200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

United States Department of the Interior

FISH AND WILDLIFE SERVICE

TAKE PRIDE IN AMERICA

Upper Columbia Fish and Wildlife Office
11103 East Montgomery Drive
Spokane, Washington 99206

March 14, 2007

IN REPLY REFER TO:

USFWS Reference: 13260-2006-P-0008, 13260-2007-F-0062
Hydrologic Unit Code: 17-02-00-16-05
Re: USFWS Biological Opinion on the Effects of the Priest Rapids Hydroelectric Project Relicensing on Bull Trout (FERC No. 2114)

Magalie R. Salas, Secretary
Attn: Bob Easton
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Dear Ms. Salas:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) based on our review of the Federal Energy Regulatory Commission's (FERC or Commission) proposed relicensing of the Priest Rapids Project (FERC No. 2114) (Project), owned and operated by Public Utility District No. 2 of Grant County (Grant PUD), located in portions of Grant, Yakima, Kittitas, Douglas, Benton, and Chelan Counties, Washington. At issue are the effects of the Project on the threatened bull trout (*Salvelinus confluentus*) and its critical habitat. This BO was prepared in accordance with section 7 of the Endangered Species Act (Act or ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). Your request for formal consultation was received on October 12, 2006.

This BO is based primarily on Grant PUD's October 2003 Final License Application and the Commission's November 2006 Final Environmental Impact Statement, as well as references cited herein. Additional detailed information/documentation used in our analysis is available upon request from the Central Washington Field Office. A complete administrative record of this consultation is on file at the Service's Central Washington Field Office in Wenatchee, Washington.

The Service acknowledges and appreciates the patience and participation of Commission personnel in completing this consultation. Thank you all for providing technical information and cooperation needed to complete this consultation.

If you have questions concerning this BO or your responsibilities under the Endangered Species Act, please contact Mark Miller at the Central Washington Field Office in Wenatchee, Washington at (509) 665-3508, ext 12, or via email at Mark_Miller@fws.gov.

Sincerely,

Susan B. Martin

Project Leader
Upper Columbia River Fish and Wildlife Office

CC:
Larry Salata, Regional Office, USFWS, Portland, OR
Estyn Mead, Regional Office, USFWS, Portland, OR
Scott Carlon, National Marine Fisheries Service, Portland, OR
Carmen Andonageau, WA Department of Fish and Wildlife, Ephrata, WA
Bob Rose, Yakama Nation, Toppenish, WA
Steve Brown, Grant PUD, Ephrata, WA

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

BIOLOGICAL OPINION

for the

Priest Rapids Project License Renewal

Federal Energy Regulatory Commission

USFWS Reference Numbers
13260-2007-F-0062
13260-2006-P-0008

Prepared by: U.S. Fish and Wildlife Service
Central Washington Field Office, Wenatchee

Issued by: Susan B. Martin Date 03/14/07
Project Leader
Upper Columbia Fish and Wildlife Office
Spokane, Washington

Table of Contents

APPENDICES

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

INTRODUCTION

This correspondence transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) based on our review of the Federal Energy Regulatory Commission's (FERC or Commission) proposed relicensing of the Priest Rapids Project (FERC No. 2114) (Project), owned and operated by Public Utility District No. 2 of Grant County (Grant PUD), located in portions of Grant, Yakima, Kittitas, Douglas, Benton, and Chelan Counties, Washington. The attached BO describes the effects of the Project on the threatened bull trout (*Salvelinus confluentus*) and its designated critical habitat. This biological opinion was prepared in accordance with section 7 of the Endangered Species Act (Act or ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). Your request for formal consultation was received in the Service's Central Washington Field Office (CWFO) on October 12, 2006.

This biological opinion is based primarily on Grant PUD's October 2003 Final License Application and the Commission's November 2006 Final Environmental Impact Statement. A complete administrative record of this consultation is on file at the CWFO in Wenatchee, Washington.

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

Consultation History

The following chronology documents the consultation process which culminated in the following BO for bull trout.

On October 29, 2003, Public Utility District No. 2 of Grant County, Washington (Grant PUD) applied to the Commission for a new license for the Project.

In its February 24, 2006, Draft Environmental Impact Statement (DEIS) and November 2006, Final Environmental Impact Statement (FEIS), the Commission determined that the proposed relicensing of the Project was not likely to adversely affect (NLAA) the bull trout and the threatened bald eagle (*Haliaeetus luecocephalus*). The rationale for the NLAA determinations was based on the unlikely occurrence of the bull trout in the action area, and the infrequency of bald eagle roost sites in the Project area.

On March 27, 2006, the Service responded to the Commission's request for concurrence on NLAA determinations for the bull trout and the bald eagle. The Service did not concur with the Commission's NLAA determinations at that time. However, after further review of the Commission's DEIS and FEIS, the Service concurred with the NLAA determination for the bald eagle because potential impacts of the Project on the bald eagle do not coincide with timeframes when bald eagles are likely to be present within the Project area. The proposed action also entails the development of a bald eagle perching and roosting tree enhancement and protection program. The Program will protect existing perching and roosting trees from beaver damage, and initiate tree enhancement through riparian plantings. This proposed work would be developed in coordination with the Service. Based on this concurrence, no further discussion of the bald eagle is included in this document.

The Service did not concur on the Commission's NLAA determination for the bull trout because current studies show that low numbers of adult and juvenile bull trout are likely to be in the action area during Project operations. Bull trout have been documented to use the Project's facilities (e.g., fishways) and occur both above the Project in the mid-Columbia River and below the Project.

On July 18, 2006, the Service met with Grant PUD to discuss the rationale for not concurring with the Commission's NLAA determination for the bull trout.

On October 12, 2006, the Commission submitted a request to the Service for formal consultation on the proposed relicensing of the Project and its effects on the bull trout and its critical habitat.

On November 9, 2006, the Service met with Grant PUD to discuss the effects of the Project on the bull trout and potential ways to minimize Project operations on this species for the term of the new operating license.

On December 22, 2006, the Service emailed a preliminary draft of this BO to Grant PUD for their review and comment.

On December 22, 2006, the Service emailed the same preliminary draft of the BO referenced above to FERC for information.

On January 19, 2007, the Service emailed a revised draft of this BO to Grant PUD and an information copy to FERC.

On January 31, 2007, the Service met with Grant PUD to discuss comments on the January 19, 2007 draft BO.

On February 9, 2007, Grant PUD provided written comments to the Service on the January 19, 2007 draft BO.

BIOLOGICAL OPINION

1.0 DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the relicensing of the Project, which consists of two dams (Priest Rapids and Wanapum), located in portions of Grant, Yakima, Kittitas, Douglas, Benton, and Chelan Counties, Washington (Figure 1). The 1,768.8-megawatt (MW) Project is an integral part of the seven-dam mid-Columbia River Hydroelectric System, which is the single largest coordinated hydroelectric system in the country. Three Public Utility Districts operate five of the facilities, while the furthest upstream facilities are federally owned and operated. The area referred to as the mid-Columbia River extends from the federally owned and operated Grand Coulee Dam to the Hanford Reach, nearly 210 miles downstream. The Project is operated in coordination with other mid-Columbia River hydro-electric projects that use project storage to reshape the inflow hydrograph to help meet hourly changes in electricity demands. The current FERC license for the Project expired on October 31, 2005.

Priest Rapids Dam

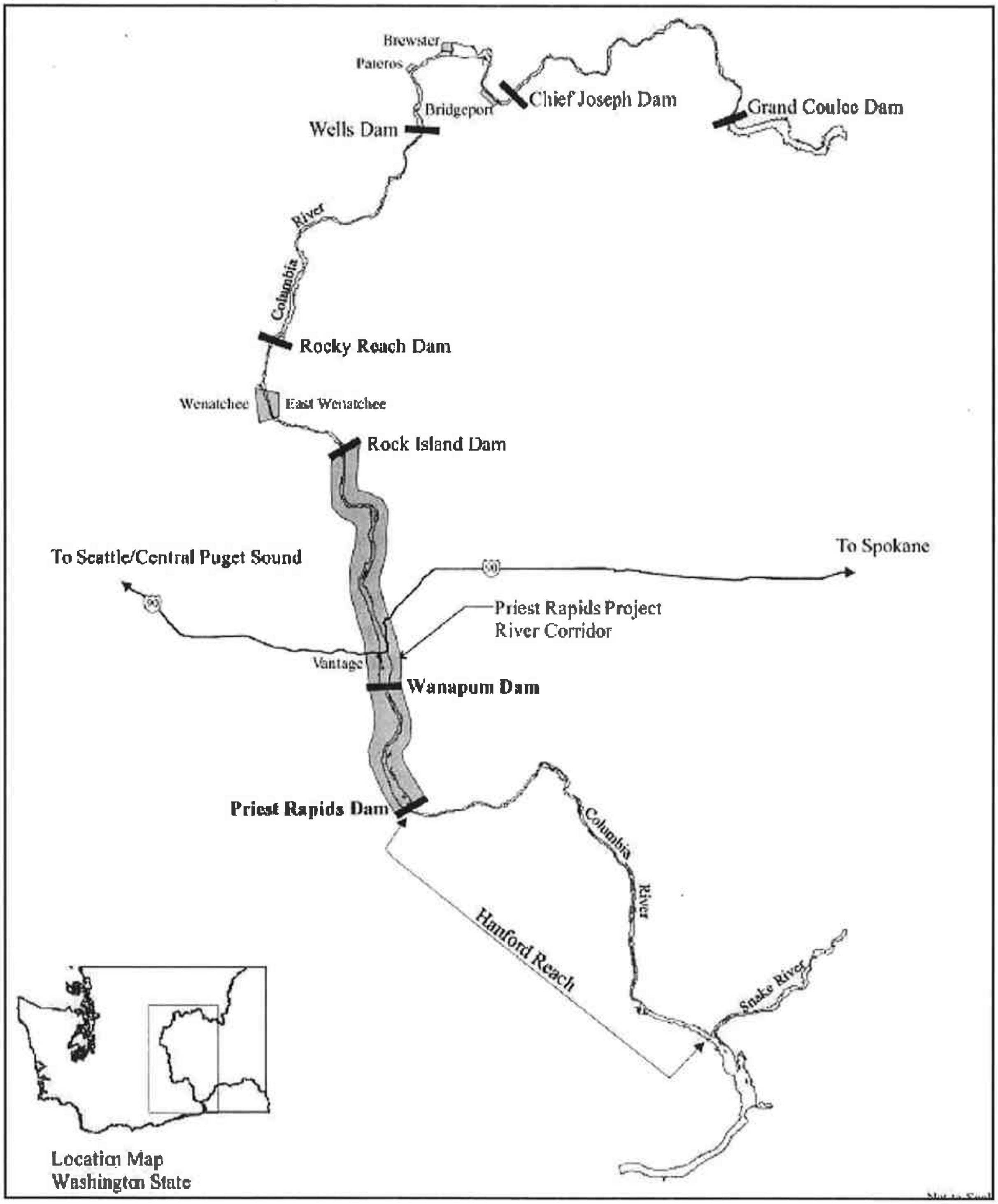
Priest Rapids Dam is located at river mile (RM) 397 just upstream of the Hanford Reach section of the Columbia River (Figure 1). The dam has a powerhouse containing 10 turbine generators with a total generating capacity of 855,000 Kilowatts (kW). Priest Rapids Dam is 10,103 feet long, and is sited essentially perpendicular to the river flow. Priest Rapids Reservoir extends for 18 miles upstream to the tailwater of Wanapum Dam, and has a surface area of approximately 7,725 acres.

Wanapum Dam

Wanapum Dam is located at RM 415 near the I-90 Bridge at Vantage, Washington (Figure 1). The dam has a powerhouse containing nine original turbine generators with a total authorized generating capacity of 810,000 kW and one, new advanced design turbine connected to an original generator with a total authorized capacity of 103,800 kW for a total authorized installed capacity of 913.8 kW. The total authorized capacity of Wanapum Dam is 1,038,000 kW based on the Commission's December 14, 2005, license amendment, which authorized the replacement of the nine original turbines at Wanapum Dam with advanced design turbines.

The total length of Wanapum Dam is 8,637 feet, with the axis of the powerhouse being almost parallel with the general direction of river flow. The dam includes a "two-elbow" design feature that is unique to dams on the Columbia River. A Future Units section designed for six additional generating units extends from the powerhouse to the spillway. Wanapum Reservoir extends 38 miles upstream to the tailwater of Chelan County PUD's Rock Island Dam, and has a surface area of approximately 14,680 acres.

Figure 1. Map showing Mid-Columbia hydroelectric projects and the Hanford Reach (source: Grant PUD 2003).



1.1 Summary of Pertinent Elements of the Proposed Action

A complete description of the proposed Project subject to relicensing is presented in Grant PUD's Final License Application and the Commission's FEIS, which are herein incorporated by reference (Grant PUD 2003 and FERC 2006). For the purposes of this biological opinion, only those elements of the proposed Project that may affect the bull trout and its critical habitat are discussed below.

The relicensing of the Project consists of the following components: (1) a habitat protection and restoration plan; (2) a hatchery supplementation plan; (3) a recreation facilities plan; (4) monitoring plans; and (5) project operations. Each of these components is discussed further below.

The Project operates under various river flow agreements and settlement agreements established by the mid-Columbia utilities, government agencies, and Tribes for the purpose of optimizing the use of the Columbia River resource for the region and the protection of fish resources. Various regional agreements that may affect Project operations/flows include, but are not limited to, the Mid-Hourly Coordination Agreement, Priest Rapids Salmon and Steelhead Settlement Agreement (Priest Rapids Agreement), and the Hanford Reach Fall Chinook Protection Program Agreement. These agreements are described in further detail in Exhibit B of Grant PUD's Final License Application and the Commission's FEIS.

1.1.1 Habitat Protection and Restoration Plan

In accordance with the Priest Rapids Agreement, Grant PUD will, in consultation with the Priest Rapids Coordinating Committee (PRCC), continue implementation of its Habitat Protection and Restoration Plan (Habitat Plan) for salmon and steelhead. The Habitat Plan is intended to facilitate the development and implementation of habitat protection and restoration actions for the spring, summer, and fall Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), sockeye salmon (*O. nerka*), and coho salmon (*O. kisutch*). Two of these anadromous fish species that occur in the project area were listed under the ESA by the National Marine Fisheries Service (NMFS). These two species are upper Columbia River (UCR) steelhead, listed as endangered on August 18, 1997 (62 FR 43937), and UCR spring-run Chinook salmon, listed as endangered on March 24, 1999 (64 FR 14308). The goal of the efforts outlined in the agreements and plan is to promote the rebuilding of self-sustaining and harvestable populations of species covered by the plan, and to mitigate for a portion (2%) of unavoidable losses of these species resulting from Project operations.

The Habitat Plan will provide for coordination with other similar programs such as those undertaken by Chelan and Douglas PUDs. At a minimum, the Habitat Plan will identify goals, objectives, a process for coordination, and a process by which habitat projects may be identified and implemented. The Habitat Plan will give a priority to restoring habitat functions important to listed stocks and other anadromous species in drainages occupied by UCR steelhead and UCR spring Chinook affected by the Project. The Habitat Plan will give priority to actions that can be implemented prior to 2010 with the available funding in order to provide maximum benefit to ESA-listed species.

Specific elements of the Habitat Plan include: 1) a performance evaluation process; and 2) an annual allocation by Grant PUD of $1,096,552 to the Priest Rapids Project Habitat Fund to mitigate for a 2% unavoidable loss of upriver ESA-listed fish stocks at Priest Rapids Dam and a 2% unavoidable loss at Wanapum Dam.

At this time, the plan does not specifically consider bull trout and accompanying critical habitat. However, the proposed action is anticipated to have a positive effect on the following bull trout habitat characteristics: 1) water temperatures; 2) complex stream channel features such as large woody debris, side channels, and undercut banks; 3) substrate of sufficient amount, size, and composition, natural hydrograph; 4) migratory corridors; and 5) abundant food base.

1.1.2 Hatchery Supplementation Plan

The Priest Rapids Hatchery was originally a spawning channel developed under a 1963 agreement between the Washington State Department of Fish and Wildlife (WDFW) and Grant PUD. Beginning in 1972, WDFW experimented with raceway culture techniques for fall Chinook at the Priest Rapids Hatchery by modifying sections of the spawning channel and removing the spawning gravels. This test program continued from 1972 through 1978 and produced positive results suggesting that the facility could be converted from a spawning channel to a rearing pond facility. In 1978, Grant PUD funded a study, which determined that the Priest Rapids spawning channel showed potential for conversion to a conventional pond-rearing hatchery. By agreement between Grant PUD and WDFW dated March 4, 1980, a production target of 100,000 pounds of fall Chinook was established for the Priest Rapids Hatchery. Since that time, the hatchery has continued to produce approximately 7 million fall Chinook smolts annually which contribute to the "upriver bright" run of fall Chinook returning to the Hanford Reach. Specifically, Grant PUD proposes the following supplementation activities under the proposed action:

1. Develop and implement a performance evaluation program to assess the hatchery program, as outlined in the Priest Rapids Agreement.

2. The White River spring Chinook supplementation program is currently conducted as a captive brood program. Activities required for this program include juvenile and adult monitoring, collection and rearing of broodstock, as well as rearing, acclimation, and release of second generation yearlings. Currently all rearing of first and second generation fish will occur outside of the White River basin. Juvenile monitoring activities are currently permitted under Service Section 10(a)(1)(a) number TE022743-2. This aspect of the supplementation plan would include the following specific components:

a. *Adult Monitoring Activities:* The spring Chinook spawning aggregate in the White River would be monitored using standard redd count techniques. This includes experienced surveyors walking in the river or along the banks looking for redds, spawning fish or dead carcasses. Surveys would occur weekly from late August through October. The coordinates of each redd will be recorded with a GPS, they will be marked with flagging and photos will be taken. The origin of adults will be identified, to the extent feasible. Biological data from individual carcasses would include fish length, determination of the sex, tissue samples for genetic analysis, and scale samples. Carcasses would be examined for external marks and internal tags. If the carcass received a coded-wire tag the head would be collected so that the tag could be retrieved and de-coded.

b. *Collection of Eggs or Fry for Broodstock*: The first generation or F1 generation of the spring Chinook captive brood program will be collected as eggs or fry from naturally deposited redds in the White River. Approximately 1,100 – 3,100 eggs or fry would be collected from up to 50 redds using standard hydraulic sampling methods during the period from September through November. Candidate redds will be identified during spawning ground surveys. If sufficient eggs cannot be collected by hydraulic sampling methods, sampling at later life stages (i.e. fry or parr) would be conducted. Sampling methods could include redd caps, dip nets, minnow traps, or seines.

c. *Acclimation and Release of F_2 Generation*: The production goal for the White River is 150,000 yearling spring Chinook smolts. Attempts would be made to provide four to eight weeks of rearing and acclimation on White River water prior to release. Acclimation facilities may include portable tanks, direct release as pre-smolts, use of net pens, and ponds. Transfers to acclimation facilities would occur in mid-March to early April. Fish would be released in late April and early May. If acclimation facilities are not available fish would be released directly into the White River in April or early May. Because survival and maturation rates of first generation broodstock can vary, production of the second generation can be unpredictable. In the event that production would exceed 150,000 yearlings, surplus fish would be released at earlier life stages (i.e. fry or parr).

3. Develop and implement a Hatchery and Genetic Management Plan (HGMP) for spring, summer, and fall Chinook salmon, steelhead, and sockeye salmon. This measure is part of the Priest Rapids Agreement.

4. To help recover natural populations to self-sustaining and harvestable levels and to mitigate for 7% unavoidable losses at Priest Rapids and Wanapum dams, Grant PUD proposes to: fund and develop hatchery facilities necessary to annually produce 600,000 yearling spring Chinook salmon, 833,000 yearling summer Chinook salmon, 1,143,000 sockeye salmon smolts, and 100,000 steelhead smolts; upgrade and renovate the Priest Rapids Hatchery and continue to annually produce 6,000,000 fall Chinook salmon smolts and 1,000,000 fall Chinook salmon fry; and to consult with the NMFS on options to develop equivalent alternative mitigation programs if annual production of 1,143,000

sockeye salmon smolts is unattainable. This measure is part of the Priest Rapids Agreement.

5. To address the effect of the Project on white sturgeon, Grant PUD proposes to construct a white sturgeon conservation facility at the Priest Rapids Hatchery. Broodstock would be obtained from the Hanford Reach or Wanapum reservoir and the conservation facility would be designed to produce yearling white sturgeon for stocking into Project reservoirs. This effort would include experimentation with hatchery supplementation to develop optimal rearing and release strategies and to monitor and evaluate the effectiveness of hatchery releases.

6. To address continuing Project effects on recreational fisheries, Grant PUD proposes to provide funding for upgrades, improvements, and operating costs at the Columbia Basin Hatchery which currently raises 1.4 million fish for stocking in roughly 140 lakes throughout the region (the majority of the lakes are within Grant County, Washington).

At this time, this plan does not include provisions that adequately reflect the needs of the bull trout and its critical habitat. Hatchery propagation programs may benefit bull trout populations by increasing densities of historically important prey items (smolts) in tributaries and mainstem habitats.

1.1.3 Recreation Facilities Plan

The Priest Rapids and Wanapum reservoir areas and project lands are open for use by the public for recreational purposes subject to the provisions of Grant PUD's draft Shoreline Management Plan, dated August 2003. Grant PUD's proposal, as modified by the Commission in its FEIS, includes the following nine elements that may affect the bull trout or its critical habitat:

1. Finalize the draft Recreation Resource Management Plan (Recreation Plan) that defines the management of existing and future recreation resources associated with the project, including: O&M costs; recreation monitoring; interpretation and education (includes interpretive displays/kiosks); integration of recreation resources with other resource management plans; and review. The plan would be guided by an adaptive management strategy.

2. Provide funding for one full-time law enforcement officer to the WDFW and for one full-time officer to be divided equally between the Grant County and Kittitas County Sheriff's Offices; continue to provide a boat at Wanapum Dam for use by local law enforcement officers.

3. Concentrate new recreation development in suitable areas that is compatible with the draft Shoreline Management Plan.

4. Finalize the draft Shoreline Management Plan and manage lands accordingly; protect the scenic quality of the mid-Columbia River and its surrounding landscape.

5. Conduct recreational use monitoring on Project lands, including BLM lands, every 6 years.

6. Provide additional signage at identified recreation sites.

7. In a final Recreation Plan, include a provision (e.g., signs) at Quilomene Dune and Bay to address wake size by boaters.

8. Dredge and lengthen the Kittitas County boat launch at Vantage.

9. In a final Shoreline Management Plan, Crescent Bar Island will be managed under the land classifications proposed as planned development and conservation, no further development will occur beyond the existing disturbed footprint; and a shoreline buffer zone will be designated on the island.

At this time, the plan does not contemplate provisions that reflect the needs of the bull trout and its critical habitat.

1.1.4 Cultural Facilities

The Project includes the Wanapum Dam Heritage Center that consists of a public museum and repository for information regarding cultural, historical, and archaeological resources of the Wanapum people. The Heritage Center consists of three areas: a museum with historical information with an observation deck, a hydroelectric Project interpretive and viewing area, and a fish ladder viewing site and interpretive facility. All three sites are located at the Wanapum Development, and are accessed via a paved road from Highway 243. Grant PUD's proposal, as modified in the Commission's FEIS, includes:

1. Continue commitments to the Wanapum Tribe reflected in the agreement entered on January 8, 1957, and subsequently modified, and through any future modifications agreed to by the parties.
2. Develop a multiple property documentation format for National Register of Historic Places evaluation.
3. Implement a proposed schedule for determining National Register eligibility and assess/address adverse effects on remaining cultural resource properties so far inventoried.
4. Within 1 year of license issuance and in consultation with the established Cultural Resource Working Group (CRWG), finalize and implement a Historic Properties Management Plan (HPMP).
5. File with the Commission a Memorandum of Agreement between Grant PUD and the Wanapum Tribe, which may include any relevant portions of past agreements, to protect cultural resources of significance.
6. Provide Department of Archaeology and Historic Preservation (DAHP) with the missing and incomplete information associated with the submitted site record and determination of eligibility forms.

7. Develop and implement protection/mitigation measures for 20 archeological sites and all other archeological sites within the Area of Project Effect (APE) known to contain human remains.
8. Determine National Register eligibility for all remaining inventoried archeological sites and other cultural resources located within the Project APE.
9. Identify site-specific project-related effects on all National Register-eligible cultural resources and implement measures to protect such sites within the Project APE.
10. Reconvene a committee similar to the Hanford Reach National Monument Federal Planning Advisory Committee to address shoreline-related effects on archeological sites in the Hanford Reach.

At this time, this program does not contemplate provisions that reflect the needs of the bull trout and its critical habitat.

1.1.5 Monitoring Plans

Grant PUD's license application, as modified in the Commission's FEIS, entails numerous anadromous fish monitoring and evaluation studies using radiotelemetry or other techniques to evaluate upstream and downstream route-specific survival at the Priest Rapids and Wanapum dams. These actions also include the development and implementation of a bull trout monitoring plan to document occurrences of bull trout in the project area. Grant PUD will also develop a monitoring plan for upstream and downstream passage of the Pacific lamprey. All respective studies, evaluations, and monitoring plans would be discussed in coordination with the PRCC and the Commission's proposed Priest Rapids Fish Forum.

It is anticipated that implementation of these monitoring plans will involve Grant PUD's request for ESA section 10(a)(1)(A) recovery permits, as appropriate.

1.1.6 Project Operations

<u>Turbine Operations</u>

A sizable number of salmon smolts pass through the turbines at the Project's Wanapum and Priest Rapids dams (Grant PUD 2003). In accordance with the Priest Rapids Salmon and Steelhead Settlement Agreement, the licensee has proposed and is in the preliminary stages of implementing measures designed to improve turbine operations at its Priest Rapids Project. One of these measures entails the replacement of existing turbines with an Advanced Hydro Turbine System to maximize smolt survival at the Wanapum Dam. More specifically, on October 2, 2003, and supplemented on April 5 and May 28, 2004, the licensee filed an application to amend the license for the Priest Rapids Project seeking authorization to replace the 10 tubines at the Wanapum Dam with 10 new, upgraded advanced turbines.

The Advanced Turbine replacement was proposed to provide increased power and hydraulic capacity, equal or improved survival of juvenile salmon passing through the units, and improved water quality by reducing the amount of spill over the dam during periods of high flows. The decision criteria for proceeding with the replacement of the remaining nine units over the next eight years was whether the Advanced Turbine testing results demonstrated equal or better fish survival than the existing turbines. Pursuant to the Commission's July 23, 2004 Order, the licensee installed and tested an Advanced Turbine at Unit 8. Consistent with the requirements of NMFS' May 2004, Biological Opinion and related Commission Orders, a study was designed and conducted to test the hypothesis that survival of Chinook salmon smolts through a new Advanced Turbine would be equal to, or greater than, passage survival through an existing unit. On October 11, 2005, the licensee filed a report on the results of biological testing of the first installed Advanced Unit turbine, and in December 2005, the Commission authorized the continued installation of Advanced Turbines at Wanapum Dam. Based on this authorization, installation of the second of 10 turbines is currently underway, with completion of the Wanapum turbine upgrade contemplated by 2012. These operational criteria entail the minimization of blade strike mortality and pressure changes during turbine passage. It is anticipated that these criteria could provide some level of benefit to the bull trout.

Grant PUD also proposes to implement measures to improve turbine passage survival of anadromous smolts at Priest Rapids Dam. The first measure involves developing operational criteria to avoid operating the turbines at settings that have been shown to lower fish survival in other turbine research. This type of program has been successfully implemented at the Wanapum Dam. While the refined operating plan is being developed, the licensee would restrict the Priest Rapids Dam turbines to non-cavitation operating mode. The second measure would research Advanced Turbines that could maximize smolt passage survival. The turbines currently in place at the Priest Rapids Dam are in good condition, so any new turbines would be installed on a longer-term replacement schedule.

Juvenile Fish Bypass

Grant PUD proposes to achieve a minimum 91% combined adult and juvenile anadromous salmonid survival performance standard at the project. This measure is part of the Priest Rapids Agreement. This would entail the development and annual revision of a downstream passage alternatives action plan (DPAAP) to contribute to achievement of the applicable performance standards at Wanapum and Priest Rapids dams. Grant PUD would develop and implement a performance evaluation program to assess improvements to juvenile salmonid passage survival.

To provide near-term compensation for annual juvenile salmonid survival that is less than the performance standard, Grant PUD would contribute to a No Net Impact (NNI) Fund. The NNI Fund would be used to undertake measures to improve juvenile salmonid survival. These measures may include, but are not limited to, capital improvements to the project's facilities to provide steady progress towards improving juvenile salmonid survival. Measures inherent to this fund can include projects that protect and enhance wetlands, riparian and riverine habitats, and anadromous salmonids affected by the operation of the Project. Projects may also include: improvements to upstream and downstream fish passage past current impediments, changes to hydroelectric operations, purchase of spill or flow, reintroduction of sockeye to other sub-basins, and assessments of other habitat supplementation programs and of habitat improvement projects.

The use of bypass programs for juvenile downstream passage would be implemented to provide fallback passage routes for adult spring and summer Chinook salmon. Grant PUD would continue the operation of the sluiceways at both Priest Rapids and Wanapum dams to provide fallback routes for steelhead and fall Chinook salmon.

The analysis of alternative application of top-spill concepts would be utilized to improve downstream juvenile salmonid survival at Priest Rapids Dam. In an effort to prevent smolts from entering the emergency wheelgate or bulkhead slots in Priest Rapids and Wanapum dams, Grant PUD would install gatewell exclusion screens. Grant PUD is also in the preliminary stages of constructing a downstream fish bypass at Wanapum Dam consisting of an ogee-crested weir through the center of Unit 11 and a submerged tailrace chute. At Priest Rapids Dam, Grant PUD is proposing to install a juvenile bypass facility located on the right side of the dam's powerhouse. The placement of each respective bypass structure at Wanapum and Priest Rapids dams will utilize the natural tendencies of salmonids to migrate downstream through the water column. If the proposed downstream bypass at Wanapum Dam fails to achieve 95% dam passage survival, Grant PUD would consult with the joint fisheries parties through the PRCC to improve survival through additional operational or structural modifications. The intent of the proposed action is to operate these types of juvenile bypass facilities in order to provide a non-turbine route for downstream passage of juvenile salmonids (April 1-August 31) and adult fish (end of summer spill to November 15).

Spillway Operations

Juvenile salmonids must pass Priest Rapids Dam either through turbines, the spillway (including sluiceway), or via gatewell dipnetting. There are currently no juvenile passage facilities operating at Priest Rapids Dam. Spill is provided as a means to improve fish passage efficiency (FPE), i.e., passage via a non-turbine route. For the spring migration season, spill of 61% of river flow is provided to cover 95% of the juvenile salmon and steelhead outmigration. This typically occurs from about mid to late April until June 15. This spill operation is limited by constraints designed to prevent lethal dissolved gas levels from occurring. The Washington Department of Ecology (WDOE) sets seasonal limits on the amount of total dissolved gas (TDG) that can occur in the Columbia River. The limit is typically 120% saturation below the Project. Therefore, if the 120% limit is exceeded, Grant PUD reduces spill until the TDG level falls to or slightly below 120%.

Juvenile salmonids migrating through Wanapum Dam must pass either through the turbines, spillway (including a sluiceway), or by gatewell dipnetting. There are currently no passage facilities operating at Wanapum Dam. Spill is provided as a means to improve FPE. For the spring migration season, Grant PUD has a goal of spilling 43% of flow to cover 95% of the juvenile salmon and steelhead outmigration. This typically occurs from about mid to late April until June 15. The Wanapum Dam spillway produces higher levels of TDG than the Priest Rapids Dam spillway; for that reason, Grant PUD installed flow deflectors in all 12 spill bays in an effort to reduce this effect. Nevertheless, the daily spill level at Wanapum Dam is typically driven by TDG limits and averages about 35% of flow over the spring migration season. In addition to bottom spill, Grant PUD installed a slotted bulkhead in spill bay 12 in 2002 to provide a surface spill route for juvenile migrants in an effort to increase FPE.

Grant PUD will coordinate its spill program for the Project with the spill activities of other projects through the PRCC. It would continue to operate each taintor gate at Wanapum Dam. Grant PUD would continue to identify and implement experimental spill regimes as may be warranted to test opportunities for improving fish survival with less spill flow and/or reducing TDG levels at either the Priest Rapids or Wanapum dams. Grant PUD would provide biological monitoring to determine the incidence of gas bubble disease (GBD) symptoms in downstream migrating juvenile salmonids and continue development of its "real-time" TDG monitoring system at the fixed monitoring sites.

Grant PUD's proposal also entails the evaluation of modifications to the spill regime and spill pattern at each dam to improve juvenile salmonid survival while remaining within applicable TDG limits. Grant PUD would continue to provide spill (61% of river flow in spring and 39% in summer) for downstream passage at Priest Rapids Dam until a better downstream passage alternative is designed, tested, and implemented. This measure is part of the Priest Rapids Agreement. Similar to Priest Rapids Dam, Grant PUD would continue to provide spill (43% river of flow in spring and up to TDG limits in summer) for downstream passage at Wanapum Dam until a better downstream passage alternative is designed, tested, and implemented. This measure is part of the Priest Rapids Agreement.

The implementation of these measures would likely provide an opportunity for juvenile and adult bull trout to pass downstream through the Project's facilities. Providing downstream passage through the proposed spill measures will also ensure that migratory connectivity of bull trout populations is maintained.

Adult Fishways

Grant PUD proposes to operate and maintain two adult fishways at each dam according to annual Fish Operating Plans and investigate methods for improving hydraulic conditions in the fishway collection channels, junction pools, and entrance pools. This measure is part of the Priest Rapids Agreement. Grant PUD proposes to provide effective fishway debris management, powerhouse collection channel velocities between 1.5 and 4.0 ft. per second, and 1 to 1.5 ft. of head across the fishway entrances for all modes of fishway operation. At this time, these annual Fish Operating Plans have no respective measures to assist in the upstream passage of adult and juvenile bull trout. The adult fishway facilities will be operated from March 1 to December 1 each year, although for operation and maintenance purposes, the primary fish passage season is considered to be April through November. Maintenance and dewatering of the adult fishway facilities would occur from December 1 to February 28. This timeframe is typically when bull trout would reside in the mainstem Columbia River.

Grant PUD is now in the preliminary stages of constructing, operating, and maintaining an off-ladder adult trapping facility in the left-bank fishway at Priest Rapids Dam. This measure is part of the Salmon and Steelhead Agreement as well. PIT-tag detection equipment would also be maintained at the Priest Rapids Dam fishways. Grant PUD would provide funding for fish counting at Priest Rapids and Wanapum dams and provide daily fish counts for both facilities. Grant PUD has also proposed completion of video monitoring capability for counting adults in fishways at both dams. Currently, bull trout are not counted specifically at the Project's facilities.

In addition to improving hydraulic conditions for salmon and steelhead at the Project's fishway facilities, Grant will modify diffusion chambers on both fishways at Priest Rapids Dam to improve adult lamprey passage. This measure would include modifying the design of the fish counting stations at Priest Rapids and Wanapum dams to improve adult lamprey passage and enumeration. If appropriate, Grant PUD would reduce fishway flows at night to improve adult lamprey passage.

The implementation of these measures would likely provide an opportunity for adult and sub-adult bull trout to pass upstream through the Project's facilities. Providing upstream passage through the proposed upstream fishways will also ensure that migratory connectivity of bull trout populations is maintained.

Hydrograph Variation

The Project, located at the head of the Hanford Reach, is the lowermost of a seven-dam hydroelectric complex on the mid-Columbia River that includes Rock Island, Rocky Reach, Wells, Chief Joseph, and Grand Coulee dams (Figure 1). This complex is operated under a power-peaking or load-following mode to meet electrical demand in the Pacific Northwest. Hydropower generation through these projects largely governs stream flow in the mid-Columbia River. As mentioned previously, the mid-Columbia projects are part of the larger Columbia River hydropower system and are operated under numerous treaties and agreements that affect river flows and fish resources.

Completion of the Columbia River hydropower and flood control system, including the Project, has altered the annual hydrograph by reducing peak spring flows, increasing average minimum flows, and shifting the period of lowest flow from winter to autumn (Anglin *et al.* 2005). Average June peak flows have been reduced to 165,000 cfs while lowest average monthly flow, which now occurs in September, has increased to 84,000 cfs. For example, operation of the Mid-Columbia River projects to meet power demand (load-following) currently results in large hourly and daily fluctuations in discharge from

Priest Rapids Dam during the spawning, incubation, emergence, and rearing periods for fall Chinook salmon. Typical project operations result in fluctuations as great as 2.1 meters/hour and 4 meters in a 24-hour period in the Priest Rapids Dam tailrace during the fall Chinook salmon emergence and rearing period.

The Project's reservoirs also rise and fall to facilitate the implementation of numerous fish protection measures. The Project license allows a 6.5 foot (ft) elevation variation of the reservoir at Priest Rapids Dam (from 481.5 ft above sea level to 488 ft). At Wanapum Dam there can be 11.5 ft elevation variation (560 ft to 571.5 ft). The reservoirs are usually operated in the upper range of those allowable river elevations.

At this time, project operations do not consider bull trout and accompanying critical habitat. However, it is anticipated that the continued implementation of the Hanford Reach Fall Chinook Protection Program Agreement will likely result in some incidental benefit for bull trout by project flows being stabilized from the spawning through emergence life history timeframes. Nevertheless, the proposed project operations in terms of hydrograph variation are anticipated to have a level of negative effect on the following habitat characteristics: 1) water temperatures in shallow-water habitats; 2) the magnitude of the Columbia River's natural hydrograph; and 3) the abundance of near-shore food resources for bull trout.

Predator Control

Grant PUD proposes to fund a northern pikeminnow (*Ptychocheilus oregonensis*) removal program in an effort to improve anadromous smolt passage survival through the reservoirs and tailraces of Priest Rapids and Wanapum dams. This funding would continue into the new license term for an effort that was originally initiated in 1995. The success of this program has improved each year as contract anglers learn more about northern pikeminnow habitat use and foraging behavior. In 1995, the program removed 3,531 northern pikminnow. By 1998 and 1999, the program removed over 10,000 per year. In recent years, the average is over 40,000. While the overall effects of this program on survival of anadromous salmonids are difficult to estimate, more than 120,000 northern pikeminnow from the Project have been removed since 1995, and the program most likely improves reservoir and tailrace passage survival of salmonid smolts.

Grant PUD also proposes to fund and implement an avian hazing and control program to improve smolt passage survival through the tailraces of Priest Rapids and Wanapum dams. Gull wires have been installed across portions of the tailrace boating-restricted zones of both dams to reduce gull predation on juvenile salmonids passing through arrays to more thoroughly cover the tailrace areas. Grant PUD also proposes to continue funding for the Wildlife Services program (formerly Animal Damage Control) of the United States Department of Agriculture to haze gulls, terns or other avian predators and provide limited lethal control to improve reservoir and passage survival for juvenile salmonids. Grant PUD has co-funded the development of an environmental assessment to guide implementation of future hazing and control programs.

At this time, these programs do not contemplate provisions that reflect the needs of the bull trout and its critical habitat. These programs may provide some level of protection for sub-adult bull trout utilizing the project area. Incremental increases in forage base for bull trout may result from the minimization of predation on juvenile anadromous salmonids. It is also anticipated that incidental catch of bull trout will occur during these programs.

PIT-tagging

As part of its anadromous fish monitoring and evaluation studies, Grant PUD proposes to conduct survival studies using passive integrated transponder (PIT)-tag technology or other suitable study methods to obtain dam and project passage survival estimates, in accordance with the Priest Rapids Agreement. These actions would entail the capture and handling of fish at their facilities. Timing of these activities typically occurs during the spring outmigration each year for salmon and steelhead (April-June).

It is anticipated that implementation of these monitoring plans will involve Grant PUD's request for ESA section 10(a)(1)(A) recovery permits, as appropriate.

1.2 Description of the Action Area

The action area includes all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action [50 CFR part 402.02]. Areas directly affected by the Project are confined to the reservoirs, forebays, dams and tailraces of each facility (approximately 1,000 feet downstream of the dam to 1,000 feet downstream of the next dam upstream). However, water quality impacts (in this case, elevated levels of total dissolved gas resulting from either voluntary or involuntary spill at Project dams) are expected to extend as far downstream as the confluence of the Yakima River nearly 60 miles (DOE 2006).

The area indirectly affected by the proposed action also includes the Yakima River Basin because bull trout affected by Project operations are expected to have some level of genetic exchange between bull trout found in the Yakima Basin and those populations in the mid-Columbia River (GENECLASS 1999; CreatePop 2003). In addition, habitat protection and enhancement projects resulting from implementation of the Priest Rapids Salmon and Steelhead Agreement (i.e., the Habitat Plan proposed herein) are likely to affect bull trout in tributary river systems of the upper Columbia River. The Columbia River, upstream of the Project, provides a significant link for bull trout to migrate to tributary systems. The Project creates a certain level of hydrologic modification that affects the flow regime of the Columbia River. Grant PUD's proposed action also entails monitoring and hatchery supplementation programs that have the potential to affect bull trout populations that utilize the Columbia River and its component tributary systems located upstream of the Project.

Based on the above considerations, the Service defines the action area as the mainstem Columbia River between RM 544.9 (approximately 1,000 feet downstream of Chief Joseph Dam) and RM 356.0, a distance of nearly 190 miles, as well as the Okanogan, Methow, Entiat, Yakima, and Wenatchee River systems.

2.0 STATUS OF THE BULL TROUT

2.1 Listing Status

The coterminous United States population of the bull trout *(Salvelinus confluentus)* was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout occurs in the Klamath River Basin of south-central Oregon and in the Jarbidge River in Nevada, north to various coastal rivers of Washington to the Puget Sound and east throughout major rivers within the Columbia River Basin to the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978, Bond 1992, Brewin and Brewin 1997, Leary and Allendorf 1997).

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation and alterations associated with: dewatering, road construction and maintenance, mining, and grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels; and introduced non-native species (64 FR 58910).

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647, 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs, plus two other population segments, into one listed taxon and the application of the jeopardy standard under section 7 of the ESA relative to this species (64 FR 58930):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

2.2 Current Status and Conservation Needs

As noted above, in recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: (1) Jarbidge River; (2) Klamath River; (3)

Columbia River; (4) Coastal-Puget Sound; and (5) St. Mary-Belly River. Each of these segments is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these units is provided below. A comprehensive discussion of these topics is found in the Service's draft recovery plan for the bull trout (Service 2002; 2004a,b), the Services Science Team Document (Whitesel et al 2004), the Critical Habitat (Service 2005a), the Rock Creek Mine Biological Opinion (Service 2006a), and the science used in the analysis for the 5-year review (Service 2005b).

Generally, the conservation needs of the bull trout are often expressed as the need to provide the four "C's": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout at multiple scales ranging from the coterminus to local populations. The recovery planning process for the bull trout (Service 2002; 2004a, b, 2006) has also identified the following conservation needs for the bull trout: (1) maintain and restore multiple, interconnected populations in diverse habitats across the range of each interim recovery unit; (2) preserve the diversity of life-history strategies; (3) maintain genetic and phenotypic diversity across the range of each interim recovery unit; and (4) establish a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Dunham et al, 2003; Rieman et al 2005).

Central to the survival and recovery of the bull trout is the maintenance of viable core areas (Service 2002, 2004a, b, 2005a, 2006). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat, and in some cases in their use of spawning habitat. Each of the interim recovery units listed above consists of one or more core areas. About 118 core areas are recognized across the United States range of the bull trout (Service 2002, 2004a, b, 2005a, 2006).

Jarbidge River

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawners, are estimated to occur within the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, angler harvest, timber harvest, and the introduction of non-native fishes (Service 2004).

The draft *Bull Trout Recovery Plan* (Service 2002; 2004a) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout within the core area; maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area; restore and maintain suitable habitat conditions for all life history stages and forms; and conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. According to the draft recovery plan, an estimated 270 to 1,000 spawning fish per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (Service 2004a).

Klamath River

This interim recovery unit currently contains 3 core areas and 12 local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (Service 2002). Bull trout populations in this unit face a high risk of extirpation (Service 2002).

The draft *Bull Trout Recovery Plan* (Service 2002) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout and restore distribution in previously occupied areas; maintain stable or increasing trends in bull trout abundance; restore and maintain suitable habitat conditions for all life history stages and strategies; conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. The draft recovery plan notes that 8 to 15 new local populations and an increase in population size from about 3,250 adults currently to 8,250 adults are needed to provide for the persistence and viability of the 3 core areas (Service 2002).

Columbia River

This interim recovery unit currently contains about 90 core areas and 500 local populations. About 62% of these core areas and local populations occur in central Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good but generally all have been subject to the combined effects of habitat degradation, fragmentation and alterations associated with one or more of the following activities: dewatering; road construction and maintenance; mining, and grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species.

The draft *Bull Trout Recovery Plan* (Service 2002) identifies the following conservation needs for this unit: maintain or expand the current distribution of the bull trout within core areas; maintain stable or increasing trends in bull trout abundance; maintain/restore suitable habitat conditions for all bull trout life history stages and strategies; and conserve genetic diversity and provide opportunities for genetic exchange.

Coastal-Puget Sound

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this unit. This interim recovery unit currently contains 14 core areas and 67 local populations (Service 2002; 2004b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this unit. With limited exceptions, bull trout continue to be present in nearly all major watersheds where they likely occurred historically within this unit. Generally, bull trout distribution has contracted and abundance has declined especially in the southeastern part of the unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, angler harvest, and the introduction of non-native species.

The draft *Bull Trout Recovery Plan* (Service 2002; 2004b) identifies the following conservation needs for this unit: maintain or expand the current distribution of bull trout within existing core areas; increase bull trout abundance to about 16,500 adults across all core areas; and maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River

This interim recovery unit currently contains 6 core areas and 9 local populations (Service 2002). Currently, the bull trout is widely distributed in the St. Mary River drainage and occurs in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (Service 2002). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (Service 2002).

The draft *Bull Trout Recovery Plan* (Service 2002) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout and restore distribution in previously occupied areas; maintain stable or increasing trends in bull trout abundance; restore and maintain suitable habitat conditions for all life history stages and forms; conserve genetic diversity and provide the opportunity for genetic exchange; and establish good working relations with Canadian interests because local bull trout populations in this unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

2.3 Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989, Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, Goetz 1989), or saltwater (anadromous) to rear as subadults or to live as adults (Cavender 1978, McPhail and Baxter 1996, WDFW et al. 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years and can be found up to 20 years old in Canada (Goetz 1989). They are iteroparous (they spawn more than once in a lifetime), and both repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Leathe and Graham 1982, Fraley and Shepard 1989, Pratt 1992, Rieman and McIntyre 1996). Some bull trout may spawn less frequently (e.g. 17 of 27 radio tagged bull trout spawned in 1 year, 5 of 27 in two years, and 1 of 27 in 3 years), based on recent telemetry data (B. Kelly-Ringel, Service pers. comm.). Downs (2006) describes that in the Trestle Creek, in Lake Pend Oreille, a larger number of bull trout spawn annually and that repeat spawners only comprise a portion of that number. Baxter and Weaver (1999) describe a 2:1 ratio of annual repeat spawners to alternate year spawners.

Growth varies depending upon life-history strategy. Resident adults range in total length from 6 to 12 inches (14-30cm) total length, and migratory adults commonly reach 24 inches (60 cm) or more (Pratt 1985, Goetz 1989). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Mortality rates of bull trout life history stages can be high; however, these rates decrease as the size of the fish increases. Egg survival can decrease with stream temperatures and alterations in habitat conditions (Service 1998, Pratt 1993). Egg to fry survival may vary between 3 to 50% depending on speed of growth, age at maturity, and fecundity (Reimant and McIntyre 1993). Fecundity may vary from less than 100 eggs in resident forms to greater than 5,000 eggs in migratory forms (Reiman and McIntyre 1993, Goetz 1989).

Sizes of bull trout varies widely depending on geography and is likely due to a variety of other factors although water temperatures and diet are thought to play a large role (Pratt 1992, Goetz 1989, Rieman and McIntyre 1993, Service 1998). General age and size classification of the migratory bull trout life history form are generally defined as: juveniles: 0-3 years old and ranging in size from less than 1 to about 5 inches (2-13cm) in total length; subadults: 3-4 years old and ranging in size from 5 to13 inches (13 to 33cm) in total length; and migratory adults: 4+ years old and greater than 13 inches (33cm) in total length (pers. comm., S. Spalding, Service, 2006; Service 1989; Goetz 1989; Pratt 1992; Reiman and McIntyre 1993; Kramer 2003; McPhail and Baxter 1996).

The iteroparous reproductive behavior of the bull trout requires year-round, two-way passage, both up and downstream, not only for repeat spawning but for foraging, rearing, and overwintering. Most fish ladders, however, were designed specifically for anadromous semelparous (fishes that spawn once and then die, and therefore require only one-way passage upstream) salmonids. Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route.

2.4 Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), fish should not be expected to simultaneously occupy all available habitats (Rieman et al.1997).

Migratory corridors are necessary to link seasonal habitats for all bull trout life history forms (Service 1998). The ability to migrate is important to the persistence of the bull trout (Rieman and McIntyre 1993; Gilpin, *in litt.* 1997; Rieman et al. 1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed, or stray, to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic composition within bull trout populations among these populations, which may encourage local adaptation within individual populations. This also suggests that reestablishment of extirpated populations may take a very long time (Spruell et al. 1999, Rieman and McIntyre 1993).

Cold water temperatures play an important role in determining bull trout habitat, as these fish are primarily found in colder streams (below 59°F), and spawning habitats are generally characterized by temperatures that drop below 48°F in the fall (Fraley and Shepard 1989, Pratt 1992, Rieman and McIntyre 1993).

Thermal requirements for the bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, Rieman and McIntyre 1993, Baxter et al. 1997, Rieman et al. 1997). Optimum incubation temperatures for bull trout eggs range from 35 to 39°F whereas optimum water temperatures for rearing range from about 46 to 50°F (McPhail and Murray 1979, Goetz 1989, Buchanan and Gregory 1997). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 46 to 48°F, within a temperature gradient of 46 to 60°F. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 52 to 54°F.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Factors that can influence bull trout ability to survive in warmer rivers include availability and proximity of cold water patches and food productivity (Myrick 2003). In Nevada, adult bull trout have been collected at 63°F in the West Fork of the Jarbidge River (S. Werdon, Service, pers. comm. 1998) and have been observed in Dave Creek where maximum daily water temperatures were 62.8 to 63.6°F (Werdon 2000). In the Little Lost River, Idaho, bull trout have been collected in water having temperatures up to 68°F; however, bull trout made up less than 50% of all salmonids when maximum summer water temperature exceeded 59°F and less than 10% of all salmonids when temperature exceeded 63°F (Gamett 1999). In the Little Lost River study, most sites that had high densities of bull trout were in an area where primary productivity increased in the streams following a fire (B. Gamett, Forest Service, pers. comm., 2002).

All life history stages of the bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, Goetz 1989, Hoelscher and Bjornn 1989, Sedell and Everest 1991, Pratt 1992, Thomas 1992, Rich 1996, Sexauer and James 1997, Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). 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 from winter through spring (Fraley and Shepard 1989, Pratt 1992, Pratt and Huston 1993).

Pratt (1992) reported increases in fine sediment reduce egg survival and emergence. Bull trout are generally found near the bottom of the streams with smaller size classes occurring closest to the bottom. They are known to use varying distances of height above the substrate at different age classes where the mean distance above the stream bed increases slightly with fish size (i.e. fish less than 4 inches or 10cm were found about 1.5 inches or 30mm above the streambed whereas fish between 4-8 inches or 10-20cm were found about 3 inches or 80 mm above the streambed) as described in Pratt (1993).

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or are near other sources of cold groundwater (Goetz 1989, Pratt 1992, Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992), and after hatching, juveniles remain in the substrate. Time from egg deposition to emergence of fry may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, Ratliff and Howell 1992).

Migratory forms are of the bull trout appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes where foraging opportunities may be enhanced (Frissell 1993). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted for bull trout in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. The dispersal of bull trout among populations provides a mechanism for supporting weaker populations or refounding those that may become extirpated (Rieman and McIntyre 1993). Benefits to migratory bull trout include greater growth in the more productive waters of larger streams and lakes, greater fecundity resulting in increased reproductive potential, and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993, MBTSG 1998, Frissell 1999). In the absence of the migratory bull trout life form, isolated populations cannot be re-established when disturbance makes local habitats temporarily unsuitable, this results in the range of the species being diminished, and the potential for enhanced reproductive capabilities is lost (Rieman and McIntyre 1993).

2.5 Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, Goetz 1989, Donald and Alger 1993). Adult migratory bull trout feed on various fish species (Leathe and Graham 1982, Fraley and Shepard 1989, Brown 1994, Donald and Alger 1993). In coastal areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) in the ocean (WDFW 1997).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one choice of food over another. For example, prey often occur in concentrated patches of abundance ("patch model"; Gerking 1998). As the predator feeds the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. In the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migratory route (WDFW 1997). Anadromous bull trout also use marine waters as migratory corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman, *in litt.*, 2003; Brenkman and Corbett, *in litt.*, 2003; Goetz, *in litt.*, 2003a,b).

A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, but this foraging strategy can change from one life stage to another. Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994) and as fish grow their foraging strategy changes as their food changes in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, mysids and small fish (Shepard et al. 1984, Boag 1987, Goetz 1989, Donald and Alger 1993). Bull trout that are 4.3 inches long or longer commonly have fish in their diet (Shepard et al. 1984), and bull trout of all sizes have been found to eat fish half their length (Beauchamp and Van Tassell 2001).

Migratory bull trout begin growing rapidly once they move to waters with abundant forage that includes fish (Shepard et al. 1984, Carl 1985). As these fish mature they become larger bodied predators and are able to travel greater distances (with greater energy expended) in search of prey species of larger size and in greater abundance (with greater energy acquired). In Lake Billy Chinook, Oregon, as bull trout became increasingly piscivorous with increasing size, the prey species changed from mainly smaller bull trout and rainbow trout for bull trout less than 17.7 inches in length, to mainly kokanee for bull trout greater in size (Beauchamp and Van Tassell 2001).

Migration allows bull trout in Washington to access optimal foraging areas and exploit a wider variety of prey resources. Bull trout likely move to or with a food source. For example, some bull trout in the Wenatchee basin, in Washington, were found to consume large numbers of earthworms during spring runoff in May at the mouth of the Little Wenatchee River where it enters Lake Wenatchee (Service 2006c). In the Wenatchee River, radio-tagged bull trout moved downstream after spawning to the locations of spawning chinook and sockeye salmon and held for a few days to a few weeks, possibly to prey on dislodged eggs, before establishing an overwintering area downstream or in Lake Wenatchee (Service 2006c).

2.6 Consulted-on Effects

Previous consulted-on projects occur throughout the range of bull trout that could affect the status of bull trout. Because of a recent court decision for the Rock Creek Mine in the Clark Fork in Montana, biological opinions for ESA Section 7 consultations across the range have been summarized. In order to assess the effects of previous actions/projects on bull trout for this Biological Opinion we incorporate by reference the Service's

Biological Opinion for the Rock Creek Mine in Montana prepared by our Region 6 office (Service 2006a). In the Status of the Species section of that opinion the Service reviewed all 137 of the biological opinions received by the Service from the time of listing in June 1998 until August 2003.

In summary, 124 biological opinions (91%) applied to activities affecting bull trout in the Columbia River population, 12 biological opinions (9%) applied to activities affecting bull trout in the Coastal-Puget Sound population, 7 biological opinions (5%) applied to activities affecting bull trout in the Klamath River population, and 1 biological opinion (less than 1%) applied to activities affecting the Jarbidge and St. Mary Belly populations. The geographic scale varied from individual actions (e.g., construction of a bridge or pipeline) within one basin, to multiple-project actions, occurring across several basins.

There were 24 different activity types analyzed in those 137 opinions (e.g., grazing, road maintenance, habitat restoration, timber sales, hydropower, etc…). Twenty actions involved multiple projects, including some of which are restorative actions for bull trout. Within each river basin, the number of actions, type of actions, and a brief description of the action was provided. Furthermore, each individual action was identified as to the cause of the effect and the anticipated effect on a spawning stream and/or migratory corridor if known (in most cases this effect was known). An attempt was made to further define the anticipated effect by duration (e.g., "short-term effects" varied from hours to several months) and a determination was made, when possible, to identify those projects with long-term benefits. Actions whose effects were "unquantifiable" numbered 55 in migratory corridors and 55 in spawning streams.

The analysis in the biological opinion occurred at the core area scale. For example, the Rock Creek Mine Biological Opinion included an evaluation of the Clark Fork River basin from the time of listing to August 2003, which includes the affected core area (Lower Clark Fork Core Area) of the Rock Creek mine project. Here 37 actions occurred in this river basin during this period, the majority (35) involved habitat disturbance with unquantifiable effects, 16 actions are ongoing, and 21 actions have been completed and effects are no longer occurring.

At the time of preparation of the Rock Creek Mine Biological Opinion there were no biological opinions within the range of bull trout with other than a no-jeopardy determination. The actions summarized in the Rock Creek Opinion (2006a) did not adversely affect bull trout populations to the extent or loss of subpopulations (population), and because all previous biological opinions were to have updated baselines and were no-jeopardy determinations, they concluded that the continued long-term survival and existence of the species had not been appreciably reduced range-wide. The assessment of all of the biological opinions from the time of listing, until August 2003 (137 biological opinions), confirmed that no actions that have undergone section 7 consultation, considered either singly or cumulatively, will appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any subpopulations (populations).

Since 2003 to July 2006 the Service has issued 198 biological opinions that have been issued within the range of bull trout (Dan Brewer, Service, 2006, pers. comm.). These biological opinions were no-jeopardy determinations and they concluded that the continued long-term survival and existence of the species had not been appreciably reduced range-wide. The Rock Creek Mine Biological Opinion also concluded that out of the 198 biological opinions prepared from 2003 to July 2006, issued in the affected core area (Lower Clark Fork Core Area), and that have undergone section 7 consultation, considered either singly or cumulatively, will not appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any subpopulation (population) and that many of them will benefit bull trout. Development of a database for tracking effects and take being worked on in the Services' Region 1 and 6 regional offices.

3.0 STATUS OF BULL TROUT CRITICAL HABITAT

3.1 Legal Status

The Service published a final critical habitat designation for the coterminus United States population of the bull trout on September 26, 2005 (70 FR 56212); the rule became effective on October 26, 2005. The scope of the designation involved the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units). Rangewide, the Service designated 143,218 acres of reservoirs or lakes and 4,813 stream or shoreline miles as bull trout critical habitat (Table 1).

Table 1. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by state.

State	Stream/Shoreline Miles	Acres
Idaho	294	50,627
Montana	1,058	31,916
Oregon	27,322	27,322
Oregon/Idaho	17	
Washington	1,519	33,353
Washington (marine)	985	

3.2 Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212). Core areas reflect the metapopulation structure of the coterminus United States population of the bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. Critical habitat units generally encompass one or more core areas and may include foraging, migration, and overwintering areas, outside of core areas, that are important to the survival and recovery (i.e., conservation) of the bull trout.

Because there were numerous exclusions associated with the final critical habitat designation process that reflect land ownership, designated critical habitat is often fragmented. These individual critical habitat segments are expected to contribute to the ability of the stream to support viable local and core area populations of the bull trout in each critical habitat unit.

The primary function of individual critical habitat units is to maintain and support viable core areas (70 FR 56212) which (1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993); (2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993; MBTSG 1998); (3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Rieman and McIntyre 1993; Hard 1995; Healey and Prince 1995; MBTSG 1998); and (4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Rieman and McIntyre 1993; Hard 1995; MBTSG 1998; Rieman and Allendorf 2001).

The Olympic Peninsula and Puget Sound Critical Habitat Units are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound bull trout population. These critical habitat units contain nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult overwintering, migration, and foraging.

Within designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Note that only the PCEs described in paragraphs (i), (vi), (vii), and (viii) below apply to marine nearshore waters identified as critical habitat; and all except PCE (iii) apply to foraging, migration, and overwintering habitat identified as critical habitat.

The PCEs of bull trout critical habitat are as follows (70 FR 56212):

(i) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72°F (0 to 22°C) but are found more frequently in temperatures ranging from 36 to 59°F (2 to 15°C). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation;

(ii) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures;

(iii) Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter;

(iv) A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a Biological Opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation. This rule finds that reservoirs currently operating under a biological opinion that addresses bull trout provides management for PCEs as currently operated;

(v) Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source;

(vi) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows;

(vii) An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish; and

(viii) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries.

In freshwater habitat, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. For designated lakes, the lateral extent of critical habitat is defined by the perimeter of the water body as mapped on standard 1:24,000 scale topographic maps.

In marine habitat, critical habitat includes the inshore extent of marine nearshore areas between mean lower low-water (MLLW) and minus10 meters (m) mean higher high-water (MHHW), including tidally influenced freshwater heads of estuaries. This refers to the area between the average of all lower low-water heights and all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore areas is based on the extent of the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) relative to the MLLW.

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on the PCEs of bull trout critical habitat in the marine environment.

3.3 Current Condition Rangewide for Bull Trout Critical Habitat

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat.

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: (1) the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Rieman and McIntyre 1993; Dunham and Rieman 1999); (2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989; MBTSG 1998); (3) the introduction and spread of nonnative species as a result of fish stocking and facilitated by degraded habitat conditions, particularly for brook trout and lake trout, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993; Rieman et al. 2006); (4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and (5) degradation of foraging, migration, and overwintering habitat resulting from reduced prey base, roads, agriculture, development, and dams.

4.0 ENVIRONMENTAL BASELINE

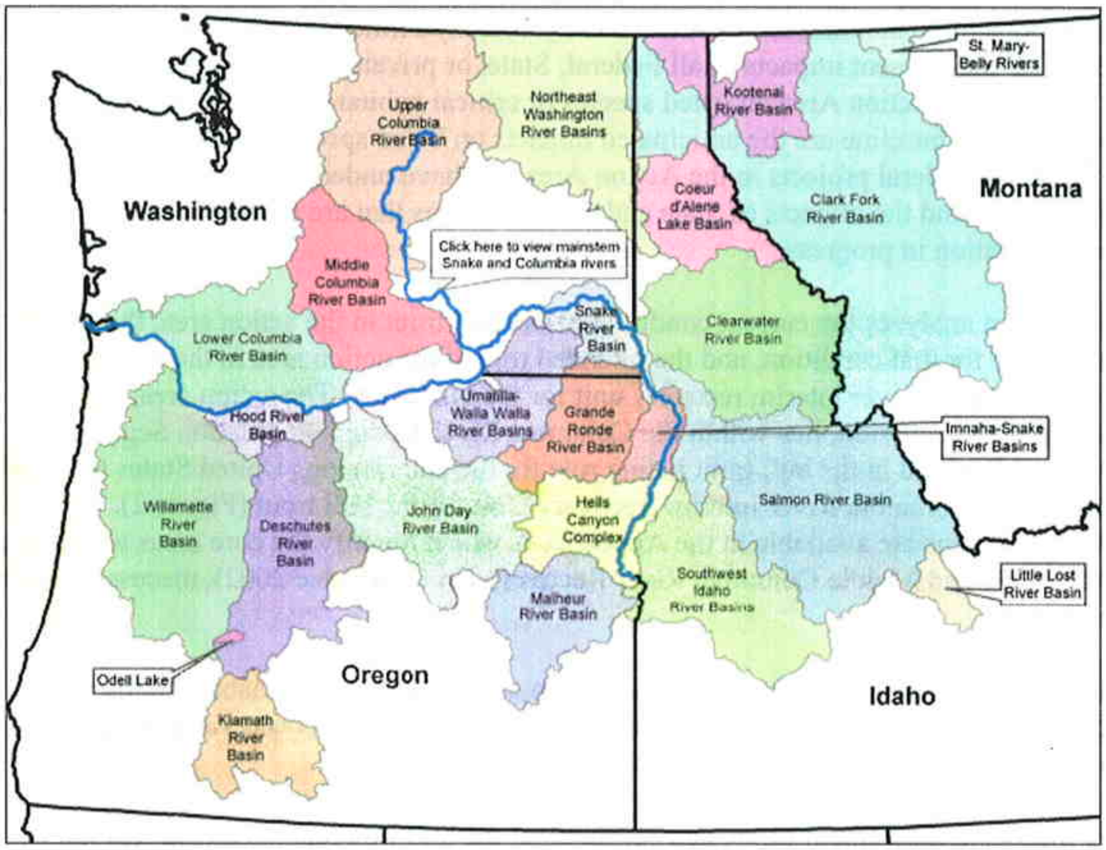
Regulations implementing the ESA (50 CFR § 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area on listed species or critical habitat. Also included in the environmental baseline are the anticipated impacts on listed species or critical habitat of all proposed Federal projects in the Action Area that have undergone section 7 consultation, and the impacts of State and private actions that are contemporaneous with the consultation in progress.

This section analyzes the current condition of the bull trout in the action area, the factors responsible for that condition, and the intended role of the action area in the conservation of the Columbia River interim recovery unit for the bull trout. The action area, at the focus of this discussion, lies within the Columbia River Distinct Population Segment which is identified in the bull trout listing rule for the coterminous United States (Service 1999) as the Columbia River Interim Recovery Unit for the bull trout (Figure 2). Additional maps are available in the Appendix A which identify the core areas within the Draft Upper and Middle Columbia River Recovery Units (Service 2002), discussed in the Action Area.

This section also analyzes the current condition of bull trout critical habitat in the action area, the factors responsible for that condition, and the intended conservation role of bull trout critical habitat within the action area.

The following assessment of the current status of the bull trout and its critical habitat in the action area is based, in part, on application of the format titled "A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Scale" (Service 1999). This format includes a decision matrix with pathways and indicators (Matrix) designed to describe the baseline of the population and habitat conditions and effects of the proposed action on these conditions. The Service uses the Matrix, the Service's Draft Recovery Plan (Service 2002), the proposed and final rules for designated Critical Habitat (2002, 2004, and 2005a), and the science associated with the development of information for the Service's 5-year review (Service 2005b).

Figure 2. Map of the Columbia River DPS also described in the Coterminus listing as the Columbia River Interim Recovery Unit. (Service 2002)



4.1 Bull Trout

Three life history forms (adfluvial, fluvial, and resident) are believed to occur in the action area. The Action Area between the mouth of the Yakima River and Chief Joseph Dam encompasses a portion of bull trout foraging, migratory, and overwintering (FMO) habitat in the mainstem Columbia River, and spawning, rearing, and foraging, migratory, and overwintering (FMO) habitat within the Wenatchee, Entiat, Methow, and Yakima River basin core areas of the bull trout.

4.1.1 Status of the Bull Trout in Mainstem Columbia River FMO Habitat

Current bull trout presence in the mainstem Columbia River may reflect the strength of the local populations within tributaries and the presence of suitable migration corridors between the tributaries and the Columbia River. For example, bull trout occur in greatest numbers in the upper Columbia River where its populations are larger and suitable habitat conditions for migration exist in the lower reaches of tributaries (Methow, Entiat, and Wenatchee Rivers). There are fewer occurrences of bull trout in the Columbia River where poorer habitat conditions in tributaries have fragmented migration corridors or reduced populations (Yakima, Walla Walla, Umatilla, and John Day rivers). Greater bull trout use of the mainstem Columbia River would be expected if habitat conditions improve and populations increase in these tributaries. Upstream passage, in the form of fishways or ladders constructed for salmon, allows bull trout to migrate upstream past dam facilities. Downstream passage through dam facilities occurs through the turbines, spillways, and juvenile bypass systems. Currently, within the action area there is only one juvenile bypass constructed and operating which is at Rocky Reach Dam.

Bull trout have been documented both upstream and downstream of the Project, including the Rocky Reach, Rock Island, Wells, Wanapum, and Priest Rapids reservoirs. Current information also suggests the presence of bull trout in the Hanford Reach of the Columbia River, located downstream of the Project (Gray and Dauble 1977 and Pfeifer et al. 2001). They have been observed upstream of the Project in the mainstem Columbia River near Chief Joseph Dam (T. McCracken, Service, 2006, pers. comm..).

<u>Juvenile Bull Trout Abundance in the Mainstem Columbia River</u>

Downstream passage of juvenile anadromous fish at dams occurs through juvenile fish passage facilities, by spilling water over dam spillways, or traveling through the powerhouse turbines. Bull trout are observed each year using the adult fish passage facilities to pass the Rocky Reach, Rock Island, and Wells Dams. Juvenile bull trout have been observed in the juvenile sampling facilities at these dams as well, although very infrequently. Bull trout were sampled in the Rocky Reach Dam prototype juvenile bypass collector in 1998, 1999, 2000, 2001, and 2002, with 23, 30, 8, 4, and 5 fish observed, respectively (Service 2004a). In 2003, no juvenile bull trout were sampled at the new Rocky Reach Dam juvenile collector sampling facility. Length measurements were not taken on these fish; however, anecdotal information from sampling facility personnel indicated that most were juvenile or sub-adult fish. Facility personnel could recall observing only two or three adult bull trout in the sampling facility during all years of prototype operation (S. Hemstrom, CPUD, pers. comm., 2003). Juvenile fish sampling in 2003 occurred for only 2 hours (8-10 am) each day, and in the evening (4-6 pm and 7 to 9 pm) one day per week. It is probable that some juvenile and adult bull trout pass undetected at night during periods when the sampling facility is not operating. This bypass will be used in future years to collect juvenile salmon (sockeye, spring chinook, summer/fall chinook) and steelhead to conduct juvenile fish passage studies (passage efficiency and survival) at Rocky Reach and Rock Island dams. Study fish are captured at the juvenile collection facility during index sampling periods (normally two hours, Monday-Friday 0800 to 1000 hours), or until 1,500 fish are collected, which ever comes first. In addition, sampling is conducted in the evenings (from 1400 to 1600, and 1900 to 2100 hours) once each week to assess how well the morning sampling period represents the migration timing. Juvenile bull trout may be captured during periods when study fish are being collected.

Numbers of bull trout captured at the Rock Island Bypass smolt trapping facility from 1997 through 2006 were 2, 7, 14, 1, 8, and 8, 2, 3, and 5 respectively (www.fpc.org, Service 2004). From 1998-2006 there were a total of 18 juvenile bull trout (when only including actual juvenile data) captured at the Rock Island Dam smolt trap facility generally between June-August. No juvenile bull trout were captured in the Rock Island Juvenile Bypass trap in 2003 (L. Praye, WDFW, pers. comm., 2003). Additionally, between 1998 and 2006 there were an additional 30 bull trout observed generally between May-August (the size was not determined). We assume that since adult bull trout are generally identified that these fish were either juvenile or sub-adult bull trout. Most of the bull trout captured at the bypass are small bull trout. Some mortality of juvenile salmon and steelhead occurs with the operation of the Rock Island bypass. The proposed juvenile bypass system is designed to achieve at least a 95% survival rate. For the purposes of this analysis, we will use a single survival rate of 94% for juvenile and sub-adult bull trout at both Project dams.

Additionally, there were bull trout observed at other smolt trapping facilities and adult ladders on the mainstem Columbia River. For example, there was one bull trout observed at McNary Dam in December of 2004 and another at Bonneville Dam in powerhouse 2 in the smolt trapping facility in March of 2005.

Numbers of juvenile bull trout have been collected from 1997-2006 at screw traps, during downstream movements within the Methow, Entiat, and Wentchee Rivers for multiple years. There has been some information collected in the Yakima River and in the N. Fork Teanaway River in multiple years during downstream monitoring as well. In the Wenatchee Basin, average numbers of juvenile bull trout collected at the screw traps are 302 in the Chiwawa River with a range of 76-605 juveniles, 4 in Nason Creek with a range of 0-13 juveniles, 2 in the Lake Wenatchee outlet with a range of 0-5 juveniles, 106 in Peshastin Creek with a range of 99-112, and 2 in the Wenatchee River at Monitor with a range of 0-4. The screw trap at Monitor on the Wenatchee River is the furthest downstream location in the Wenatchee River, and it is likely that these fish travel downstream to the Columbia River for its feeding opportunities and overwintering conditions.

One screw trap in the lower part of the Entiat River averages 14.5 juvenile bull trout captured, but has had as many as 38 captured (www.cbr.washington.edu/dart/dart.html). All of these juveniles are expected to migrate out of the Entiat and into the FMO habitat in the Columbia River because of the increased feeding and high quality overwinter habitat there. In the Methow River, sampling at screw traps on the Twisp River averaged 28 with a range of 6-49 juvenile bull trout. On the Methow River near Carlton, in the lower portion of the Methow, only 2 juvenile bull trout have been seen at the screw trap or an average of 0.7 juveniles in the 3 years it has operated. This is the furthest downstream screw trap in the Methow and it is likely that these fish could move into the Columbia River for optimizing forage and overwintering opportunities.

Not all screw trap data is collected year round or similarly. Not all bull trout that could be passing downstream are collected at these traps because not all of the water goes through them. Some screw traps are located in places that may not be conducive to the collection of bull trout which are stream bottom oriented, as compared to other salmonids. Depending on geology and flow conditions, the traps may be located in a portion of the channel that bull trout do not use. Traps are also shut down for safety in high flows during the spring or fall. Little correction factors are available for the quality of the screw trap data for bull trout. However, the Service believes that information likely represents the minimum number of bull trout moving downstream into the mainstem Columbia River.

There is also some data available on juvenile bull trout in the N. Fork Teanaway Basin. Three bull trout juveniles were counted in a panel weir in Jungle and Jack creeks and 1 bull trout juvenile counted in a Fyke net in the N. Fork Teanaway (Pearsons et al, 1998).

In summary, we estimate that annually 84 adult and 30 juvenile and sub-adult bull trout use the Wanapum reservoir (see Appendix B). About 30% of adult bull trout used multiple core areas for some portion of their life history, and 10% appeared to spawn in different core areas in succeeding years (BioAnalysts Inc 2004).

SubAdult Bull Trout Abundance in the Mainstem Columbia River and at Project Facilities

Grant PUD conducted a multi-gear, multi-season sampling effort over numerous habitat types in 1999. This evaluation suggests infrequent bull trout use within close proximity of the Priest Rapids and Wanapum dams (Pfeifer et al. 2001). Only 2 subadult bull trout were captured during this effort.

Other data indicate that bull trout use of the Project fishways is limited at this time. The licensee conducts regular operations to remove fish collected within gatewells at both the Wanapum and Priest Rapids dams during the juvenile salmonid outmigration. During these activities, no bull trout have been observed at Priest Rapids Dam. During similar gatewell operations at Wanapum Dam for the period of 1997-2003, only 3 bull trout have been observed (1 in each of the years 1998, 1999, and 2000). Over the last 43 years, 3 bull trout have been documented within the Project fish ladders. During fish ladder maintenance at Priest Rapids Dam during 2000, 1 bull trout (36-cm long) was found and released alive from the left bank fish ladder on December 8, 2000 (T. Dresser, Grant County PUD, personal communication). At Wanapum Dam, a single bull trout (42-cm long) was salvaged from the left bank fish ladder during maintenance efforts on December 12, 2000 (T. Dresser, Grant County PUD, personal communication). One adult bull trout has been observed using the Project fishways at Wanapum fish ladder on July 23, 2002 (T. Dresser, Grant County PUD, pers. comm..).

Adult Bull Trout Abundance in Fish Ladder Passage Counts and Smolt Trap Monitoring Systems in the Mainstem Columbia River

Bull trout are routinely observed (and counted) by Chelan and Douglas PUD employees while the fish are passing through the fish ladders (Service 2004). Before the installation of computer video-monitoring, bull trout were documented by direct observation at fish ladder windows. Since 1992, fish have been counted utilizing round-the-clock computer video recordings during adult salmon passage periods. Counts prior to 1998 did not differentiate bull trout from other trout.

Chelan and Douglas PUDs, owners and operators of the Rock Island, Rocky Reach and Wells hydroelectric projects, began to enumerate bull trout using the adult passage facilities in 1998. A total of 83 bull trout passed Rocky Reach Dam between May 3 and July 31 that year (Chelan PUD, 2002 unpublished data). In 1999, from May 10 to November 14, 128 bull trout passed the project. In 2000, 2001, and 2002, counts of bull trout using the fish ladder from April 20 to November 14 were 216, 204, and 201, respectively. More than 80% of bull trout passage for these years occurred from May 1 to July 31. In 2003 (April 14 to September 3), 206 bull trout passed Rocky Reach Dam. Between 2004 and 2006 a total of 161, 155, and 132 bull trout, respectively passed Rocky Reach Dam, with most between May and August. In all years on record, the majority of the bull trout passed the Project in May and June (75 to 90%). Although the extent of bull trout passage at other times of the year is unknown, some bull trout do use fish ladder facilities to pass the facilities in September, October, and November (Service 2004, www.cbr.washington.edu/dart/dart.html). Fish counting ends around November 15 each year. For most years, the counting period was limited to 3 to 8 months. More recently, counting may occur for up to 10 months of a year.

Generally, fewer bull trout are observed at Rock Island Dam each year compared with Rocky Reach Dam. In 1998, 1999, 2000, and 2001, the numbers of bull trout observed at Rock Island were 48, 56, and 88, and 82, respectively (CPUD, 2002 unpublished data). Between 55 and 70% of the fish that passed Rock Island Dam in those years did so in May and June. In 2002, 87 bull trout passed Rock Island Dam from April 14 to November 14; most of these fish passed in May and June (75%). From April 14 to September 3, 2003, 77 bull trout passed Rock Island Dam, 55 of those during May and June. Between the years of 2004-2006, a total of 114, 69, and 35 bull trout, respectively passed Rock Island Dam, most in May through August. For most years, the counting period was limited to 3 to 8 months. More recently, counting may occur for up to 10 months of a year.

At Wells Dam, counts of bull trout passing the dam began in 1999. Data from 1999-2006, indicate that 47 to 108 (www.cbr.washington.edu/dart/dart.html) pass the dam in any given year; most pass through the ladder in May and June. Chelan County PUD reported that bull trout pass through the ladder at Wells Dam in similar pattern and numbers to that at the Rock Island and Rocky Reach Dams; however, it should be noted that the counting period is limited from 3 to 7 months of the year (Service 2004a-CPUD HCP; FERC 2006; www.cbr.washington.edu/dart/dart.html). More recently, counting may occur for up to 10 months of a year.

In addition, adult bull trout are also counted in the mainstem Columbia River at Rock Island smolt trapping facilities. There were 8 adults observed from 1998-2006 in the smolt trapping facilities at Rock Island Dam. Bull trout are also seen at other smolt trapping facilities in the mainstem Columbia and other tributaries (Rock Island, Snake, Grand Rhonde, John Day, etc.

In the lower Yakima River, there have been 5 bull trout observed in the mainstem near CleElum, Swauk Creek, Ellensburg, confluence of Naches River, and Benton City.

In summary, the adult fishway or ladder counts suggest an average of 82 fish passing Rock Island Dam, 203 at Rocky Reach Dam, and 71 at Wells Dam. Adult bull trout are also seen at other maintem dams in smolt trapping facilities both upstream and downstream of the Project. Although fish counts at adult fishways generally only cover 5-8 months and sometimes 10 months during a year, most fish are believed to pass through the dams in May and July. We estimate that annually 84 adult use the Wanapum reservoir (see Appendix B). About 30% of adult bull trout used multiple core areas for some portion of their life history, and 10% appeared to spawn in different core areas in succeeding years (BioAnalysts Inc 2004).

Radio Telemetry Data for Adult Bull Trout

In an effort to evaluate the status of the bull trout in the mid-Columbia River, Grant PUD, along with Chelan and Douglas PUDs, initiated research which focused primarily on fish passage at the Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells hydroelectric projects (BioAnalysts, Inc. 2004). This research investigated: (1) passage at the five hydroelectric facilities, specifically, migration rate from the tailrace of the projects to the ladder entrances, from the ladder entrances to the ladder exits, and from the ladder exits to the next upstream project or the tributary of residence, and fallback rate at each project; (2) tributary selection and residence; and (3) mainstem Columbia River residence.

With regard to the Priest Rapids Project, results of the research indicated that of the 79 bull trout radio-tagged, 10 (12.7%) were detected within Wanapum reservoir (BioAnalysts, Inc. 2004). Five of the 10 fish used the area of the reservoir upstream of Tekison Creek, where the other five used the entire reservoir, including one fish moving downstream of Priest Rapids Dam. These fish made extensive upstream and downstream movements into multiple tributaries, between and within years, including into the Methow, Entiat, and Wenatchee Rivers. Most moved into tributaries by July and reentered the mainstem Columbia River in November. Five of the 10 fish that used the reservoir moved as much as 87 miles (140 km) in distance in a one-way movement. One fish entered the Okanogan River but shortly thereafter moved downstream and entered the Methow River. Use of the mainstem Columbia River was extensive and occurred year-round, but most bull trout moved into tributaries by July and re-entered the Columbia in November (Appendix C summarizes the tributary use, movements, and locations of tagged bull trout in tributaries).

The Service initiated a telemetry study in the Wenatchee River basin, in 2000 (Service 2006), and 43 of 51 bull trout that were tagged were grouped by similar movement patterns. These included those fish that overwintered in Lake Wentachee, the upper Wentachee/Columbia River, and the Middle Wenatchee/Columbia River. Data described in the draft report included 9 out of 43 (21%) radio tagged bull trout which made large movement of up to 106 miles (170 km) one way in the Columbia River. The data suggests that 22% of the radio tagged fish spawned multiple times over a 2-3 year period and about 88% of the fish radio tracked for one year spawned. Key FMO habitat was used between months and for a year or more in Icicle Creek (8 months), mainstem Columbia River (9 months), and the mainstem of the Wenatchee River (12 months).

These data represent the best available information to characterize bull trout use of the Priest Rapids Project Area and the mainstem Columbia River. About 13 to 21% of radio tagged fish make large movements from 87-106 miles (140 to 170km), or on average 17% are long distance migratory fish. Fish used both the more riverine environment of the upper Wanapum reservoir and the full reservoir. One of these long distance migrating fish was located below Priest Rapids dam in the tailrace. Of the 15 bull trout collected and tagged at Rock Island Dam, 4 returned to locations downstream from the dam and indicated an inconsistent pattern in bull trout use of specific rearing locations within the Columbia River (See Appendix C).

<u>Productivity (growth and survival)</u>
Bull trout less than 5 inches in length (11cm) feed on aquatic insects. Once they are larger, their diet shifts to a mix of insects and fish or primarily fish (Pratt 1992). Migratory bull trout incrementally increase in size once they begin to feed on a diet of fish. A recent radio telemetry study in the Columbia River mainstem (BioAnalysts Inc. 2004) determined the age classes of 36 of the fish tagged in the mainstem; they ranged from 12 fish at age 4, 19 at age 5, 3 at age 6, and 3 at age 7. Five of these tagged fish spawned previously on one or more occasions (BioAnalysts Inc. 2004). Over half of the radio-tagged bull trout detected within the Wells Dam tailrace entered the hatchery outfall. Given that bull trout are opportunistic feeders, these fish could have been taking advantage of the large concentrations of juvenile fish within the hatchery outfall system (BioAnalysts Inc. 2004). Fish in the Columbia River that had scales analyzed showed large growth spurts once they reached a certain age and this can be associated with migratory behavior. The growth spurts observed were assumed to have occurred when bull trout enter the Columbia River, where the preybase is abundant.

The mainstem Columbia River, including the reservoirs, provides an abundant food source for migratory bull trout during the fall, winter, and spring. Forty-four species of resident fishes are listed as likely to occur in the mid-Columbia River reach between Chief Joseph and Rock Island dams (NMFS, 2000). Thirty-seven species of fish were collected in the Rocky Reach section of the Columbia River during relicensing studies conducted for the Rocky Reach Project (Duke Engineering, 2001). Forage fish such as juvenile salmon and steelhead, whitefish, sculpins (family Cottidae), suckers (family Catostomidae), and minnows (family Cyprinidae) that are present throughout the Columbia River were collected in these studies (Service 2004).

Bull trout evolved with anadromous and resident salmonids and prey on juvenile salmonids. Large numbers of hatchery-raised salmon and steelhead are released into the Columbia River system annually and provide an abundant source of prey for bull trout. In 2000, about 83 million hatchery salmon and steelhead were released into the Columbia/Snake River system (Fish Passage Center, 2001).

Connectivity (Habitat Access and Condition)

The Columbia River (from the Pacific Ocean to Chief Joseph Dam) serves as a migration corridor, providing foraging, habitat, and overwintering area for bull trout for fluvial bull trout that spawn in the major tributary systems (Brown 1992; Service 2001; and BioAnalysts, Inc. 2002).

Although there are no natural physical barriers between each of the major tributaries and the mainstem Columbia River, 9 mainstem dams likely preclude upstream migration and downstream passage of bull trout when fish ladders are not being operated. These structures are designed and operated primarily for anadromous salmonids and not specifically for bull trout and require maintenance during a time period in which they are not operated. In the upper Columbia River where there are higher numbers of bull trout using the mainstem, it appears that dams do affect the ability of bull trout to move upstream and downstream between dams and tributaries to reach spawning grounds (BioAnalysts, Inc. 2002, 2003, 2004). Migration rates are slowed as evidenced in tagged bull trout placed downstream of the dams (BioAnalysts, Inc. 2004). On average, adult bull trout with implanted radio transmitters took longer to pass dams than to move through reservoirs (BioAnalysts, Inc. 2004). Dams on the mainstem in general can cause injury or death, delay passage, cause fallback (with a 26% mortality rate through turbines), affect water quality, and hydrographic variation, as evidenced in may studies implemented on the mainstem Columbia River (Mendel and Milks 1995, Service 2000).

Downstream passage at dams for juvenile anadromous fish is provided by fish passage facilities, by spilling water over dam spillways, or traveling through the powerhouse. Bonneville, John Day and McNary dams have fish screens and bypass facilities for juvenile anadromous salmonids. The Dalles Dam turbines are not screened and fish pass the dam through an ice-trash sluiceway. Fish pass the Upper Columbia River projects via the spillways or similar passage devices. Wells Dam uses a hydrocombine which incorporates a spillway above the powerhouse. During the summer, fish that are collected at juvenile fish facilities at McNary Dam are transported by barge or truck and released at a site downstream from Bonneville Dam. It is uncertain if the juvenile fish facilities are effectively passing bull trout because these structures were designed for juvenile anadromous salmon and steelhead. Only 1 bull trout has been recorded at the juvenile fish facilities at the Lower Columbia River dams. That fish was captured at the John Day Dam Smolt Monitoring Facility in May, 2002 (http://www.fpc.org). There is also a possibility that bull trout have not been recorded properly in the past at some of the smolt monitoring projects on the mainstem Snake and Columbia Rivers. Small numbers of juvenile and adult bull trout have been collected at the Rock Island Dam Smolt Monitoring Facility and at the Rocky Reach Dam surface collector (http://www.fpc.org).

While juvenile fish passage facilities were not specifically developed for the downstream passage of larger fish such as migrating steelhead kelts or adult bull trout, most of these systems have not been shown to injure or kill these life stages. However, a 40 to 50% injury rate has been measured in some years to adult salmonids passing through the juvenile fish bypass system at McNary Dam (Wagner and Hilson, 1993). The overall efficiency of adult salmonids, including bull trout, passing dams via juvenile bypass facilities and spill has not been thoroughly examined (Service 2004d).

The mortality rate for adult bull trout passing through turbines has not been studied but a surrogate can be used. Mortality estimates ranging between 22% and 57% for adult steelhead that passed through turbines was described in a summary of adult fish fallback rates and mortality (Service 2000). Fourteen to 26% mortality was reported for fallback rates through turbines at federal dams on the Snake River by Mendel and Milks (1995) in the FCRPS BO (Service 2000). "Fallback" rates relate to the potential for fish to "fallback" through the dams, resulting in contact with structural features of the dam (spillways, turbines, or fish ladders). Adult mortality is likely to be higher than for juveniles (Service 2000, 2004).

Water temperatures can develop into thermal barriers reducing or eliminating fish passage and migration. During the fall, winter, and spring when bull trout are foraging, overwintering, and migrating in the Columbia River, water temperatures range from approximately 28 to 70°F (-2 to 21°C), depending on life history stage and form, geography, elevation, diurnal and seasonal variation, and local groundwater influence. Water temperatures typically exceed 70°F (21°C) during August and September. Average maximum daily water temperature readings for the last ten years have been less than 68°F (20°C) in the forebays of Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams (Service 2004d). The 10-year average maximum daily water temperatures at Bonneville, The Dalles, John Day, and McNary dam forebays are lower than 70°F (21°C) except from early August to early September.

The degree of historic movement among core areas before construction of the mainstem dams is difficult to infer. Preliminary analysis of a limited number of microsatellite loci suggest that allele frequency patterns in the Yakima River basin have been influenced by gene flow from the upper Columbia as well as the lower Columbia and the Snake River (Y. Reiss, USFS, pers. comm. 2004). The consistency of this pattern across a larger sample of loci remains to be investigated. Results of current telemetry studies suggest that gene flow among the Wenatchee, Entiat, and Methow core areas is likely (BioAnalysts 2004), and gene flow between these core areas and the Yakama Core Area is still possible (BioAnalysts, Inc. 2004).

Downstream of the Action Area passage of bull trout is also limited or reduced by 4 federally operated dams, [Bonneville (Rkm 235, Rm146.1), The Dalles (Rkm 308.1, Rm191.5), John Day (Rkm 346.9, Rm 215.6), and McNary (Rkm 469.8, Rm 292)]. These facilities are operated by the Army Corps of Engineers and form a series of reservoirs in the lower Columbia River (Service 2004d). Flow in the Columbia River upstream and downstream of each of these dams is affected by operations for hydropower, navigation, flood control, and anadromous fish migration. The Columbia River is free-flowing downstream from Bonneville Dam.

Five dams operated by the public utility districts of Grant, Douglas, and Chelan counties form a series of reservoirs in the Upper Columbia River: Priest Rapids (Rkm 638.9, Rm 397.1), Wanapum (Rkm 669, Rm 415.8), Rock Island (Rkm 729.5, Rm 453.4), Rocky Reach (Rkm 762.2, Rm 473.7), and Wells (Rkm 828.8, Rm 515.1) dams (Service 2004d). River flows within this reach of the Columbia River are controlled by releases from these projects and releases from Federal and Canadian dams that are located upstream. Flows are controlled for flood control, hydroelectric power, recreation, irrigation, cultural resource protection, resident fish protection, and anadromous fish migration.

The Columbia River is free flowing from Priest Rapids Dam downstream to McNary Reservoir near the City of Richland, Washington. Flows downstream from Priest Rapids Dam are also affected by power peaking operations at that project.

Columbia River dams downstream from Chief Joseph Dam have fish passage facilities that have been designed for upstream passage of migrating anadromous fish, primarily for salmon and steelhead. Bull trout have been observed by fish counters in the fish ladders at Bonneville and the Dalles dams (http://www.fpc.org). Records at lower Columbia River dams may not accurately represent bull trout passage because adult fish counts and juvenile anadromous fish monitoring ceased after October 31, and fish counters do not always record bull trout sightings. Bull trout have been observed passing the fish ladders at Wanapum, Rock Island, Rocky Reach, and Wells dams. These bull trout have been observed passing through the ladders at similar or lower rates compared to salmon and steelhead (Chuck Peven, CCPUD, pers. comm. 2004).

Bonneville, John Day and McNary dams have fish screen and bypass facilities for juvenile anadromous salmonids. The Dalles Dam turbines are not screened and fish pass the dam through an ice-trash sluiceway. Fish pass the upper Columbia River dam projects via spillways or similar passage devices. During the summer, fish that are collected at juvenile fish facilities at McNary Dam are transported by barge or truck and released at a site downstream from Bonneville Dam. It is uncertain if the juvenile fish facilities are effectively passing bull trout because these structures were designed for juvenile anadromous salmon and steelhead. Only 3 bull trout have been officially recorded at the juvenile fish facilities at the lower Columbia River dams; one at Mcnary Dam on 12/21/2004 (http://www.fpc.org, 1/11/2007); 1 at the John Day Dam Smolt Monitoring Facility in May, 2002 (http://www.fpc.org, 1/11/2007); and 1 at the Bonneville power house 2 on 3/21/2005(http://www.fpc.org, 1/11/2007). There is also a possibility that bull trout have not been recorded properly in the past at some of the smolt monitoring projects on the mainstem Snake and Columbia Rivers. Small numbers of juvenile and adult bull trout have been collected at the Rock Island Dam Smolt Monitoring Facility and at the Rocky Reach Dam surface collector (http://www.fpc.org).

Summary of habitat Conditions
Analysis of habitat conditions for bull trout within the mainstem Columbia River includes using the Matrix pathways for assessing bull trout habitat conditions for water quality, habitat access, habitat elements, channel condition, flow/hydrology, and watershed conditions at the tributary/local population scale and at the river basin/core area. The mainstem Columbia River is considered to be functioning at high risk or (i.e. functioning at unacceptable condition) for bull trout. In general, this is due to the fact that the area is functioning at high risk for most of the pathways including: water quality, habitat access, channel condition, flow/hydrology, and non-native fish presence. It is also because the other remaining pathways are functioning at moderate risk (i.e. "functioning at risk") for habitat elements and watershed condition. Refer to the Matrix for definitions of these rankings.

Consulted-on and Other Effects that have Influenced the Condition of the Bull Trout in the Mainstem Columbia River FMO Habitat.

The assessment in the Rock Creek Mine BO (Service 2006a) of all of the biological opinions from the time of listing, until July 2006 (335 biological opinions), confirmed that no actions that have undergone section 7 consultation, considered either singly or cumulatively, will appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any local populations, and that many of them will benefit bull trout. Locally there have been a few biological opinions on the Mainstem Columbia River, in the action area, based on potential adverse effects such as: the Service's Biological Opinion for the Vernita Bar Site Selection Project by the Corps of Engineers (Service 2005, Ref: 1-09-2005-F-0363) which will accrue only sub-lethal take; the Mid-Columbia Habitat Conservation Plan (Service 2004, Ref: 04-0203) which will accrue both lethal and sub-lethal take; the Chief Joseph Dam Hatchery and Lake Chelan Dam FERC relicensing, Lake Entiat Estates Project, and the Federal Columbia River Power System (FCRPS) Project, which will accrue both lethal and sublethal take; and several minor Corps of Engineers overwater structure projects and a blanket permit (RGP5) project, which will accrue minimal sub-lethal take.

Available information indicates implementation of section 6 and/or section 10(a)(1)(A) permits in the basin have resulted in direct effects to bull trout due to capture and handling and indirect mortality [(Bureau of Reclamation (BOR), Washington Department of Fish and Wildlife (WDFW), Environmental Protection Agency (EPA), Central Washington University (CWU), Yakama Nation, and Service fisheries studies)]. Although projects associated with the restoration programs may result in long-term benefits for bull trout and their habitat, all projects included in the proposed action resulted in take of this species.

It is unknown how many non-Federal actions have occurred in the mainstem FMO habitat since the listing of bull trout. Activities such as emergency flood control, development, and infrastructure maintenance are conducted on a regular basis and affect riparian and instream habitat. Hydraulic Permits issued by the State also affect bull trout and their habitat. Recent land-use changes from agriculture to urban development along the riparian areas may also affect bull trout and their habitat. County permits have likely increased for construction of homes in floodplain and riparian areas.

Statewide Federal restoration programs which include riparian restoration, restoration of fish passage at barriers, and habitat improvement projects have been authorized in the Core Areas. The watershed groups have coordinated to apply for monies to complete stream habitat work along the mainstems. The Biological Opinion for the Chelan and Douglas County PUD HCP requires bull trout monitoring and the associated tributary funding is providing restoration for salmonid habitats. The FCRPS Biological Opinion also provides for bull trout monitoring and associated restoration project that will benefit bull trout. The Washington State Forest Practice Rules HCP Biological Opinion will include some adverse impacts but will allow for restoration actions on or near state forested lands, including fish barrier (i.e. culverts) removal/replacement.

Natural events such as fire and flooding cause changes in the environment. The mainstem Columbia River was subject to 100-year flood events in 1990, 1995/1996, and 2006 as well as several other flood events that caused the dams to open flood gates and remove woody debris accumulations. These caused extreme hydrologic fluctuations, extreme velocities and quantities of water to spill over the flood gates, ladders, and through turbines. This likely caused degradation of habitat, including a loss of habitat for protection from high water, and a loss of woody debris for habitat complexity in the action area and may have directly harmed bull trout at the project dams due to the hydrologic fluctuations.

Global warming may also be contributing to stream temperature changes in the mainstem of the Columbia River. Warmer air temperatures and increasing frequency of rain on snow events due to winter rainstorms contribute to changes in habitat conditions for bull trout. Warmer water in the FMO habitat makes it more difficult for bull trout to migrate and feed because they are trying to thermo-regulate. Increased severity of hydrologic events may lead to a higher frequency of disruptions and less stability in habitat conditions (i.e. streambeds, pools, and other habitats may have more sediments or may be altered more frequently to develop complex spawning or rearing habitat, etc).

Threats

Bull trout habitat conditions within the mainstem Columbia River are highly altered, with degraded habitat conditions such as: high temperatures, poor water quality that exceeds established thresholds and regulations, altered hydrologic patterns, and passage barriers being the key concerns. Of particular concern is habitat connectivity at the Project's dams. Up to 50%-70% of the time that migratory bull trout are expected to use the mainstem Columbia River FMO habitat, the adult fishways at the Project and other dams are closed or non-operational so they block access to bull trout for upstream migration (FERC 2006).

4.1.2 Bull Trout Status in the Yakima, Wenatchee, Entiat, and Methow Core Areas

These core areas currently support 35 local populations of bull trout: 16 in the Yakima; 7 in the Wenatchee; 2 in the Entiat; and 10 in the Methow. Although well distributed across the action area, these populations occur in low abundance and generally have declining, slightly increasing, to stable population trends. Within this Action Area, stable trends generally indicate the populations that are not decreasing or increasing through time, and that are functioning at low numbers. No stable and clearly increasing population trends occur in any of the core areas analyzed here. The migratory form of the bull trout is not present in many populations and habitat conditions and connectivity are fragmented. Habitat conditions are degraded within these core areas, but generally these conditions improve as you move upstream in the watershed as described in watershed assessments and previous biological opinions. Chronic habitat issues within these core areas include relatively high water temperature, passage barriers, and prolonged low-flow conditions.

The current condition of the bull trout within these core areas has been caused by dams, forest management practices, livestock grazing, agricultural practices and irrigation diversions, mining, residential development, recreational development, fisheries management, diking for flood control, and roads/culverts. A detailed discussion of bull trout status within each of these core areas and the factors influencing that status is presented in Chapters 21 and 22 of the draft *Bull Trout Recovery Plan* (Service 2002), which are herein incorporated by reference; the scientific analysis for the draft bull trout 5 year review (Service 2005b); subbasin plans; and our core area analysis and the bull trout Matrix Habitat Condition. Summaries for each core area in the action area are presented below.

Yakima Core Area

Abundance, Productivity, Connectivity, Habitat Conditions

Bull trout are dispersed throughout the Yakima River basin. Resident and migratory (both fluvial and adfluvial) bull trout are all found within the Yakima Core Area. Bull trout in the Yakima Core Area are currently found in 16 local populations. There are discussions about possible reintroduction of one additional population (Taneum Creek). Currently 8 of the 16 populations likely contribute individuals to the mainstem Columbia River based on information developed in genetic and radio telemetry reports in the Yakima Core Area.

The Yakima Core Area populations persist at low numbers, in fragmented, local populations. Since 1998, redd counts have varied from 455-687, averaging 534. The overall trend in redd counts in the Yakima Core Area is unstable and decreasing and because of the lack of interconnectivity, it is currently considered to be at intermediate risk from the deleterious effects of genetic drift. Given the lack of consistent population-census information, the low numbers of spawning migratory bull trout in most of the

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

local populations, the continued lack of connectivity, and decreased numbers of redds in one of the largest populations, bull trout in the Yakima Core Area are considered to have low resiliency and to be at increased risk of extirpation from stochastic events.

The Yakima Core Area is unique in that it's located between the upper and lower Columbia and Snake River Core Areas which makes it a possible population "mixing zone" between these areas in terms of demographic and genetic exchange. It is a very long watershed with long sections of FMO habitat in the mainstem, connectivity to the Columbia River, and where historic connectivity provided many large wetland and lake habitat features that bull trout could choose to use as FMO habitat. Historically, bull trout could have chosen to migrate upstream or downstream from these lakes to spawning habitat. However currently, passage is blocked by 5 BOR dams for irrigation purposes. Spawning also occurs both earlier and later here than other Core Areas.

Information provided for the consultation and described in the mainstem Columbia River baseline section above suggests 2 to 6 bull trout have been observed in the Wanapum and Priest Rapids Reservoirs within the project facilities such as the fishways. These fish ranged in size from 14-16 inches (36 to 42 cm). Two of the fish were found in fish ladders during maintenance activities in December, and were likely using the fish ladders as foraging, holding, or overwinter habitat and not just passing through the fishway. Because the Yakima is the closest core area, these fish were found in December, and these fish are of a smaller migratory size class, these fish could be from the Yakima populations.

Analysis of habitat conditions for bull trout within the Yakima Core Area includes using the Matrix pathways for assessing bull trout habitat conditions for water quality, habitat access, habitat elements, channel condition, flow/hydrology, and watershed conditions at the tributary/local population scale and at the river basin/core area. Brook trout presence can indicate degraded habitat conditions and is also addressed to some degree for habitat. There are 6 local populations (Ahtanum and Taneum Creeks, Bumping, Cle Elum/ Waputs, Teanaway, and the Upper Yakima Rivers) of bull trout and one potential local population or spawning tributaries where most Matrix pathways are functioning at high risk (i.e. functioning at unacceptable condition). There are 10 local populations (Box Canyon, Crow, Deep, Gold, Indian, and Rattlsnake Creeks and the American, Kachess, N. Fork Tieton, S. Fork Tieton Rivers) that are functioning at moderate risk (i.e. functioning at risk).

At the Yakima Core Area scale, habitat conditions for spawning and rearing areas for all local populations are functioning at high risk (i.e. functioning at unacceptable condition) for the pathways of habitat access, channel condition, flow/hydrology, and brook trout presence and are functioning at moderate risk (i.e. functioning at risk) for the pathways of water quality and habitat elements. This is generally due to blocked migratory corridors, loss of complex river habitat altered channel and watershed conditions, and extreme hydrologic patterns. The condition of FMO habitat in the Yakima Core Area is at high risk of not functioning adequately for bull trout because of poor water quality, lack of adequate habitat complexity, poor channel, flow or hydrology, and watershed conditions, and the presence of brook trout. Refer to the Matrix for definitions of these rankings.

Consulted-on and Other Effects that have Influenced the Condition of the Bull Trout in the Yakima Core Area.

The assessment in the Rock Creek Mine BO (Service 2006a) of all of the biological opinions from the time of listing, until July 2006 (335 biological opinions), confirmed that no actions that have undergone section 7 consultation, considered either singly or cumulatively, will appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any local populations and that many of them will benefit bull trout. Locally there have been a high to moderate number of biological opinions in the Yakima Core Area, in the action area, based on potential adverse effects to the population and/or habitat such as the following examples (though not an exhaustive list): the Washington Forest Practices and Plum Creek HCP, USFS Box Canyon Road Improvement, emergency consultation on Salmon La Sac Road Failure, and Pollalie Ridge Fire emergency consultation, Washington Department of Transportation programmatic consultation for road maintenance and repairs, the USFS programmatic consultation for culvert replacement and noxious weed treatments, numerous BOR diversion maintenance and work projects, Lower Ahtanum Diversion and Town Diversion Dam projects, Naches-Cowiche Fish Ladder Modification, Coleman Creek Fish Screen Replacement project, and BORs Fish Salvage from the Tieton Pool project, which will accrue both lethal and sub-lethal take.

Available information indicates implementation of section 6 and/or section 10(a)(1)(A) permits in the basin have resulted in direct effects to bull trout due to capture and handling and indirect mortality (BOR, WDFW, EPA, CWU, Yakama Nation, and FWS fisheries studies). Although projects associated with the restoration programs may result in long-term benefits for bull trout and their habitat, all projects included in the proposed action resulted in take of this species.

It is unknown how many non-Federal actions have occurred in the Yakima Core Area since the listing of bull trout. Activities such as emergency flood control, development, and infrastructure maintenance are conducted on a regular basis and affect riparian and instream habitat. Hydraulic Permits issued by the State also affect bull trout and their habitat. Recent land-use changes from agriculture to urban development along the riparian areas may also affect bull trout and their habitat. County permits have likely increased for construction of homes in floodplain and riparian areas.

Statewide Federal restoration programs which include riparian restoration, restoration of fish passage at barriers, and habitat improvement projects have been authorized in the Yakima Core Area. The Yakima River watershed groups have coordinated to apply for monies to complete stream habitat work along the mainstem Yakima River and its tributaries and are working with the U.S. Forest Service to complete culvert repairs. Most large fish passage culverts on national forest land have been replaced with open bottom arches or bridges. The Plum Creek Timber Company Cascades HCP was developed on lands in the I-90 Corridor. The HCP has provisions for timber harvesting and other land management activities that benefit bull trout. Impacts to bull trout and their habitat from grazing in Ahtanum Creek on WDNR lands and Ahtanum Irrigation

District lands have been reduced with the placement of a fence in 2004 along riparian areas adjacent to most of the spawning habitat. Impacts to bull trout and their habitat from grazing on national forest lands in the South Fork Tieton have been reduced with the changes to special use permits that preclude cows from areas with redds during and after spawning, and reduce effects to riparian areas. Natural events such as fire, flooding, and global warming also cause changes in the environment within the Yakima Core Area.

Threats

In summary, continued threats to the bull trout in the Yakima Core Area include: water quality and water quantity degradation and migration barriers associated with a lack of passage in five major BOR storage reservoirs, diversions and water withdrawals, degradation of stream habitat within the drawdown zone of irrigation reservoirs, and the contamination in the Yakima River from pesticides and other agriculturally related chemicals; continuing effects of past logging activities (such as road construction); livestock practices on both private, state and federal lands in riparian areas and spawning areas; mining in the form of placer suction dredging and hard rock mining; residential development and urbanization along the riparian corridors; fish management and associated hatchery stocking, fishing regulations, poaching, non-native species introduction within bull trout habitat; increased fire frequency in eastern Washington shifting from historic levels and causing frequent large scale disturbances in the core area; and contamination in the Yakima River from pesticides and other agriculturally related chemicals.

Wenatchee Core Area

Abundance, Productivity, Connectivity, Habitat Conditions

Bull trout are dispersed throughout the Wenatchee River basin. Resident and migratory (both fluvial and adfluvial) bull trout are all found within the Wenatchee Core Area. Bull trout in the Wenatchee Core Area are currently found in 7 local populations. All populations have connectivity to the mainstem Columbia River. Currently, 5 of the 7 local populations are thought to contribute individuals into the mainstem Columbia River based on data from multiple radio-telemetry and some genetic analysis (BioAnalysts Inc., 2004; Appendix C; and the Service 2006c).

All bull trout populations but one in the Wenatchee Core Area, persist in low numbers and are at risk for genetic drift and inbreeding. The range of redds in the Wenatchee Core Area varies from 283 in 2001 to 706 in 2006. Since 2000, there are an average of 452 redds in the Wenatchee Core Area. This is greater than the 391 redds which existed for the Wenatchee populations in 1998 at the time of listing. Overall, the trend for the Wenatchee Core Area seems to be stable and suggests a slightly increasing trend. Given the lack of consistent population census information in the record of redd count surveys and the low numbers of adult spawning bull trout in most of the local populations, this Core Area is considered to be at moderate resiliency and intermediate risk of extirpation from stochastic events.

The Wenatchee Core Area is unique in that it has connectivity to the Columbia River and to a large natural lake in the upper basin. Bull trout can choose to use the lake and/or the Wenatchee and Columbia Rivers as FMO habitat and to go upstream or downstream to spawning habitat. As radio-telemetry has indicated, bull trout are able to exhibit resident, fluvial, and adfluvial patterns and mix between local populations and migrate both upstream and downstream of the Wenatchee River in the mainstem Columbia River (BioAnalysts, Inc, 2004, Service 2006).

Information provided for the consultation and described in the mainstem Columbia River in the baseline section above, and in multiple radio-telemetry studies suggests that a higher proportion of Wenatchee fish (about 21%) make longer movements than bull trout from other core areas. The redd survey data from the five local populations that likely use the Columbia River indicates a mean of 368 redds or 736 fish could be assumed to access the mainstem Columbia River. Approximately 154 fish or 21% of those could make long movements as summarized in radio-telemetry studies (Service 2004, BioAnalysts 2004, B. Kellyringel, Service, pers. comm.). Similar data from radio-telemetry studies by the PUD suggests that 37.5% of the radio-tagged fish that used Wanapum Reservoir were associated with the Wenatchee Core Area (BioAnalysts, Inc. 2004). The number of bull trout that make these long range movements to the Project area to use Wanapum Reservoir is at least 58 fish of the Wenatchee Core Area populations (Appendix B).

Analysis of habitat conditions for bull trout within the Wenatchee Core Area includes using the Matrix pathways for assessing bull trout habitat conditions for water quality, habitat access, habitat elements, channel condition, flow/hydrology, and watershed conditions at the tributary/local population scale and at the river basin/core area. Brook trout presence can indicate degraded habitat conditions and is also addressed to some degree for habitat. There are 4 (Icicle, Nason, Peshastin Creeks and the Little Wenatchee River) local populations of bull trout or spawning tributaries where most Matrix pathways are functioning at high risk (i.e. functioning at unacceptable condition), there are 2 (Chiwaukum Creek and the White River) local populations that are functioning at moderate risk (i.e. functioning at risk), and 1 local population (Chiwawa River) that is functioning at low risk (i.e. functioning appropriately).

At the Wentachee Core Area scale, habitat conditions for spawning and rearing for all local populations of bull trout are functioning at high risk (i.e. functioning at unacceptable condition) for the pathways of water quality, habitat elements, watershed conditions, and brook trout presence and are functioning at moderate risk (i.e. "functioning at risk") for the pathways of habitat access, channel condition, and flow/hydrology. This is generally due to passage obstructions/barriers that delay migration, a loss of complex habitat, altered channel and watershed conditions and hydrologic patterns. The condition of FMO habitat in the Yakima Core Area is at high risk of not functioning adequately for bull trout because of poor water quality, lack of adequate habitat complexity, poor channel conditions, flow or hydrology, and watershed conditions, and the presence of brook trout. Refer to the Matrix for definitions of these rankings.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

Consulted-on and Other Effects that have Influenced the Condition of the Bull Trout in the Wenatchee Core Area.

The assessment in the Rock Creek Mine BO (Service 2006a) of all of the biological opinions from the time of listing, until July 2006 (335 biological opinions), confirmed that no actions that have undergone section 7 consultation, considered either singly or cumulatively, will appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any local populations and that many of them will benefit bull trout (see the Status section for additional information). Locally there have been a few biological opinions in the Wenatchee Core Area, within the action area, based on potential adverse effects to the population and/or habitat such as in the following examples, though not an exhaustive list: the Washington Forest Practices and PUD HCPs, FCRPS Project, Washington Department of Transportation programmatic consultation for road maintenance and repairs, the USFS programmatic consultation for culvert replacement and noxious weed treatments, numerous BOR diversion maintenance and work projects, the Mid-Columbia Coho Reintroduction project, Icicle Creek and Restoration projects, White River Road Relocation project, Icicle Complex Fire Emergency Consultation and Rehabilitation projects, Dirtyface Fire Emergency Consultation, and the Leavenworth National Fish Hatchery Ongoing Operations project, which will accrue both lethal and sub-lethal take.

Available information indicates implementation of section 6 and/or section 10(a)(1)(A) permits in the basin have resulted in direct effects to bull trout due to capture and handling and indirect mortality (BOR, WDFW, EPA, CWU, Yakama Nation, and FWS fisheries studies). Although projects associated with the restoration programs may result in long-term benefits for bull trout and their habitat, all projects included in the proposed action resulted in take of this species.

It is unknown how many non-Federal actions have occurred in the Wenatchee Core Area since the listing of bull trout. Activities such as emergency flood control, development, and infrastructure maintenance are conducted on a regular basis and affect riparian and instream habitat. Hydraulic Permits issued by the State also affect bull trout and their habitat. Recent land-use changes from agriculture to urban development along the riparian areas may also affect bull trout and their habitat. County permits have likely increased for construction of homes in floodplain and riparian areas.

Statewide Federal restoration programs which include riparian restoration, restoration of fish passage at barriers, and habitat improvement projects have been authorized in the Wenatchee Core Area. The Wenatchee River watershed groups have coordinated to apply for monies to complete stream habitat work along the mainstem Wenatchee River and its tributaries and are working with the U.S. Forest Service to complete culvert repairs. Most large fish passage culverts on national forest land have been replaced with open bottom arches or bridges. The Biological Opinion for the Chelan and Douglas County PUD HCP requires bull trout monitoring and the associated tributary funding is providing restoration for salmonid habitats. The FCRPS Biological Opinion also provides for bull trout monitoring and associated restoration projects that will benefit bull trout. The Washington State Forest Practice Rules HCP Biological Opinion will include some adverse impacts but will allow for restoration actions on state forested lands. Natural events such as fire, flooding, and global warming also cause changes in the environment within the Wenatchee Core Area.

Threats

In summary, continued threats to the bull trout in the Wenatchee Core Area include: destruction of habitat and losses of populations that occurred from historical dams due to logging, irrigation, and power generation; current migratory delay caused at Tumwater dam and other fish collection weirs; irrigation diversions and water withdrawals; small-scale gold mining; effects from residential development and urbanization; effects from recreational developments, presence of non-native brook trout; historical harvest of large numbers of adult bull trout and incidentally caught bull trout in the current sockeye fishery in Lake Wenathchee; effects from activities in the mainstem Columbia River that adversely impact FMO habitat for populations that spawn in the Wenatchee Core Area; effects of degraded habitat and degraded passage conditions at dams on juvenile, sub-adult, and adult life-history stages of the bull trout; increased frequency of high-intensity crown fires and fire severity due to past fire suppression, grazing, silvicultural practices, and timber harvest practices; and contamination in the Wenatchee River from pesticides and other agriculturally related chemicals.

Entiat Core Area

Abundance, Productivity, Connectivity, Habitat Conditions

Bull trout are dispersed in the Entiat River Core Area up to a falls on the mainstem Entiat and within the Mad River. They are presumed to be primarily fluvial, rearing there, and in the Columbia River (Service 2002). Currently, 2 local populations of bull trout are found in the Entiat Core Area. The 2 local populations are thought to be isolated from each other due to a natural thermal barrier (Service 2002). Both local populations contribute individuals to the mainstem Columbia River based on radio-telemetry reports and some genetic and otolith information (BioAnalysts, 2004; Service 2006c; Appendix C).

The Entiat Core Area populations persist at a very low abundance due to the low number of spawning fish, restricted and reduced spawning distribution, and limited opportunities for refounding. Redd numbers range from 33 in 2002 to 57 in 2003 for the entire core area and since 2000, there is an average of approximately 45 redds (90 spawning adults), similar to what the number was at the time of listing in 1998. This average is from 6 years of data from only 2 local populations. Overall, the Entiat Core Area redd counts seem to exhibit no real trend but numbers are generally stable and low in abundance. Because of the low number of adults and the fact that there are only two local populations, the Entiat Core Area is considered to be at risk of both inbreeding depression and genetic drift. In the draft Bull Trout Recovery Plan (Service 2002), the U.S. Forest Service expressed concern for the long-term persistence of bull trout in the Entiat Core Area. Given the overall lack of long-term, consistent, population census information of redd count survey data, the low numbers of adult spawners, and the loss of spawning habitat due to a log jam, the Entiat Core Area is considered to be at low resiliency and increased risk of extirpation from stochastic events.

The Entiat Core Area is unique in that it has only two local populations, its populations are located within a relatively shorter distance to the Columbia River than most other core areas, connectivity exists between it and the mainstem Columbia River, and most fish within both of its local populations access and use the mainstem of the Columbia River for FMO habitat for a larger portion of the year than other bull trout populations.

Information provided for the consultation, current site specific radio-telemetry information, observation, and some genetic information show that both local populations use the mainstem Columbia River as the major overwintering, migratory, and feeding habitat for more time than originally thought. Bull trout in the Entiat Core Area are exposed to the effects of mainstem dams to a greater degree than any other core area. However, future restoration and recovery actions may increase overall abundance within the core area. Site specific information from radio-telemetry studies and some genetic information (BioAnalysts 2004, and Service 2006c) suggests that a high proportion of the Entiat local population fish use the Wanapum Reservoir. Approximately 50% of the radio tagged fish tracked by the Chelan PUD found that they migrated into the Wanapum Reservoir (BioAnalysts, Inc. 2004). Using a mean of 45 redds or 90 adult bull trout, and the fact that 17% of the 90 could be long range migratory fish, based on the telemetry data, we determined that 15 fish could use the Wanapum Pool (Appendix C).

Analysis of habitat conditions for bull trout within the Entiat Core Area includes using the Matrix pathways for assessing bull trout habitat conditions for water quality, habitat access, habitat elements, channel condition, flow/hydrology, and watershed conditions at the tributary/local population scale and at the river basin/core area. Brook trout presence can indicate degraded habitat conditions and is also addressed to some degree for habitat. There are only 2 local populations in the Entiat Core Area. In the Entiat local population spawning/rearing areas, most Matrix pathways are functioning at high risk (i.e. functioning at unacceptable condition), and in the Mad River local population spawning and rearing areas, most of the Matrix pathways are functioning at moderate risk (i.e. functioning at risk).

At the Entiat Core Area scale, spawning and rearing habitat conditions are functioning at high risk (i.e. functioning at unacceptable condition) for the pathways of water quality, habitat elements, channel conditions, flow/hydrology, watershed conditions, and brook trout presence and are functioning at moderate risk (i.e. functioning at risk) for the pathway of habitat access. This is generally due to passage obstructions/barriers that delay migration, a loss of complex habitat, altered channel and watershed conditions and hydrologic patterns. The condition of FMO habitat in the Entiat Core Area is at high risk of not functioning adequately for bull trout because of poor water quality, lack of adequate habitat complexity, poor channel conditions, flow or hydrology, and watershed conditions, and the presence of brook trout. Refer to the Matrix for definitions of these rankings.

Consulted-on and Other Effects that have Influenced the Condition of the Bull Trout in the Entiat Core Area.

The assessment in the Rock Creek Mine BO (Service 2006a) of all of the biological opinions from the time of listing, until July 2006 (335 biological opinions), confirmed that no actions that have undergone section 7 consultation, considered either singly or cumulatively, will appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any local populations and that many of them will benefit bull trout (see the Status section for additional information). Locally there have been a few biological opinions in the Wenatchee Core Area, within the action area, with potential adverse effects to the population and/or habitat such as in the following examples (though not an exhaustive list): the Washington Forest Practices and PUD HCPs, FCRPS Project, Washington Department of Transportation programmatic consultation for road maintenance and repairs, the USFS programmatic consultation for culvert replacement and noxious weed treatments, numerous BOR diversion maintenance and work projects, the Mid-Columbia Coho Reintroduction project, Preston Fox Recreation and Vegetation Management project, Goose-Maverick Recreational Tie Trail and Mad River Trail Relocation project, and the Bridge to Bridge Restoration Project, which will accrue both lethal and sub-lethal take.

Available information indicates implementation of section 6 and/or section 10(a)(1)(A) permits in the basin have resulted in direct effects to bull trout due to capture and handling and indirect mortality (BOR, WDFW, EPA, CWU, Yakama Nation, and FWS fisheries studies). Although projects associated with the restoration programs may result in long-term benefits for bull trout and their habitat, all projects included in the proposed action resulted in take of this species.

It is unknown how many non-Federal actions have occurred in the Entiat Core Area since the listing of bull trout. Activities such as emergency flood control, development, and infrastructure maintenance are conducted on a regular basis and affect riparian and instream habitat. Hydraulic Permits issued by the State also affect bull trout and their habitat. Recent land-use changes from agriculture to urban development along the riparian areas may also affect bull trout and their habitat. County permits have likely increased for construction of homes in floodplain and riparian areas.

Statewide Federal restoration programs which include riparian restoration, restoration of fish passage at barriers, and habitat improvement projects have been authorized in the Entiat Core Area. The Entiat River watershed groups have coordinated to apply for monies to complete stream habitat work along the mainstem Entiat River and its tributaries and are working with the U.S. Forest Service to complete culvert repairs and road work. Most large fish passage culverts on national forest land have been replaced with open bottom arches or bridges. The Biological Opinion for the Chelan and Douglas County PUD HCP requires bull trout monitoring and the associated tributary funding is providing restoration for salmonid habitats. The FCRPS Biological Opinion also provides for bull trout monitoring and associated restoration project that will benefit bull trout. The Washington State Forest Practice Rules HCP Biological Opinion will include some adverse impacts but will allow for restoration actions on state forested lands.

Natural events such as fire, flooding, and global warming also cause changes in the environment within the Entiat Core Area.

Threats

In summary, continued threats to the bull trout in the Entiat Core Area include: Destruction of habitat and losses of populations that occurred from historical dams and from logging, irrigation, and power generation; irrigation diversions and water withdrawals; effects from residential development and urbanization; high road densities identified in the baselines of biological assessments; effects from recreational developments, presence of non-native brook trout; loss of 4.2 miles of spawning habitat in the upper most portion of the Mad River due to log jam development; effects from activities in the mainstem Columbia River that adversely impact FMO habitat for populations that spawn in the Entiat Core Area; effects of degraded habitat and degraded passage conditions at dams on juvenile, sub-adult, and adult life-history stages of the bull trout; effects from fire suppression including large fires during 1994 and the reduction of large woody debris (LWD) and the removal of key pieces of wood; increased frequency of high-intensity crown fires and fire severity due to past fire suppression, grazing, silvicultural practices, and timber harvest practices; and contamination in the Entiat River from pesticides and other agriculturally related chemicals.

Methow Core Area

Abundance, Productivity, Connectivity, Habitat Condition

Bull trout are dispersed throughout the Methow River basin. Resident and migratory (adfluvial and fluvial) life-history forms are present. Bull trout in the Methow Core Areas are found in 10 local populations. Nine of the 10 local populations contribute individuals into the mainstem Columbia River. This is supported by radio telemetry, some genetics data, and pit tagging operations in some of the tributaries (BioAnalysts, Inc., 2004, USGS 2005, and M. Nelson, pers. comm.., 2004; Appendix B).

Methow Core Area populations persist at low numbers, in fragmented, local populations. Since 2000, redd counts have varied from 117 to174, averaging 152. This is slightly higher than the 127 redds at the time of listing. The overall trend for the Methow Core Area is slightly increasing however redds surveys are conducted differently every year and there is high variability. The Methow is considered to be at risk of inbreeding and genetic drift. Given the lack of consistent population-census information, the low numbers of spawning migratory bull trout in most of the local populations, and the large distances between populations of bull trout, the Methow Core Area is considered to have low resiliency and to be at increased risk of extirpation from stochastic events.

The Methow Core Area is unique in that it supports local populations that move long distances to use FMO habitat in the mainstem Columbia Rivers. It has a large amount of bull trout habitat in wilderness areas, is a very long drainage, and has many subsurface flowing reaches where bull trout must migrate through early in the summer in order to access spawning habitat in tributaries. Bull trout in these reaches are also subjected to freezing if surface water is not flowing before winter. Spawning timing is both early and later than other Core Areas.

Information provided for the consultation and described in the mainstem Columbia River baseline section, radio-telemetry, and genetics information shows that likely 10 of the local populations could use the mainstem of the Columbia River. The remaining population is situated adjacent to a lake and is likely an adfluvial population using the lake as FMO habitat. Using a mean redd count from these 10 populations, 155 redds, or 310 fish may use the mainstem Columbia River. According to site specific radio-telemetry data, 17% of the tagged fish were long range migratory fish, therefore 53 of the Methow Core Area bull trout could make long range movements. Using site specific radio telemetry data 12.5% or 7 of these Methow Core Area bull trout could use the Wanapum Pool (Appendix B).

Analysis of habitat conditions for bull trout within the Wenatchee Core Area includes using the Matrix pathways for assessing bull trout habitat conditions for water quality, habitat access, habitat elements, channel condition, flow/hydrology, and watershed conditions at the tributary/local population scale and at the river basin/core area. Brook trout presence can indicate degraded habitat conditions and is also addressed to some degree for habitat. There are 4 local populations (Beaver, Goat, and Gold Creeks and the Chewuch River) of bull trout or spawning tributaries where most Matrix pathways are functioning at high risk (i.e. functioning at unacceptable condition), and there are 5 local populations (Early Winters and Wolf Creeks, and the Lost, Upper Methow, and Twisp Rivers) that are functioning at moderate risk (i.e. functioning at risk).

At the Methow Core Area scale, habitat conditions for spawning and rearing for all local populations of bull trout are functioning at high risk (i.e. functioning at unacceptable condition) for the pathways of channel conditions, flow/hydrology, watershed conditions, and are functioning at moderate risk (i.e. "functioning at risk") for the pathways of water quality, habitat access, habitat elements, and presence of non-native fish. This is generally due to low instream flows, passage obstructions/barriers that delay migration, a loss of complex habitat, altered channel and watershed conditions and hydrologic patterns, poor watershed conditions, and presence of non-native fish. The condition of FMO habitat in the Yakima Core Area is at high risk of not functioning adequately for bull trout because of poor water quality, lack of adequate habitat complexity, poor channel conditions, flow or hydrology, and watershed conditions, and the presence of brook trout. Refer to the Matrix for definitions of these rankings.

<u>Consulted-on and Other Effects that have Influenced the Condition of the Bull Trout in the Methow Core Area.</u>

The assessment in the Rock Creek Mine BO (Service 2006a) of all of the biological opinions from the time of listing, until July 2006 (335 biological opinions), confirmed that no actions that have undergone section 7 consultation, considered either singly or cumulatively, will appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any local populations, and that many of them will benefit bull trout (see the Status section for additional information). Locally there have been a few biological opinions in the Methow Core Area, within the action area, with potential adverse effects to the population and/or habitat such as in the following examples (though not an exhaustive list): the Washington Forest Practices and PUD HCPs, FCRPS Project, Washington Department of Transportation programmatic consultation for road maintenance and repairs, the U.S. Forest Service programmatic consultation for culvert replacement and noxious weed treatments, numerous BOR diversion maintenance and work projects, the Mid-Columbia Coho Reintroduction project, Wolf Creek Diversion Restoration project, Skyline Irrigation Company Operations and Special User Permit, Chewuch Diversion Dam Fish Passage Renovation, Fulton Dam Project, Aspen Meadows/Twisp Watershed projects, Andrews Creek Bridge Removal Project, Thirtymile Bridge Replacement Project, Chewuch Flood Emergency Consultation, Thirtymile Farewell, Needles, Spur Peak and Tripod Fires Emergency Consultation and restoration projects, and U.S. Forest Service ongoing projects, which will accrue both lethal and sub-lethal take.

Available information indicates implementation of section 6 and/or section 10(a)(1)(A) permits in the basin have resulted in direct effects to bull trout due to capture and handling and indirect mortality (BOR, WDFW, EPA, CWU, Yakama Nation, and FWS fisheries studies). Although projects associated with the restoration programs may result in long-term benefits for bull trout and their habitat, all projects included in the proposed action resulted in take of this species.

It is unknown how many non-Federal actions have occurred in the Entiat Core Area since the listing of bull trout. Activities such as emergency flood control, development, and infrastructure maintenance are conducted on a regular basis and affect riparian and instream habitat. Hydraulic Permits issued by the State also affect bull trout and their habitat. Recent land-use changes from agriculture to urban development along the riparian areas may also affect bull trout and their habitat. County permits have likely increased for construction of homes in floodplain and riparian areas.

Statewide Federal restoration programs which include riparian restoration, restoration of fish passage at barriers, and habitat improvement projects have been authorized in the Methow Core Area. The Methow River watershed groups have coordinated to apply for monies to complete stream habitat work along the mainstem Methow River and its tributaries and are working with the U.S. Forest Service to complete culvert repairs and road work. Most large fish passage culverts on national forest land have been replaced with open bottom arches or bridges. The Biological Opinion for the Chelan and Douglas County PUD HCP requires bull trout monitoring and the associated tributary funding is providing restoration for salmonid habitats. The FCRPS Biological Opinion also provides for bull trout monitoring and associated restoration project that will benefit bull trout. The Washington State Forest Practice Rules HCP Biological Opinion will include some adverse impacts but will allow for restoration actions on state forested lands. Natural events such as fire, flooding, and global warming also cause changes in the environment within the Methow Core Area.

Threats
In summary, continued threats to the bull trout in the Methow Core Area include: Destruction of habitat and losses of populations that occurred from historical dams and due to logging, irrigation, and power generation; irrigation diversions and water withdrawals; effects from residential development and urbanization; areas of subsurface flow in the Twisp and Upper Methow rivers; high road mile densities identified in the baselines of biological assessments; effects from recreational developments, presence of non-native brook trout; grazing related erosion in private bottom lands in the Methow River area; effects from activities in the mainstem Columbia River that adversely impact FMO habitat for populations that spawn in the Methow Core Area; effects of degraded habitat and degraded passage conditions at dams on juvenile, sub-adult, and adult life-history stages of the bull trout; effects from fire suppression including large fires in 2001-2006; increased frequency of high-intensity crown fires and fire severity due to past fire suppression; and contamination in the Methow River from pesticides and other agriculturally related chemicals.

4.1.2.1 River Basins Not Analyzed in Detail

Bull trout are known to occur in the Okanogan River in British Columbia (McPhail and Carveth 1992). While there are anecdotal reports on bull trout occurrence in the Okanogan River (United States portion), the current distribution within the Okanogan basin is unknown (Wells, N. pers. comm., 2000 as referenced in Service 2002). A radio telemetry project conducted by the public utilities (Chelan, Douglas, and Grant County) did document a bull trout moving past a radio telemetry receiver near the mouth of the Okanogan River and then moving back down to the Methow River (BioAnalysts, Inc. 2004). There have not been enough habitat or population surveys to look for high quality habitat and bull trout in Okanogan River tributaries.

The current distribution of bull trout within the Okanogan basin is unknown and further investigation is needed. The Service Upper Columbia Recovery Unit Bull Trout Recovery Team recommends that expanded surveys be conducted to verify status and distribution in the area. The draft bull trout recovery plan (Service 2002) does not describe the Okanogan basin as a core area. However, this area may provide an important habitat need in terms of forage and overwintering for bull trout using the mainstem Columbia River. Since bull trout have not recently been found in the Okanogan River in Washington, effects to bull trout in the Okanogan River, from this project, are not expected to occur. Further analysis of the Okanogan portion of the Action Area for bull trout effects will not occur in this biological opinion.

4.1.3 Ongoing Conservation Measures within the Action Area

Currently, timber management on U.S. Forest Service lands is guided by several land management plans including: the Record of Decision for the Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (Northwest Forest Plan) (USFS and BLM 1994); the Record of Decision for the Environmental Assessment for Interim Strategies For Managing

Anadromous Fish-Producing Watersheds on Federal Lands in Eastern Oregon and Washington, Idaho, and portions of California (PACFISH) (USDA and BLM 1995); and the Decision Notice for the Inland Native Fish Strategy Interim Strategies for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and Portions of Nevada (INFISH) (USDA 1995). The Northwest Forest Plan is implemented in the Yakima, Wenatchee River, Entiat River, and the west half of the Methow River. Land management activities relative to bull trout in the eastern half of the Methow River are guided by standards contained in PACFISH and INFISH. These strategies are overlaid with on-site forest management plans that, when implemented, are designed to reduce impacts to aquatic species, riparian areas, and listed fish. Portions of the Yakima, Wenatchee, Entiat, and Methow, are classified as "key watersheds" under the Record of Decision for the Northwest Forest Plan (USFS and BLM 1994). Road and riparian restoration work has been on-going in these watersheds, particularly in the White River within the Wenatchee core area; Mad River within the Entiat Core Area; and within the upper Yakima portion of the Yakima Core Area. Providing passage at culverts, irrigation and diversion dams, and riparian restoration have been the focus of restoration in the Methow Core Area.

Within the Action Area, fishing regulations closed most angling for bull trout, and some streams are closed in spawning areas or are listed under selective fishery regulations with no harvest of bull trout allowed. Stocking of hatchery trout has stopped in the mainstem rivers following listing of steelhead by NOAA. There is no longer an active stocking program for brook trout in most of the basins.

Several Habitat Conservation Plans (HCPs) including: Washington Forest Practices Aquatic Lands HCP; Plum Creek I90 HCP; Chelan, Douglas County PUD HCP Biological Opinion and associated tributary funds are focused on strategies to restore passage at forest roads, reduce sedimentation, monitor bull trout, reduce impacts to instream flows, and improve passage on the mainstem Columbia River and in mainstem tributaries.

BPA and BOR restoration activities and Salmonid Recovery Plan and Watershed planning are working together to develop strategies for prioritizing restoration actions. These processes are working to coordinate watershed restoration for the mid and upper Columbia River basin and its tributaries.

4.1.4 Conservation Needs of the Bull Trout in the Action Area

The following characterization is based on information presented in the Service's draft *Bull Trout Recovery Plan* and information derived from applying the Matrix to bull trout populations within the action area.

Viable populations of the bull trout in the action area are essential to the conservation of species within each of the core areas, the Columbia River interim recovery unit, and the coterminus listing (Service 2002, Service 1999). To maintain or restore the likelihood of long-term persistence of self-sustaining, complex, interacting groups of bull trout within the action area, the Service has identified the following needs: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas; 2) maintain stable or increasing trends in abundance of bull trout; 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies; and 4) conserve genetic diversity and provide opportunities for genetic exchange.

The Columbia River (the Pacific Ocean to Chief Joseph Dam) serves as a migration corridor, as well as providing foraging habitat, and an overwintering area for bull trout. Currently, bull trout have been known to spend up to 6 months or more in the mainstem before returning to spawn in their core areas. Although currently fragmented by dams, the mainstem provides habitat that maintains interactions between populations of bull trout in the tributaries within each of the core areas in the action area. Connectivity in the mainstem provides for genetic diversity and population characteristics necessary for recovery including: distribution, stable or increasing trends, and suitable habitat condition for all bull trout life history stages (Rieman and McIntyre 1993, Service 2002). Isolated populations can not be replenished when disturbances make local habitats unsuitable, the range is decreased, and/or the potential for reproduction capabilities are lost (Rieman and McIntyre 1993).

Several components in the mainstem Columbia River are necessary for bull trout based on studies on their habitat requirements and population biology. Furthermore, they have been documented by some of the primary constituent elements for bull trout habitat that is listed as critical for the species (Service 2005a). In migratory habitat, bull trout need at least the following habitat conditions:

Water temperatures ranging from -2 C to 22 C, depending on life history stage and form, geography, elevation, diurnal and seasonal variation, and local groundwater influence (PCE 1).

A natural hydrograph including peak, high, low, and base flows within historic ranges or if regulated according to a biological opinion, that supports bull trout populations by minimizing daily and day-to-day fluctuations, etc (PCE 4).

Migratory corridors with no physical, biological or chemical barriers between spawning, rearing, overwintering, and foraging habitats (PCE 6).

An abundant food base including prey items such as: macroinvertebrates, crayfish, and forage fish (PCE 7).

Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival, are not inhibited (PCE 8).

The Core Areas are central to the survival and recovery of the bull trout is the maintenance of viable core areas (Service 2002, 2004a, 2005a, 2006). They are thought to be the scale necessary for maintaining a functioning metapopulation of bull trout because they contain the habitat qualities necessary for them to spawn, rear, forage, overwinter, and migrate and the contiguous habitat necessary to survive catastrophic events. A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat, and in some cases in their use of spawning habitat. The following are unique qualities of each of the core areas within the Action Area. According to Service bull trout recovery teams and the Service's draft recovery plan, maintenance and connectivity of the FMO habitat is important to the function of all core areas in the action area.

The Yakima Core Area is unique in that it's located between the upper and lower Columbia and Snake River Core Areas which makes it a possible population "mixing zone" with genetic characteristics of its own of other core areas. Spawning also occurs early and later than other Core Areas.

The Wenatchee Core Area is unique in that it has connectivity to the Columbia River and to a large natural lake in the upper basin. Bull trout can choose to use the lake and/or the Wenatchee and Columbia Rivers as FMO habitat and to go upstream or downstream to spawning habitat.

The Entiat Core Area is unique in that it has only two local populations, its populations are located within a relatively shorter distance to the Columbia River than most other core areas, connectivity exists between it and the mainstem Columbia River, and most fish within both of its local populations access and use the mainstem of the Columbia River for FMO habitat for a larger portion of the year than other bull trout populations.

The Methow Core Area is unique in that it supports local populations that move long distances to use FMO habitat in the mainstem Columbia Rivers. It has a large amount of bull trout habitat in wilderness areas, is a very long drainage, and has many subsurface flowing reaches where bull trout must migrate through early in the summer in order to spawn. Bull trout in these reaches are also subjected to freezing if surface water is not flowing before winter. Spawning timing is both early and later than other Core Areas.

In summary, using site specific information from radio telemetry, genetics, and other information, there are individuals from each core area using the mainstem Columbia River. We estimated that there were 4 from the Yakima, 58 from the Wenatchee, 15 from the Entiat, and 7 from the Methow for a total of 84 adults that could possibly use the mainstem Columbia River (Appendix B). This estimate is close to the estimated total of 82 adult bull trout counted in the fish ladder at Rock Island Dam each year, and supports our population estimate.

4.2 Bull Trout Critical Habitat

Regulations implementing the ESA (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 that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

4.2.1 Status and Extent of Columbia River Critical Habitat Units in the Action Area

This environmental baseline analysis is based on information provided in the proposed and final critical habitat rules, and the Washington Bull Trout Critical Habitat map (dated January, 2006, at a scale of 1:100,000) and the analysis developed in the Washington Forest Practices HCP Biological Opinion (Service 2006b). Critical habitat contains eight Primary Constituent Elements. In summary, PCE #1 is for stream temperature, PCE #2 for complex stream channels, PCE #3 for substrate (spawning only), PCE #4 for natural hydrographs, PCE #5 for springs, seeps, groundwater, PCE #6 for migratory corridors), PCE #7 for an abundant food base, and PCE #8 for permanent water. These are described further in the Status section of this document.

Within the Action Area, the extent of designated critical habitat is within streams and rivers within the Yakima River basin, the only core area within the Middle Columbia River Basin Critical Habitat: Unit 20. See the map in Appendix A showing the Middle Columbia River Basin Critical Habitat Unit and the list of designated stream reaches. Reaches of stream and river which are designated as critical habitat for bull trout are interspersed with sections of non-designated reaches. Interspersed, excluded stream segments are not consistently identifiable on this map due to limitations related to scale and land ownership information. Therefore, this map should be considered a coarse approximation of final critical habitat locations.

Critical habitat in the Yakima River core area supports 16 local bull trout populations, one potential local population (Taneum Creek), and FMO habitat throughout the core area. The majority of designated critical habitat lies within the lower portions of the larger river system on non-federal lands. The Action Area encompasses spawning and rearing and FMO habitat within designated critical habitat reaches for these local populations. Eleven of 16 local populations actually have designated critical habitat within them. There is some critical habitat which contains FMO habitat that is outside of tributaries with local populations.

Critical habitat that supports spawning and rearing critical habitat is located within the mainstem Yakima River upstream of Easton Lake Dam to Keechelus Dam. Critical habitat that supports FMO habitat is located from the junction of Ahtanum Creek and the Yakima River up to Easton Dam (just below Kachess River). There are exclusions applied in portions of both the spawning and rearing and FMO reaches of the Yakima River.

In the Naches River there are segments of critical habitat that support FMO habitat identified from the mouth upstream to the confluence of the Bumping River, with some exclusions that apply in the upper portion of the reach and in a few interspersed segments. Segments of critical habitat that support FMO habitat are located in the tributaries to the Naches River, Bumping River and Tieton River; and segments of spawning and rearing critical habitat are located within the Tieton River and Rattlesnake Creek, and NF Tieton River. Both have large interspersed segments that are excluded.

In Ahtanum Creek, segments that supports spawning and rearing habitat are designated in the mainstem generally upstream from the confluence of the North and South Forks. There are segments of FMO critical habitat within the mainstem Ahtanum Creek, and in the North Fork and South Fork where large segments are excluded.

In the Teanaway River, segments that support spawning and rearing and FMO habitat are located generally within the mainstem from the confluence with the NF Teanaway and upstream to a barrier falls; critical habitat that supports spawning and rearing habitat is located in Jungle and Jack Creeks; and critical habitat that supports FMO habitat is located in the Teanaway mainstem and the Middle Fork. In the Cle Elum River system, segments of critical habitat that support FMO habitat are located within the mainstem both above and below Cle Elum Lake and within the Cooper River system below Cle Elum Lake, with some exclusions interspersed. Segments of critical habitat that support spawning and rearing habitat are located upstream of Cle Elum Lake and with some small interspersed segments in both the Cle Elum River and Cooper River.

In the Kachess River, critical habitat that supports spawning and rearing and FMO habitat is located between the mouth and the Dam at Kachess Lake, and upstream of the lake in the Kachess River and in Box Canyon Creek. Some FMO critical habitat segments are downstream of the lake.

In Gold Creek, designated critical habitat that supports spawning and rearing habitat is limited.

In the Middle Columbia River Basin Critical Habitat Unit, critical habitat that support spawning and rearing were ranked at high risk of becoming non-functional in the following local populations: Ahtanum Creek, Teanaway River, the Mainstem Yakima River, and Cle Elum River. Critical habitat segments in the following local populations were ranked at moderate risk of becoming non-functional: Gold Creek, Rattlesnake Creek, and North Fork Tieton. All critical habitat segments that support FMO in this core area were ranked at high risk of becoming non-functional. For further details see the explanation of critical habitat analysis above and the Environmental Baseline section for bull trout habitat conditions from which most PCE conditions were derived.

4.2.1 Condition of Critical Habitat in the Middle Columbia River Basin: Unit 20

Bull trout in the Middle Columbia Critical Habitat Unit may have been extirpated from some former habitats and remaining populations are fragmented and isolated due to a variety of factors. Critical habitat is degraded due to isolation by dams, agricultural practices, and associated water withdrawals that have affected stream temperatures, passage, sediment, and flows. Multiple BOR irrigation reservoirs currently lack fish passage and preclude movement between local populations (spawning and rearing habitat) and FMO habitat. Additional activities affecting critical habitat in the basin include forestry practices, grazing, roads, mining, non-native species, contaminants, and residential development. In addition, drought conditions have increased the potential for fire impacts within most forested areas in the Yakima Basin.

Common to all the critical habitat units are past logging operations and the infrastructure necessary to carry out these activities. Such operations were mostly unregulated until the 1970's, although reforestation has been required since 1946. In 1974, the Washington Forest Practices Act was passed into law providing the start of comprehensive regulations on State and private forestry operations. The updated State Forest Practice Rules and the Northwest Forest Plan are expected to reduce the level of future timber harvest impacts to bull trout streams on private and public lands. The Forest Practices Habitat Conservation Plan was completed in 2006 (Service 2006b), and while adverse effects to critical habitat may occur it is expected to improve forest conditions in Washington State in the long term. Federal management on national forest lands incorporated the aquatic conservation strategy of Northwest Forest Plan, PACFISH, and INFISH beginning in 1993 through 1995. These management strategies have improved management on national forest lands in Washington and reduced the impact of forest management, which has resulted in a reduced rate of degradation within the Action Area. Legacy effects from past logging and road building on Federal and non-Federal lands will likely continue for decades. Habitat conditions needed for bull trout recovery will require additional habitat restoration and threat abatement from land- and water-management practices affecting freshwater habitats. The descriptions below describe the condition of designated critical habitat within the Action Area of this Opinion. Within the Middle Columbia Critical Habitat Unit, all PCEs (particularly 1, 2, 4, 5, 6, 7, and 8) have experienced some degree of degradation since listing as described below.

The condition of PCEs is further described using the format of the Matrix, which includes the following habitat pathways: water quality, habitat access, habitat elements, channel conditions and dynamics, flow/hydrology, and watershed conditions to address bull trout habitat conditions. The bull trout environmental baseline assessment summarized information from multiple indicators or similar information when describing each pathway in the Matrix. An additional evaluation of forage base was included in the critical habitat analysis.

In summary, PCEs are generally addressed in the Matrix: PCE #1 (temperature) by the water quality pathway; PCE #2 (complex stream channels) by the habitat elements and channel conditions and dynamics pathways; PCE #3 (substrate) by the water quality and habitat elements pathways; PCE #4 (natural hydrograph) by the flow/hydrology and watershed conditions pathways; PCE #5 (springs, seeps, groundwater) by the flow/hydrology and watershed conditions pathways; PCE #6 (migratory corridors) by the Matrix habitat access pathway; PCE #7 (abundant food base) by assessing all pathways together and evaluating the capacity for adequate forage to be present; and PCE #8 (permanent water) by the flow/hydrology pathway. In addition, PCE #7 (abundant food base) by looking at connectivity, presence of productive foraging areas (e.g., lake or estuary), presence of anadromous fish, and presence of non-native fish.

All the PCEs apply to areas of foraging, migrating, and overwintering habitat or spawning and rearing habitat, except PCE #3 (substrate). This PCE addresses substrates needed for spawning and rearing habitat and does not address or is not applicable to bull trout foraging, migrating, and overwintering habitat requirements.

The analysis ranked the PCE condition using high, moderate, or low (H, M, and L) which pertains to functioning at unacceptable condition, functioning at risk, and functioning appropriately. This is the same process we used for the bull trout baseline habitat condition ranking. This ranking is applied to the functionality of the PCEs in the areas of designated critical habitat.

In the Yakima River basin there is critical habitat that supports spawning and rearing for 5 local populations (Ahtanum Creek and Bumping, Cle Elum, Teanaway and the Upper Yakima Rivers) that is at high risk of becoming non-functional (i.e. functioning at unacceptable condition) in most pathways of the Matrix. Critical habitat segments in 5 additional local populations (Box Canyon, Gold, Rattlesnake Creeks and Kachess and North Fork Tieton Rivers) were ranked at moderate risk of becoming non-functional (i.e. functioning at risk) in most pathways for the Matrix. All critical habitat segments in Ahtanum Creek and Bumping, Cle Elum, Kachess, Teanaway, Upper Yakima, Naches, and Tieton Rivers that support FMO in this core area were ranked at high risk of becoming non-functional. Also see the explanation of critical habitat analysis and the Bull Trout Environmental Baseline section above from which most PCE conditions were derived (Table 3 below).

At the Middle Columbia Critical Habitat Unit scale, conditions of the PCEs in spawning and rearing segments of critical habitat are ranked at high risk of becoming non-functional due to conditions in the Matrix pathways of habitat access, channel conditions, flow/hydrology, watershed conditions, and prey base, conditions of the PCEs in spawning and rearing segments of critical habitat are ranked at moderate risk of becoming non-functional due to conditions in the Matrix pathways of water quality and habitat elements. The conditions of the PCEs in FMO habitat segments of critical habitat are all ranked at high risk of becoming non-functional due to conditions in all Matrix pathways.

4.2.2 Conservation Role of Critical Habitat for the Middle Columbia River Basin Unit: 20

The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212). Individual critical habitat segments are expected to contribute to the ability of the stream or river to support viable local and core area populations of the bull trout in each critical habitat unit.

The primary function of the Middle Columbia River Unit is to maintain and support the Yakima River Core Area. Critical habitat in the Yakima River should ensure the persistence of bull trout in the Yakima core area within the Columbia River Interim Recovery Unit. It needs to contain the habitat necessary to sustain it; provide for persistence of strong local populations; and provide habitat for migratory fish. Its function should assist in ensuring connectivity and migration between populations so that bull trout are distributed throughout the historic range in order to preserve both genetic and phenotypic adaptations for maintaining genetic and phenotypic diversity within not only the interim recovery unit and the Columbia River distinct population segment, but across the range of bull trout. See the list of PCEs in the Status section describing the conditions necessary for the critical habitat to support local populations and core areas of bull trout.

5.0 EFFECTS OF THE ACTION

"Effects of the action" refers to the direct and indirect effects of an action on the listed 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 considered as immediate effects of the project 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. Both interrelated and interdependent activities are assessed by applying the "but-for test" which asks whether any action and its resulting impact would occur "but-for" the proposed Federal action.

"Insignificant effects" relate to the size of the impact and should never reach the scale where take occurs. "Discountable effects" are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

One important aspect of the analysis of project effects is the term of the proposed action. The proposed license for the Project is 50 years and multi-year impacts, aggregated over a long period of time, can be substantial.

5.1 Bull Trout

5.1.1 Summary of the Effects of the Proposed Action

Both adverse and beneficial effects to the bull trout are anticipated with implementation of the proposed action. Beneficial effects to bull trout within the Yakima, Wenatchee, Entiat, and Methow core areas are expected in conjunction with the implementation of habitat restoration activities to promote recovery of salmon and steelhead. Adverse effects to bull trout using the mainstem Columbia River are expected; these effects include: (1) continued presence of fish passage barriers and entrainment at Project dams; (2) inundation of fish spawning and rearing habitat; (3) modification of streamflow and water temperature regimes; (4) dewatering of shallow water zones during power operations; (5) reduced productivity in reservoirs; (6) gas supersaturation of waters downstream of dams; (7) loss of native riparian habitats; (8) water level fluctuations

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

interfering with establishment of riparian vegetation; and (9) establishment of non-native riparian vegetation along affected reaches. All of these adverse impacts have a variety of effects to individuals of several local populations of the bull trout. In addition, each of these local populations has different resiliencies to endure these effects and thus have differential risks regarding their persistence.

The Priest Rapids and Wanapum dams have fish passage facilities, but these fishways were designed for anadromous fish, not resident fish such as the bull trout. Small numbers of bull trout have been observed using fish passage facilities, however, these facilities may be a factor in the isolation of bull trout populations if they are not readily available to migrating bull trout. Migratory bull trout formerly linked resident bull trout to the overall gene pool for this species. Migration barriers have isolated these populations, potentially causing a loss of genetic diversity. Based on the best available information on bull trout movement patterns, the typical operation of the adult fishways coincides with only about 50 to 67% of the time migratory bull trout are anticipated to move within the mainstem Columbia and utilize FMO habitats. Entrainment of bull trout through turbines is likely to occur at these dams. Bull trout can be killed or injured when passing the dams. Those that survive passage may be isolated in downstream reaches.

Reservoirs created by Project dams have also inundated mainstem and tributary habitat used by bull trout. However, these reservoirs now provide habitat for populations of bull trout, similar to that expected to be used by adfluvial bull trout. This habitat was not available prior to reservoir fill and the creation of these water bodies, which are now similar to lakes, but presents potential challenges to bull trout including higher water temperatures, habitat simplification, and increased interactions with predators and competitors.

Flow releases from the Project alter the natural flow regime, affect water temperature, and cause repeated and prolonged changes to the wetted perimeter. Load-following operations, which change the flow and water elevation of the river on a frequent basis, cause large areas of the river margins to become alternately wet and then dry, adversely affecting aquatic insect survival and production (Hauer and Stanford 1997) and riparian vegetation growth. Changes in water depth and velocity, and physical loss or gain of wetted habitat can cause juvenile and sub-adult trout to be displaced, increasing their vulnerability to predation and adversely effecting their survival. These effects also indirectly adversely affect bull trout by degrading the habitat of their prey (small fish) and the food upon which the prey species depend (aquatic insects). High levels of gas supersaturation can cause gas bubble trauma in fish. Uncontrolled spill at the Project can produce high levels of total dissolved gas and may adversely impact the bull trout. Specific effects associated with the proposed action are discussed below.

5.1.2 Effects of the Action on the Bull Trout by Project Element

This section will characterize the effects of the action by Project element, focusing on population-based effects. Section 5.1.3, the Matrix analysis, will focus on the habitat-based effects. In order to quantify the effects of the action, we estimated the population likely to be affected in the mainstem Columbia, the location where most of the Project effects are anticipated to occur (see the Environmental Baseline and Appendix B). In addition, we have estimated, to the degree possible, which core areas the bull trout likely to use the Wanapum Reservoir may have come from. This estimate was derived primarily from radio-telemetry information and genetic relationships between populations suggesting varying degrees of relatedness. This provides important context for the significance of the effects of the action to bull trout. Effects to a large, resilient population are less severe than effects to a small population that is not resilient when evaluating the Project impacts in terms of the reproduction, numbers, or distribution of bull trout. This is especially true when considering the 50-year term of this Project, which may have a large influence on the survival and recovery of the species in the Mid-Columbia. We estimate that annually 84 adult and 30 juvenile and sub-adult bull trout use the Wanapum reservoir (see Appendix B). About 30% of adult bull trout used multiple core areas for some portion of their life history, and 10% appeared to spawn in different core areas in succeeding years (BioAnalysts Inc 2004).

5.1.2.1 Turbine Operations

Operation of the hydroelectric turbines at the Project is expected to result in some level of injury and mortality of bull trout as a result of downstream movement through turbines at the Priest Rapids and Wanapum dams. These effects may include physical injury or mortality from contact with turbine structures including wicket gates, turbine runners, or the spiral case. Injuries are commonly shear related, including eye injuries, gill and operculum damage, and decapitations, as well as strike-related injuries such as head trauma and hemorrhaging. Indirect effects may include increased susceptibility to predation caused by disorientation following turbine passage or increased susceptibility to infection caused by scale loss or non-lethal wounds incurred during turbine passage.

The best information that is available to quantify the effects of turbine operations is highly variable depending on a number of factors including project design, and we are aware of no studies directed specifically at bull trout. Related turbine studies on anadromous fish (Eicher et al. 1987) found that, in general, smaller fish survive at a different rate than do larger fish in turbine passage. The combined adult and juvenile salmonid survival performance standard for fish passing through the turbines at Priest Rapids and Wanapum Dams is 91% (NOAA 2004). This 91% standard includes a 93% project-level (reservoir and dam) juvenile performance standard.

Effects of Turbine Operations to Adult Bull Trout

The mortality rate for adult bull trout passing through turbines has also not been studied, so we used related salmonids as a surrogate. Adult mortality is expected to be higher than for juvenile fish (Service 2000c and Service 2004A). Mortality estimates ranging between 22% and 57% for adult steelhead that passed through turbines were reported in a summary of adult fish fallback rates and mortality (Service 2000c), and a 14% to 26% mortality estimate was reported for fallback through turbines at FCRPS projects on the Snake River (Mendel and Milks 1995). "Fallback" is a term used to describe the

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

potential for adult bull trout migrating upstream through the fishladder to "fallback" through the Project's dams, resulting in increased contact with structural features of the dam (spillways, turbines or fish ladders) and potential injury (this is described in detail in the "adult fishway operation" section of this effects analysis). For the purposes of this analysis, we used the upper end of the FCRPS estimate of 26% as our mortality estimate (Mendel and Milks 1995), which also overlaps mortality estimates previously described by the Service (2000c).

Based on the population estimate described in the Environmental Baseline and in Appendix B, the Service anticipates that about 84 adult bull trout are likely to use the Wanapum Reservoir. However, radio-telemetry data (BioAnalysts, Inc. 2004) suggests that only 50% of the fish that use the Wanapum Reservoir use the lower portion (i.e., downstream of Tekison Creek) and only 10% pass through Wanapum Dam into the Priest Rapids Reservoir and Dam. To be conservative, we assume that any fish that enter the lower Wanapum Reservoir may also use the Priest Rapids Reservoir, especially when we consider the limited data currently available. In addition, the 50-year term of the Project allows for substantial variation in bull trout movements. Based on the population estimate and this radio-telemetry data, we anticipate 42 adult bull trout (50% of our population estimate of 84) to use the lower portion of the Wanapum Reservoir, and 8 (i.e., 10% of 84 fish) may pass through the Project dam turbines annually. Although this estimate is based on a small sample size, it represents the best available information on bull trout use of the Wanapum Reservoir at this time.

The Service anticipates that all bull trout that go through the turbines will be injured by a number of direct and indirect effects mentioned above, that 26% will be killed, and all survivors will be injured. Based on our population estimate, on an annual basis we anticipate that 2 of the 8 bull trout that go through the turbines at Wanapum are expected to be killed, and all 6 survivors will be injured to some degree. If these remaining 6 bull trout then move through the turbines at Priest Rapids dam, then another 2 are expected to be killed and all 4 survivors may incur additional injuries. Based on radio-telemetry data (BioAnalysts Inc. 2004), these 8 bull trout are anticipated to originate from core areas as follows: 1 from the Methow, 3 from the Entiat, 3 from the Wenatchee, and 1 from the Yakima core areas.

Bull trout that make multiple passes through the Project dams due to fallback or their normal movement patterns would experience additive effects. Similarly, alternate-year spawners (estimated to be about 12% of adults, or less than 1 of the 4 bull trout subject to turbine operation effects) may experience a greater frequency and additive impact of effects. This is because they spend more time in FMO habitats (months to years) including the mainstem Columbia than bull trout that migrate into tributaries to spawn annually. Although very little information is available to characterize the frequency of bull trout movements through dams, a fallback rate of about 8% was calculated for steelhead at Wanapum and Priest Rapids dams (GPUD 2003). Using an 8% fallback rate, less than 1 bull trout (i.e., 8% of 8 fish) would have to pass through the turbines again; however, when a small local population is impacted, the effects are proportionally large. As a result, our estimate represents the minimum anticipated effect of turbine operations to adult bull trout.

The effects of the action are anticipated to impact bull trout from the Methow, Entiat, Wenatchee, and Yakima core areas. Included for each core area is a qualitative assessment of resiliency of each local population to provide some context for the effects of the action (we assumed resiliency is primarily a function of population size). We acknowledge this is likely an over-simplification, but in most cases, we have little information to suggest which local populations are contributing individuals into the Wanapum Reservoir. Project monitoring would greatly enhance our understanding of the effects of this project element, particularly deriving a genetic baseline and additional radio-telemetry tracking.

Methow Core Area

The Methow core area is expected to contribute 7 fish (of the 84 total) into the Wanapum Reservoir that may originate from 9 of 10 local populations in this basin, including the Beaver, Early Winters, Goat, Gold, and Wolf creeks, and the Chewuch, Lost, Methow, and Twisp rivers. The Methow has been characterized as unstable but with a slight increasing trend, and is influenced by a single large local population (i.e., the Twisp River). Since 1998, redd counts have varied from 117 to 174, averaging 152. This estimate was derived from 7 years of comparable data from 7 of 10 local populations. Overall, the core area is considered to have low resiliency, but some local populations are considered more resilient than others. From most resilient to least, they are: Twisp River, Methow River, Wolf Creek, Chewuch River, Goat Creek, Gold Creek, Early Winters, Lost River, and Beaver Creek. Radio-telemetry suggests that about 12% of adult bull trout that use the Wanapum Reservoir originated from the Methow core area, but identification of which local population was not possible.

Entiat Core Area

The Entiat core area is anticipated to contribute 15 fish (of the 84 total) into the Wanapum Reservoir that may originate from both the Mad and Entiat Rivers local populations. The local populations within the Entiat core area have been characterized as stable but at low abundance with no distinguishable trend. Since 1998, redd counts have varied from 33 to 53, averaging 45. This estimate was derived from 7 years of comparable data from 2 local populations. Although a new spawning reach was discovered in the Entiat in 2004, this data was not factored into the core area trend because the information was not comparable, and was outside the index reach. The core area is considered to have low resiliency, with the Mad River typically numbering four times the redds of the Entiat River. Radio-telemetry suggests that about half of adult bull trout that use the Wanapum Reservoir originated from the Entiat core area, 75% of which come from the less resilient Entiat River local population. Given the mortality rate (26%) associated with adult turbine passage, the chronic low redd numbers (averaging 6.3) and the high proportion of fish originating from the Entiat local population, the Service suggests this local population will remain at depressed levels under current management. This may result in an increased risk of extirpation due to stochastic events.

Wenatchee Core Area

The Wenatchee core area is anticipated to contribute 58 fish (of the 84 total) into the Wanapum Reservoir that may originate from 5 of 7 local populations from the Chiwaukum, Icicle, Nason, and Peshastin creeks and the Chiwawa River local populations. The Wenatchee is unstable but suggests a slightly increasing trend, and is influenced by a single large local population (i.e., the Chiwawa River). Since listing in 1998, redd counts have varied from 242 to 706, averaging 452. This estimate was derived from 7 years of comparable data from 4 of 7 local populations. The core area is considered to have moderate resiliency, but some local populations are considered more resilient than others. From most resilient to least, they are: Chiwawa River, and Chiwaukum, Nason, Ingalls, and Icicle creeks. Radio-telemetry suggests that about 37% of adult bull trout that use the Wanapum Reservoir originated from the Wenatchee core area, but the local population was not identified.

Yakima Core Area

The Yakima core area is anticipated to contribute 4 fish (of the 84 total) into the Wanapum Reservoir that may originate from 8 local populations. The Yakima is unstable and suggests a decreasing trend, and is influenced by three large local populations. Since listing in 1998, redd counts have varied from 455 to 687, averaging 534. This estimate was derived from 8 years of comparable data from 10 of 16 local populations. The core area is considered to have low resiliency, but some local populations are considered more resilient than others. From most resilient to least, they are: Deep Creek, Rattlesnake Creek, American River, Crow Creek, Ahtanum Creek, Bumping River, mainstem Yakima River, and the Teanaway River.

Although site-specific radio-telemetry data suggests that no tagged fishes moved into the mainstem Columbia (WDFW 2006a), the study period was short and may not reflect the full range of bull trout movements over the 50-year term of the Project. Nonetheless, the Yakima is a highly degraded system, connectivity between local populations is poor, and it is very long; from the most downstream local population (Ahtanum Creek), it is approximately 107 river miles to the Columbia River. Although genetic data suggests the Yakima is unique and at least historically served as a "mixing zone" between Upper Columbia and Snake River fish (Reiss 2003; Y. Reiss, pers. comm.), it is unclear to what degree genetic or demographic connectivity currently exists. However, 4 adult bull trout have been observed in the Wanapum and Priest Rapids Reservoirs (GPUD 2003).

Effects of Turbine Operations to Juvenile and Sub-Adult

The juvenile anadromous survival rate is variable depending on the design and operation of each dam, but typically ranges from 90 to 95% survival. Observed survival estimates at Wanapum Dam range from about 88 to 96 % (GPUD 2003), and range from about 94 to 98% at Priest Rapids Dam (GPUD 2005). There is no evidence to suggest that juvenile bull trout would survive at different rates than juvenile anadromous species; however, important differences in physiological and behavioral stress tolerances may or may not exist for resident and anadromous salmonids (Miller and Hillman 1994). For the purposes of this analysis, we will assume a single survival rate of 94% for juvenile and sub-adult bull trout at both dams, and that only 10% of all fish pass through the turbines (i.e., due to the high attraction flows, screens, and other mechanisms to direct juvenile and sub-adults away from the turbines and toward spillways or bypass structures).

Based on the population estimate described in the Environmental Baseline and in Appendix B, the Service anticipates that at least 30 juvenile or sub-adult bull trout are likely to use the Wanapum Reservoir. Assuming all juveniles migrate downstream of both dams, then only 3 juvenile or sub-adult bull trout (10% of 30 not diverted toward the spillway or bypass structures) are anticipated to pass through turbines and will be injured or killed. Considering an estimated survival rate of 94% at each dam, 28 of 30 will be injured and 2 of 30 will be killed.

Summary of Effects of Turbine Operations to Adult, Juvenile, and Sub-Adult Bull Trout

We anticipate 8 adult and at least 30 juvenile and sub-adult bull trout will be impacted by turbine operations annually. The significance of this effect depends in part on the resiliency of the local population(s) impacted annually and over the 50 year term of the Project. In general, we assume that unless a significant annual impact is observed, that the aggregated effect of the action over the 50-year term of the Project is unlikely to result in a measurable change in the persistence of any given local population within a core area (considering their reproduction, numbers, and distribution). As described above, this is estimated to some degree for adult bull trout, but is unknown for juvenile and sub-adult bull trout. Impacts to adults are assumed to be more significant than to juvenile and sub-adult bull trout, which have relatively high mortality rates and relatively few are expected to be recruited into the breeding population (Downs et al. 2006).

Turbine operations are anticipated to impact adult bull trout from all core areas in the action area. Impacts to bull trout from the Methow and Wenatchee core areas are anticipated to be relatively minor. Based on the population trends, connectivity between populations, and the number of individuals anticipated to be affected, bull trout in the Methow and Wenatchee are expected to be relatively resilient to Project effects. However, impacts to bull trout from the Entiat and Yakima core areas are of concern. The status and trend of bull trout from the Entiat core area suggests neither an increasing or decreasing population, but rather stability at low abundance. With only 2 local populations in the entire core area and both contributing a large proportion of individuals relative to the population size, any significant Project impacts may have core area implications. Turbine operations are likely to contribute to maintaining the Entiat core area in a depressed condition, which may result in an increased risk of extirpation due to stochastic events. The status and trend of bull trout from the Yakima core area suggests unstable and decreasing populations, and connectivity between local populations is poor. Although turbine operations are anticipated to effect few fish, the local populations in the Yakima core area have little resiliency, poor connectivity between populations, and are at increased risk of extirpation due to stochastic events. However, current and future restoration activities in the action area are expected to continue, potentially increasing the condition of bull trout habitat and in turn population abundance. Project monitoring would greatly enhance our understanding of the effects of this project element, especially deriving a genetic baseline and additional radio-telemetry tracking.

5.1.2.2 Fish Bypass

As described in the Project description, the primary juvenile fish downstream passage measure at the Project's Priest Rapids Dam is the seasonal use of tainter-gate spill. Survival of salmonid smolts through the spillway at Priest Rapids Dam has ranged from 95-98% in studies conducted from 2000-2002. Grant PUD proposes to replace this spill program during the next license period with a juvenile bypass structure. During the interim period, Grant PUD would consult with the PRCC and may develop plans to modify spill patterns or amounts. Downstream passage operations would continue to cover 95% of the downstream smolt migration as determined by in-season monitoring indexed upstream of the Project. During the proposed construction of the Priest Rapids bypass system, Grant PUD would consult with the PRCC to develop interim operations for spill patterns and volumes at the Priest Rapids Dam.

Since spillway survival rates for salmonids at Wanapum Dam are generally low (87-88%), Grant PUD transitioned into developing a fish bypass facility for its Wanapum Dam as well. With the completion of the downstream passage alternatives study (Jacobs Civil Inc. 2003), Grant PUD transitioned to a process resulting in a new passage measure designed to replace the current fish spill program at the Wanapum Dam. This measure is designed to meet 95% dam smolt passage survival at Wanapum Dam in a cost-effective manner. With the low survival rates measured through standard tainter gate spill (87-88%) for salmonids, Grant PUD proposed and is currently in the preliminary stages of constructing a 20,000 cfs surface bypass at the future unit location at Wanapum Dam. This proposal was based on the recommendations of Jacobs Civil Inc. (2003), who ranked a variety of future unit bypass concepts highly when compared to alternative concepts. However, bull trout are very substrate-oriented and may have different survival rates than salmon and steelhead (Pratt 1992). Project monitoring of effects would reduce the uncertainty in this estimate and increase our understanding of bull trout use of the Wanapum reservoir.

Based on the preference of salmon and steelhead smolts to maintain a constant depth in their migration and resist sounding, a surface oriented outlet was adopted. Further, to provide sufficient flow to compete with the nearby powerhouse intakes, a quantity of flow judged sufficient to develop a discernable flow field for salmon and steelhead in the area of the powerhouse was established. Finally, to deliver bypassed fish safely to the tailrace while minimizing dissolved gas effects, efforts were directed toward optimizing the tailrace discharge component to minimize turbulence and potential injury, predation, entrainment of air, and erosion of the riverbed. The resulting design is a 20,000-cfs ogee-crested weir constructed through the center slot at Unit 11. This facility, currently under construction, is slated to be completed by approximately March 15, 2007, and will be operated seasonally to improve survival of salmon and steelhead during their downstream migrations.

During periods of operation, juvenile bypass facilities such as those being constructed and proposed by Grant PUD at their Wanapum and Priest Rapids dams are likely to result in beneficial effects from increased downstream passage survival of juvenile, sub-adult, and adult bull trout. However, the position of the bypass and pool elevation are important considerations in the effectiveness of the bypass and corresponding survival rates. Adverse effects to bull trout resulting from facility operations may include turbulence, physical injury, predation, entrainment of air, and erosion of the riverbed resulting in increased turbidity.

As described in the Environmental Baseline and Appendix B, we have estimated at least 30 juvenile and sub-adult bull trout may use the Wanapum Reservoir annually. The juvenile bypass should improve the survival of downstream migrant juvenile and sub-adult bull trout to at least 95%, so we expect no more than 1 of the 30 juvenile and sub-adult bull trout will be killed. Indirect effects of water quality effects including turbulence, entrainment of air, and erosion of the riverbed resulting in increased turbidity may impact all juvenile and sub-adult bull trout, but these effects are expected to be minor; the Service arbitrarily estimates that only about 6 individuals (or 20% of all juvenile and sub-adult bull trout) will experience these effects to such a degree that they result in injury. However, increased turbulence and turbidity, which reduce sight distances, and concentrating fish into a small area may also increase their susceptibility to predation. The effects of predation will be addressed in the predator control section below. Adult bull trout are known to use the juvenile bypass system as well, but very infrequently. However, a 40 to 50% injury rate has been measured for adult salmonids at McNary Dam (Wagner and Hilson, 1993). For this analysis we estimate 1 adult bull trout, most likely from the Entiat or Wenatchee core area (see Appendix B), may be impacted by the juvenile bypass system. Effects to adults are believed to be sub-lethal, and often take the form of scale loss or other minor injury.

In summary, we estimate that 1 adult will be injured, no more than 1 juvenile or sub-adult bull trout will be killed and 6 will be injured annually. However, downstream fish passage is expected to be safe and reliable with at least a 95% survival rate. In addition, the potential for injury and death of juvenile and sub-adult bull trout is off-set to some degree by improved downstream passage. The Service is unable to determine from which local population these 30 juvenile and sub-adult bull trout may have originated, but presumably they are from the upstream Methow, Entiat, and Wenatchee core areas. The adverse effects to juvenile and sub-adult bull trout are considered relatively minor given they have naturally high mortality rates and relatively few are expected to be recruited into the breeding population (Downs et al. 2006). In addition, the three core areas likely involved (i.e., the Methow, Entiat, and Wenatchee) are stable or increasing in population size, suggesting recruitment is currently adequate. However, core area abundance is low in the Methow and Entiat, and the Wenatchee is heavily influenced by a single large local population. Overall, the adverse effects of the juvenile bypass system are likely offset by the beneficial effects of increasing juvenile and sub-adult bull trout passage.

5.1.2.3 Adult Fishway Operation

Continued, current operation of the adult fishways is likely to result in delays in upstream movement of adult bull trout, impeded upstream passage of juveniles and sub-adults, and injury or mortality of adults due to contact with structures within the fishways and fallback. As described in the proposed action, adult fishways are operated seasonally, 24 hours a day, to accommodate salmon and steelhead passage (March 1 through November 30), with the assumption that this operation also provides some benefit to bull trout. These fishways are also subject to maintenance activities, primarily December through February, and may include power-washing, scrubbing, and the use of detergents to remove aquatic vegetation. During this maintenance period, bull trout will be unable to move upstream to use seasonal habitats. This impairment of normal behavior and movement patterns likely affects foraging opportunities, use of cover, and other key aspects of their life history.

Delay and General Effects

Direct effects to bull trout may include physical injury from contact with fishway structures. A number of indirect effects may stem from temporary fatigue, which may be a function of the length of the ladder and water velocity, including an increased susceptibility to predation, or a decreased ability to compete for cover or forage. In addition, increased susceptibility to infection caused by scale loss or non-lethal wounds incurred during fishway negotiation may also result. The Service will conservatively estimate all fish using adult fishways may incur some sub-lethal injury.

The Priest Rapids and Wanapum Dams have fishways located on both the right (east) and left (west) sides of each development. In 2003, from May 26 to May 28, one bull trout passed through the Priest Rapids and Wanapum Dams (BioAnalysts, Inc. 2003). Further evidence suggests the importance of adult fishways for bull trout in the mainstem Columbia River. In 2003, from April 14 to August 19, 2002 bull trout passed Rocky Reach Dam via the adult fishway (Chelan PUD 2003c). Most of these fish passed the dam in May and June, which is consistent with past observations of bull trout passing Rocky Reach. Mainstem migrations by adult bull trout, peaking in May and June, are consistent with an adaptive behavior shown by other bull trout populations in the Columbia River Basin to gain access to spawning tributaries that have reduced flows and suboptimal temperatures following the peak of the hydrograph in the spring (Service 2002; Pratt and Huston 1993; Baxter 2002).

Although bull trout use of adult fishways at the Priest Rapids Project is currently believed to be limited, evidence of bull trout use above the project at other hydropower facilities suggests a delay in migration. BioAnalysts, Inc. (2004) suggested additional time was required for migrating bull trout to pass Rocky Reach Dam. It is not clear, whether these

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

bull trout required more time to find fishway entrances or whether these fish held up to take advantage of potential foraging opportunities in the tailrace. It is not known whether passage delay results in late arrival at spawning locations and subsequently decreased spawning success, higher rates of egg superimposition, or increased adult mortality. However, the temporal distribution of bull trout spawning activity in the Yakima, Wenatchee, Entiat, and Methow Rivers is within the ranges reported for other fluvial and adfluvial populations in the Columbia River Basin (Service 2002; Pratt and Huston 1993; Fraley and Shepard 1989; Goetz 1989). In addition, these fishways were designed for adult salmon and steelhead, so their effectiveness in passing bull trout is uncertain. Bull trout use of the Priest Rapids and Wanapum adult fishways may become more evident over the course of the new project license and as recovery actions are implemented.

In 2003, NOAA concluded that small delays for listed steelhead and spring Chinook at Rocky Reach Dam and Rock Island Dam are compensated for by faster travel through the slower flowing reservoirs (NOAA 2003a). In addition, NOAA also concluded that any delays that do occur are more likely to affect species that spawn soon after completing their migration (summer/fall-run Chinook salmon or sockeye salmon are more likely to be affected than those that hold in the rivers or streams for considerable periods of time prior to spawning). Lastly, NOAA wrote……. "the effect of delays passing the fishway on Permit Species is likely non-existent for currently ESA-listed Permit Species and non-existent to very small for currently unlisted Permit Species. Thus the proposed action [continued operation of fishways] should have no effect, or a slight beneficial effect, on upstream migrating adults compared to the migration observed under unimpounded conditions." (NOAA 2003a). Passage times for radio-tagged bull trout are comparable to those found for anadromous salmonids (Table 2) and similar effects for bull trout should be expected.

While the Service considered NOAA's conclusion, it should be noted that the life history of the bull trout is quite different than salmon and steelhead. The frequency, timing and routes of upstream and downstream passage by bull trout are not well understood. This is particularly true of downstream passage. For example, subadult downstream passage may occur at any time, and the routes available are dependent on the time of year (e.g., considering flow, habitat access, temperature, etc.). From results of telemetry studies, adult bull trout are most likely to move downstream after spawning and re-enter the mainstem Columbia in mid to late fall (BioAnalysts, Inc. 2004). Because Columbia River migratory bull trout are present in very low densities compared to other fish species, and they have relatively unpredictable migration behavior (especially subadults), effective study methods to evaluate downstream passage have not been developed (BioAnalysts, Inc. 2004).

Table 2: Comparison of adult salmon, steelhead and bull trout median passage rates at Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells hydroelectric projects.

Median passage (hrs)					
	Rock Island	Rocky Reach	Wells	Priest Rapids	Wanapum
Bull trout	4-18	14	5-8	---	---
Spring Chinook	20-39	31-37	27-29	45-75	37-46
Steelhead	4	13	12	14	11
Summer Chinook	15	23-30	33-47	29	23
Fall Chinook	19	60	31-46	38	41
Sockeye	17	36	5-21	19	30

Sources: Stuehrenberg et al. 1995; Swan et al. 1994; Alexander et al. 1998; English et al. 1998, 2001; Peery et al. 1998; BioAnalysts 2003.

With specific reference to the Project, radio-telemetry studies at the Priest Rapids Dam indicate that fish suffer migration delay in the collection channel of the left bank fishway at the dam. The median project passage times reported from adult spring Chinook salmon radio-telemetry studies at Priest Rapids Dam are 44.9 hours in 1993 (Stuehrenberg et al. 1995), 58.6 hours in 1997 (Peery et al. 1998), and 74.7 hours in 1998 (English et al. 1999). By comparison, median time for radio-tagged Chinook to bypass a project on the lower Snake River during an average flow year is 20.6 hours (Bjornn et al. 1995). Recent changes in Priest Rapids Dam fishway operations have been completed (closure of collection channel orifice gates and changes in fishway entrance gate configurations) in part to improve hydraulic conditions in the Priest Rapids Dam upstream fishways. Although these changes have mostly resolved the fishway entrance water elevation differential issue, channel velocities are not yet improved so that they meet standards used at other mainstem Columbia and Snake River basin hydroelectric projects. Reducing delay should minimize the impact on survival and spawning success for spring Chinook salmon and steelhead, as well as bull trout that periodically utilize these fishways.

The potential also exists for adult bull trout migrating upstream through the fishladder to fallback through the Project's dams, resulting in increased contact with structural features of the dam (spillways, turbines or fish ladders) and potential injury. This effect was previously described in the Turbine Operations project element above and will not be analyzed here.

It is also likely that upstream movement of juvenile and sub-adult bull trout within the mainstem of the Columbia River may be impeded or precluded by the operation and maintenance of the Project dams. Since the construction of these dams, the only upstream avenue is the adult fishways which were designed for adult anadromous fish, and may be velocity barriers for juvenile and sub-adult bull trout. However, no studies have been conducted to assess the ability of juvenile or subadult bull trout to successfully negotiate the adult fishway. The Service assumes that subadults may be able to ascend the fishways depending on the design and flow conditions, but that juvenile bull trout are unlikely to be able to negotiate the fishways because they are not strong swimmers. A small proportion of sub-adult bull trout, arbitrarily estimated to be 10%, may also attempt to ascend the adult fishways and may incur injury. Isolation of bull trout below the Project may result in altered growth and survival due to differences in the abundance and location of prey, altered flow patterns, warm water temperatures and degraded water quality, simplified habitat, and exposure to competition to predation. Life history traits may also be influenced by the lack of free movement throughout the system. Fish that may have exhibited a fluvial life history pattern could tend toward an adfluvial life history pattern due to changes in environmental factors.

Effects during the Maintenance Period

Based on the best available information on typical bull trout movement patterns, the operation of the adult fishways (i.e., when the fishways are operating) coincides with about 50 to 67% of the time migratory bull trout are anticipated to move within the mainstem Columbia and use FMO habitats. However, the fishways are operating during the key time period, when bull trout are moving into their spawning tributaries. This assumes most bull trout spend 3 to 5 months (i.e., typically between July to November) in spawning and rearing habitats and 6 to 9 months (i.e., typically November through July) in FMO habitats (based primarily on BioAnalysts, Inc. [2003 and 2004]; Service 2006b; Appendix B). The effects of isolating bull trout during the maintenance period is not well understood. Presumably this alters normal behavior patterns by limiting foraging opportunities, reducing habitat access, restricting use of refugia, and may ultimately reduce growth and survival. Other considerations include whether these fish spawn every year or alternate years, and the effects to other life history stages such as sub-adults and juveniles.

Alternate-year spawning may be a function of energetics, and if growth and survival are generally reduced during the maintenance period because habitat access is reduced, then the proportion of fish expected to use this reproductive strategy may increase. Downs et al. (2006) observed about 88 percent of bull trout spawned annually in an unobstructed adfluvial system, consistent with Baxter and Westover (1999), who found a 2:1 ratio. However, the Service (2006c) observed only 22% of bull trout spawned multiple times over a 2 to 3 year period, suggesting a higher rate of alternate-year spawning in the Wenatchee core area, a system characterized by numerous seasonal barriers including mainstem hydroelectric dams. Although this inference is speculative, it conforms to the energetics hypothesis that reduced growth and survival may increase the incidence of alternate-year spawning. Overall, these fish may be at increased risk of injury or death, or may contribute fewer progeny to a local population, if they cannot move normally and exploit mainstem Columbia habitats.

Use of the mainstem Columbia by juvenile and sub-adult bull trout may result in similar reductions in growth and survival anticipated in adults, but predation may also increase. Decreased habitat access, especially to tributaries or other areas with relatively high amounts of cover, may result in decreased survival. In addition, non-native predators appear to exist in higher densities and have a competitive advantage in the mainstem Columbia versus tributary habitats. The access to and quality of nearshore habitats, which may be some of the best areas of habitat complexity and cover for juvenile and sub-adult bull trout, are impacted by the fluctuation of river levels due to hydropower generation. These impacts are described in the Hydrographic Variation Project element and will not be analyzed here.

Adult fishways are also subject to maintenance activities, and may include power-washing, scrubbing, and the use of detergents to remove aquatic vegetation. Prior to maintenance, the fishways must be dewatered. Dewatering occurs gradually to encourage fish to move out of the fishways. However, the potential for stranding remains, and bull trout have been observed in the fishways just prior to maintenance activities (Appendix B). Fish salvage occurs to remove fish that are stranded and they are placed back into the river as soon as possible. Once dewatered, maintenance effects to water quality are likely to be minor. Although detergents are used in fishway maintenance and can impact water quality, the likelihood of bull trout being exposed is relatively low because there is no attractant (e.g., flow, habitat, prey concentration, etc.) to the area. Even if present, bull trout are expected to avoid the area soon after exposure.

Summary of Effects of Adult Fishway Operations

Based on the information described in the Environmental Baseline and Appendix B, the Service estimates 8 adult bull trout will be injured through the use of the Project fishway; if 12% of these fish are alternate-year spawners (Downs et al. 2006, Appendix B), then 1 of these 8 bull trout will spend an extended amount of time in these FMO habitats and may be impacted to a greater degree. The primary mechanism of effect is the delay in passage of adult bull trout. As previously described, the fishways are operated 50 to 67% (or closed 33 to 50%) of the time adult bull trout are in the mainstem Columbia, impacting their ability to use seasonal habitats, move between core areas, and can reduce growth and survival. A small proportion of sub-adult bull trout, estimated to be 10% or 3 fish, may also attempt to ascend the adult fishways and may incur injury such as abrasions, scale loss, and secondary infections, all of which can reduce growth and survival. However, these sub-adults may be at increased risk of predation from the adult fish using these fishways; we estimate 1 of these 3 fish may die from predation.

Fishway operations are anticipated to impact adult bull trout from all core areas in the action area. Overall, impacts to bull trout from the Methow and Wenatchee core areas are likely to be relatively minor, based primarily on the population trends and number of individuals anticipated to be affected, but impacts to bull trout from the Entiat and Yakima core areas are of concern. The status and trend of bull trout from the Entiat core area suggests neither an increasing nor decreasing population, but rather stability at low abundance. The status and trend of bull trout from the Yakima core area suggests unstable and decreasing populations, and connectivity between local populations is poor. Although most of the impacts of this Project element are non-lethal, reductions in growth and survival during the maintenance period may be putting selective pressures on reproductive strategies and increasing the frequency of alternate-year spawning. This strategy produces fewer progeny than annually spawning fish, and may be one factor in the low numbers in the Entiat core area, and a declining trend in the Yakima. Although this is speculative, both the Entiat and Yakima core areas have low resiliency to the effects of the action. However, current restoration activities in the action area are expected to continue, as well as restoration actions associated with the proposed action, potentially increasing overall bull trout abundance. Project monitoring would greatly enhance our understanding of the effects of this project element, especially deriving a genetic baseline and additional radio-telemetry tracking.

5.1.2.4 Spillway Operation

The elevation of the mid-Columbia River reservoirs is generally regulated during high flow periods using spillway gates, which open individually and allow water to pass through separate spillway bays. The gates pass water seasonally that is surplus to power generation needs, or as directed by the Priest Rapids Coordinating Committee for assisting downstream migration of juvenile salmon and steelhead. Chapman et al. (1994a; 1994b) concluded that spillways are currently the most benign routes for juvenile salmonids to pass the mid-Columbia River dams. The survival of salmon and steelhead fish that pass through the spillways at Wanapum and Priest Rapids Dams is about 87% (GPUD 2003). However, spill may result in supersaturated levels of total dissolved gas (TDG). Information provided for this biological opinion suggests that supersaturated gases may extend from these dams downstream to the confluence of the Yakima River (DOE 2006).

Supersaturated gases in fish tissues tend to pass from the dissolved state to the gaseous phase as internal bubbles or blisters; this condition, called gas bubble trauma (GBT) or gas bubble disease (GBD), can be debilitating or even fatal. For these reasons, the mid-Columbia River PUDs limit voluntary spillway discharge levels during the fish passage season to ensure that TDG does not exceed 120% of saturation in Project tailraces, or 115% of saturation in project forebays for more than 12 hours over a 24-hour period, or as otherwise ordered by TDG waivers issued by the Washington Department of Ecology. Due to these operational constraints, spill can be limited under normal operating conditions. In a regulated river environment, the ability of a fish to survive high TDG levels may depend on its ability to avoid supersaturated water conditions (Weitkamp and Katz 1980). Stevens et al. (1980) found that in laboratory conditions, coho, sockeye and Chinook salmon smolts, and rainbow trout avoided water saturated at 125% to 145%. Avoidance behavior of saturated water was not as strongly correlated at levels reduced to 115%. Other laboratory and field experiments suggest that juvenile salmonids will remain in deeper water, if it is available, to compensate for TDG of 120% - 125% (Weitkamp and Katz 1980). Hydrostatic pressure at depth compensates for approximately 10% of gas saturation for each 1 meter of depth.

In a review of hydropower effects on the bull trout, Miller and Hillman (1994) found no information on TDG effects on this species. Ryan et al. (2000) reported that 3.9% of all resident non-salmonid fish sampled in the lower Snake and mid-Columbia rivers, Washington, showed signs of gas bubble disease, and at continuous levels of 120 to 125%, approximately 5% showed signs of GBD. More recently, Weitkamp et al. (2003a; 2003b) studied fish behavior during high TDG periods in the Lower Clark Fork River, Idaho, and the effects of supersaturation and incidence of GBD on bull trout and other resident freshwater fish. During spill periods in 1999, TDG levels ranged between 120 and 130 percent of saturation continuously for nearly two months in May and June. Only 5.9 percent of all fish sampled (2,709) showed any signs of GBD. Eight bull trout captured by electrofishing (sampling efficient to only 6-7 feet of depth) during this period showed no signs of GBD; the highest incidence of GBD was observed in large-scale suckers (14.3%) and yellow bullhead (11.4%) in 1999. During the 2000 spill season, TDG commonly spiked from 115 to 130 percent of saturation for a few hours on a daily basis; three bull trout captured in this period showed no signs of GBD. Very few (0.1%) of the fish sampled during the 2000 spill season showed any signs of GBD (Weitkamp 2003a).

These rates of GBD are comparable to those measured at the Project, specifically Priest Rapids Dam. The total number of juvenile salmonids examined for GBD during the 2001 spring spill season was 1,818 fish. About 3.9% of these fish were found to exhibit GBD signs (GPUD 2003). Throughout summer spill conditions in 2001, 1,352 fish (predominantly Chinook) were examined for GBD and assessed a GBD rate of 2.7% (GPUD 2003).

During the spring spill 2002 season, a total of 1,243 fish were examined for GBD signs. Fifty-four fish were found to have GBD symptoms with a total rate of 4.3%, at an average total dissolved gas percent saturation in the Project's Priest Rapids forebay of 116.3% on examination days (GPUD 2003). Throughout the summer spill season, 1,035 fish were also examined for GBD. Rarely does the total dissolved gas percent saturation for summer exceed that of spring but the year 2002 was the exception, with an observation of 120.1% total dissolved gas saturation in the Priest Rapid's forebay. The overall GBD rate was also higher, with 5.9% of all fish displaying GBD signs (GPUD 2003). For the purpose of this analysis, we will assume 4% of all juvenile or sub-adult bull trout may show signs of GBD. However, the mainstem Columbia River in the vicinity of the Project contains considerable habitat with depths exceeding 30 feet, which may provide adequate hydrostatic compensation for fish during the short periods when TDG levels exceed 120% of saturation. The degree to which fish successfully avoid high TDG levels by using the depth of the water column is unknown.

Based on the information described in the Environmental Baseline and Appendix B, the Service estimates 8 adults and 30 juvenile or sub-adult bull trout will be present during spill operations. However, construction of the juvenile bypass is expected to be completed by Spring 2007, minimizing or eliminating the need to use the spillways to facilitate the downstream movement of fish. If spillways are used to assist the downstream movement of fish, we anticipate 1 adult and 4 juvenile or sub-adult bull trout will be killed (i.e., 87% survival for 8 adults and 30 juvenile or sub-adult fish). We also anticipate 1 juvenile or sub-adult bull trout will be injured by GBD. Overall, the adverse effects to juvenile and sub-adult bull trout are considered relatively minor given they have naturally high mortality rates and relatively few are expected to be recruited into the breeding population (Downs et al. 2006). The Service has little information to suggest from which local population these juvenile and sub-adult bull trout originated from, but they are presumably from the upstream Methow, Entiat, Wenatchee core areas. The effect of 1 adult bull trout dying depends in part on the resiliency of the local population(s) impacted annually and over the 50-year term of the Project. However, the loss of a single adult fish may not make a measurable difference in terms of the persistence of the local population.

5.1.2.5 Hydrograph Variation

The above project elements are all closely related to hydropower generation. However, describing the interrelated nature of the effects of these project elements is very complex. Some of the above project elements (and impacts) are obviously related to others, whereas others have no clear linkage. As a result, in this section we summarize the interrelated and indirect effects of hydropower generation.

A general effect of the operation of any hydroelectric facility is a change to the natural hydrograph. Modification of the hydrograph may be expressed in a number of different ways, but may be most pronounced in changes to the pool/river elevation, water quality, water velocity, and peak and base flows. For these reasons, the Service has termed this project element "hydrograph variation." The timing and magnitude of peak and base flows in the highly modified mainstem Columbia River has the effect of moderating the intensity of peak and base flow fluctuations, which in turn alters a large number of ecosystem processes and impacts key aspects of fish behavior. For example, spring freshets, which are known to be instrumental in maintaining the health of a river (e.g., as a habitat forming or restoring event), are also key triggers for both upstream and downstream migration of fishes. Moderation of the hydrograph has the effect of limiting to some extent, or in some cases, completely eliminating this key ecosystem process.

Changes in pool elevation, including the impounding of water that may fluctuate several feet per day, can lead to a variety of effects. These include increased bank erosion and sedimentation (observed as increased turbidity), an increased proportion of deep water habitat, and inundation of habitat for bull trout, their fish and macroinvertebrate prey. Habitat access and availability (especially off-channel habitat) and riparian vegetation (e.g., vigor, percent cover, species composition, etc.) including large woody debris, can also be decreased. Water velocity is often slowed behind (i.e., upstream of) dams, typically increasing water temperatures which can facilitate habitat conditions that may favor competitors and predators of native fishes including the bull trout. Water quality may be degraded through increased sedimentation from bank erosion and fluctuating water levels, gas super-saturation and increased temperature from project activities.

Other key considerations of an altered hydrograph include the disruption of processes and functions of sediment and large woody debris, pool frequency and quality, and the numerous impacts to fish habitat.

Beyond habitat effects, the response of the bull trout to disturbance (i.e., human presence, noise, etc.) is not well understood. However, it is known that fishes, like other animals, can detect a wide range of external stimuli. Environmental factors that most often affect fish behavior are sound, light, chemicals, temperature, and pressure. For instance, the classic fright response of salmonids to sounds is the "startle" or "start" behavior (Moore and Newman 1956; Burner and Moore 1962; Vander Walker 1967; Popper and Carson 1998). Such behaviors involve sudden bursts of swimming that are short in duration and length and are characterized as "startle" or general avoidance of the site (McKinley and Patrick 1986). This could result in the disruption of normal bull trout feeding (Service 2004b).

Variation of reservoir levels can also impact the operation of fishways, juvenile bypass structures, and other operational features of the Project. This may result in decreased survival of individual bull trout through increased turbine entrainment, decreased use of the bypass facility, and other impacts. Monitoring of this aspect of Project implementation would decrease the uncertainty in our estimates and increase our understanding of bull trout use of the Wanapum reservoir.

Based on the information described in the Environmental Baseline and Appendix B, the Service estimates 84 adults and 30 juvenile or sub-adult bull trout will use the Wanapum and Priest Rapids Reservoirs and may be impacted by hydrologic variations. The effects of hydrologic variation to adults are likely sub-lethal in nature because adult bull trout are more tolerant of a wide range of environmental conditions and are more mobile. However, juvenile or sub-adult bull trout are more susceptible to environmental conditions and are less mobile and may experience some level of mortality (i.e., the Service arbitrarily estimated that 10% of juvenile or sub-adult bull trout [or 3 of 30 fish] will be killed). As a result, the Service believes that 27 juvenile or sub-adult and 84 adult bull trout will be injured, and 3 juvenile or sub-adults will be killed.

Overall, the adverse effects to juvenile and sub-adult bull trout are considered relatively minor given they have naturally high mortality rates and relatively few are expected to be recruited into the breeding population (Downs et al. 2006). The Service has little information to suggest from which local population these bull trout originated from, but they are presumably from the upstream Methow, Entiat, Wenatchee core areas. The effect of 1 adult bull trout dying depends in part on the resiliency of the local population(s) impacted annually and over the 50-year term of the Project. However, the loss of a single adult fish may not make a measurable difference in terms of the persistence of the local population.

5.1.2.6 Predator Control Program

It is anticipated that the activities associated with the avian control program are not likely to adversely affect the bull trout, while the northern pikeminnow control program is likely to result in the injury or mortality of adult and juvenile bull trout for the reasons discussed below.

Avian Predator Control Program

Avian control methods consist largely of land-based activities that include gull wires installed across the project tailrace and pyrotechnics discharges to discourage predation on juvenile salmonid smolts. The avian control program may include lethal removal of birds each year when necessary. The marginal increase in human activity associated with control measures on the reservoirs is not likely to adversely affect the bull trout. The avian control measures are likely to have a slight beneficial effect on juvenile bull trout by reducing their likelihood for depredation while near the project facilities. The effects of these measures were summarized in Grant PUD's April 18, 2005, letter to the Service (Service Reference 2005-0308).

Northern Pikeminnow Control Program

Direct effects to individual bull trout from the Grant PUD pikeminnow predator control program will likely occur through injury or immediate or delayed hooking mortality. It has been estimated that as many as 14% of all salmon and steelhead smolts may be consumed by piscivorous fish (GPUD 2003). Presumably this same rate applies to juvenile and sub-adult bull trout. Terminal gear in the rod and reel fishery typically consists of a beaded spinner with a #4 single barbed hook. Live bait (worms) and artificial plastics are added to the hook. Terminal gear in the long-line fishery typically consists of size #6 hooks baited with worms, crickets, and/or waste fish flesh. Grant PUD has managed the northern pikeminnow removal program since 1995. From 1995 through 2005, approximately 275,387 northern pikeminnow have been removed from the Priest Rapids Project area. During this timeframe, no bull trout have been reported as captured through the implementation of this program (Pocke, D. pers. comm., Grant PUD 2006). However, bull trout are regularly hooked in other areas of the mainstem Columbia (e.g., near Wells Dam), in areas where their densities are presumably higher. The larger numbers may be a function of reporting (i.e., bull trout were historically lumped into the category of "other species" in fishway observations and reporting) or identification error. Given the long-term nature of this Project and the uncertainty in the manner and extent of bull trout use in this area of the mainstem Columbia, the Service concludes that this program has the potential to injure or kill individuals of the species.

Based on the information described in the Environmental Baseline and Appendix B, the Service estimates 84 adults and 30 juvenile or sub-adult bull trout will use the Wanapum and Priest Rapids Reservoirs and may be impacted by the pikeminnow predator control program. Juvenile and sub-adult bull trout will likely experience a beneficial effect as pikeminnows are removed and their mortality rate presumably decreases. Adult bull trout may be incidentally hooked and can be injured or killed, although there is no record of this in the Wanapum or Priest Rapids Reservoirs. Nonetheless, the Service estimates 1 adult bull trout may be hooked and die. The effect of 1 adult bull trout dying depends in part on the resiliency of the local population(s) impacted annually and over the 50-year term of the Project. However, the loss of a single adult fish may not make a measurable difference in terms of the persistence of the local population.

5.1.2.7 Habitat Restoration Plan

Some direct and indirect effects on bull trout are likely to occur resulting from implementation of actions funded under the Project's Habitat Restoration Plan. The premise of the plan is the protection of existing productive habitat and restoration of high priority habitat by restoring, when practical, natural processes that, over time, will create and maintain suitable habitat conditions without human intervention. The plan will fund third party conservation efforts in the Yakima, Wenatchee, Entiat, Methow, and Okanogan river basins. Habitat restoration projects and plans to purchase conservation easement or land in fee will be submitted to the Priest Rapids Habitat Committee. Examples of projects to be funded by the plan may include, but are not limited to: 1) providing access to currently blocked stream sections or oxbows; 2) removing dams or other passage barriers on tributary streams; 3) improving or increasing the hiding and resting cover habitat that is essential for anadromous species during their relatively long adult holding period; 4) improving in-stream flow conditions by addressing water diversion or withdrawal structures; or 5) purchasing (or leasing on a long-term basis) conservation easements to protect or restore important aquatic habitat and shoreline areas.

The Priest Rapids Habitat Committee, of which the Service is a member, will decide if the projects meet criteria for funding. Projects will have to be reviewed by state and federal agencies to receive permits for construction. Habitat restoration projects will likely benefit bull trout through the protection of important habitat found within mid-Columbia River bull trout core areas (Service 2002). Projects that may increase in-stream flow volume and lead to decreased temperatures in the Methow and Entiat River Basins will benefit all life stages of bull trout by improving access through migration corridors, pool depth, in-stream cover, and preferred water temperatures.

Habitat restoration projects are likely to require a period of construction that may result in short term disturbances such as noise, increased turbidity, and disturbance associated with increased human presence. Many of these activities may require dewatering of a stream reach to facilitate construction, involving fish removal and salvage, and can result in the injury or death of bull trout. Overall, these projects are expected to result in net positive benefits for bull trout if additional aquatic habitat is created by the project or if upstream migration barriers are removed allowing bull trout access back into historically utilized watersheds. However, passage barrier removal could potentially introduce non-native brook trout to isolated stream reaches where currently only resident bull trout exist. Any passage barrier which controls the upstream distribution of migratory bull trout, salmon or steelhead would likely act as a barrier to brook trout. Habitat improvement projects that involve removal of fish barriers should verify the presence or absence of resident bull trout and brook trout before any barrier is removed.

Based on the number and distribution of funded projects so far, up to 2 projects are anticipated to occur in any subbasin each year. The Service acknowledges that this is a coarse estimate, and that it is conceivable that the number of projects conducted in a subbasin may vary based on a number of factors and objectives. However, the Service believes that effects of these actions will be moderated by review of the potential projects by the Habitat Committee, in which the Service has representation. By selecting projects that provide some benefit to the bull trout, the conservation needs of the species are likely to be met to some degree. Habitat Restoration Plan projects are expected to benefit the bull trout in the long-term, in spite of any short-term adverse effects that occur and with the realization that most of these projects are anticipated for the benefit of salmon and steelhead. Although these actions are reasonably certain to occur and may result in the injury or death of bull trout, there is insufficient information to evaluate the site-specific location, nature, magnitude, timing, frequency, or duration of potential adverse effects.

5.1.2.8 Hatchery Supplementation Plans

Grant PUD is proposing and is in the preliminary stages of implementing actions related to its supplementation programs. These include the Priest Rapids Salmon and Steelhead Settlement Agreement Hatchery Compensation Plan, the White Sturgeon Augmentation Plan, and funding of the Columbia Basin Hatchery. A variety of supplementation, outplanting, acclimation, and other activities are on-going or proposed in the Yakima, Wenatchee, Entiat, Methow, and Okanogan river basins.

The operation of the broodstock trapping facilities and hatchery evaluation activities (spawning ground surveys, snorkel surveys and smolt trap operation) is conducted by the Washington Department of Fish and Wildlife. These activities have previously undergone consultation and are authorized under an ESA section 6(c)(1) permit issued by the Service on February 14, 2000 (permit # 6007.2100). Grant PUD is also authorized to take (harass by survey, trap, capture, handle, and release) bull trout in conjunction with monitoring populations and distribution for the purpose of enhancing its survival, as specified in the permittee's March 10, 2006, amendment request, and in accordance with the specific terms and condition of its take permit (TE-022743-3).

New hatchery and conservation facilities are proposed as part of re-licensing. In accordance with the Priest Rapids Salmon and Steelhead Settlement Agreement Hatchery Compensation Plan and original license requirements, Grant PUD proposes to help recover natural populations of salmon and steelhead to self-sustaining and harvestable levels and to mitigate for 7 percent unavoidable losses at the Wanapum and Priest Rapids developments. Although preliminary, the Service is aware of plans for the construction of a new Chinook hatchery and acclimation facilities in the White River and Nason

Creek, tributaries of the Wenatchee River, as a means to meet supplementation goals. Similarly, broodstock collection will occur in the White River, as will release of Chinook smolts.

In addition, to address the effect of the Priest Rapids Project on white sturgeon, Grant PUD proposes to construct a white sturgeon conservation facility at its Priest Rapids Hatchery. Broodstock would be obtained from the Hanford Reach or Wanapum Reservoir and the conservation facility would be designed to produce yearling white sturgeon for stocking into the Priest Rapids Project reservoirs. This effort would include experimentation with hatchery supplementation to develop optimal rearing and release strategies and to monitor and evaluate the effectiveness of hatchery releases. Grant PUD would also address continuing project effects on recreational fisheries by providing funding for upgrades, improvements, and operating costs at the Columbia Basin Hatchery which currently raises 1.4 million fish for stocking in roughly 140 lakes throughout the region. The majority of the lakes are within Grant County, Washington.

Overall, the hatchery supplementation Project element is conceptual in nature, and little information is available to evaluate the site-specific location, nature, magnitude, timing, frequency, or duration of potential adverse effects to bull trout. Adverse effects assessed in this consultation are restricted to those associated with the White River Chinook supplementation program. This program is comprised of adult monitoring, broodstock collection, and the acclimation and release of smolts. Overall, hatchery supplementation programs are likely to provide some benefit to bull trout populations by increasing densities of a historically important prey item (smolts) in tributaries and mainstem habitats. However, adverse effects are likely from a variety of Project activities (described below), and the release of thousands of smolts can result in short-term, but high intensity, impacts to the prey base.

Adult Monitoring Activities

The spring Chinook spawning aggregate in the White River would be monitored using standard redd count techniques. Experienced surveyors walk in the river or along the banks looking for redds, spawning fish or dead carcasses. Surveys would occur weekly from late August through October. The coordinates of each redd will be recorded with a GPS, then marked with flagging and photos taken. The origin of adults will be identified, to the extent feasible. Biological data from individual carcasses would include fish length, determination of the sex, tissue samples for genetic analysis, and scale samples. Carcasses would be examined for external marks and internal tags. If the carcass received a coded-wire tag the head would be collected so that the tag could be retrieved and de-coded.

The primary effect of this action is the disturbance of bull trout during spawning and the potential for bull trout redds to be trampled by surveyors. Since Chinook and bull trout redds overlap in the White River in both location and timing, the Service expects some degree of redd superimposition. Direct effects may include surveyors directly stepping on bull trout redds, causing some level of mortality, and disturbance to spawning fish. In experimental tests, a single wading event just before hatching can result in up to 43 percent mortality of eggs (Roberts and White 1992). Indirect impacts to bull trout redds may include mobilizing sediment that fills the interstitial spaces of bull trout redds, decreasing oxygen availability, and causing mortality of eggs or fry. In both cases however, accurate identification of bull trout redds and surveyor avoidance should minimize effects to a great degree. Disturbance to spawning fish may be unavoidable, and may result in the delay of spawning or even decreased spawning success. However, this effect is believed to be relatively minor if disturbance is minimized in both duration and proximity by the surveyors.

Broodstock Collection (of eggs or fry)

The first generation (or F1 generation) of the spring Chinook captive brood program will be collected as eggs or fry from naturally deposited redds in the White River. Approximately 1,100 – 3,100 eggs or fry would be collected from up to 50 redds using standard hydraulic sampling methods during the period from September through November. Candidate redds will be identified during spawning ground surveys. If sufficient eggs cannot be collected by hydraulic sampling methods, sampling at later life stages (i.e. fry or parr) would be conducted. Sampling methods could include redd caps, dip nets, minnow traps, or seines.

The primary effect of this action is the disturbance of bull trout during spawning, accidental trampling of redds, and captures of non-target bull trout by redd caps, dip nets, minnow traps, or seines. Disturbance effects and trampling of redds (and avoidance and minimization measures) were previously described above and will not be assessed here. The effects of capturing bull trout can range from injury to death, depending on the methodology and site-specific conditions. Generally, a number of measures to minimize effects commonly employed in section 10 scientific collection permits are used, and are hereby incorporated by reference. They include measures such as frequently checking redd caps and minnow traps (up to several times a day), and the timing of seining. Bull trout are very substrate-oriented and most active at night. Seining during the day and avoiding areas with high densities of bull trout redds should minimize the capture of bull trout. Frequent checking of the minnow traps and redd caps, and the quick release of bull trout would also minimize the potential for injury or death of bull trout, including cannibalism.

Acclimation and Release of F_2 Generation

The production goal for the White River is 150,000 yearling spring Chinook smolts. Attempts would be made to provide four to eight weeks of rearing and acclimation on White River water prior to release. Acclimation facilities may include portable tanks, direct release as pre-smolts, and the use of net pens and existing ponds. Transfers to acclimation facilities would occur in mid-March to early April. Fish would be released in late April and early May into the White River, typically when the hydrograph is increasing. If acclimation facilities are not available, fish would be released directly into the White River in April or early May. Because survival and maturation rates of first generation broodstock can vary, production of the second (F_2) generation can be unpredictable. In the event that production would exceed 150,000 yearlings, surplus fish would be released at earlier life stages (i.e. fry or parr). Habitat modification is expected to be extremely limited, and would not include water impoundment structures, installation of barriers (except the temporary use of nets), and no streambed alternation (e.g., excavation, concrete, etc.). No information was provided regarding maintenance activities associated with these acclimation facilities, so those effects were not assessed.

In 2001, NOAA conducted an assessment of the effects of net-pen salmon farming in the Pacific Northwest (NOAA 2001). In their analysis, they found that the primary issues most likely to affect the environment were (1) the impact of bio-deposits (fish feces and uneaten feed) from farm operations beneath the net-pens, (2) the impact on benthic communities by the accumulation of heavy metals in the sediments below the net-pens, and (3) the impact on non-target organisms by the use of therapeutic compounds (both pharmaceuticals and pesticides) at net-pen farms. While the proposed acclimation facilities are anticipated to have far less severe impacts than net-pen salmon farming due to differences in intensity and duration of use, many of the same pathways of effect may occur. The following analysis mirrors the approach used by NOAA (2001) and is hereby incorporated by reference.

Above ground portable tanks: Above ground portable tanks may be used to acclimate Chinook smolts. Typically they are placed on a temporary wooden platform, are located in an existing opening or disturbed area, and use a submersible pump to withdraw water from the White River. Smolts would be contained for up to 2 months, and then released into the White River. With this smolt release is the discharge of the water used in the portable tank. The water quality of this discharge will likely be degraded by bio-solids (uneaten food and feces) and trace heavy metals and contaminants (especially zinc) associated with fish food. Although concentrated, this discharge would occur in a short-term pulse and when mixed with the White River, may only cause a short-term water quality impact until it is diluted.

Net Pens: The existing net pens in Lake Wenatchee, formerly used for sockeye acclimation, may also be used for acclimation. These net pens are located near the confluence of the White River, an area already attractive to adult bull trout (and other predators such as the northern pikeminnow) but the presence of smolts will likely increase their likelihood of presence. The water quality of this discharge will likely be degraded by bio-solids and trace heavy metals and contaminants associated with fish food. This may in turn effect the benthic biota immediately around the net pens, which is in an area that receives little flushing so concentrations may accumulate through time. As a result, this effect to the benthos, one of the key trophic levels in the food web, may impact the prey base of the bull trout. However, it is difficult to determine the likelihood of this impact given the uncertainty of the severity of water quality impacts. Project monitoring would greatly improve our understanding of the magnitude of effect of this Project element.

Existing Ponds and Off-channel Habitats: Existing ponds and off-channel habitats may also be used as acclimation facilities. Temporary nets will be used to contain the smolts and separate the pond/off-channel habitat from perennial waterways, but little to no habitat modification will be required. Although it is possible bull trout may be accidentally confined in these pond/off-channel habitat areas, the Service believes this is extremely unlikely to occur. The Service assumes these areas are in general, hydrologically connected such that water flows freely, at least seasonally, between these existing ponds and off-channel habitats and the perennial waterway. This discharge from the existing ponds and off-channel habitats and the perennial waterway will likely be degraded by bio-solids and trace heavy metals and contaminants associated with fish food. In general, the Service assumes a lower concentration of contaminants would be discharged per unit time, but would continue as a chronic effect as long as these areas are hydrologically connected to the perennial waterway. In cases where surface waters are not hydrologic connected, this contaminant pathway may be restricted to groundwater interactions. However, it is difficult to determine the likelihood of this impact given the uncertainty of the severity of water quality impacts. Project monitoring would greatly improve our understanding of the magnitude of effect of this Project element.

Summary of Effects of the White River Chinook Supplementation Program. Although there will be adverse effects, the primary effect of this action may be beneficial, with the release of smolts increasing the density and availability of a seasonal prey base. However, water quality impacts, disturbance of bull trout during spawning, and the accidental capture of bull trout is likely to occur and may result in the modification of the behavior of bull trout or injury. Impacts to the prey base can also be substantial when thousands of smolts are released and compete for the same resources other fish, including the bull trout, are expected to use. Based on information provided in the Environmental Baseline
and local knowledge of bull trout use in the White River and Lake Wenatchee area, the Service expects 32 adult and 6 juvenile/sub-adult bull trout will be injured by adult monitoring, broodstock collection, and acclimation activities. In addition, 2 juvenile/sub-adult bull trout may be cannibalized. This estimate was derived as follows:

Adult Monitoring: Based on historic averages for bull trout redd densities, surveyors conducting spawning surveys for Chinook are likely to encounter 41 bull trout redds. Assuming 2 fish per redd, surveys coincided with about 5% of all spawning (i.e., one 8-hour survey per a 168 hour week), half of these fish significantly impacted by disturbance, and surveys occurring for 8 weeks, then disturbance to 16 spawning or post-spawning adult bull trout is anticipated.

Broodstock Collection: Assuming hydraulic sampling overlaps with all 3.3 miles of spawning habitat in the White River, then 41 bull trout redds may be encountered. Assuming 8 weeks of sampling and using the estimate above for adult monitoring, disturbance to 16 spawning or post-spawning adult bull trout is anticipated. If a sufficient number of eggs cannot be collected by hydraulic sampling methods, sampling at later life stages (i.e. fry or parr) would be conducted using redd caps, dip nets, minnow traps, or seines. Assuming daytime sampling (i.e., a time period when bull trout are least active [about 10% of night]), a low capture rate (not to exceed 10%) for bull trout, and densities of 10 bull trout/100m (Service 2004c), then about 6 juvenile or sub-adult bull trout may be captured. Cannibalism may occur, especially when crowding occurs, so the Service estimates 2 of these 6 juvenile or sub-adult bull trout may be eaten.

Acclimation Activities: Water quality impacts associated with acclimation facilities are potentially acute (i.e., discharge from above ground portable tanks) and chronic (i.e., net pens and existing ponds and off-channel habitats). In general, the higher concentration acute effects are anticipated to cause a potential disturbance or startle effect to bull trout, whereas the lower concentration chronic effects are expected to result in impacts to the prey base. Assuming discharge of water from the portable tanks is measurable for 400m downstream of the point of discharge, that water quality impacts result in injury to all bull trout in the first 100m but is halved each subsequent 100m, and the density of bull trout is 10 fish/100m, then injury is anticipated to occur to 18 juvenile or sub-adult bull trout. Adult bull trout are anticipated to be in Lake Wenatchee so their exposure risk is minimal. Chronic effects of water quality degradation from discharges from net pens and existing ponds and off-channel habitats is expected to impact the prey base (i.e., species abundance, species composition, exposure to contaminants, low dissolved oxygen affinity, following NOAA [2001]), however, the Service is unable to quantify the magnitude of effect to bull trout. Project water and sediment monitoring would increase our understanding of the potential effects of this activity to bull trout.

5.1.2.9 Monitoring Plans

A number of post-relicensing monitoring studies, which have not yet been fully designed, are part of the proposed action. They include a variety of activities, including fish surveys for multiple species, habitat monitoring and assessment, and implementation monitoring. These activities may occur throughout the action area with variable amounts of intensity. Many of these activities may involve capture, handling, marking (e.g., pit-tagging, wire tags, radio tags, etc.), or sampling (e.g., fin clips for genetic sampling), which can result in the injury or death of bull trout. Some of these methodologies can be substantial in their impact, involving gill nets or physical features that may temporarily impair or preclude fish passage. Habitat assessment and monitoring can vary in their effects to bull trout, ranging from negligible to severe impacts depending on the activity.

Although these actions are reasonably certain to occur and may result in the injury or death of bull trout, there is insufficient information to evaluate the site-specific location, nature, magnitude, timing, frequency, or duration of potential adverse effects.

5.1.2.10 Recreational Facilities

As described in the project description, the Project includes a number of recreation facilities associated with the Wanapum development. In general, the Priest Rapids and Wanapum reservoir areas and project lands are open for use by the public for recreational purposes subject to the provisions of Grant PUD's draft Shoreline Management Plan, dated August 2003. These include picnic areas, heritage centers, boat launches, dam overlooks, resorts, visitor centers, golf courses, ranches, and other facilities. These developments can have a wide range of effects to bull trout and its habitat, including shoreline development (which can accelerate erosion, impact riparian functions, etc.), use of fertilizers and herbicides that degrade water quality, hazard tree removal (which can impact large woody debris recruitment and function, etc.), and the potential for gas and oil contamination at boat launches, all of which can result in direct and indirect effects to bull trout.

Although these actions are reasonably certain to occur and may result in the injury or death of bull trout, there is insufficient information to evaluate the site-specific location, nature, magnitude, timing, frequency, or duration of potential adverse effects.

5.1.2.11 Cultural Facilities

The Project includes the Wanapum Dam Heritage Center that consists of a public museum and repository for information regarding cultural, historical, and archaeological resources of the Wanapum people. The Heritage Center consists of three areas: a museum with historical information with an observation deck, a hydroelectric Project interpretive and viewing area, and a fish ladder viewing site and interpretive facility. All three sites are located at the Wanapum Development, and are accessed via a paved road from Highway 243. These developments can have a wide range of effects to bull trout and its habitat, including shoreline development (which can accelerate erosion, impact riparian functions, etc.), use of fertilizers and herbicides that degrade water quality, hazard tree removal (which can impact large woody debris recruitment and function, etc.), and the potential for gas and oil contamination at boat launches, all of which can result in direct and indirect effects to bull trout.

Although these actions are reasonably certain to occur and may result in the injury or death of bull trout, there is insufficient information to evaluate the site-specific location, nature, magnitude, timing, frequency, or duration of potential adverse effects.

5.1.3 Significance of the Effects of the Action on Bull Trout

The findings presented below are based, in part, on applying "A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Scale" (Service 1999d). Under this approach, the effects of the proposed action have been evaluated in the context of considering the existing condition of affected bull trout populations (and critical habitat) in the action area with respect to the following Matrix pathways: population characteristics; water quality; habitat access; habitat elements; channel conditions and dynamics; flow/hydrology; and watershed conditions. The final Matrix pathway is integration, designed to aggregate the effects of the proposed action by Project element and informing the section 7(a)(2) analysis. The proximity, distribution, timing (duration, frequency), type, intensity, and severity of effects caused by the proposed action are also considered in determining the degree of effect resulting from implementation of the proposed Federal action (Service and NMFS 1998).

The analysis of Project effects on the bull trout using the Matrix is presented is summarized in Table 3. Note that the Matrix was developed before the draft *Bull Trout Recovery Plan*, and so the Matrix uses the term "subpopulation." For the purpose of using the Matrix in this consultation, the Service considers the term "subpopulation" to be analogous with "local population".

As summarized in Table 3, some Matrix pathways are impacted to a greater degree than others by the Project elements. In particular, the population characteristics pathway (e.g., population size, growth and survival, life history diversity and isolation, and persistence and genetic integrity) are impacted by all project elements and the water quality pathway (e.g., temperature, sediment, and chemical contaminants and nutrients) are impacted by nearly all project elements. The habitat access pathway (e.g., physical barriers) is moderately impacted, with 5 of 11 Project elements affecting fish passage to some degree. The hydrographic variation project element is one of the few Project elements that affects all Matrix pathways, and all but one risk ranking is high. The following summarizes the effects of action grouped by Matrix pathways.

5.1.3.1 Population Characteristics

The following summarizes the population-based effects described in section 5.1.2. Overall, the effects of the action are anticipated to kill 4 adult and 9 juvenile or sub-adult bull trout, and injure 99 adult and 40 juvenile or sub-adult bull trout annually. These fish are anticipated to originate from all four core areas, and the significance of these effects depends in part on the resiliency of the local population(s) impacted annually and over the 50 year term of the Project. While impacts to bull trout from the Methow and Wenatchee core areas are likely to be relatively minor, based primarily on the population trends and number of individuals anticipated to be affected, impacts to bull trout from the Entiat and Yakima core areas are of concern. The status and trend of bull trout from the Entiat core area suggests neither an increasing or decreasing population, but rather stability at low abundance. Project effects are likely to contribute to maintaining the Entiat core area in a depressed condition, which may result in an increased risk of extirpation due to stochastic events. The status and trend of bull trout from the Yakima core area suggests unstable and decreasing populations, and connectivity between local populations is poor. Although the proposed action is anticipated to effect few fish, the local populations in the Yakima core area have little resiliency and are at increased risk of extirpation due to stochastic events.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

Table 3. Overall Risk[1] of Project Effects to Bull Trout by Selected Pathways of the Matrix.

Project Element	**Matrix Pathways**						
	Subpopulation Characteristics	Water Quality	Habitat Access	Habitat Elements	Channel Condition/ Dynamics	Flow/ Hydrology	Watershed Conditions
Turbine Operations	H	L					
Fish Bypass	L	L					
Adult Fishways	H	L	H				
Spillway Operations	H	H					
Hydrograph Variation	H	H	M	H	H	H	H
Predator Control	M						
Project Habitat Fund[2]	M	L	L	M	L	L	M
Supplementation Plan[2]	M	M	M	M	L	L	L
Monitoring Plans[2]	L		L	L			
Cultural Facilities[2]	L	M					L
Recreation Facilities[2]	L	M		L	L		L

[1] – Risk of Project effects are qualitative estimates (high, moderate, and low) by the Service based on the proximity, distribution, timing (duration, frequency), type, intensity, and severity of effects caused by the proposed action.

[2] - Based on the information provided, there is insufficient information to evaluate the site-specific nature and magnitude of the potential effects of some Project elements. In these cases, the Service relied on best professional judgment and experience from past and current federal actions that are similar in nature to qualitatively estimate the degree of effect.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

5.1.3.2 Water Quality

The primary mechanism of the effects to the water quality pathway are related to temperature increases due to impounding water and reducing velocity, increased sediment due to fluctuating river levels and bank erosion (which is also related to higher temperatures), and gas supersaturation due to spillway operations. These impacts were analyzed in detail in section 5.1.2.5 as they relate to population effects. Other water quality degradation may occur due to cultural and recreational facilities, supplementation, and the Project habitat fund. However, little site-specific information was provided so only the conceptual aspects of impacts, including run-off and effluent discharges, were qualitatively assessed; separate analyses will be required for future supplementation efforts so impacts can be assessed and minimized at that time. In addition, turbine operations, the juvenile fish bypass, and adult fishways may also degrade the temperature, sediment, and chemical contaminant/nutrient indicators, mainly through increasing erosion and turbidity, and periodic maintenance activities.

The overall effect of the action is to likely maintain degraded water quality in the mainstem Columbia. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk"). In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is the potential for low to moderate degradation of water quality at the project scale, but is likely to maintain degraded water quality. However, some habitat fund activities may improve water quality to some degree at a localized scale. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk") in the Methow FMO, Entiat core area and FMO, Wenatchee core area and FMO, Yakima core area and FMO; and being at moderate risk (i.e., "functioning at risk") in the Methow core area.

5.1.3.3 Habitat Access

The primary physical barrier to normal movement and behavior patterns of adult bull trout is the seasonal closure of the fishways, which can isolate them from upstream habitats. Juvenile and sub-adult bull trout are also expected to be impacted, but they may not be able to ascend the fishways even when open. The effects of isolation of bull trout by adult fishway operations were previously described in section 5.1.2.3. Hydrographic variation (i.e., fluctuating water levels) may also create temporary physical barriers by dewatering access to nearshore and off-channel habitats. Degraded water quality, especially high water temperatures and supersaturated gases, may create temporary thermal or chemical barriers, at least in some areas of the mainstem Columbia. The supplementation plan may create substantial barriers (e.g., concrete weirs) depending on the design and placement of future hatchery, acclimation, and other facilities. Monitoring can also result in temporary barriers, such as gill nets used for research efforts. However, both supplementation and monitoring efforts will require a separate analysis so impacts can be analyzed and minimized at that time. The overall effect of the action is to maintain a degraded condition for habitat access.

The overall effect of the action is to likely maintain degraded habitat access in the mainstem Columbia. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk"). In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is likely to maintain degraded habitat access. However, some habitat fund activities may improve habitat access at a localized scale. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk") in the Yakima core area; and being at moderate risk (i.e., "functioning at risk") in the Methow core area and FMO, Entiat core area and FMO, Wenatchee core area and FMO, and Yakima FMO.

5.1.3.4 Habitat Elements

A number of habitat elements are impacted by hydrographic variation and the impoundment of the Columbia River. Increased levels of sediment from fluctuating river levels and bank erosion has increased substrate embeddedness. Large woody debris has been decreased due to the fluctuations in river levels, altering riparian vegetation composition, vigor, and mortality. In addition, what large woody debris is mobilized is typically captured at log booms and removed from the river as part of Project maintenance. Pool frequency and quality, especially primary pools, have also been inundated by the Project and maintained by hydrographic variation. Off-channel habitat has also been reduced in quality and access due to fluctuating river levels and overall channel simplification. Refugia have likely been eliminated in most cases, although the increased depth of the Columbia may have created thermal refuge in cases where cold water sources are present (e.g., upwelling, large groundwater influences). Future habitat fund projects, supplementation plan activities, and monitoring may also effect habitat elements, but little information was provided to assess these effects.

The overall effect of the action is to likely maintain degraded habitat elements in the mainstem Columbia. This is based primarily on the overall risk rating of the baseline function of this pathway being at moderate risk of not functioning (i.e., "functioning at risk"). In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is the potential for low to moderate degradation of habitat elements at the project scale, but is likely to maintain a degraded condition. However, some habitat fund activities may improve habitat elements to some degree at a localized scale. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk") in the Methow FMO, Entiat core area and FMO, Wenatchee core area and FMO, and Yakima FMO; and being at moderate risk (i.e., "functioning at risk") in the Methow and Yakima core areas.

5.1.3.5 Channel Condition/Dynamics

Hydrographic variation has resulted in an overall change in wetted width/maximum depth ratio, increasing this ratio and overall water depth (especially in the mainstem Columbia and the confluence and lower portions of tributaries). While increased water depth is generally beneficial to the bull trout, it is accompanied with slower water, warmer temperatures, simplified habitat conditions, and other habitat degradation. Streambank condition is also impacted, primarily by the fluctuations in pool/river level. Effects can stem from direct bank erosion, but also impacts to the condition and extent of riparian vegetation, which, if degraded, can lead to additional stream bank instability. Floodplain connectivity is also impacted by hydrographic variation, reducing hydrologic connectivity between off-channel habitat, wetlands, and riparian areas. In addition, the extent of wetlands has likely been reduced and riparian vegetation and succession have been altered significantly. Little information was provided to evaluate the effects of recreational facilities, but presumably streambank condition and floodplain connectivity have been degraded through the development and maintenance of nearshore and in-stream structures. Future habitat fund projects and the supplementation plan activities may also impact channel condition and dynamics, but little information was provided to assess these effects.

The overall effect of the action is to likely maintain degraded channel conditions and dynamics in the mainstem Columbia. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk"). In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is the potential for low to moderate degradation of channel conditions and dynamics at the project scale, but is likely to maintain a degraded condition. However, some habitat fund activities may improve channel conditions and dynamics to some degree at a localized scale. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk") in the Methow core area and FMO, Entiat core area and FMO, Wenatchee FMO, Yakima core area and FMO; and being at moderate risk (i.e., "functioning at risk") in the Wenatchee core area.

5.1.3.6 Flow/Hydrology

Hydrographic variation has resulted in a moderation of the amplitude of hydrographic change, a function of regulating the mainstem Columbia for hydropower generation. While this has resulted in lower proportional change in peak flows, higher base flows have resulted from water impoundment. A natural hydrograph would have the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation. As a result of the proposed action, a highly modified hydrograph with altered peak and base flows will be continued. This impairs a number of natural ecosystem processes, including sediment, large woody debris, and other key functions. Future habitat fund projects and the supplementation plan activities may also impact channel condition and dynamics, but little information was provided to assess these effects.

The overall effect of the action is to likely maintain degraded flow and hydrology conditions in the mainstem Columbia. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk"). In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is the potential for low to moderate degradation of flow and hydrology conditions at the project scale, but is likely to maintain a degraded condition. However, some habitat fund activities may improve flow and hydrology conditions to some degree at a localized scale. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk") in the Methow core area and FMO, Entiat core area and FMO, Wenatchee FMO, Yakima core area and FMO; and being at moderate risk (i.e., "functioning at risk") in the Wenatchee core area.

5.1.3.7 Watershed Conditions

Hydrographic variation has resulted in substantial effects to the condition of the watershed condition pathway. The disturbance history in the action area has been altered by substantial changes to the hydrograph due to hydropower generation, degraded riparian areas, and nearly a century of fire suppression. This has lead to the impairment of a number of ecosystem processes that support habitats used by bull trout. Analysis of the riparian conservation area indictor in particular suggests a condition that is fragmented, poorly connected, and provides limited protection to aquatic species. In addition, the natural disturbance regime in terms of floods and fires has departed substantially from its historic properly functioning condition. This likely translates to an overall watershed condition of poor quality, little resiliency, and limited ability to provide habitat for the bull trout in the long term. Little information was provided to evaluate the effects of recreational facilities, but riparian areas have been degraded especially when roads have been constructed. Future habitat fund projects and the supplementation plan activities may also impact watershed condition, but little information was provided to assess these effects.

The overall effect of the action is to likely maintain degraded watershed conditions in the mainstem Columbia. This is based primarily on the overall risk rating of the baseline function of this pathway being at moderate risk of not functioning (i.e., "functioning at risk"). In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is the potential for low to moderate degradation of watershed conditions at the project scale, but is likely to maintain a degraded condition. However, some habitat fund activities may improve watershed conditions to some degree at a localized scale. This is based primarily on the overall risk rating of the baseline function of this pathway being at high risk of not functioning (i.e., "functioning at unacceptable risk") in the Methow core area and FMO, Entiat core area and FMO, Wenatchee core area and FMO, Yakima core area and FMO.

5.1.3.8 Integration

The last step of the Matrix analysis is integration, which is a summary of the effects of the action. Overall, bull trout are anticipated to originate from all four core areas and be exposed to the effects of one or more Project elements. The significance of these effects depends in part on the resiliency of the local populations within the four core areas impacted annually and over the 50-year term of the Project. While impacts to bull trout from the Methow and Wenatchee core areas are likely to be relatively minor, based primarily on the population trends and number of individuals anticipated to be affected, impacts to bull trout from the Entiat and Yakima core areas are of concern. The status and trend of bull trout from the Entiat core area suggests neither an increasing or decreasing population, but rather stability at low abundance. Project effects are likely to contribute to maintaining the Entiat core area in a depressed condition, which may result in an increased risk of extirpation due to stochastic events. The status and trend of bull trout from the Yakima core area suggests unstable and decreasing populations, and connectivity between local populations is poor. Although the proposed action is anticipated to effect few fish, the local populations in the Yakima core area have little resiliency and are at increased risk of extirpation due to stochastic events.

Habitat effects in the mainstem Columbia FMO are anticipated to maintain a degraded condition, with the most severe effects expected to occur to water quality, habitat access, and multiple habitat indicators associated with hydrographic variation. In the tributaries, the overall effect of the action (i.e., the supplementation plan, monitoring, and habitat fund Project elements) is the potential for low to moderate degradation of the condition of habitat indicators at the project scale, but is likely to maintain a degraded condition. However, some habitat fund activities may improve the conditions of some indicators to some degree at a localized scale, but are unlikely to change the overall ranking of a pathway at the core area scale.

5.2 Effects of the Action on Bull Trout Critical Habitat

Critical habitat for bull trout is designated within only the Yakima basin and effects will only occur there. Only the Project habitat fund, supplementation plan, and monitoring Project elements are anticipated to impact sections of streams designated as bull trout critical habitat. For additional discussion on the effects to bull trout habitat from the project elements, please refer to the "Bull Trout Effects" section. The PCEs apply to areas designated as critical habitat used by bull trout for foraging, migrating, overwintering, and for spawning and rearing. The only exception is that PCE #3 (substrates) addresses substrates needed for spawning and rearing and does not address or is not attributable to bull trout foraging, migrating, and overwintering requirements.

As described in the Environmental Baseline, 10 of 16 local populations contain critical habitat. Critical habitat in Ahtanum Creek, Bumping River, Teanaway River, Cle Elum River, and Upper Mainstem Yakima River local populations are at high risk of being non-functional for bull trout; and critical habitat in the Gold Creek, Box Canyon Creek, Kachess River, Rattlesnake Creek, and the North Fork Tieton River local populations are at an overall moderate risk of being non-functional for bull trout. The habitat in the Yakima core area has 5 dams on BOR reservoirs which block off migratory access to the most functioning habitat and to the largest bull trout populations. All critical habitat in FMO areas in the Yakima basin are at high risk for becoming non-functional for bull trout.

Implementation of future actions conducted under the Project habitat fund, supplementation plan, and monitoring Project elements proposed have the potential to adversely affect all eight PCEs. Although effects are likely to be site-specific, the more severe effects to the PCEs have the potential to affects PCE 1, 2, 3, 4, and 6. Indirect effects from habitat restoration activities and hatchery supplementation may result in a decrease in prey base (PCE 7). It is anticipated that both adverse and beneficial effects will result from these activities, although adverse effects in both the short- and long-term may potentially occur before the beneficial effects are realized. At the critical habitat unit scale, the effects of the action to the habitat conditions or PCEs are anticipated to range from low to high, depending on site specific factors and the frequency, timing, duration, and intensity activities involved in habitat restoration, hatchery supplementation, and monitoring over the course of 50 years. In summary, there are critical habitat segments in five local populations that are at a high risk to adverse effects due to baseline habitat conditions, five local populations that are at a moderate risk to adverse effects due to baseline habitat conditions and all FMO areas are at a high risk to adverse effects due to baseline conditions.

Habitat Restoration Plan projects are expected to benefit the bull trout in the long-term, in spite of any short-term adverse effects that occur and with the realization that most of these projects are anticipated for the benefit of salmon and steelhead. Although these actions are reasonably certain to occur and may result in the injury or death of bull trout, there is insufficient information to evaluate the site-specific nature, timing, duration, frequency, and magnitude of potential effects, let alone which river basin or local population of bull trout may be affected.

The Service believes that for Hatchery Supplementation Plans, adherence to water right limits, water quality NPDES permits, and NOAA Fisheries intake screening criteria will minimize effects to bull trout from supplementation activities. Although these actions are reasonably certain to occur there is insufficient information to evaluate the site-specific nature, timing, duration, frequency, and magnitude of the potential effects, let alone which river basin or local population of bull trout may be affected.

In Monitoring Plans, some methodologies can be substantial in their impact, involving gill nets or physical features that may temporarily impair or preclude fish passage. Habitat assessment and monitoring can vary in their effects to bull trout, ranging from negligible to severe impacts depending on the activity. Based on the information provided to the Service in this consultation, there is insufficient information to evaluate the site-specific nature, timing, duration, frequency, and magnitude of the potential effects from implementation of monitoring plans, including which river basin or local population of bull trout may be affected.

The lack of information for the three project elements that will affect critical habitat limits the analysis of effects for this section. Further description of future activities will insure appropriate assessment of effects to critical habitat.

6.0 CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. 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.

As the human population in the State of Washington continues to grow, residential growth and demand for dispersed and developed recreation is likely to occur. This trend is likely to result in increasing habitat degradation from riparian road construction, levee building, bank armoring, and campsite development on private lands. These activities tend to remove riparian vegetation, disconnect rivers from their floodplains, interrupt groundwater-surface water interactions, reduce stream shade (and increase stream temperature), reduce off-channel rearing habitat, and reduce the opportunity for large woody debris recruitment. Each subsequent action by itself may have only a small incremental effect, but taken together they may have a substantive effect that would further degrade the watershed's condition and resiliency, and undermine efforts to improve the habitat conditions necessary for listed species to survive and recover.

Watershed assessments and other education programs may reduce these adverse effects by continuing to raise public awareness about the potentially detrimental effects of residential development and recreation on salmonid habitats and by presenting ways in which a growing human population and healthy fish populations can co-exist. For this description of cumulative effects, the Service assumes that future non-Federal activities in the area of the proposed action will continue into the immediate future at present or increased intensities. Accordingly, these actions will contribute to maintenance of at risk and non-functioning habitat indicators in the action area.

Cumulative effects from a variety of activities are likely to adversely affect the bull trout and the PCEs of bull trout critical habitat. These actions include, but are not limited to, industrial and residential development, road construction and maintenance, mining, forest activities, agriculture and grazing, and fire management. Impacts from these activities have the potential to degrade PCEs 1, 2, 3, 4, 5, 6, and 7 within the Action Area. Water storage facilities and future dams for irrigation are likely to adversely affect PCE 8.

7.0 CONCLUSION

Bull Trout

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of the proposed relicensing action, and the cumulative effects, it is the Service's biological opinion that the relicensing action, as proposed, is not likely to jeopardize the continued existence of the bull trout. We reached this conclusion for the following reasons:

1. The environmental baseline for the action area indicates that although bull trout are widely distributed, abundance is generally low and productivity highly variable. The overall status and trend in the Methow and Wenatchee core area show a slight increase in population size, the Entiat core area is stable but in low abundance, and the Yakima core area is in decline. Habitat conditions are highly variable across the action area, but generally increase in quality when moving upstream into the tributaries. The mainstem Columbia River is highly altered, yet provides key FMO habitats.

2. The effect of the action will result in the injury and death of adult and juvenile or sub-adult bull trout across 4 core areas. This includes direct mortality from turbine and spillway operations, delays in migratory behavior, and a variety of habitat-based effects related to hydrologic variation. Beneficial effects, however, include a juvenile bypass system, predator control, and a habitat restoration program. Overall, the proposed action provides limited but adequate connectivity between core areas, the key conservation role of the mainstem Columbia River.

3. Cumulative effects are anticipated to degrade or maintain degraded conditions across the action area. Key issues include floodplain development and function, water quality and quantity, fish passage (connectivity), and habitat fragmentation.

4. Overall, the relicensing of the Priest Rapids Project will not diminish the numbers, distribution, or reproduction of bull trout to a degree that will appreciably reduce the likelihood of survival and recovery of bull trout in the Columbia River interim recovery unit.

Incidental take of bull trout may occur, given that bull trout are known to occupy the action area. Incidental take may occur as a result of turbine operations, juvenile bypass, adult fishways, spillway operations, hydrographic variation, and predator control. Based on the information provided, there was insufficient information to evaluate the site-specific nature and magnitude of the potential effects of remaining Project elements. So, while these Project elements were considered in this section 7(a)(2) analysis, the Service cannot issue incidental take for those Project elements at this time.

Bull Trout Critical Habitat

After reviewing the current status of bull trout critical habitat, the environmental baseline for the action area, the effects of the proposed relicensing action, and the cumulative effects, it is the Service's biological opinion that the relicensing action, as proposed, is not likely to destroy or adversely modify bull trout critical habitat. We reached this conclusion for the following reasons:

1. The status of critical habitat is relatively unchanged since it was designated. Approximately 4,813 miles of critical habitat was designated in Oregon, Washington, Idaho, and Montana.

2. The environmental baseline for the PCE's of critical habitat in the Middle Columbia River Basin (unit 20) is relatively unchanged since it was designated, with few significant consulted-upon effects. Although degraded, this critical habitat unit continues to function in the manner for which it was designated.

3. The effects of the action on bull trout critical habitat will be restricted to designated habitat in the Yakima subbasin, and are anticipated to be affected primarily by habitat fund projects. Because these actions are designed to restore habitat conditions and ecosystem processes, only short-term degradation of the PCE's of designated critical habitat are anticipated. Long-term benefits may result.

4. Overall, the sum of the effects of relicensing of the Priest Rapids Project will not appreciably diminish the value and function of designated critical habitat for the bull trout.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

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 attempt to engage in any such conduct. Harm is further defined by Service 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. Harass is defined by Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include but are not limited to, 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 agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Commission and Grant PUD for the exemption in section 7(o) (2) to apply. In order to monitor the impact of incidental take, the Commission and Grant PUD must report the progress of the action and its impact on the bull trout to the Service as specified in this Incidental Take Statement [(50 CFR 402.14(i)(3)].

Anticipated Amount or Extent of Take of the Bull Trout

Based on the preceding "Effects of the Action" analysis, the amount and types of take described in Table 4 are anticipated with implementation of the proposed action over the life of the Project.

Effect of the Take

In the accompanying Biological Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout, and is not likely to destroy or adversely modify bull trout critical habitat. Table 4 summarizes the type of take authorized by Project element. Note that not all Project elements received incidental take coverage because either not enough information was provided or the Service does not anticipate the injury or death of individuals from that element.

Table 4. Summary of Priest Rapids Hydroelectric Project relicensing elements assigned annual "take" in this biological opinion

Project Element	Type of Take	Lethal Take		Non-lethal Take	
		Adult	Juvenile/ Sub-adult	Adult	Juvenile/ Sub-adult
Turbine Operations	Harm or Harass	4	2	4	28
Juvenile Fish Bypass	Harm or Harass	0	1	1	6
Spillway Operations	Harm or Harass	1	4	7	26
Adult Fishways	Harass	0	1	8	2
Hydrograph Variation	Harm or Harass	0	3	84	27
Predator Control	Harm or Harass	1	0	0	0
White River Supplementation Program	Harass	0	2	32	6
	TOTAL	**6**	**13**	**136**	**95**

Reasonable and Prudent Measures

The Service believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the impacts of take of the bull trout. These RPMs and accompanying terms and conditions shall be integrated into a Bull Trout Management Plan to be completed by Grant PUD within 1 year of the issuance of this Biological Opinion. Specific elements shall include the following:

RPM 1. FERC shall require Grant PUD, in coordination with the Service, to provide adequate year-round passage conditions for bull trout at Project facilities.

RPM 2. FERC shall require Grant PUD, in coordination with the Service, to design and implement a bull trout monitoring program that will adequately detect Project impacts, including those caused by hydrologic modifications and changes in water quality, on adult and sub-adult bull trout.

RPM 3. FERC shall require Grant PUD, in coordination with the Service and the PRCC, to implement the Hanford Reach Fall Chinook Protection Program Agreement within the limitations of the existing agreement in a manner that incorporates the conservation needs of the bull trout.

RPM 4. FERC shall require Grant PUD, in coordination with the Service, to minimize the effects of the White River Spring Chinook Supplementation Program to all life stages of bull trout.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Commission and Grant PUD must comply with the following terms and conditions, which implement the RPMs described above. These terms and conditions are non-discretionary.

The Service believes the following terms and conditions are necessary and appropriate to minimize the impacts of take of the bull trout during the term of the Project's new operating license:

1. To implement RPM 1, FERC shall require Grant PUD, in coordination with the Service, to continue operating the existing adult upstream fishways at Project dams year-round. These facilities shall be operated according to criteria agreed to in the Priest Rapids Salmon and Steelhead Settlement Agreement (109 FERC ¶62,216) and/or Grant PUD's annual Fishway Operating Plans. During winter maintenance activities, only one fishway shall be closed at any one time at each Project facility to ensure that bull trout passage is possible at all times.

2. To implement RPMs 1 and 2, FERC shall require Grant PUD to develop and implement a bull trout monitoring plan, including the counting and reporting of all bull trout life stages moving past Wanapum and Priest Rapids dams between April 15 and November 15 of each year, for an experimental period of five years. The plan shall be developed in coordination with and shall be approved by the Service within one year of the Commission's issuance of a new operating license to Grant PUD. The monitoring plan shall include provisions for adaptive management to address changing conditions, assess on-going adverse effects, and investigate potential corrective actions. This may include evaluating the efficiency of upstream and downstream passage for all life stages of the bull trout (e.g., fishway water velocity impacts to subadults), development of survival standards for bull trout, development of a genetics baseline (i.e., using non-lethal means such as fin clips), and investigation of potential corrective actions for project-related water quality degradation. Annual reports regarding observations, effects, or monitoring results specific to bull trout shall be prepared and submitted by Grant PUD to the Service. In addition, FERC shall require Grant PUD, in coordination with the Service, to develop or identify an appropriate forum to address the issues raised in these reports.

3. To implement RPM 2, FERC shall require Grant PUD, in coordination with the Service, to record and report bull trout occurrences during the following activities: fish counting at fishways; juvenile bypass activities; gatewell dipping; turbine maintenance activities; fishway maintenance activities; hatchery activities; and northern pikeminnow control program activities. Bull trout detections shall be reported to the Service per the reporting requirements above under term and condition 2.

4. To implement RPM 2, FERC shall require Grant PUD, in coordination with the Service, to PIT tag sub-adult bull trout whenever they are incidentally captured during on-going PIT tagging efforts conducted for anadromous and other fish management activities. Bull trout detections shall be reported to the Service per the reporting requirements above under term and condition 2.

5. To implement RPM 2, FERC shall require Grant PUD, in coordination with the Service, to report incidental take as precisely as possible. In order to accomplish the monitoring of take, the Service suggests the use of empirically collected data including PIT-tagging, radio-telemetry, or other appropriate technology.

6. To implement RPM 2, FERC shall require Grant PUD, in coordination with the Service, to collect genetic samples of all bull trout over 70 mm handled as part of ordinary Project operations. This may provide valuable information on the conservation status and genetic relationships between bull trout populations in the Columbia basin. This is consistent with the existing permit for the operation of screw trap collection.

7. To implement RPM 2, FERC shall require Grant PUD, in coordination with the Service, to develop and implement a plan to collect data for evaluating the effect of hydrologic variations and water quality impacts on all bull trout life stages within Project reservoirs. The plan shall include provisions for adaptive management to address changing conditions, assess on-going effects, and investigate potential corrective actions. These data shall be reported annually to the Service per the reporting requirements above under Term and Condition 2.

8. To implement RPM 3, FERC shall require Grant PUD, in coordination with the Service and the PRCC, to implement the Hanford Reach Fall Chinook Protection Program Agreement within the limitations of the existing agreement in a manner that incorporates the conservation needs of the bull trout.

9. To implement RPM 4, FERC shall require Grant PUD, to minimize impacts to bull trout redds. Disturbance of or impacts to bull trout habitat shall be minimized during all activities associated with the White River Spring Chinook Supplementation Program. Grant PUD shall take precautions so as to avoid stepping in/on areas that may be potential redd locations for resident or fluvial/adfluvial bull trout (i.e., small gravel deposits behind boulders; under overhanging vegetation; near wood debris or logs; or areas of hydraulic influence such as confluences of tributaries, springs, seeps, pool tail crests, or edges of pools), since redds of resident and small fluvial/adfluvial bull trout at these locations may be difficult to see due to their small size.

10. To implement RPM 4, FERC shall require Grant PUD to avoid disturbance of spawning bull trout. Any purposeful take of bull trout that are spawning or are near spawning is prohibited. Grant PUD shall minimize activities near actively-spawning bull trout as well as post-spawned bull trout that appear to be in a weakened condition.

11. To implement RPM 4, FERC shall require Grant PUD, to monitor traps (i.e., redd caps and minnow traps) at least 1 time daily. Traps should be checked more frequently (at least 2 times a day) when any bull trout are captured or if crowding produced by an increasing catch rate results in a higher probability of injury or death to bull trout being held in the live box.

12. To implement RPM 4, FERC shall require Grant PUD to conduct all seining during the daylight hours, excluding the first hour after sunrise and the hour prior to sunset. This should minimize the exposure of juvenile and sub-adult bull trout to accidental capture.

13. To implement RPM 4, FERC shall require Grant PUD to avoid hydraulic sampling of Chinook eggs in areas where redd superimposition is suspected (i.e., areas where individual Chinook and bull trout redds directly overlap). The primary reach of concern is from the Napeequa River to Panther Creek. This should minimize the likelihood of direct removal of bull trout eggs or fry from the substrate.

14. To implement RPMs 2 and 4, FERC shall require Grant PUD, in coordination with the Service, to conduct water and sediment sampling related to the discharges of degraded water from acclimation facilities. This information will provide a metric to quantify effects to the bull trout and state water quality standards, and may be used to develop or refine the anticipated level of incidental take.

Reporting Requirements

In order to monitor the impacts of incidental take, Grant PUD shall prepare a report describing the progress of implementing the proposed relicensing and its impact on the bull trout. The report, which shall be submitted to the Central Washington Field Office annually on or before February 1, shall list and describe the work that was completed and the number of bull trout, if any, observed or incidentally taken during the course of implementing the Project.

Upon locating a dead, injured, or sick endangered or threatened species specimen, initial notification must be made to the nearest Service Law Enforcement Office (Spokane, Washington; telephone 509.928.6050). Care should be taken in handling sick or injured specimens to ensure effective treatment and care or the handling of dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the level of incidental take described above is exceeded, such incidental take represents new information requiring reinitiation of consultation (assuming the Commission retains discretion or control over the action) and review of the RPMs provided. Grant PUD must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

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. For this consultation, the Service has the following recommendations for the Commission and Grant PUD to consider:

1. Implement recovery actions and restoration opportunities identified in the Service's draft *Bull Trout Recovery Plan* (Service 2002).

REINITIATION NOTICE

This concludes formal consultation on the Commission's proposed relicensing of the Grant PUD hydropower project. 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.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

LITERATURE CITED

Allendorf, F.W. and N. Ryman. 2002. The role of genetics in population viability analysis. Pages 50-85 *in* S.R. Beissinger and D.R. McCullough (eds). Population Viability Analysis. The University of Chicago Press, Chicago, IL.

ADFG (Alaska Department of Fish and Game). 1963. Investigations of anadromous Dolly Varden populations in the Lake Eva-Hanus Bay drainages, southeastern Alaska. Dingell-Johnson Project Report, 1962-63, Vol. 4.

Armstrong, R.H. 1965. Some migratory habits of the anadromous Dolly Varden *Salvelinus malma* (Walbaum) in southeastern Alaska. Alaska Department of Fish and Game. Research Report No. 3. Juneau, Alaska. 36 p.

Baxter, C.V. 2002. Fish Movement and Assemblage Dynamics in a Pacific Northwest Riverscape. Ph.D. Dissertation, Oregon State University, Corvallis, OR. 174 pp.

Baxter, C.V., and F.R. Hauer. 2000. Geomorphology, hyporheic exchange, and the selection of spawning habitat by bull trout (*Salvelinus confluentus)*. Canadian Journal of Fisheries and Aquatic Sciences. 57: 1470-1481.

Baxter, J.S.D., and J.D. McPhail. 1997. Diel microhabitat preferences of juvenile bull trout in an artificial stream channel. North American Journal of Fisheries Management 17:975-980.

Baxter, J.S. and W.T. Westover. 1999. Wigwam River bull trout: habitat conservation trust fund progress report (1998). British Columbia Ministry of Environment, Fisheries Progress Report Ko54, Cranbrook.

Beauchamp and Van Tassell. 2001. Modeling of seasonal trophic interactions of bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society. Vol. 130: 204-216.

Behnke, R.J. 2002. Trout and salmon of North America. George Scott (ed). Free Press, New York, NY. 384pp.

BioAnalysts, Inc. 2002. Movements of bull trout within the mid-Columbia River and tributaries, 2001 - 2002. Final Report prepared for Public Utility District No. 1 of Chelan County, Wenatchee, Washington.

BioAnalysts, Inc. 2003 DRAFT. Movements of bull trout within the mid-Columbia River and tributaries, 2002-2003 DRAFT. Draft report prepared for the Public Utility No. 1 of Chelan County. Wenatchee, Washington. July 2003.

BioAnalysts, Inc. 2004. Movements of bull trout within the mid-Columbia River and tributaries, 2001-2004. Final report prepared for the Public Utility No. 1 of Chelan, Douglas, and Grant Counties. Wenatchee, Washington. May 2004.

Bisson, P.A., R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B. Grette, R.A. House, M.L. Murphy, K.V. Koski and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. *In* Streamside management: forestry and fishery interactions. E.O. Salo and T.W. Cundy, Editors., Univ. Washington, Institute of Forest Resources : 143-190.

Bjornn, T. C., J. P. Hunt, R. P. Tolotti, P. J. Keniry, and R. R. Ringe. 1995. Migration of adult Chinook salmon and steelhead past dams and reservoirs in the lower Snake River and into tributaries – 1993. Technical Report 95-1 of Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, for U. S. Army Corps of Engineers, Walla Walla District, Washington, and Bonneville Power Administration, Portland, Oregon.

Boag, T.D. 1987. Food habits of bull char (*Salvelinus confluentus*), and rainbow trout (*Salmo gairdneri*), coexisting in the foothills stream in northern Alberta. Canadian Field-Naturalist 101(1): 56-62.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 *In*: Howell, P.J. and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Bonneau, J. L. and D. L. Scarnecchia 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125(4): 628-630.

Brenkman, S. J. and S. C. Corbett. 2005. Extent of anadromy in bull trout and implications for conservation of a threatened species. North American Journal of Fisheries Management 25(3):1073-1081.

Brewin P.A. and M. K. Brewin. 1997. Distribution Maps for Bull Trout in Alberta. Pages 206-216 *in:* Mackay, W.C., M.K. Brewin and M. Monita, editors. Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Brown, L.G. 1992. On the zoogeography and life history of Washington native char Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*). Washington Department of Wildlife, Fisheries Management Division Report. Olympia, Washington.

Bryant, M.D. 1983. The role and management of woody debris in West Coast salmonid nursery streams. North American Journal of Fisheries Management 3:322-330.

Bryant, F.G., and Z.E. Parkhurst. 1950. Survey of the Columbia River and its tributaries; area III, Washington streams from the Klickitat and Snake Rivers to Grand Coulee Dam, with notes on the Columbia and its tributaries above Grand Coulee Dam. USFWS, Special Scientific Report 37, 108 pp.

Buchanan, D. M. and S. V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 1-8 *in*: Mackay, W.C., M.K. Brewin and M. Monita, editors. Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Buckman, R.C., W.E. Hosford, and P.A. Dupee. 1992. Malheur River Bull Trout Investigations. Pages 45-47 in Howell, P.J. and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Burner, C.J. and H.L. Moore. 1962. Attempts to guide fish with underwater sound. U.S. Fish and Wildlife Service. Spec. Sci. Report. Fish. 403:1-30.

Carl 1985. Management plan for bull trout in Alberta. Pages 71 to 80 in: D.D. MacDonald, Proceedings of the Flathead River basin bull trout biology and population dynamics modeling information exchange. Cranbrook, BC: British Columbia Ministry of Environment, Fisheries Branch.

Cavender, T. M. 1978. Taxonomy and distribution of the bull trout *Salvelinus confluentus* (Suckley), from the American northwest. Calif. Fish and Game 64:139-174.

Chapman, D., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays, C. Peven, B. Suzumoto, and R. Klinge. 1994a. Status of summer/fall chinook salmon in the mid-Columbia region. Report for Chelan, Douglas, and Grant County PUDs. Don Chapman Consultants, Boise, ID. 412 p. + app.

Chapman, D., C. Peven, T. Hillman, A. Giorgi, and F. Utter. 1994b. Status of summer steelhead in the Mid-Columbia River. Report for Chelan, Douglas, and Grant County PUDs. Don Chapman Consultants, Boise ID.

Chelan PUD. 2002. Unpublished fish ladder count data for Rocky Reach. Public Utility District No. 1 of Chelan County.

Chelan PUD. 2003a. Rocky Reach and Rock Island Fish Passage Plans. March, 2003.

Chelan PUD. 2003b. Biological Evaluations for the Rocky Reach Fish Passage System - 2003. Study Plan. March 2003.

Chelan PUD. 2003c. Biological assessment of proposed actions in the Rocky Reach hydroelectric project habitat conservation plan. Prepared for the Federal Energy Regulatory Commission by the Public Utility District No. 1 of Chelan County. October 15, 2003.

Clancy, C.G. 1993. Statewide Fisheries Investigations, Bitterroot Forest Inventory. Helena, MT: Montana Department of Fish, Wildlife, and Parks, Fisheries Division. [not paginated]. Job Completion Report. Project F-46-R-4. (As referenced in U.S. Department of Interior 1998d)

Connor, E., D. Reiser, K. Binkley, D. Paige, and K. Lynch. 1997. Abundance and distribution of an unexploited bull trout population in the Cedar River Watershed, Washington. Pages 403-411 *in* Mackay, W.C., M.K. Brewin, and M. Monita, editors. Friends of the bull trout conference proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary.

Costello, A. B., T. E. Down, S. M. Pollard, C. J. Pacas, and E. B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: An examination of microsatellite DNA variation in bull trout, Salvelinus confluentus (Pisces: Salmonidae). Evolution 57(2):328-344.

Craig, S.D. and R.C. Wissmar. 1993. Habitat Conditions Influencing a Remnant Bull Trout Spawning Population, Gold Creek, Washington. (draft report) Fisheries Research Institute, University of Washington. Seattle, WA.

Crane, P.A., L.W. Seeb, and J.E. Seeb. 1994. Genetic relationships among *Salvelinus* species inferred from allozyme data. Canadian Journal of Fisheries and Aquatic Science 51:182-197.

Crow, J. F. and M. Kimura. 1970. An introduction to population genetics theory. Harper and Row, New York.

DeCicco, A.L. 1992. Long-distance movements of anadromous Dolly Varden between Alaska and the U.S.S.R. Arctic 45(2): 120-123.

DOE (Department of Ecology). 2006. Draft Water Quality Certification. Priest Rapids Hydroelectric Project, FERC No. 2114. November 2006.

Dolloff, C.A. 1986. Effects of stream cleaning on juvenile coho salmon and Dolly Varden in southeast Alaska. Transactions of the American Fisheries Society 115: 743-755.

Donald, D.B. and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71:238-247.

Downs, C.C., D. Horan, E. Morgan-Harris, and R. Jakubowski. 2006. Spawning demographics and juvenile dispersal of an adfluvial bull trout population in Tresle Creek, Idaho. N. Amer. J. of Fisheries Management 26:190-200.

Dunham, J.B. and G.L. Chandler. 2001. Models to predict suitable habitat for juvenile bull trout in Washington State. Final report to U.S. Fish and Wildlife Service, Lacey, WA.

Dunham, J. B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9(2): 642-655.

Dunham, J. B., M. K. Young, R. E. Greswell, and B. E. Rieman. 2003a. Effects of fire on fish populations: landscape perspectives on persistence of native fishes and nonnative fish invasions. Forest Ecology and Management 178(1-2):183-196.

Dunham, J. B., B. Rieman, and G. Chandler. 2003b. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-904.

Eicher Associates, Inc. 1987. Turbine-related fish mortality: Review and evaluation of studies. Final report, November 1987. Electric Power Research Institute, Palo Alto, CA. EPRI AP-5480, Research Project 2694-4.

Elliott, S.T. 1986. Reduction of a Dolly Varden population and macrobenthos after removal of logging debris. Transactions of the American Fisheries Society 115:392-400.

FERC (Federal Energy Regulatory Commission). 2006. Final Environmental Impact Statement. Priest Rapids Hydroelectric Project, FERC No. 2114. November 2006.

Fish Passage Center. 2001 data. (http://www.fpc.org/)

Fish Passage Center. 2002 data. (http://www.fpc.org/)

Fraley, J.J. and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63(4): 133-143.

Frankham, R. 1995. Effective population size/adult population size ratios in wildlife: a review. Genetical Research 66:95-107.

Franklin, I.A. 1980. Evolutionary changes in small populations. Pages 135-150 *in*: Soulé M. and B.A. Wilcox (eds). Conservation Biology: an evolutionary-ecological perspective. Sinauer Associates, Sunderland, MA.

Franklin, I.R. and R. Frankham. 1998. How large must populations be to retain evolutionary potential? Animal Conservation 1:69-70.

Frissell, C.A. 1997. A spatial approach to species viability: Conservation of fishes in the Columbia River Basin. Biological Station Open File Report Number 101-97. Flathead Lake Biological Station, University of Montana, Polson, MT.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File Report Number 156-99. Flathead lake Biological Station, The University of Montana, Polson, MT.

Gamett, B. 1999. The history and status of fishes in the Little Lost River Drainage, Idaho. Final Report. May 1999. 297pp.

Gerking, Shelby D. 1998. Feeding Ecology of Fish. Academic Press, San Diego. 216pp.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, literature review. Willamette National Forest, Eugene, Oregon.

Goetz, F. 1994. Distribution and juvenile ecology of bull trout (*Salvelinus confluentus*) in the Cascade Mountains. Master's Thesis. Oregon State University, Corvallis, OR.

Graham, P. J., Shepard, B. B., and Fraley, J. J. 1981. Use of stream habitat classifications to identify bull trout spawning areas in streams. Pages 186-190 *in* N. B. Armantrout. Acquisition and utilization of aquatic habitat inventory information. American Fisheries Society. Portland, Oregon.

Grant PUD (Public Utility District No. 2 of Grant County). 2003. Final Application for New License. Priest Rapids Hydroelectric Project (FERC No. 2114). October 29, 2003.

Grant PUD (Public Utility District No. 2 of Grant County). 2005. Priest Rapids Project – Summary Report of Activities. May 2005.

Grant PUD. 2006. Annual Activity Report 2005—May 3, 2004 Biological Opinion. Priest Rapids Hydroelectric Project. February 15, 2005.

Gray, R.H. and D.D. Dauble. 1977. Checklist and relative abundance of fish species from the Hanford Reach of the Columbia River. Northwest Science, 51(3): 208-214.

Gresswell, R.E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society 128:193-221.

Grewe, P.M., N. Billington, and P.D.N. Hebert. 1990. Phylogenetic relationships among members of *Salvelinus* inferred from mitochondrial DNA divergence. Canadian Journal of Fisheries and Aquatic Science 47:984-991.

Haas, G.R., and J.D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Canadian Journal of Fisheries and Aquatic Sciences 48:2191-2211.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17:304-326.

Harvey, B. C., T. E. Lisle, T. Vallier, D.C. Fredley. 1995. Effects of suction dredging on streams: a review and evaluation strategy. Report to Gray Reynolds, deputy chief National Forest System, USDA Forest Service. September 29, 1995.

Hauer, F.R., and J.A. Stanford. 1997. Long-term influence of Libby Dam operation on the ecology of the macrozoobenthos of the Kootenai River, Montana and Idaho. University of Montana, Flathead Lake Biological Station, open file report to the Montana Dept. of Fish, Wildlife and Parks.

Healy, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-184.

Hedrick, P.W. and S. T. Kalinowski. 2000. Inbreeding depression in conservation biology. Annual Review of Ecology and Systematics 31:139-162.

Hillman, T. W. and M. D. Miller. 1993. Estimated abundance and total numbers of chinook salmon and trout in the Chiwawa River, Washington 1992. Report to Chelan County Public Utility District, Washington. DonChapman Consultants inc. Boise, Idaho.

Hillman, T. W. and M. D. Miller. 1994. Estimated abundance and total numbers of chinook salmon and trout in the Chiwawa River Basin, Washington 1993. Report to Chelan County Public Utility District, Washington. Don Chapman Consultants inc. Boise, Idaho.

Hillman, T. W. and M. D. Miller. 1995. Abundance and total numbers of chinook salmon and trout in the Chiwawa River Basin, Washington 1994. Report to Chelan County Public Utility District, Washington. Don Chapman Consultants inc. Boise, Idaho.

Hindes, R. 1994. Wenatchee River Watershed Ranking Project. Chelan County Conservation District, Wenatchee, WA.

Hoelscher, B. and T.C. Bjornn. 1989. Habitat, density and potential production of trout and char in Pend O'reille Lake tributaries. Project F-71`-R-10, Subproject III, Job No. 8.Idaho Department of Fish and Game, Boise, ID.

House, R.A., and P.L. Boehne. 1987. The effect of stream cleaning on salmonid habitat and populations in a coastal Oregon drainage. Western Journal of Applied Forestry 2:84-87.

Howell, P.J. and D.V. Buchanan, eds. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Jacobs Civil Inc. 2003. Fish passage alternatives study. Priest Rapids Hydroelectric Project. Prepared for Public Utility District No. 2 of Grant County. January 31, 2003.

Jakober, M. 1995. Autumn and winter movement and habitat use of resident bull trout and westslope cutthroat trout in Montana. M.S. Thesis, Montana State University, Bozeman, MT.

Kanda, N., R., Leary, and F. W. Allendorf. 1997. Population genetic structure of bull trout in the upper Flathead River drainage. Pages 299-308 *in* W.C. Mackay, M.K. Brewin and M. Monita (eds). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Alberta, Canada.

Klarin, P.N., K.M. Branch, M.J. Hershman and T.F. Grant. 1990. An analytical review of state and federal coastal management Systems and Policy Responses to Sea Level Rise. Report to Washington State Department of Ecology, Olympia, Washington.

Kramer K. 2003. Management Brief: Lower Skagit Bull Trout, Age and Growth Information Developed From Scales and Collected From Anadromous and Fluvial Char. January 2003. Washington Department of Fish and Wildlife. 18p.

Kraemer, C. 1994. Some observations on the life history and behavior of the native char, Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) of the North Puget Sound Region. Wash. Dept. of Wildlife. Draft.

Kreiter, S. 2001. Bull trout study updates. Chelan PUD, Wenatchee, Washington.

Kreiter, S. 2002. Bull trout study updates. Chelan PUD, Wenatchee, Washington.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241: 1455-1460.

Leary, R. F., F. W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology 7(4): 856-865.

Leary, R.F. and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720.

Leathe, S.A. and P. Graham. 1982. Flathead Lake Fish Food Habits Study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study.

Lisle, T.E. 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Whales Island, Southeast Alaska. North American Journal of Fisheries Management 6: 538-550.

Lynch, M. and R. Lande. 1998. The critical effective size for a genetically secure population. Animal Conservation 1:70-72.

Martin, S.B., and W.S. Platts. 1981. Influence of forest and rangeland management on anadromous fish habitat in western North America, effects of mining. U.S. Forest Service, Intermountain Forest and Range Experiment Station, General Technical Report PNW-119.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Report prepared for the Montana Bull Trout Restoration Team, Helena, MT.

McCullough, D., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Summary of technical literature examining the physiological effects of temperature on salmonids. Issue paper 5. Prepared as part of the EPA Region 10 water quality criteria guidance development project. Seattle, WA.

McKinley, R.S. and P.H. Patrick. 1986. Use of behavioral stimuli to divert sockeye salmon smolts at the Seton Hydroelectric station, British Columbia. In: W.C. Micheletti, [ed] Proceedings of the electric power Research Institute Conference on Fish Protection at Steam and Hydro Plant, San Francisco, California, Oct. 28-30. P. 453-463.

McMahon, F., A. Zale, J. Selong, and R. Barrows. 2001. Growth and survival temperature criteria for bull trout. Annual report 2000 (year three). National Council for Air and Stream Improvement. 34 p.

McPhail J. D. and R. Carveth. 1992. A foundation for conservation: the nature and origin of the freshwater fish fauna of British Columbia. Fish Museum, Department of Zoology, University of British Columbia. Vancouver, B.C., Canada.

McPhail, J.D. and C. Murray. 1979. The early life history of Dolly Varden *(Salvelinus malma)* in the upper Arrow Lakes. Report to the British Columbia Hydro and Power Authority and Kootenay Department of Fish and Wildlife. University of British Columbia, Department of Zoology and Institute of Animal Resources, Vancouver, B.C. (As referenced in USDI, 1997).

McPhail, J.D. and J.S.D. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries management report no. 104. University of British Columbia. Vancouver, B.C.

Mendel, G. and D. Milks. 1995. Upstream passage and spawning of fall Chinook salmon in the Snake River. Washington Department of Fish and Wildlife, Hatcheries Program, Olympia, Washington.

Miller, M. D. and T. W. Hillman. 1994. Effects of Hydroelectric Facilities on Bull Trout. Report to Pacific Northwest Utilities Conference Committee, Portland, OR. Don Chapman Consultants. June 1, 1994.

Miller, P.S. and R.C. Lacy. 1999. VORTEX: a stochastic simulation of the extinction process. Version 8 user's manual. Conservation breeding specialists group (SSC/IUCN), Apple Valley, MN.

Mongillo, P. E. 1993. The distribution and status of bull trout/Dolly Varden in Washington State. Washington Department of Wildlife. Fisheries Management Division, Report 93-22. Olympia, Washington. 45 pp.

Moore, H.L. and H.W. Newman. 1956. Effects of sound waves on young salmon. U.S. Fish and wildlife Service. Special Scientific Report 172. 19 p.

Murphy, M.L., J. Heifetz, S.W. Johnson, K.V. Koski and J.F. Thedinga. 1986. Effects of clear-cut logging with and without buffer strips on juvenile salmonids in Alaskan streams. Canadian Journal of Fisheries and Aquatic Sciences 43: 1521-1533.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska–requirements for protection and restoration. NOAA Coastal Ocean Program Decision Analysis Series Number 7. NOAA Coastal Office, Silver Springs, Maryland. 156 p.

Myrick, C.A. 2003. Bull Trout temperature thresholds peer review summary. USFWS, Lacey WA.

Nelson, M., T. McMahon, and R. Thurow. 2002. Decline of the migratory form in bull charr, *Salvelinus confluentus*, and implications for conservation. Environmental Biology of Fishes, 64:321-332, 2002.

Nightingale, B., and C. A. Simenstad. 2001. Overwater structures: marine issues. White Paper, Res. Proj. T1803, Task 35, Wash. State Dept. Transportation, Washington Sate Trans. Center (TRAC), Seattle, WA. 133 pp + appendices.

NOAA (National Oceanic and Atmospheric Administration). 2001. The Net-pen Salmon Farming Industry in the Pacific Northwest. NOAA Technical Memorandum NMFS-NWFSC-49. U.S. Department of Commerce. Seattle, WA. 125 pp.

NOAA (National Oceanic and Atmospheric Administration). 2003a. Biological Opinion. Unlisted Species Analysis, and Magnuson-Stevens Fishery Conservation And Management Act Consultation for Proposed Issuance of a Section 10 Incidental Take Permit to Public Utility District No. 1 of Chelan County for the Rocky Reach Hydroelectric Project (FERC No. 2145) Anadromous Fish Agreement and Habitat Conservation Plan and Construction of a Small Turbine Unit in the Attraction Water Conduit of the Adult Fishway. ESA/EFH Tracking Number F/NWR/ 2002/01897. August 12, 2003.

NOAA (National Oceanic and Atmospheric Administration). 2004. Biological Opinion. Effects to listed species from Operations of the Federal Columbia River Power System. . U. S. Department of Commerce. National Marine Fisheries Service.

NOAA (National Oceanic and Atmospheric Administration). 2000. Report for 2000 field collection for research project: Utilization of nutrients from spawning salmon by juvenile chinook and steelhead in the Columbia and Snake River basins. U. S. Department of Commerce. National Marine Fisheries Service.

NPPC (Northwest Power Planning Council). 2001a. Draft Methow subbasin summary. Prepared by J. Foster.

NPPC (Northwest Power Planning Council). 2001b. Draft Entiat subbasin summary. Prepared by L. Berg and S. Matthews.

NPPC (Northwest Power Planning Council). 2001c. Draft Wenatchee subbasin summary. Prepared by L. Berg and D. Lowman.

Parametrix, Inc. 2000. Anadromous Fish Agreements and Habitat Conservation Plans for the Wells, Rocky Reach, and Rock Island Hydroelectric Projects. Draft Environmental Impact Statement prepared for the National Marine Fisheries Service in cooperation with Public Utility District No. 1 of Douglas County, Public Utility District No. 1 of Chelan County, and Federal Energy Regulatory Commission. November 2000.

Pearsons, Todd N., Geoffrey A McMichael, Kennth D. Ham, Eric L. Bartrand, Anthony L. Fritts, Charles W. Hopley - Washington Department of Fish and Wildlife, Yakima River Species Interactions Studies, Progress Report 1995-1997, Report to Bonneville Power Administration, Contract No. 1996BI64878, Project No. 199506402, 311 electronic pages (BPA Report DOE/BP-64878-6)

Pfeifer, B., J.E. Hagen, D. Weitkamp, D.H. Bennett, J. Lukas, and T. Dresser. 2001. Evaluation of fish species present in the Priest Rapids project area, Mid-Columbia River, Washington, U.S.A. Final completion report to Grant County Public Utility District No. 2, Ephrata, Washington.

Pfrender, M.E., Spitze, K., Hicks, J., Morgan, K., Latta, L., and M. Lynch. 2000. Lack of concordance between genetic diversity estimates at the molecular and quantitative-trait levels. Conservation Genetics 1:263-269.

Phillips, R.B., S.L. Sajdak, and M.J. Domanico. 1995. Relationships among charrs based on DNA sequences. Nordic Journal of Freshwater Research 71:378-391.

Pleyte, Kay A., Shan D. Duncan, and Ruth B. Phillips. 1992. Evolutionary relationships of the salmonid fish genus *Salvelinus* inferred from DNA sequences of the first internal transcribed spacer (ITS 1) of ribosomal DNA. Molecular Phylogenetics and Evolution, 1(3):223-230.

Popper, A.N. and T.J. Carlson. 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127(5): 673-707.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game, Boise, ID.

Pratt, K.L. 1992. A review of bull trout life history. *In*: P. J. Howell and D. V. Buchanan (eds.). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. Pp. 5-9.

Pratt, K.L. and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in Lake Pend Oreille and the lower Clark Fork River: (draft report) Prepared for the WWPC, Spokane, WA.

Proebstel, D.S., R.J. Behnke, and S.M. Noble. 1998. Identification of salmonid fishes from tributary streams and lakes of the mid-Columbia basin. Joint publication by U.S. Fish and Wildlife Service and World Salmonid Research Institute, Colorado State University.

PSWQAT (Puget Sound Water Quality Action Team). 2000. 2000 Puget Sound Update: Seventh Report of the Puget Sound Ambient Monitoring Program. Puget Sound Water Quality Action Team. Olympia, Washington. Literature References.

Quigley, T.M. and S.J. Arbelbide, tech. editors. 1997. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins: volume III. General Technical Report PNW- GTR-405. U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management

Ratcliff, D.E. 1992. Bull Trout Investigations in the Metolius River- Lake Billy Chinook System. Pages 37-44 in Howell, P.J. and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon (As referenced in USDI, 1997).

Reed, D. H., and R. Frankham. 2001. How closely correlated are molecular and quantitative measures of genetic variation? A meta-analysis. Evolution 55:1095-1113.

Reiss, K.Y. 2003. Genetic variability within bull trout (*Salvelinus confluentus*) populations in the Yakima River basin. M.S. Thesis, Central Washington University, WA. 62 pp.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. MS thesis, Montana State University, Bozeman, MT.

Riehle, M.D. 1993. Metolius Basin Water Resources Monitoring, Progress Report 1988-1992. U.S. Department of Agriculture, Forest Service, Deschutes National Forest, Bend, Oregon. (As referenced in USDI 1997).

Riehle, M., W. Weber, A.M. Stuart, S.L. Thiesfeld and D.E. Ratliff. 1997. Progress report of the multi-agency study of bull trout in the Metolius River system, Oregon. *In*: Friends of the Bull Trout Conference Proceedings, May 5-7, 1994. W.C. MacKay, M.D. Brewin, M. Monita, Co-editors. The Bull Trout Task Force. Calgary, Alberta. Pages 137-144.

Rieman, B.E. and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764.

Rieman, B., and J. Clayton. 1997. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22(11):6-15.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rieman, B.E. and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society. Vol. 124 (3): 285-296.

Rieman, B.E. and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997a. Distribution, status and likely future trends of bull trout within the Columbia River and Klamath Basins. North American Journal of Fisheries Management 17(4): 1111-1125.

Rieman, B., Lee, D., Chandler, G. and D. Myers. 1997b. Does wildfire threaten extinction for salmonids? Responses of redband trout and bull trout following recent large fires on the Boise National Forest. Pgs. 47-57 *in*: J. Greenlee (ed.), Proceedings – Fire effects on rare and endangered species and habitats conference, Nov. 13 - 16, 1995. Coeur d'Alene, Idaho.

Rieman, B.E. and J. R. Lukens. 1979. Lake and reservoir investigation: Priest Lake creel census. Job Completion Report. Project F-73-R-1, Subproject III, Study, I, Job I. Boise, ID. Idaho Department of Fish and Game. 105 pp.

Roberts, B.C, and R.G. White. 1992. Effects of angler wading on survival of trout eggs and pre-emergent fry. North American Journal of Fisheries Management 12:450-459.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.H. Lachner, R.N. Lea, and W.B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication 12, Bethesda, Maryland.

Rode, M. 1990. Bull trout, *(Salvelinus confluentus)* Suckley, in the McCloud River: status and recovery recommendations. Administrative Report Number 90-15. California Department of Fish and Game, Sacramento, CA.

Ryan, B. A., E. M. Dawley, and R. A. Nelson. 2000. Modeling the effects of supersaturated dissolved gas on resident aquatic biota in the mainstem Snake and Columbia rivers. North American Journal of Fisheries Management 20:192-2002.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho.

Schmetterling, D.A. and M.H. Long. 1999. Montana Anglers' Inability to Identify Bull Trout and Other Salmonids. Fisheries 24(7):24–27.

Sedell, J.R. and F.H. Everest. 1991. Historic changes in poll habitat for Columbia River Basin salmon under study for TES listing. Draft USDA Report. Pacific Northwest Research Station. Corvallis, OR.

Selong, J. H., T. E. McMahon, A. V. Zale, and F. T. Barrows. 2001. Effect of temperature on growth and survival of bull trout, with application of an improved method for determining thermal tolerance in fishes. Transactions of the American Fisheries Society 130:1026-1037.

Service (U.S. Fish and Wildlife Service). 1992. Production and Habitat of Salmonids in Mid-Columbia River Tributary Streams: USFWS, Monograph I, 1992. Mid-Columbia River Fish Resource Office, Leavenworth, WA.

Service (U.S. Fish and Wildlife Service). 1997. An analysis of fish populations in Icicle Creek, Trout Creek, Jack Creek, Peshastin Creek, Ingalls Creek, and Negro Creek, Washington, 1994 and 1995. Mid-Columbia River Fishery Resource Office, Leavenworth, WA. Prepared by B. Kelly-Ringel.

Service (United States Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Endangered species consultation handbook.

Service (U.S. Fish and Wildlife Service). 1999a. Bull trout spawning ground surveys of Panther, Mill and Nason Creeks, Washington, 1998. Mid-Columbia River Fishery Resource Office, Leavenworth, Washington. Prepared by B. Kelly-Ringel.

Service (U.S. Fish and Wildlife Service). 1999b. Summary of snorkel surveys in Icicle Creek in the large pool adjacent to the Leavenworth National Fish Hatchery. Mid-Columbia River Fishery Resource Office, Leavenworth, Washington. Prepared by B. Kelly-Ringel.

Service (U.S. Fish and Wildlife Service). 1999c. Survey of fish populations in French Creek, Washington. Mid-Columbia River Fishery Resource Office, Leavenworth, Washington. Prepared by B. Kelly-Ringel and L. Murphy.

Service (U.S. Fish and Wildlife Service). 1999d. A Framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale: matrix of pathways and indicators.

Service (United States Fish and Wildlife Service). 2000a. Bull trout occurrence and habitat selection. Western Washington Fish and Wildlife Office, Lacey, Washington. October 23, 2000.

Service (U.S. Fish and Wildlife Service). 2000b. Wenatchee basin bull trout radio telemetry study updates. Mid-Columbia River Fishery Resource Office, Leavenworth, Washington. Prepared by B. Kelly-Ringel and J. De La Vergne.

Service (U.S. Fish and Wildlife Service). 2000c. Biological Opinion. Effects to listed species from Operations of the Federal Columbia River Power System. U.S. Fish and Wildlife Service Regions 1 and 6, Portland, Oregon and Denver, Colorado.

Service (U.S. Fish and Wildlife Service). 2001. Wenatchee basin bull trout radio telemetry study updates. Mid-Columbia River Fishery Resource Office, Leavenworth, Washington. Prepared by B. Kelly-Ringel and J. De La Vergne.

Service (United States Fish and Wildlife Service). 2002. Bull trout (*Salvelinus confluentus*) draft recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 137 pp.

Service (U.S. Fish and Wildlife Service). 2002c. Icicle Creek Restoration Project, Final Environmental Impact Statement.

Service (United States Fish and Wildlife Service). 2004a. Biological and Conference Opinion. License amendments to incorporate the Rocky Reach, Rock Island, and Wells Anadromous Fish Agreements and Habitat Conservation Plans. U.S. Fish and Wildlife Service, Central Washington Field Office, Wenatchee, Washington. May 12, 2004. 129p.

Service. (U.S. Fish and Wildlife Service). 2004b. Biological Opinion for the Cushman Hydroelectric Project (P-460). May 12, 2004. U.S. Fish and Wildlife Service, Region 1, Western Washington Fish and Wildlife Office, Lacey.

Service (U.S. Fish and Wildlife Service). 2004c. Biological Opinion on the USDA Forest Service 2004-2008 fish passage restoration program in Washington and eastern Oregon. USDI Fish and Wildlife Service, Portland, OR and Lacey WA.

Service (U.S. Fish and Wildlife Service). 2004d. Administrative record: Mainstem Columbia River critical habitat documentation. USDI Fish and Wildlife Service, Portland, OR. 24pp.

Service (U.S. Fish and Wildlife Service). 2005a. Endangered and threatened wildlife and plants: designation of critical habitat for the bull trout; final rule. Federal Register. Vol. 70, No. 185: 56212-56311.

Service (U.S. Fish and Wildlife Service). 2005b. Bull trout core area templates – completed by core area analysis. W. Fredenberg and J. Chan, *editors*. USDI Fish and Wildlife Service, Portland, OR. 660 pp.

Service (U.S. Fish and Wildlife Service). 2006. Biological Opinion for the Rock Creek Mine. U.S. Fish and Wildlife Service, Region 6, Helena, MT.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

Service (U.S. Fish and Wildlife Service). (Service 2006b). Washington State Forest Practices Habitat Conservation Plan Biological Opinion (FPHCPBO). U.S. Fish and Wildlife Service, Region 1, Lacey, WA.

Sexauer, H. M. and P. W. James. 1993. A survey of the habitat use by juvenile and pre-spawning adult bull trout, *Salvelinus confluentus*, in four streams in the Wenatchee National Forest. Ellensburg, WA, Central Washington University.

Shepard, B., S.A. Leathe, T.M. Weaver, and M.D. Enk. 1984. Monitoring levels of fine sediment within tributaries to Flathead Lake, and impacts of fine sediment on bull trout recruitment. Proceedings of the Wild Trout III Symposium. Yellowstone National Park, Wyoming. On file at: Montana Department of Fish Wildlife, and Parks, Kalispell, Montana.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, ID.

Smith, H.A. and P.A. Slaney. 1979. Age, growth, survival and habitat of anadromous Dolly Varden (*Salvelinus malma*) in the Keogh River, British Columbia. British Columbia Ministry of Environment. Fisheries Management Report. Vancouver, B.C. 56 p.

Soulé, M.E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. Pages 151-169 *in*: Soulé, M.E. and B.A. Wilcox (eds). Conservation biology: an evolutionary-ecological perspective. Sinauer, Sunderland, MA.

Soulé, M.E. 1987. Viable Populations for Conservation. Cambridge University Press, Cambridge, UK. 206pp.

Spence, B. C., G. A. Lomnicky, R. M. Hughs, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon.).

Spruell, P., and F. Allendorf. 1997. Nuclear DNA analysis of Oregon bull trout. Final report to the Oregon Department of Fish and Wildlife. Division of Biological Sciences, University of Montana.

Spruell, P. and Maxwell, B.A. 2002. Report on the samples taken from Early Winters Creek and Goat Creek in the Methow River. University of Montana, Missoula, MT.

Spruell, P., B. Rieman, K. Knudsen, F. Utter and F. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of bull trout populations. Ecology of Freshwater Fish 1999: 8: 114-121.

Spruell, P., Hemmingsen, A.R., Howell, P.J., Kanda, N., and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4:17-29.

Stevens, D. G., A. V. Nebeker, and R. J. Baker. 1980. Avoidance responses of salmon and trout to air-supersaturated water. Transactions of the American Fisheries Society. 109:751-754.

Stuehrenberg, Lowell C., G. A. Swan, L. K. Timme, P. A. Ocker, B. M. Eppard, R. N. Iwamoto, B. L. Iverson, and B. P. Sandford. 1995. Migrational characteristics adult spring, summer, and fall Chinook salmon passing through reservoirs and dams, of the Mid-Columbia River. Coastal Zone and Estuarine Studies Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington. 117p.

Swanberg, T. 1997. Movements of and habitat use by fluvial bull trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society. 126: 735-746.

Taylor, E., S. Pollard and D. Louie. 1999. Mitochondrial DNA variation in bull trout (*Salvelinus confluentus*) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170.

Thom, R.M. 1992. Accretion rates of low intertidal salt marshes in the Pacific Northwest. Wetlands 12:147-156.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Thorpe, J.E. 1994. Salmonid Fishes and the Estuarine Environment. Estuaries. 17 (1A): 76-93.

USDA (United States Department of Agriculture. 1995. Decision Notice, Environmental Assessment, and Finding of No Significant Impact for the Inland Native Fish Strategy: Interim strategies for managing fish-producing watersheds in eastern Oregon and Washington, Idaho, western Montana and portions of Nevada. Forest Service. (INFISH)

USDA and USDI (United States Department of Agriculture and United States Department of the Interior). 1995. Decision Notice, Environmental Assessment, and Finding of No Significant Impact for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in eastern Oregon, Washington, Idaho, and Portions of California. Forest Service and Bureau of Land Management. (PACFISH)

USDI (United States Department of Interior). 1997. Endangered and threatened wildlife and plants; proposal to list the Klamath River population segment of bull trout as an endangered species and Columbia River population segment of bull trout as a threatened species. Fish and Wildlife Service. June 13, 1997. Federal Register 62(114): 32268-32284.

USDI (United States Department of Interior). 1998a. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Klamath River and Columbia River Distinct Population Segments of Bull Trout. June 10, 1998. Federal Register 63(111):31647-31674.

USDI (United States Department of Interior). 1998b. Candidate and listing priority assignment form: bull trout in the Klamath River and Columbia River Bull Trout Population Segments.

USDI (United States Department of Interior). 2002. Endangered and threatened wildlife and plants; Proposed designation of critical habitat for the Klamath River and Columbia River distinct population segments of bull trout and notice of availability of the draft recovery plan; proposed rule and notice. November 29, 2002. Federal Register, Vol. 67: 71236.

USFS (U.S. Forest Service). 1993. Beaver Creek Stream Survey Report. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (U.S. Forest Service). 1994. Chewuch River Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (U.S. Forest Service). 1995a. Twisp River Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (U.S. Forest Service). 1995b. Wolf Creek Stream Survey Report. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (U.S. Forest Service). 1995c. Lake Creek Stream Survey Report. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (U.S. Forest Service). 1995d. Goat Creek Watershed Analysis and Interim Late Successional Reserve Assessment. Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (U.S. Forest Service). 1995e. Inland Native Fish Strategy Environmental Assessment. Forest Service; Intermountain, Northern, and Pacific Northwest Regions.

USFS (United States Forest Service). 1996a. Watershed assessment: Entiat analysis area. Wenatchee National Forest. Wenatchee, Washington.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

USFS (U.S. Forest Service). 1996b. Gold Creek Stream Survey. Wenatchee National Forest, Wenatchee, WA.

USFS (U.S. Forest Service). 1996c. Nason Creek Watershed Analysis Environmental Assessment. Wenatchee National Forest, Wenatchee, WA.

USFS (U.S. Forest Service). 1998a. Upper Methow Watershed Analysis, Okanogan National Forest, Methow Valley Ranger District, Winthrop, WA.

USFS (United States Forest Service). 1998b. Biological assessment for steelhead, spring chinook, bull trout, and cutthroat trout for the proposed actions of the Mud-Potato road relocation project on the Entiat Ranger District of the Wenatchee National Forest Chelan County, Washington. Wenatchee National Forest, Wenatchee, Washington.

USFS (U.S. Forest Service). 1998c. Biological assessment for steelhead, spring chinook, bull trout, and cutthroat trout for the proposed actions of livestock grazing on the Entiat Ranger District of the Wenatchee National Forest, Wenatchee, WA

USFS (U.S. Forest Service). 1998d. Peshastin Stream Survey. Wenatchee National Forest, Wenatchee, WA.

USFS (United States Forest Service). 1999a. Lost River and Robinson Creek Watershed Analysis. Okanogan National Forest, Methow Valley Ranger District, Winthrop, Washington.

USFS (United States Forest Service). 1999b. Mainstem Wenatchee River watershed assessment. Wenatchee National Forest, Wenatchee, Washington.

USFS (U.S. Forest Service). 1999d. Peshastin Creek Watershed Assessment. Leavenworth Ranger District. Wenatchee National Forest, Wenatchee, WA.

USFS (U.S. Forest Service). 2001a. Upper Methow Watershed Aquatic Species Biological Assessment. Okanogan-Wenatchee National Forests. Prepared by J. Haskins and D. Hopkins.

USFS (U.S. Forest Service). 2001b. Lower Methow Watershed Biological Assessment. Okanogan-Wenatchee National Forests. Prepared by B. Baer and J. Molesworth.

USFS (U.S. Forest Service). 2002. Road densities in the Wenatchee, Entiat, and Methow Basins. Corporate database info.

USFS (U.S. Forest Service). 2004. Comparison of Yakima Basin allele frequencies to Spruell (2003) samples in the northwest: e-mail and file from Yuki Reiss, Wenatchee National Forest, Wenatchee, WA.

USFS (U.S. Forest Service) and BLM (Bureau of Land Management). 1994. Record of Decision of Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl; Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted owl.

VanDerwalker, J.G. 1967. Response of salmonids to low frequency sound. In: W.N. Tavolga [Ed] Marine Bio-acounstics. Volume II. Pergamon Press. Oxford, England. P. 45-58.

Volk, E.C. 2000. Using otolith strontium to infer migratory histories of bull trout and Dolly Varden from several Washington state rivers. Submitted to Olympic National Park in fulfillment of Contract # 2550041. Washington Department of Fish and Wildlife, Olympia.

Wagner, P. and T. Hillson. 1993. 1991 Evaluation of adult fallback through the McNary Dam juvenile bypass system. Contract DACW68-82-C-0077. To the Walla Walla District, Corps of Engineers. By Washington Department of Fish and Wildlife. Olympia, Washington.

Waples, R.S. 2002. Definition and estimation of effective population size in the conservation of endangered species. Pages 147-168 *in* S.R. Beissinger and D.R. McCullough (eds). Population Viability Analysis. The University of Chicago Press, Chicago, IL.

WDFW (Washington Department of Fish and Wildlife). 1992. Draft management guide for the bull trout Salvelinus confluentus (Suckley) on the Wenatchee National Forest. Washington Department of Wildlife. Wenatchee, Washington. Prepared by L. Brown.

WDFW (Washington Department of Fish and Wildlife). 1997. Washington Department of Fish and Wildlife hatcheries program. Operations program - Lewis river complex for January 1, 1997 to December 31,1997. Washington Department of Fish and Wildlife, Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 1998. Washington State salmonid stock draft inventory: bull trout/Dolly Varden. Washington Department of Fish and Wildlife, Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 1999a. Collection of Spring Chinook Salmon *Oncorhynchus tshawytscha* Eggs from Nason Creek and White River During 1999. Prepared by K. Peterson and B.Dymowska. WDFW, Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 1999b. Gold and Fish: Rules and Regulations for Mineral Prospecting and Placer Mining in Washington State.

WDFW (Washington Department of Fish and Wildlife). 2006a. Draft radio-telemetry report on bull trout movements in the Yakima Basin. Washington Department of Fish and Wildlife, Yakima, WA.

WDFW (Washington Department of Fish and Wildlife). 2006b. Microsatellite analysis of Yakima basin bull trout (*Salvelinus confluentus*). Washington Department of Fish and Wildlife, Olympia, WA. 39 pp.

WDG (Washington Department of Game). 1984. Lake Chelan fisheries investigations in cooperation with Chelan County Public Utility District, Chelan County WA. Prepared by L. Brown.

Weaver, T.M. and R.G. White. 1985. Coal Creek Fisheries monitoring study No. III. Quarterly progress report. U.S. forest Service, Montana State Cooperative Fisheries Research Unit, Bozeman, MT.

Weaver, T. M. 1992. Status of the adfluvial bull trout populations in Montana's Flathead drainage: the good, the bad, and the unknown. P. 449 *In*: Mackay, W. C., M. K. Brewin, M. Monita (eds.) Friends of the bull trout conference proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary.

Weitkamp, D. E. and M. Katz. 1980. A review of dissolved gas super-saturation literature. Transactions of the American Fisheries Society. 109:659-702.

Weitkamp, D. E., R. D. Sullivan, T. Swant, and J. Dosantos. 2003a. Gas bubble disease in resident fish of the Lower Clark Fork River. Transactions of the American Fisheries Society. 132:865-876, 2003.

Weitkamp, D. E., R. D. Sullivan, T. Swant, and J. Dosantos. 2003b. Behavior of resident fish relative to total dissolved gas supersaturation in the Lower Clark Fork River. Transactions of the American Fisheries Society 138:856-864, 2003.

Whitesel, T.A. and 7 coauthors. 2004. Bull Trout Recovery Planning: A review of the science associated with population structure and size. Science Team Report # 2004-01. U.S. Fish and Wildlife Service, Region 1 Portland, Oregon, USA.

Williams, R. N., R. P. Evans, and D. K. Shiozawa. 1995. Mitochondrial DNA diversity in bull trout from the Columbia River basin. Idaho Bureau of Land Management Technical Bulletin No. 95-1.

Wright, S. 1931. Evolution of Mendelian populations. Genetics 16:97-159.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

WSCC (Washington State Conservation Commission). 1999. Salmon and steelhead habitat limiting factors. Water Resource Inventory Area 46: Methow Watershed. Washington State Conservation Commission, Olympia, Washington.

WSCC (Washington State Conservation Commission). 2000. Salmon and Steelhead Habitat Limiting Factors (Water Resource Inventory Area 48 - (Methow Watershed). Prepared by C. Andonaegui.

WSCC (Washington State Conservation Commission). 2001. Salmon and steelhead habitat limiting factors. Water Resource Inventory Area 45: Wenatchee Watershed. Washington State Conservation Commission, Olympia, Washington.

WSOFM (Washington State Office of Financial Management). 2000. Washington State Census. www.ofm.wa.gov/census2000.

Wyman, K. H. 1975. Two unfished salmonid populations in Lake Chester Morse. M.S. Thesis, University of Washington. Seattle, Washington.

Ziller. 1992. Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon. *In*: Howell, P.J. and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Personal Communication

Brenkman, S. and S. C. Corbett. Fisheries Biologists, Olympic National Park, Port Angeles, Washington,

Chan, J., USFWS, Fish and Wildlife Biologist, 510 Desmond Drive SE, Suite 102, Lacey, Washington, 98503-1263

De La Vergne, J., USFWS, Fish and Wildlife Biologist, Central Washington Field Office, 215 Melody Lane, Suite 119, Wenatchee, Washington, 98801

De La Vergne, J. U.S. Fish and Wildlife Service, Wenatchee, Washington. 2001.

De La Vergne, J. U.S. Fish and Wildlife Service, Wenatchee, Washington. 2002.

De La Vergne, J. U.S. Fish and Wildlife Service, Wenatchee, Washington. 2003.

Dresser, T. Public Utility District No. 2 of Grant County, Ephrata, Washington. 2000.

Dresser, T. Public Utility District No. 2 of Grant County, Ephrata, Washington. 2002.

Kraemer, C. WDFW, Fisheries Biologist, 16018 Mill Creek Boulevard Mill Creek, Washington 98012-1296

Kelly-Ringel, B. U.S. Fish and Wildlife Service, Leavenworth, Washington. 2001.

MacDonald, K. U.S. Forest Service, Wenatchee, Washington. 2001.

Pocke, D. Public Utility District No. 2 of Grant County, Ephrata, Washington. 2006

Wells, N. U.S. Forest Service, Okanogan, Washington. 2000.

Werdon, S. U.S. Fish and Wildlife Service, Reno, Nevada. 1998

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

In litt. References

Brenkman and Corbett, *in litt.*, 2003. Radio-telemetry Study Report. Olympic National Park, National Park Service.

Partridge, M. 2001. Article in the Wenatchee World. Staff writer.

USFS (U.S. Forest Service). 1992. Beaver Creek Stream Surveys Report.

USFWS (U.S. Fish and Wildlife Service). 1998a. Peshastin Creek stream survey report, 1997. Leavenworth, WA. Prepared by M. Cappellini.

USFWS (U.S. Fish and Wildlife Service). 1998b. Informal Consultation Letter (1-3-98-I-394 through 398) for livestock Grazing in Five Watersheds in the Methow: Wolf Creek, Twisp River, Chewuck River, Upper Methow River, Lower Methow River within the Northwest Forest Plan Area. USFWS, Wenatchee Office, Wenatchee, WA.

USFWS (U.S. Fish and Wildlife Service). 2002. Survey of fish populations in Chiwaukum Creek, 2001. Leavenworth, WA. Prepared by B. Kelly-Ringel.

Appendix A

Maps

Figure A-1. As part of the Columbia River Distinct Population Segment the Draft Upper Columbia River Bull Trout Recovery Plan Unit is shown below (Service 2002)

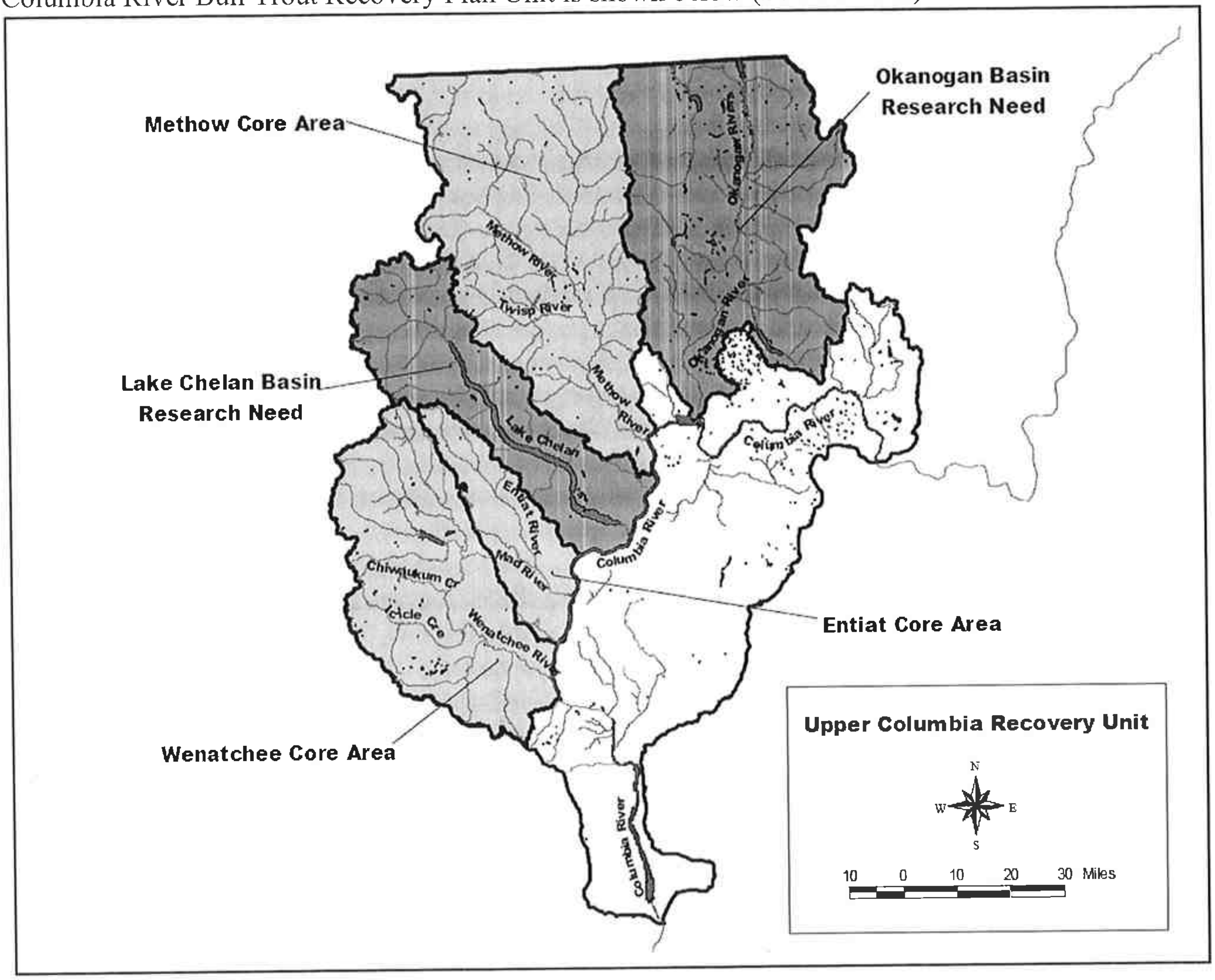


Figure A-2. As part of the Columbia River Distinct Population Segment the Draft Middle Columbia River Bull Trout Recovery Plan Unit is shown below (Service 2002)

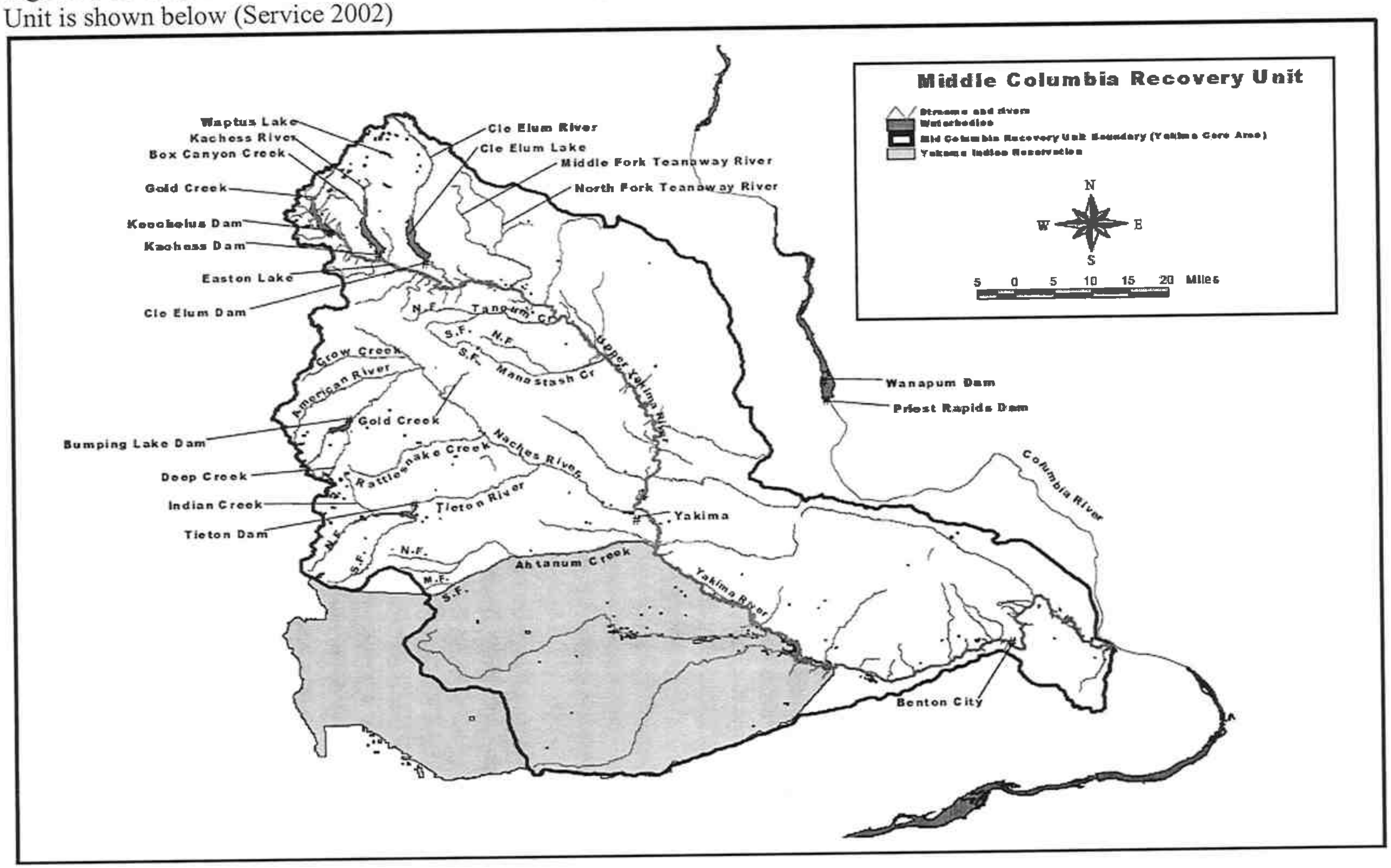


Figure A-3. Map of Bull Trout Critical Habitat in the Yakima Basin: Unit 20-Middle Columbia River Basin (Service 2005)

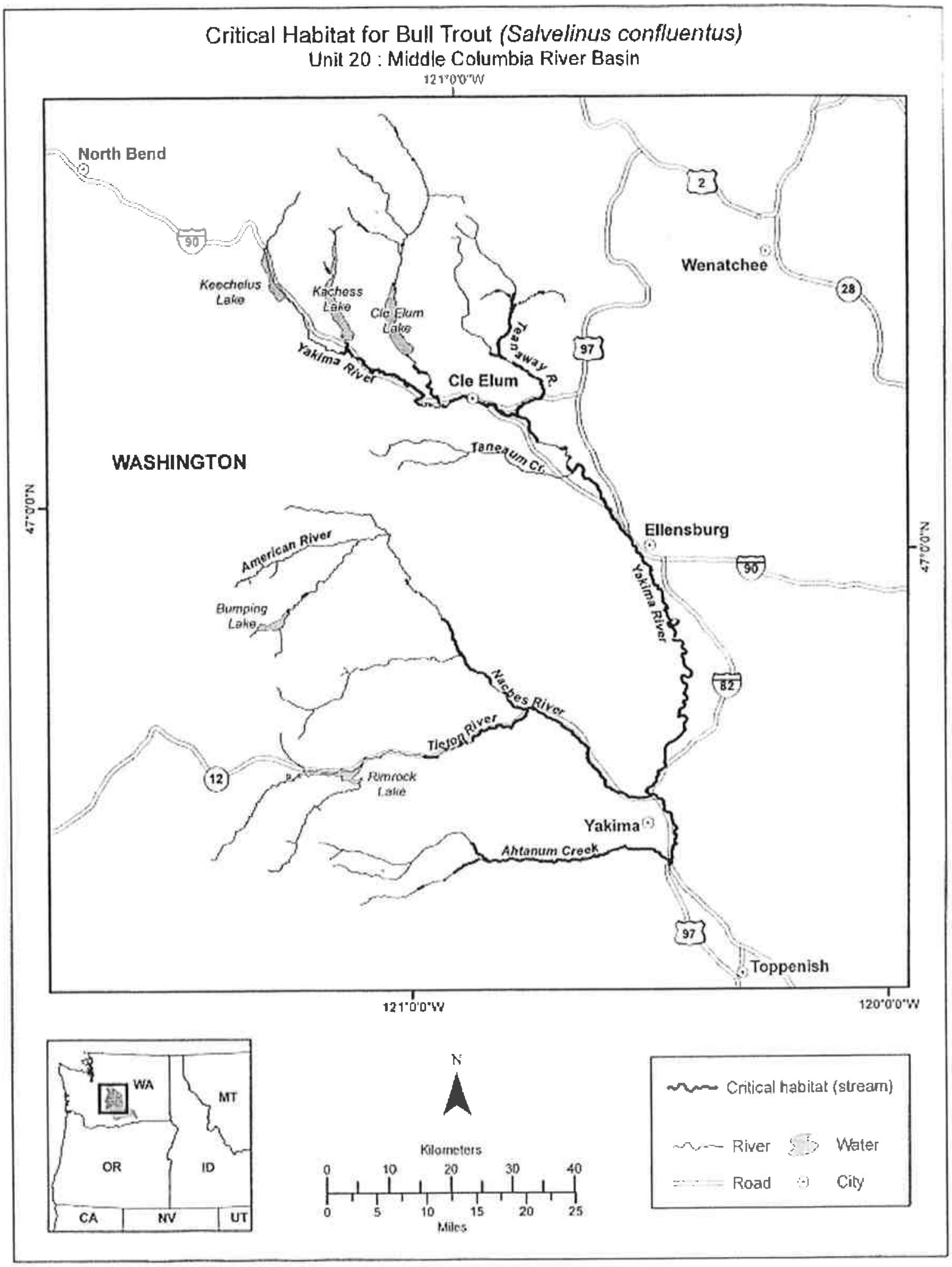


Figure A-4. List of Waterbodies designated as Critical Habitat in Unit 20- Middle Columbia River Basin (Service 2005).

(20) Unit 20: Middle Columbia River Basin.

(i) Critical habitat is designated on the water bodies listed in the following table:

Name	Stream end-point latitude	Stream end-point longitude	Stream end-point latitude or lake center	Stream end-point longitude or lake center
Ahtanum Creek	46.529 N.	120.472 W.	46.523 N.	120.853 W.
Box Canyon Creek	47.361 N.	121.243 W.	47.377 N.	121.257 W.
Bumping River	46.989 N.	121.094 W.	46.831 N.	121.377 W.
Cle Elum River	47.177 N.	120.990 W.	47.589 N.	121.161 W.
Cooper River	47.391 N.	121.098 W.	47.456 N.	121.213 W.
Gold Creek	47.390 N.	121.382 W.	47.475 N.	121.316 W.
Jack Creek	47.319 N.	120.855 W.	47.334 N.	120.742 W.
Jungle Creek	47.333 N.	120.855 W.	47.333 N.	120.923 W.
Kachess River	47.251 N.	121.200 W.	47.429 N.	121.222 W.
Naches River	46.630 N.	120.514 W.	46.989 N.	121.094 W.
North Fork Ahtanum Creek	46.523 N.	120.853 W.	46.538 N.	121.211 W.
North Fork Teanaway River	47.251 N.	120.877 W.	47.454 N.	120.965 W.
North Fork Tieton River	46.635 N.	121.261 W.	46.508 N.	121.435 W.
Rattlesnake Creek	46.820 N.	120.929 W.	46.760 N.	121.315 W.
South Fork Ahtanum Creek	46.523 N.	120.853 W.	46.454 N.	121.118 W.
Teanaway River	47.167 N.	120.834 W.	47.257 N.	120.897 W.
Tieton River	46.746 N.	120.786 W.	46.656 N.	121.129 W.
Yakima River	46.529 N.	120.472 W.	47.322 N.	121.339 W.

Appendix B. Estimation of the Bull Trout use of the Mainstem Columbia River

Information Considered – fish counts, radio-telemetry, and other information in the Action Area as noted below. The focus of this analysis was to determine an estimate of the distribution, abundance, and movement patterns of bull trout in the mainstem Mid-Columbia (i.e., from Priest Rapids to Grand Coulee Dam).

Summary of Existing Information

Rock Island Dam (Chelan PUD, unpublished data, 1998-2006)

1. Between 1998 and 2001, the number of bull trout passing upstream through Rock Island Dam has ranged from 48 to 88. Between 55 and 70% of the fish that passed Rock Island Dam in those years did so in May and June.
2. In 2002, a total of 87 bull trout passed through Rock Island Dam. About 75% of these fish passed in May and June.
3. In 2003, a total of 77 bull trout passed Rock Island Dam between April 14 to September 3, about 71% (55 fish) during May and June.
4. Between 2004 through 2006, a total of 114, 69, and 35 bull trout, respectively, passed Rock Island Dam, most in May through August (USFWS and USFS summarized data, 2007).
5. The 2002 and 2003 data were relied on most heavily in this analysis because it is among the most recent data that was collected. For all years, the counting period was limited to 3 to 8 months.

Rocky Reach Dam (Chelan PUD, unpublished data, 1998-2006)

1. In 1998, a total of 83 bull trout passed upstream through Rocky Reach Dam between May 3 and July 31.
2. In 1999 from May 10 to November 14, 128 bull trout passed the project.
3. In 2000, 2001, and 2002, counts of bull trout using the fish ladder from April 20 to November 14 were 216, 204, and 201, respectively. More than 80% of bull trout passage for these years occurred from May 1 to July 31.
4. In 2003 (April 14 to September 3), 206 bull trout passed Rocky Reach Dam.
5. In all years on record, the majority of the bull trout passed the Project in May and June (75 to 90%).
6. Between 2004 through 2006, a total of 161, 155, and 132 bull trout, respectively, passed Rocky Reach Dam, most in May through August (USFWS and USFS summarized data, 2007).
7. The 2002 and 2003 data were relied on most heavily because it is among the most recent data that was collected. For all years, the counting period was limited to 3 to 8 months.

Wells Dam (Chelan PUD, unpublished data, 1999-2006)

1. Data summarized by the USFWS and USFS suggests total bull trout counts from 1999 to 2006 range from 47 to 108, with most passing upstream through Wells Dam in May and June.
2. CPUD reports that Wells Dam has a "similar pattern" as Rock Island and Rocky Reach Dams, but that the counting period was limited to 3 to 7 months.

Columbia River Data Access in Real Time [DART]:
(http://www.cbr.washington.edu/dart/dart.html)

1. 2006 screw trap data for the Methow, Entiat, and Wenatchee Rivers enumerating the downstream movement of juvenile bull trout: Chiwawa (76), Entiat (8), Lake Wenatchee (1), Methow (2), Twisp (6), Wenatchee (1), no data for the Nason and Peshastin traps.
2. The three most downstream (nearest the mainstem Columbia) traps are the Methow (2), Entiat (8), and Wenatchee (1).
3. Little correction or expansion factors are available for these data for bull trout. The Service assumes this represents the minimum number of bull trout moving into the mainstem Columbia annually.

CPUD Juvenile Bypass (2004 BO on the Mid-Columbia HCP)

1. Juvenile bypass operated 24/7, April 1- August 31. Downstream migrating fish are collected at the sampling facility five days each week (Monday – Friday) for 2 hours (0800 to 1000 hours) or until roughly 1,500 fish have been collected (whichever comes first). In addition, sampling is conducted in the evenings (1400 to 1600 and 1900 to 2100 hours) once each week to assess how well the 0800 to 1000 hours sample represents the migration in general.
2. Rocky Reach: The juvenile bypass collector observed 4 to 30 juvenile bull trout between 1998 and 2002 (23, 30, 8, 4, and 5 fish, respectively); no juvenile bull trout were observed in 2003.
3. Rock Island: Numbers of bull trout captured in the Rock Island Bypass smolt trap facility ranged from 1 to 30 between 1997 through 2002 (2, 7, 30, 1, and 8, respectively). No juvenile bull trout were captured in 2003 (L. Praye, WDFW, pers. comm., 2003).

Report to CPUD (BioAnalysts, Inc. 2004)

1. A total of 79 adult migratory bull trout were radio-tagged at Wells, Rocky Reach, and Rock Island Dams in 2001 and 2002.
2. Fish made extensive upstream and downstream movements into multiple tributaries, between and within years, including the Methow, Entiat, and Wenatchee Rivers. One fish entered the Okanogan River (detected at RK 9), but shortly thereafter moved downstream and entered the Methow River.
3. Use of the mainstem Columbia was extensive and occurred year–round, but most bull trout moved into tributaries by July and reentered the Columbia in November.
4. 10 of the 79 fish (12.7%) radio-tagged in the mainstem Columbia River moved into the Wanapum pool. Five fish used the upstream half of the pool (upstream of Tekison Creek), the other half used the entire pool, with one fish moving downstream of Priest Rapids. Fish moved as many as 140 km one-way. Table B-1 summarizes the movements of these fish.

Summary of the GPUD 1999 Fish Inventory

1. In 1999, a fish inventory was conducted in a 58-mile stretch of the Columbia River between river miles 395 and 453 (FERC 2003). Set lines, gill nets, beach seines, minnow traps, and electrofishing gear were used to collect over 58,000 individual fish from 38 species in tributary, forebay, reservoir, backwater, and tailrace habitats.
2. Sampling occurred primarily in July through November, during both day and night hours. Although 93% of the fish collected were juvenile Cyprinids from beach seining, salmonids were collected at an intermediate rate and consisted mainly of juvenile Chinook.
3. Federally-listed species captured in reservoirs and tailraces included 261 spring Chinook, 28 steelhead, and 2 bull trout. Both bull trout were collected by boat electrofishing in November; one at RM 399 (2 miles upstream of Priest Rapids Dam), and one at RM 430 (midway between Whiskey Dick and Quilomene Creeks in the Wanapum pool).

Spawning demographics and Juvenile Dispersal (Downs et al. 2006)

1. Annual repeat spawning was more common that alternate-year spawning (about 88%) over 4 years; this is consistent with Baxter and Westover (1999) that found a 2:1 ratio.
2. Emigration of juveniles occurred in two pulses: one in the spring associated with spring runoff/increasing water temperatures, and a second in fall as stream temperatures drop/fall rains began.
3. Based on otolith microchemistry, most of the sampled adults emigrated at age 3 or 4, and none had emigrated at age 0.

Wenatchee River Radio-telemetry (Kelly-Ringel and De La Vergne, 2006 draft)

1. 43 of the 51 radio-tagged fish were grouped by similar movement patterns: Lake Wenatchee, Upper Wenatchee/Columbia, and Mid-Wenatchee/Columbia.
2. 9 of 43 radio-tagged fish (all of the Upper Wenatchee/Columbia and Mid-Wenatchee/Columbia fishes) made large movements of up to 170 km one-way into the Columbia River; Lake Wenatchee fishes remained in the lake or upper tributaries. Only the Upper Wenatchee/Columbia fishes moved between all groups.
3. Alternate-year spawning: use of known spawning areas suggests 22% of radio-tagged fish spawned multiple times over a 2 to 3 year period; about 88% of radio-tagged fish tracked for only 1 year spawned.
4. Key FMO habitats were used about 8 (Icicle Creek), 9 (mainstem Columbia River), or 12 (Wenatchee River) months of the year.

Other Priest Rapids and Wanapum Dams Information

1. During fish salvage within the gatewells during juvenile salmonid outmigration, only 3 bull trout were observed at Wanapum Dam during 1997 and 2003 (one each observed in 1998-2000). No bull trout were observed

during similar activities at Priest Rapids Dam (GPUD, unpublished data, 1997-2003).

2. During fish ladder maintenance, one bull trout (36 cm) was salvaged from the Priest Rapids Dam on December 8, 2000. Fish ladder maintenance at Wanapum Dam salvaged one bull trout (42 cm) on December 12, 2000 (GPUD, unpublished data, 2001).
3. One bull trout was observed using the Wanapum fish ladder on July 23, 2002 (GPUD, unpublished data, 2002).

Summary

1. Adult fishway data suggests an average of 82 fish passing Rock Island Dam annually, 203 at Rocky Reach Dam, and 71 at Wells Dam.
2. Although fish counts at adult fishways only cover about 5 to 8 months each year, most fish are believed to move through the dams in May and July.
3. About 13 to 21% of sampled fish make large movements (up to 140 to 170 km); for the purpose of this analysis, we estimate 17% (the mean of 13 and 21%) of bull trout may make these large movements.
4. Otolith microchemistry suggest age-0 emigrants are not making a significant contribution to adult returns; presumably this age class experiences high mortality.
5. Alternate-year spawning is estimated to occur in about 12% of the breeding population.
6. Few bull trout have been incidentally observed in the operation and maintenance of Priest Rapids and Wanapum Dams.
7. A lack of understanding of the manner and limitations of data collected for juvenile bull trout in the Mid-Columbia confounds the use of this information.
8. Juvenile bypass data suggests few juvenile bull trout use the mainstem Columbia; a total of 1 to 30 and 4 to 30 juveniles have been observed at Rock Island and Rocky Reach Dams, respectively.
9. The high number of juvenile bull trout observed at the Chiwawa screw trap but low numbers observed at the Wenatchee River trap at Monitor, may suggest:
   a. that juveniles from the Chiwawa remain in Lake Wenatchee or the upper tributaries rather than move downstream (similar to the adult use patterns)
   b. they experience high mortality
   c. contribute few individuals to the mainstem Columbia

Adult Population Estimate

<u>Assumptions</u>

Absent site-specific information, the Service assumes that the probability of migratory bull trout from a given local population within a core area using the mainstem Columbia is related to several factors:

1. The probability decreases with increased distance to the mainstem.
2. The probability increases with an increase in population size (assuming a constant likelihood for all fish, larger populations are expected to contribute more individuals into the mainstem).

3. A migratory form must be present.
4. A local population isolated by barriers to upstream passage may contribute migratory fish, but only downstream; in the unlikely event this occurs, these fish are deemed unable to return to their spawning tributary and are no longer considered part of that local population.
5. Migratory bull trout may go upstream and downstream repeatedly, within tributaries and the mainstem Columbia.
6. Alternate-year spawners (includes all non-annual spawning fish; the interval between spawning is at least 2 years) may spend extended periods of time in FMO habitat, in tributaries, and the mainstem Columbia.
7. Absent site-specific information, the Service is only able to describe which local populations are contributing individual bull trout. However, some information suggests that a high proportion of some local populations (i.e., the Entiat) may use the mainstem Columbia River (BioAnalysts, Inc. 2004).
8. Smaller size-classed adults are assumed to be recent immigrants to the mainstem Columbia. Because mortality rates are presumably inversely related to size, and exposure to mortality is related to time spent in the mainstem Columbia, we assume that smaller size-classed adults are associated with the nearest core area to the dams (i.e., the Yakima).

Characterization of Core Area Populations

Characterization of the status and trend of the local populations that contribute individuals to the mainstem Columbia River provides valuable context of the significance of the effect of the action to these local populations. A highly resilient local population (e.g., high population numbers and good habitat conditions) impacted by the proposed action is anticipated to be at lower risk of extirpation than a local population of low resiliency (e.g., low population numbers and poor habitat conditions).

1. *Methow Core Area*: overall, the Methow is unstable but indicates a slight increasing trend, and is influenced by a single large local population. Since listing in 1998, redd counts have varied from 117 to 174, averaging 152. This estimate was derived from 7 years of comparable data from 7 of 10 local populations. The core area is considered to have low resiliency.

2. *Entiat Core Area*: overall, the Entiat is stable, but is low in numbers with no distinguishable trend. Since listing in 1998, redd counts have varied from 33 to 53, averaging 45. This estimate was derived from 7 years of comparable data from 2 local populations. The core area is considered to have low resiliency.

3. *Wenatchee Core Area*: overall, the Wenatchee is unstable but indicates a slightly increasing trend, and is influenced by a single large local population. Since listing in 1998, redd counts have varied from 242 to 706, averaging 452. This estimate was derived from 7 years of comparable data from 4 of 7 local populations. The core area is considered to have moderate resiliency.

4. *Yakima Core Area*: overall, the Yakima is unstable, and indicates a decreasing trend, and is influenced by three large local populations. Since listing in 1998, redd counts have varied from 455 to 687, averaging 534. This estimate was derived from 8 years of comparable data from 10 of 16 local populations. The core area is considered to have low resiliency.

Population Estimate

This population estimate incorporates the above assumptions and characterization of local populations by core area to determine the approximate number of fish that may move large distances and use the Wanapum Reservoir. We assume this represents about 17% of these local populations (based on BioAnalysts Inc. [2004] and Kelly-Ringel and De La Vergne, [2006 draft]), and that 12% of these fish are alternate-year spawners (Downs et al. [2006]) and may spend extended periods of time in FMO habitats including the mainstem Columbia.

1. *Methow Core Area*: We assume that 9 of 10 local populations (i.e., the Beaver, Early Winters, Goat, Gold, and Wolf creeks, and the Chewuch, Lost, Methow, and Twisp rivers) contribute individuals into the mainstem Columbia. This is supported by radio-telemetry and some genetic data; future restoration actions (especially that which removes barriers and increases streamflow) may increase overall abundance within the core area. Using a mean of 155 redds from these 9 local populations (which includes the best available data, not just comparable data used in the core area characterization), we estimate:

a. 310 fish may use the mainstem Columbia (155 redds x 2 fish/redd)
b. 53 fish may make long movements (230 x 17%) and 6 may be alternate-year spawners
c. 7 fish from up to 9 local populations may use the Wanapum Reservoir (12.5% of fish that used Wanapum were tagged at Wells and are generally associated with the Methow River; based on BioAnalysts Inc [2004]).

Site-specific information generally supports this estimate, but the small sample size suggests the possibility of error. We nonetheless conservatively estimate 7 Methow fish may use the Wanapum Reservoir.

2. *Entiat Core Area*: We assume that both local populations contribute individuals into the mainstem Columbia. This is supported by radio-telemetry and some genetic data; future restoration actions (especially that which removes barriers, increases streamflow, and increases habitat complexity) may increase overall abundance within the core area. Site-specific information suggests that a high proportion of Entiat fish use the Wanapum Reservoir (e.g., the least abundant of the 4 core areas was associated with 50% of the radio-tagged fish that used the Wanapum Reservoir). Using a mean of 45 redds from these 2 local populations, we estimate:

a. 90 fish may use the mainstem Columbia (45 redds x 2 fish/redd)
b. 15 fish from 2 local populations may make long movements (90 x 17%) and 2 may be alternate-year spawners

We did not attempt to further differentiate what proportion of these fish made long range movements into the Wanapum Reservoir; we suggest that potentially all of the Entiat fish use the Wanapum Reservoir based on the information available. As a result, we assume all 15 Entiat fish presumed to make long movements may use the Wanapum Reservoir.

3. *Wenatchee Core Area*: We assume that 5 of 7 local populations (the exceptions being the White River and Little Wenatchee) contribute individuals into the mainstem Columbia. This is supported by radio-telemetry and some genetic data, and future restoration actions (especially that which removes barriers) may increase overall abundance within the core area. However, site-specific information suggests that a higher proportion of Wenatchee fish (about 21%) make long movements than suggested above. Using a mean of 368 redds from these 5 local populations (which includes the best available data, not just comparable data used in the core area characterization), we estimate:

a. 736 fish may use the mainstem Columbia (368 redds x 2 fish/redd)
b. 154 fish may make long movements (736 x 21%), and 18 may be alternate-year spawners
c. 58 fish from up to 5 local populations may use the Wanapum Reservoir (37.5% of fish that used Wanapum were tagged at Rock Island Dam and are generally associated with the Wenatchee River; based on BioAnalysts Inc [2004]).

This estimate is supported by a multi-year radio-telemetry study specific to the Wenatchee River. As a result of these data, we suggest 58 Wenatchee fish may use the Wanapum Reservoir.

4. *Yakima Core Area*: We assume that 8 of 16 local populations (i.e., the Ahtanum, Crow, Deep, Rattlesnake creeks, and the American, Bumping, Teanaway, and mainstem Yakima rivers) are capable of contributing individuals into the mainstem Columbia. Future restoration actions (especially that which removes barriers, increases streamflow and a natural hydrograph, and increases habitat complexity) may increase this potential and the overall abundance of individuals within the core area.

However, site-specific radio-telemetry data suggests that no tagged fishes moved into the mainstem Columbia (WDFW 2006). The Yakima is a highly degraded system and is very long; from the most downstream local population (Ahtanum), it is approximately 107 river miles to the Columbia River. Although genetic data suggests the Yakima is unique and at least historically served as a "mixing zone" between Upper Columbia and Snake River fish (Reiss 2003; Y. Reiss, pers. comm.), it is unclear to what degree connectivity currently exists. However, anecdotal information suggests 2 to 6 bull trout (i.e., it is unknown if these are different or some of the same fish; by arithmetic mean, we estimate 4 bull trout) have been observed in the gatewells of Wanapum and Priest Rapids Reservoirs (GPUD, unpublished data). In addition, GPUD collected 2 bull trout in the Wanapum and Priest Rapids reservoirs. Although we cannot definitively describe from which core area these fish originated, we assume they came from the Yakima because this is the closest core area to the Project dams. As a result, we will conservatively estimate 4 Yakima fish may use the Wanapum Reservoir.

However, if adult bull trout in the Yakima eventually move in a similar fashion as the Methow, Entiat, and Wenatchee core areas, then we would expect the following using a mean of 187 redds from 8 local populations:

a. 374 fish may use the mainstem Columbia (187 redds x 2 fish/redd)
b. 64 fish may make long movements (374 x 17%), and 15 may be alternate-year spawners
c. Some proportion of these 64 fish may use the Wanapum and Priest Rapids Reservoirs

So from either approach, we estimate 4 bull trout from the Yakima may currently use the mainstem Columbia and Wanapum Reservoir, this number may be much higher if bull trout movement begins to resemble that observed in the Methow, Entiat, and Wenatchee core areas in the future.

<u>Summary of Adult Population Estimate</u>

We estimate 7 Methow, 15 Entiat, 58 Wenatchee, and 4 Yakima bull trout, for a total of 84 fish from 24 local populations, may use the Wanapum Reservoir annually. This population estimate nearly approximates the 82 total fish estimated to ascend Rock Island Dam each year, and although this may be coincidental, suggests this is a reasonable approach. However, due to numerous assumptions and the nature of these data, this population size should be considered a rough approximation and more monitoring should be conducted to refine this estimate.

Juvenile/Sub-adult Population Estimate

<u>Assumptions</u>

The Service assumes that the probability of juvenile and sub-adult bull trout from a given local population within a core area using the mainstem Columbia is related to several factors:

1. The probability decreases with increased distance to the mainstem.
2. The probability increases with an increase in population size (assuming a constant likelihood for all fish, larger populations are expected to contribute more individuals).
3. Once a juvenile or sub-adult leaves the spawning and rearing habitats (i.e., downstream into FMO habitat), the Service assumes they will not return to the local population except as a migratory adult if they survive to sexual maturity.
4. Once in FMO habitats, upstream and downstream movements may occur where access is adequate. Mainstem dams are considered complete barriers for juveniles, but a small, unknown proportion of sub-adults may be able to move upstream through adult fishways. To simplify this analysis, all juvenile and sub-adult bull trout are considered unable to move upstream through the adult fishways.

5. In general, juvenile and sub-adult mortality is high, decreasing as the size of the fish increases.
6. Sub-adult bull trout were defined as being <33 cm. This estimate was used after review of typical size classifications of fluvial and adfluvial forms in Washington and Montana (range: 29-36 cm). Juvenile bull trout were defined as <13 cm (note: these numbers reflect migratory, not resident, life history types).
7. Absent site-specific information, the Service is only able to describe which local populations are contributing individual bull trout. However, some information suggests that a high proportion of some local populations (i.e., the Entiat) may use the mainstem Columbia River.
8. Mortality rates are presumably inversely related to size, and exposure to mortality is related to time spent in the mainstem Columbia. We assume that core areas closer to the dams contribute more individuals than those further away.

Characterization of Core Areas

Characterization of the status and trend of the local populations that contribute individuals to the mainstem Columbia River provides valuable context for the significance of the effect of the action to these local populations. A highly resilient local population (e.g., high population numbers and good habitat conditions) impacted by the proposed action is anticipated to be at lower risk of extirpation than a local population of low resiliency (e.g., low population numbers and poor habitat conditions).

However, little comparable data exists to make inferences about the population size of juvenile and sub-adult bull trout in the mainstem Columbia. Screw trap data (Columbia River DART: www.crb.washington.edu/dart/dart.html) did not include expansion factors or describe assumptions. The most downstream screw traps in the Methow, Entiat, Wenatchee, and Yakima core areas, presumably the best indicator of the number of bull trout entering the mainstem Columbia, report 1 to 14 juveniles collected. Other weir, electroshocking, and hook and line sampling in the Yakima core area also reports low numbers, from 1 to 5 individuals, although some adults were also included in these totals. The highest number of juvenile or sub-adults ever reported come from smolt monitoring efforts at Rock Island and Rocky Reach Dams (USFWS 2004a), although the data at Rock Island included some adults or did not consistently specify age or size classification. For these reasons, we will use the Rocky Reach data which does appear to be consistently collected; they report collecting up to 31 fish during anadromous salmonid sampling efforts (May through August), but also report no observations some years. Similar patterns of low reported use of the mainstem has been reported throughout the Columbia Basin in the Snake, Grande Rhonde, and John Day Rivers (Fish Passage Center; http://www.fpc.org/).

As a result, the Service has very little information on which to base a population estimate for juvenile or sub-adult bull trout. For the purpose of this analysis, we will use the highest number reported at Rock Reach Dam, 30 bull trout, to represent the minimum number of juvenile or sub-adults impacted. This low number may reflect the natural and anthropogenic high mortality rate of juvenile and sub-adult bull trout, as well as sampling bias, low detection probability, and other factors.

Although this is a rough approximation and may be a substantial underestimate, it represents the best information available. Project monitoring would greatly enhance our understanding of the estimate of the actual number of juvenile or sub-adults impacted. There is not enough information available to suggest from which local populations these bull trout originated or the proportion of contribution from each core area. The Service believes all core areas contribute individuals to some degree, but are unable to quantify the proportion.

Table B-1. Movement of Bull Trout utilizing the Wanapum Reservoir, Mainstem Columbia, and Key Tributaries. (An "X" indicates use of an area by the radio-tagged bull trout; data was summarized from BioAnalysts, Inc. (2004).

Fish Identification	Location Tagged[1]	Tributary[2]			Tailrace[3]			Wanapum Use[4]		Core Area[5]	Local Population[5]
		Wen	Ent	Met	Wells	RR	RI	Upper	Lower		
6	RR		X			X	X	X		Entiat	Entiat R.
7	RR		X			X	X	X	X	Entiat	Entiat R.
15	RR		X		X	X	X	X		Entiat	Entiat R.
36	RI	X			X	X	X	X		Wenatchee	Unknown
99	Wells	X	X	X	X	X	X	X		Methow	Unknown
101	RR	X	X			X	X	X		Unknown[6]	Unknown
105	RI	X					X	X	X	Wenatchee[7]	Unknown
110	RI	X	X		X	X	X	X	X	Unknown[8]	Unknown
113	RI	X					X	X	X	Wenatchee	Unknown
118	RR		X			X	X	X	X	Entiat	Mad R.

[1] – Indicated the dam where the fish was captured and radio-tagged (RR = Rocky Reach, RI = Rock Island).
[2] – Indicates use of a tributary (Wen = Wenatchee, Ent = Entiat, Met = Methow).
[3] – Indicates a radio-telemetry location within a dam tailrace (RR = Rocky Reach, RI = Rock Island).
[4] – The Service divided the Wanapum Reservoir into upper or lower portions, using Tekison Creek as the dividing line.
[5] – Bull trout were associated with a core area or local population if use patterns were consistent with spawning behavior.
[6] – Fish 101 suggested use patterns consistent with spawning in both the Mad River (Entiat Core Area) in 2002 and Peshastin Creek (Wenatchee Core Area) in 2003.
[7] – Fish 105 is likely to have migrated downstream of Wanapum and Priest Rapids Dams.
[8] – Fish 110 may have died during the study; the expelled transmitted was recovered near Quilomene Creek.

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

Appendix C

Tributary Use by Radio-tagged Adult Bull Trout from PUD Study, 2001-2005
(BioAnalysts, Inc. 2004)

Table C-1: Table 6 as referenced in BioAnalysts, Inc. 2004

Table 6: Tributaries selected by adult bull trout tagged at Rock Island, Rocky Reach, and Wells dams and the dates they entered and left those tributaries, 2001.

Tagging Information			Tributary Residence			
Release	Code	Date	Entrance	Exit	Subbasin	Location
			Rock Island Dam			
Down	32	21-May-01	04-Jun-01	23-Nov-01	Entiat	Mad River
Down	55	19-Jun-01	28-Jun-01	---	Entiat	Mad River
Down	35	30-May-01	13-Jun-01	---	Wenatchee	Peshastin Creek
Up	48	03-Jul-01	NA	NA	Dead	
Up	4	17-May-01	30-May-01	---	Methow	Twisp River
Up	13	24-May-01	11-Jun-01	---	Methow	Twisp River
Up	36	13-Jun-01	21-Sep-01	02-Nov-01	Wenatchee	Mainstem Wenatchee River
			Rocky Reach Dam			
Down	29[1]	21-May-01	06-Jun-01	---	Entiat	Mad River
Down	18[1]	23-May-01	07-Jun-01	---	Entiat	Mad River
Down	15	25-May-01	06-Jun-01	02-Nov-01	Entiat	Mainstem Entiat River
Down	11	29-May-01	06-Jun-01	02-Nov-01	Entiat	Mainstem Entiat River
Down	54	30-May-01	11-Jun-01	---	Methow	Libby Creek
Down	8	11-Jun-01	30-Jun-01	---	Wenatchee	Chiwawa River
Down	46	18-Jun-01	23-Jun-01	11-Dec-01	Wenatchee	Icicle Creek
Down	5	17-May-01	30-May-01	---	Wenatchee	Mainstem Wenatchee River
Down	9	07-Jun-01	27-Aug-01	16-Nov-01	Wenatchee	Mainstem Wenatchee River
Down	25	25-Jun-01	29-Jun-01	---	Wenatchee	Mainstem Wenatchee River
Down	34[1]	10-Jul-01	16-Jul-01	---	Wenatchee	Mainstem Wenatchee River
Up	45	15-Jun-01	29-Jun-01	---	Entiat	Mad River
Up	47	19-Jun-01	01-Jul-01	---	Entiat	Mad River
Up	3	15-May-01	22-May-01	---	Entiat	Mad River
Up	24	22-May-01	04-Jun-01	---	Entiat	Mad River
Up	6	29-May-01	10-Jun-01	17-Oct-01	Entiat	Mainstem Entiat River
Up	7	04-Jun-01	08-Jun-01	11-Nov-01	Entiat	Mainstem Entiat River
Up	37	06-Jun-01	11-Jun-01	09-Nov-01	Entiat	Mainstem Entiat River
Up	50	13-Jul-01	18-Jul-01	24-Sept-01	Entiat	Mainstem Entiat River
Up	20	21-May-01	30-May-01	16-Dec-01	Methow	Twisp River
Up	12	24-May-01	10-Jun-01	07-Oct-01	Methow	Twisp River
Up	14	25-May-01	02-Jun-01	---	Methow	Twisp River
			Wells Dam			
Down	17	24-May-01	02-Jun-01	10-Aug-01	Entiat	Mainstem Entiat River
Down	22	29-May-01	08-Jun-01	---	Methow	Mainstem Methow River
Down	26	22-May-01	01-Jun-01	16-Dec-01	Methow	Twisp River
Down	19	22-May-01	01-Jun-01	---	Methow	Twisp River
Down	33	22-May-01	08-Jun-01	13-Apr-02	Methow	Twisp River
Up	28	22-May-01	24-May-01	---	Methow	Mainstem Methow River
Up	23[1]	29-May-01	01-Jun-01	---	Methow	Mainstem Methow River
Up	21	22-May-01	24-May-01	02-Nov-01	Methow	Twisp River
Up	31[1]	21-May-01	27-May-01	---	Methow	Buttermilk Creek
Up	16	23-May-01	25-May-01	---	Methow	Buttermilk Creek

[1] Based on detection histories for these fish, it appears that they exited the tributary of residence. However, due to a lack of detections at the fixed telemetry sites on the tributary of residence, a date of exodus can not be established.

Table C-2 Table 7 as referenced in BioAnalysts, Inc. 2004.

Table 7: Tributaries selected by adult bull trout tagged at Rock Island, Rocky Reach, and Wells dams and the dates they entered and left those tributaries, 2002.

Tagging Information			Tributary Residence			
Release	Code	Date	Entrance	Exit	Subbasin	Location
			Rock Island Dam			
Down	105	04-Jun-02	27-Jun-02	17-Dec-02	Wenatchee	Mainstem Wenatchee River
Down	113	07-Jun-02	22-Jun-02	06-Nov-02	Wenatchee	Mainstem Wenatchee River
Down	90[3]	23-May-02	01-Jul-02	04-Sep-02	Entiat	Mainstem Entiat River
Down	115	12-Jun-02	01-Jul-02	04-Sep-02	Entiat	Mainstem Entiat River
Up	110[1]	04-Jun-02	---	---	Columbia River	---
Up	97[2]	20-May-02	19-Jun-02	---	Entiat	Mad River
Up	119[4]	12-Jun-02	29-Jun-02	---	Entiat	Mad River
Up	109[3]	07-Jun-02	20-Jun-02	17-Dec-02	Entiat	Mad River
			Rocky Reach Dam			
Down	127	27-Jun-02	---	---	Columbia River	---
Down	104	30-May-02	01-Jul-02	09-Oct-02	Wenatchee	Mainstem Wenatchee River
Down	125	26-Jun-02	06-Jul-02	06-Nov-02	Wenatchee	Mainstem Wenatchee River
Down	126	18-Jun-02	14-Jul-02	14-Jan-03	Wenatchee	Mainstem Wenatchee River
Down	101	03-Jun-02	25-Jun-02	06-Nov-02	Entiat	Mad River
Down	106	06-Jun-02	27-Jun-02	09-Oct-02	Entiat	Mainstem Entiat River
Down	111	04-Jun-02	18-Jun-02	06-Nov-02	Entiat	Mad River
Down	118	11-Jun-02	01-Jul-02	09-Oct-02	Entiat	Mainstem Entiat River
Down	114	10-Jun-02	01-Jul-02	09-Oct-02	Entiat	Mad River
Down	120	27-Jun-02	13-Jul-02	09-Oct-02	Entiat	Mad River
Down	95[1]	29-May-02	09-Jun-02	---	Entiat	Mainstem Entiat River
Down	89[2]	21-May-02	09-Jun-02	---	Methow	Twisp River
Down	46	18-Jun-01	04-Jul-02	01-Aug-02	Entiat	Mainstem Entiat River
Up	124	24-Jun-02	---	---	Columbia River	---
Up	103	06-Jun-02	21-Jun-02	09-Oct-02	Entiat	Mainstem Entiat River
Up	121	07-Jun-02	20-Jun-02	06-Nov-02	Entiat	Mad River
Up	88[2]	20-May-02	06-Jun-02	---	Entiat	Mad River
Up	92	23-May-02	19-Jun-02	04-Sep-02	Entiat	Mad River
Up	122[4]	12-Jun-02	20-Jun-02	---	Entiat	Mainstem Entiat River
Up	123[4]	21-Jun-02	01-Jul-02	---	Entiat	Mainstem Entiat River
Up	98[3]	30-May-02	12-Jun-02	09-Oct-02	Entiat	Mad River
Up	116	10-Jun-02	24-Jun-02	---	Methow	Twisp River
Up	100	04-Jun-02	27-Jun-02	---	Methow	Twisp River
Up	108[2]	03-Jun-02	23-Jun-02	---	Methow	Twisp River
Up	7	04-Jun-01	11-Jun-02	04-Aug-02	Entiat	Mainstem Entiat River
			Wells Dam			
Down	112	11-Jun-02	19-Jun-02	15-Nov-03	Methow	Mainstem Methow River
Down	93[1]	28-May-02	24-Jun-02	---	Methow	Twisp River
Down	96[1]	03-Jun-02	22-Jun-02	---	Methow	Twisp River
Down	102[2]	04-Jun-02	26-Jun-02	---	Methow	Twisp River
Up	99	04-Jun-02	01-Aug-02	06-Nov-02	Wenatchee	Mainstem Wenatchee River
Up	91	23-May-02	03-Jun-02	---	Methow	Mainstem Methow River
Up	94	03-Jun-02	20-Jun-02	---	Methow	Mainstem Methow River
Up	107[1]	03-Jun-02	09-Jun-02	---	Methow	Twisp River
Up	117[1]	12-Jun-02	21-Jun-02	---	Methow	Twisp River

[1] The transmitters for these fish were recovered at the tributary or location of residence during the 2002 study period.
[2] The transmitters for these fish were recovered at the tributary or location of residence during the 2003 study period.
[3] The transmitters for these fish were recovered after tributary exodus during the 2003 study period in the Columbia River.
[4] These fish are suspected of perishing or shedding their tags in the tributary of residence.

Table C-3: Table 8 as referenced in BioAnalysts, Inc. 2004.

Table 8: Tributaries selected by adult bull trout tagged at Rock Island, Rocky Reach, and Wells dams and the dates they entered and left those tributaries, 2003.

Tagging Information			Tributary Residence			
Release	Code	Date	Entrance	Exit	Subbasin	Location
			Rock Island Dam			
Down	113	07-Jun-02	16-Jun-03	21-Nov-03	Wenatchee	Chiwawa River
			Rocky Reach Dam			
Down	101	03-Jun-02	22-Jun-03	17-Oct-03	Wenatchee	Peshastin Creek
Down	104	30-May-02	01-Jun-03	21-Oct-03	Entiat	Mainstem Entiat River
Down	106	06-Jun-02	20-Apr-03	23-Nov-03	Entiat	Mainstem Entiat River
Down	114	10-Jun-02	22-Jun-03	04-Oct-03	Entiat	Mad River
Down	118	11-Jun-02	08-Apr-03	17-Oct-03	Entiat	Mad River
Down	120	27-Jun-02	18-Jun-03	18-Nov-03	Entiat	Mad River
Down	125	26-Jun-02	18-Jun-03	---	Entiat	Mad River
Down	126	18-Jun-02	18-Jun-03	22-Nov-03	Wenatchee	Chiwawa River
Down	127	27-Jun-02	13-Jun-03	17-Oct-03	Entiat	Mad River
Up	92	23-May-02	14-Jun-03	---	Entiat	Mad River
Up	103	06-Jun-02	13-Jun-03	21-Oct-03	Entiat	Mainstem Entiat River
Up	121	07-Jun-02	08-Jun-03	21-Oct-03	Entiat	Mad River
			Wells Dam			
Up	99	04-Jun-02	03-Jun-03	28-Oct-03	Methow	Mainstem Methow River

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

200703195180 Received FERC OSEC 03/19/2007 06:11:05 PM Docket# P-2114-116

Submission Contents