale where

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[31] *See* Spence et al., *An Ecosystem Approach to Salmonid Conservation*, ManTech Environmental Research Services Corporation, Corvallis, Oregon (1996).

[32] *See* NMFS, *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (MPI) (1996).

[33] These definitions are adapted from those found in NMFS, *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (MPI) (1996), and; U.S. Fish and Wildlife Service and National Marine Fisheries Service., *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.* U.S. Government Printing Office, Washington, D.C. (1998)

take occurs.[34] A "discountable effect" is defined as being so extremely unlikely to occur that a reasonable person cannot detect, measure, or evaluate it. This level of effect requires informal consultation, which consists of NMFS concurrence with the action agency's determination.

"May affect, likely to adversely affect." Some portion or aspect of the action has a greater than insignificant probability of having a detrimental effect upon individual organisms or habitat. Such detrimental effect may be direct or indirect, short- or long-term. The action is "likely to adversely affect" if it has the potential to hinder attainment of relevant properly functioning indicators, or if there is more than a negligible probability of taking proposed or listed salmon or resulting in the destruction or adverse modification of their habitat. This determination would apply when the overall effect of an action has short-term adverse effects even if the overall long-term effect is beneficial. In such instances, NMFS conducts a jeopardy analysis.

The above effects determinations are applicable to individual fish, including fry and embryos. The MPI should be applied at spatial scales appropriate to the proposed action so that its habitat effects on individuals are fully taken into account. For example, if any of the indicators in the MPI are thought to be degraded by the proposed action to the extent that take of an individual fish results, the action is determined to be "may affect, likely to adversely affect." For actions that are likely to adversely affect, NMFS must conduct a jeopardy analysis and render a biological opinion resulting in one of the conclusions below:

"Not likely to jeopardize" and/or "Not likely to result in the destruction or adverse modification of critical habitat." The action does not appreciably reduce the likelihood of species survival and recovery or result in the destruction or adverse modification of its critical habitat.

"Likely to jeopardize" and/or "Likely to result in the destruction or adverse modification of critical habitat." The action appreciably reduces the likelihood of species survival and recovery or results in the destruction or adverse modification of its critical habitat.

D. Consider Cumulative Effects in the Action Area.

The ESA implementing regulations define "cumulative effects" as those effects caused by future projects and activities unrelated to the action under consideration (not including discretionary Federal actions) that are reasonably certain to occur within the action area.[35] Since all future discretionary Federal actions will at some point be subject to § 7 consultation, their effects will be considered at that time and are not included in cumulative effects analysis.

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[34] "Take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in such conduct." 16 USC §1532(19) (1988).

[35] 50 CFR § 402.02 (1999).

E. Jeopardy Determinations.

In this step of the analysis, NMFS determines whether (a) the species can be expected to survive, with an adequate potential for recovery, under the effects of the proposed or continuing action, the environmental baseline and any cumulative effects; and (b) whether the action will appreciably diminish the value of critical habitat for both the survival and recovery of the species. In completing this step of the analysis, NMFS determines whether the action under consultation, together with all cumulative effects when added to the environmental baseline, is likely to jeopardize the continued existence of the listed species or result in destruction or adverse modification of critical habitat.

For the jeopardy determination, NMFS uses the consultation regulations and the MPI analysis method to determine whether actions would further degrade the environmental baseline or hinder attainment of PFC at a spatial scale relevant to the listed ESU. That is, because salmon ESUs typically consist of groups of populations that inhabit geographic areas ranging in size from less than ten to several thousand square miles (depending on the species), the analysis must applied at a spatial resolution wherein the actual effects of the action upon the species can be determined.

The analysis takes into account the species' status because determining the impact upon a species' status is the essence of the jeopardy determination. Depending upon the specific considerations of the analysis, actions that are found likely to impair currently properly functioning habitat, appreciably reduce the functioning of already impaired habitat, or retard the long-term progress of impaired habitat towards PFC at the population or ESU scale will generally be determined likely to jeopardize the continued existence of listed salmon, adversely modify their critical habitat, or both. Specific considerations include whether habitat condition was an important factor for decline in the listing decision, changes in population or habitat conditions since listing, and any new information that has become available.

If NMFS anticipates take of listed salmon incidental to the proposed action, the biological opinion is accompanied by an incidental take statement with reasonable and prudent measures to minimize the impact of such take, and non-discretionary terms and conditions for implementing those measures. Discretionary conservation recommendations may also accompany the biological opinion to assist action agencies further the purposes of habitat and species conservation specified in §§ 7(a)(1) and 7(a)(2).

F. Identify reasonable and prudent alternatives to a proposed or continuing action that is likely to jeopardize the continued existence of the listed species.

If the proposed or continuing action is likely to jeopardize the listed species or destroy or adversely modify critical habitat, NMFS must identify reasonable and prudent alternatives that comply with the requires of § 7(a)(2) and with the applicable regulations. The reasonable and prudent alternative must be consistent with the intended purpose of the action, consistent with the action agency's legal authority and jurisdiction, and technologically and economically feasible. At this stage of the consultation, NMFS will also indicate if it is unable to develop a reasonable and prudent alternative.

IV. Application Tools Useful in Conducting § 7 Analyses - The Matrix

As previously mentioned, NMFS has developed an analytic methodology to help determine the environmental effects a given action will have by describing an action's effects on PFC.[36] This document includes a *Matrix of Pathways and Indicators* (MPI; often called "The Matrix,") and a dichotomous key for making effects determinations based on the condition of the environmental baseline and the likely effects of a given project. The MPI helps the action agency and NMFS describe current freshwater habitat conditions, determine the factors limiting salmon production, and identify sensitive areas and any risks to PFC. This document only *helps* make effects determination, it does not describe jeopardy criteria per se.

The pathways for determining the effects of an action are represented as six conceptual groupings (*e.g.*, water quality, channel condition, and dynamics) of 18 habitat condition indicators (*e.g.*, temperature, width/depth ratio). Default indicator criteria[37] (mostly numeric, though some are narrative) are laid out for three levels of environmental baseline condition: properly functioning, at risk, and not properly functioning. The effects of the action upon each indicator is classified by whether it will restore, maintain, or degrade the indicator.

The MPI provides a consistent, but geographically adaptable, framework for effects determinations. The pathways and indicators, as well as the ranges of their associated criteria, are amenable to alteration through the process of watershed analysis. The MPI, and variations on it, are widely used in § 7 consultations. The MPI is also used in other venues to determine baseline conditions, identify properly functioning condition, and estimate the effects of individual management prescriptions. This assessment tool was developed for forestry activities. NMFS is working to adapt it for other types of land management, and for larger spatial and temporal scales.

For practical purposes, the MPI analysis must sometimes be applied to geographic areas smaller than a watershed or basin due to a proposed action's scope or geographic distribution. These circumstances necessarily reduce analytic accuracy because the processes essential to aquatic habitats extend continuously upslope and downslope, and may operate quite independently between drainages.[38] Such loss of analytic accuracy should typically be offset by more conservative management practices in order to achieve parity of risk with the watershed approach. Conversely, a watershed approach to habitat conservation provides greater analytic certainty, and hence more flexibility in management practices.

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[36] NMFS, *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (MPI) (1996).

[37] The unmodified "matrix" uses ranges of values for indicators that are generally applicable between species and across the geographic distribution of salmon. The indicators can be, and have been, modified for more specific geographic and species applications.

[38] L. B. Leopold, *A View of the River*, Harvard University Press, Cambridge, Massachusetts, chapter 1 (1994).

V. Conclusion

The NMFS has followed regulations under §§ 7 and 10 of the ESA to develop an analytical procedure used to consistently assess whether any proposed action would jeopardize or conserve federally protected species. There is a legacy of a more than a century of profound human alterations to the Pacific coast drainages inhabited by salmon.[39] The analytical tool described as the MPI enables proposed actions to be assessed in light of the species current status, the current conditions, and expected effects of the action. Proposed actions that fail to conserve fish and their habitats as initially proposed can be redesigned to avoid jeopardy and begin to restore watershed processes. Conservation of listed salmon will depend largely on the recovery of watershed processes that furnish their aquatic habitat.

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[39] *See* Cone and Ridlington, *The Northwest Salmon Crisis, a Documentary History*. Oregon State University Press, Corvallis, Oregon, pp. 12-21 & 154-160 (1996); W. Nehlsen *et al.*, *Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washington*, Fisheries, Vol.16(2), pp. 4-21 (1991).

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