United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

October 31, 2007

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USFWS X-reference: none
Hydrologic Unit Codes: 17-03-00-03 (Yakima River Basin)

Nancy Weintraub
Bonneville Power Administration
KEC-4
P.O. Box 3621
Portland, OR 97208-3621

Dear Ms. Weintraub:

This correspondence transmits the U. S. Fish and Wildlife Service's (Service) Biological Opinion (BO), which is based upon our review of the Yakima Fisheries Project 2006 through 2011 (Project), located in Benton, Kittitas, and Yakima Counties, Washington. The attached BO describes the effects of the Project on the bull trout (*Salvelinus confluentus*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

The cover letter and Biological Assessment (BA) from the Bonneville Power Administration (BPA) were received in the Service's Central Washington Field Office (CWFO) on June 21, 2007. The administrative record for this consultation is on file in the CWFO.

The BPA concluded the Project "may affect, is likely to adversely affect" the bull trout (*Salvelinus confluentus*), in accordance with section 7(a)(2) of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*).

Our analysis in the attached BO concludes that implementation of the proposed Project will not jeopardize the continued existence of the bull trout. The accompanying incidental take statement provides the NMFS with an exemption from the section 9 prohibitions described in the Act.

Please note that the accompanying incidental take statement includes mandatory "reasonable and prudent measures" and "terms and conditions" that are designed to minimize incidental take.

If you have questions about this BO or your responsibilities under the Endangered Species Act, please contact David Morgan of the CWFO in Wenatchee, at (509) 665-3508, ext. 24 or via email at David_T_Morgan@fws.gov.

Sincerely,

Acting Supervisor

Enclosure

cc:
Sent by email:
Dennis Beich, Washington Department of Fish and Wildlife, Region 2, Ephrata, WA
beichdvb@dfw.wa.gov

Biological Opinion

For the

Yakima Fisheries Project 2006 through 2011

U.S. Department of Energy

Bonneville Power Administration

KEC-4
P.O. Box 3621
Portland, Oregon 97208-3621

FWS Reference Number
13260-2008-F-0004

Consultation by: David Morgan, Biologist
U. S. Fish and Wildlife Service
Central Washington Field Office, Wenatchee

Issued by: Richard J Torquemada Date 10/29/07

Richard Torquemada, ~~Deputy~~ Acting Project Leader

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INTRODUCTION

This document transmits the U. S. Fish and Wildlife Service's (Service) biological opinion (BO) based on our review of the proposed Yakima Fisheries Project (Project) located in Benton and Kittitas Counties, Washington, and its effects on the threatened bull trout (*Salvelinus confluentus*). On May 24, 2007 the Service received your completed biological assessment (BA) and request for formal consultation. This consultation was conducted in accordance with Section 7 of the Endangered Species Act (ESA or Act) of 1973, as amended (16 U. S. C. 1531 et seq.). The objective of the following BO is to determine whether the proposed Project is likely to jeopardize the continued existence of the middle Columbia River interim recovery unit of bull trout. The standards for determining jeopardy are described in Section 7(a)(2) of the Endangered Species Act and further defined in 50 C.F.R. 402.14.

The Bonneville Power Administration (BPA) is providing funding to the Yakama Nation (YN) for ongoing studies, research, and artificial production of spring, summer, and fall Chinook (*Oncorhynchus tshawytscha*), and coho (*Oncorhynchus kisutch*) salmon throughout the Yakima River Basin as part of the Yakima/Klickitat Fisheries Project. This BA covers Project actions in the Yakima basin through 2011; actions in the Klickitat basin will be addressed separately. The Project would involve a series of actions including collecting broodstock, incubating eggs and rearing fry in hatcheries, acclimating and releasing smolts, and studying the natural production, ecological interactions, long-term fitness, and culturing/genetics of the fish. The YN and the Washington Department of Fish and Wildlife (WDFW) jointly manage the project, with the YN as lead agency. WDFW and the YN are the fisheries co-managers for the anadromous fish stocks in these basins.

This BO is based upon information provided in the BA for species under U. S. Fish and Wildlife Service jurisdiction received from BPA, published literature and unpublished reports, and the proposed and final rules for listing the bull trout, and the draft Recovery Plan for bull trout (especially the chapter for the middle Columbia River recovery unit). A complete administrative record of this consultation is on file in the Central Washington Field Office (CWFO) in Wenatchee.

Consultation History

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

1. On June 10, 1998, the Service issued a Final Rule listing the Klamath and Columbia River Distinct Population Segments (DPS) of bull trout as threatened species. This listing was superseded on November 1, 1999, when the Service listed the bull trout as threatened throughout the coterminous United States (64 FR 58910).

2. On November 30, 2006, the BPA, National Marine Fisheries Service, WDFW, YN, and the Service met to discuss and review the Project, and to strategize how

to complete permitting procedures. Over the next few months the Service and BPA communicated several times to develop the BA outline and a matrix to facilitate analysis of Project effects.

3. On May 3, 2007, the BPA submitted a draft BA for the proposed project and requested feedback from the Service. We provided comments shortly thereafter.

4. On May 24, 2007, the Service received from BPA a final BA and a request for formal consultation under the Act.

5. On June 21, 2007, the Service and BPA agreed that the BA was complete and that the Service would begin the BO shortly.

BIOLOGICAL OPINION

1 Description of the Proposed Action.

The Project contains many elements involving four salmon species. Activities are planned for numerous locations throughout the Yakima basin. Most of the spring, summer, and fall Chinook salmon activities are continuations or expansions of existing programs. All components will use existing infrastructure. No new hatcheries or construction is included. As described in the BA, step 1 phase 1 (program feasibility studies between 1999 and 2004) was previously consulted on (Service reference 1-9-99-I-131). The Project also includes a coho salmon component described as step 1 phase 2. The Project does not include future activities, described in the BA as step 2, or as the Yakima Coho Master Plan.

This consultation only applies to the BPA-funded Project activities, many of which are supported by pre-existing facilities not funded by BPA, including some located outside of the Yakima basin. None of these other facilities is part of the "larger action" as defined in 50 C.F.R. 402.14, such as a Federal or State hatchery where some Project eggs are incubated, a Bureau of Reclamation or Public Utility District dam where some Project broodstock are collected, et cetera (see Description of the Proposed Action). The effects of Project activities conducted at these locations are evaluated in this BO, but this BO does not provide blanket coverage under Section 7 to the organizations that fund, or the programs that operate, those other facilities.

In order to facilitate the analysis during consultation, the BPA and the Service jointly developed a table including the Project activities, location, and possible consequences for bull trout. This table is included in the BO as Appendix C. For complete details, refer to the BA. A summary of Project actions is provided below.

- Broodstock collection: this activity will occur at several existing locations, most of which are on the lower Yakima River. Two other locations include Cowiche Dam (Naches River mile 3 near Naches), Rosa Dam (Yakima River mile 128 below Ellensburg).
- Adult releases: this activity will occur throughout the Yakima basin and will generally involve up to 20 adults per location. With the exception of Ahtanum Creek, this activity will occur in streams where bull trout are not known to exist currently.
- Juvenile rearing: this activity will occur at existing hatcheries in Columbia basin, including some located outside the Yakima basin.
- Juvenile acclimation and release: this activity will occur in the lower Yakima basin for summer and fall Chinook, and in the mid and upper Yakima basin for spring Chinook and coho. Release numbers will vary from about 1,000 up to 250,000 fish. Most of these sites will be located several miles downstream from bull trout spawning and rearing locations.
- Juvenile collection: this activity will occur at several existing fish traps at dams or screw traps throughout the Yakima basin, generally in lower sections of larger rivers.
- Juvenile surveys: this activity will occur in most or all coho release areas using standard field techniques ranging from snorkeling to electrofishing.

- Spawning surveys: this activity will occur in the lower Yakima basin for summer and fall Chinook, and in the mid and upper Yakima basin for spring Chinook and coho.
- Radio tracking adult salmon: this activity will occur at existing dams using radio telemetry equipment.
- Predator surveys: this activity will occur in the lower and middle Yakima mainstem river and will involve collection of and stomach content analysis from pikeminnow and other species, not bull trout.
- Non-target taxa monitoring: this activity will occur throughout the Yakima basin, including small tributaries where bull trout are known to exist, usually by collecting juvenile fish and comparing growth indices, presence versus absence, etc.
- Domestication research: this activity will occur throughout the Yakima basin, generally in lower sections rivers and large streams, usually by collecting adult salmon in nets or by angling.
- Residual/precocial monitoring and competition indices: this activity will occur throughout the Yakima basin and will include snorkeling, electrofishing, stomach content analysis, and microhabitat surveys.
- Stream sediment impact monitoring: this activity will occur throughout the Yakima basin and will collect gravel samples.
- Carcass distribution: this activity will occur in tributaries, side channels and beaver ponds of upper Yakima River, Naches River, and Little Naches River.

The Project does not include new construction or significant habitat alteration. Compared to some programs which include hatchery activities, the Project does not include substantial spatial or temporal overlap with critical components of the bull trout life-cycle, complete passage blockage, major surface water diversion and stream bypass, etc. However, the Project does include several components, spread out over a large area, where direct and indirect harm may occur to individual bull trout.

This consultation is limited to activities which can be described in sufficient details and will be implemented in the foreseeable future. Therefore its duration is limited. Because some aspects of the Project are experimental, future Project activities are expected to change in ways that have yet to be determined. Regardless of future Project changes, new consultation will be needed in 2011. As described below, Project effects on bull trout and their critical habitat are minor. Therefore the Service anticipates that limiting the duration of this consultation is appropriate and would not result in significant additive adverse effects on bull trout or their critical habitat that might otherwise be obscured by conducting a follow-up consultation in the future as the program changes.

1.1 Definition of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. 402.02). The action area for this consultation is the Yakima River from the mouth extending upstream into numerous tributaries near their headwaters. Because the Project includes no new construction, and all

significant components will take place in the river, the service does not expect upland disturbance to result.

2 Status of the Species

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); and introduced non-native species (64 FR 58910).

The bull trout was initially listed as three separate 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.

Thus, the Service's jeopardy analysis for the proposed Project is done at the scale of the Columbia River DPS.

2.2 Current Status and Conservation Needs

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 (USFWS 2002a; 2004a, b).

The habitat conservation needs of the bull trout are generally expressed as the four Cs--cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality 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 United States to local populations. The recovery planning process for the bull trout (USFWS 2002a; 2004a, b) 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.

Central to the survival and recovery of the bull trout is the maintenance of viable core areas (USFWS 2002a, 2004a, b). 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 114 core areas are recognized across the coterminus United States range of the bull trout (USFWS 2002a; 2004a, b).

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 preserve the species' resilience to changing environmental conditions.

2.2.1 *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, including about 50 to 125 spawners, are estimated to occur within the core area. The current depressed 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 (USFWS 2004a). The draft bull trout recovery plan 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 (USFWS 2004a).

2.2.2 *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 (USFWS 2002a). Bull trout populations in this unit face a high risk of extirpation (USFWS 2002a). The draft bull trout recovery plan (USFWS 2002a) 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 calls for 8 to 15 new local populations and an increase in population size from about 3,250 adults currently to 8,250 adults to provide for the persistence and viability of the 3 core areas (USFWS 2002a).

2.2.3 *Columbia River*

This interim recovery unit currently contains about 90 core areas and 500 local populations. 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 (USFWS 2002a) 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.

2.2.4 *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 (USFWS 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 (USFWS 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.

2.2.5 *St. Mary-Belly River*

This interim recovery unit currently contains 6 core areas and 9 local populations (USFWS 2002a). 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 (USFWS 2002a). 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 (USFWS 2002a). The draft bull trout recovery plan (USFWS 2002a) 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 and Population Dynamics

Like other salmonids from western North America, the bull trout is a well studied fish species. Detailed summaries of available information about the diverse life-history strategies exhibited by bull trout and the resulting variability in population dynamics are available in the Service's draft bull trout recovery plan and in the background information for the 5-year status review of the bull trout. A brief overview of this information is presented in Appendix A.

2.4 Consulted-on Effects

Projects subject to Section 7 consultation under the Act have occurred throughout the range of bull trout. Singly or in aggregate, these projects could affect the species' status. In order to assess the effects of previous actions/projects on bull trout, we incorporate by reference the Service's Biological Opinion for the Rock Creek Mine in Montana prepared by our Region 6 office (USFWS 2006). In the Status of the Species section of that BO, the Service reviewed 137 BOs produced by the Service from the time of listing in June 1998 until August 2003. The Service analyzed 24 different activity types (e.g., grazing, road maintenance, habitat restoration, timber sales, hydropower, etc.). Twenty BOs involved multiple projects, including restorative actions for bull trout.

The geographic scale of projects analyzed in these BOs varied from individual actions (e.g., construction of a bridge or pipeline) within one basin, to multiple-project actions, occurring across several basins. Some large-scale projects affected more than one DPS. In summary, 124 BOs (91 percent) applied to activities affecting bull trout in the Columbia River population, 12 BOs (9 percent) applied to activities affecting bull trout in the Coastal-Puget Sound

population, 7 BOs (5 percent) applied to activities affecting bull trout in the Klamath River population, and 1 BO (less than 1 percent) applied to activities affecting the Jarbidge and St. Mary Belly populations.

Our aggregate analysis of BOs was also stepped-down from the DPS to the core-area scale (USFWS 2006). For example, the Rock Creek Mine Biological Opinion included an evaluation of the Lower Clark Fork River basin from the time of listing until August 2003. Of 37 actions that occurred in this river basin during this period, the majority (35) involved habitat disturbance with unquantifiable effects, 16 actions were ongoing, and 21 actions had been completed and effects were no longer occurring. Similarly, the number of actions, type of actions, and a brief description of the action was provided for each river basin where bull trout may have been adversely affected (USFWS 2006).

For each action, the causes of adverse effects were identified as were the anticipated consequences for spawning streams and/or migratory corridors, if possible (in most cases, these consequences were known). Actions whose effects were "unquantifiable" numbered 55 in migratory corridors and 55 in spawning streams. The Service also attempted to define the duration of anticipated effects (e.g., "short-term effects" varied from hours to several months). Projects likely to result in long-term benefits also were identified.

At the time of preparation of the Rock Creek Mine Biological Opinion, all other BOs within the range of bull trout reached a "no-jeopardy" determination. After reviewing previous BOs, the Service concluded that the continued long-term survival and existence of the bull trout had not been appreciably reduced range-wide (USFWS 2006). The Service's assessment of BOs from the time of listing until August 2003 (137 BOs), confirmed that no actions that had undergone Section 7 consultation during this period, considered either singly or cumulatively, would appreciably reduce the likelihood of survival and recovery of the bull trout or result in the loss of any (sub) populations (USFWS 2006).

Between August 2003 and July 2006, the Service issued 198 additional BOs that included analyses of effects on bull trout (Brewer, D., USFWS, 2006, pers. comm.). These BOs also reached "no-jeopardy" determinations, and the Service concluded that the continued long-term survival and existence of the species had not been appreciably reduced range-wide due to these actions (USFWS 2006). All BOs issued after July 2006 also reached "no-jeopardy" determinations.

2.5 Status of Bull Trout Critical Habitat

2.5.1 Legal status

The FWS published a final critical habitat designation for the coterminous 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 St. Mary-Belly River population segments (also considered as interim

recovery units). Rangewide, the FWS designated 143,218 acres of reservoirs or lakes and 4,813 stream or shoreline miles as bull trout critical habitat.

Although critical habitat has been designated across a wide area, some critical habitat segments were excluded in the final designation based on the benefits of inclusion versus the benefits of exclusion (see Section 3(5)(A) and Exclusions under Section 4(b)(2) in the final rule). This process resulted in all proposed critical habitat being excluded in 9 proposed critical habitat units: Unit 7 (Odell Lake), Unit 8 (John Day River Basin), Unit 15 (Clearwater River Basin), Unit 16 (Salmon River Basin), Unit 17 (Southwest Idaho River Basins), Unit 18 (Little Lost River), Unit 21 (Upper Columbia River), Unit 24 (Columbia River), and Unit 26 (Jarbidge River Basin). The remaining 20 proposed critical habitat units were designated in the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation.

2.5.2 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). The core areas reflect the metapopulation structure of 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 of bull trout.

Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit.

The primary function of individual critical habitat units is to maintain and support core areas 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 historical 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 marine 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 sub-adult overwintering, migration, and foraging.

Within the 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, and sheltering. Note that only the PCEs described in paragraphs 1), 2), 3), and 4) apply to marine nearshore waters identified as critical habitat; and all except PCE 3) apply to foraging, migration, and overwintering habitat identified as critical habitat.

The PCEs are as follows:

1. 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;

2. 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;

3. 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;

4. 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;

5. Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source;

6. 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;

7. An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish; and

8. 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 would 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 minus 33 feet (10 meters) 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 feet (10 meters) 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 physical and biological features of the marine environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212; USFWS 2004b). Our evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998). Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Columbia River, Coastal-Puget Sound, and St. Mary-Belly River population segments.

2.5.3 Current Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively 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) fragmentation and isolation of local populations due to 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 non-native 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.

3 Environmental Baseline

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. The Project action area is essentially the same area as the middle Columbia River interim recovery unit for the bull trout. Characterizing the environmental baseline for highly mobile species requires a multi-scale analysis that evaluates the condition of all areas used by the affected population. The population of bull trout found in the action area of a project often inhabits a much larger area through the course of its life cycle. For example, bull trout often migrate over 100 kilometers (km) between spawning and overwintering habitat. For bull trout, the Service primarily considers two different spatial scales: 1) the watershed or specific reaches in a watershed affected by the proposed project, and 2) the "core area" scale, which is an interbreeding group of local bull trout populations.

The *Draft Bull Trout Recovery Plan* (USFWS 2002b) included all local populations in the Yakima basin in a single core area. However, based on migratory blockages and limited opportunities for migration under current conditions, certain functional population groups can be described (pers comm. D. Morgan, 2005; comments provided to the lead entity during the Yakima Basin Salmon Recovery Plan process). Normally the watershed or reach scale is used to characterize habitat conditions in the vicinity of the proposed action. The condition of habitat at this scale is evaluated in terms of habitat indicators in the Matrix of Pathways and Indicators (Matrix) (USFWS 1999). Normally the core area scale covers the bull trout population that is most likely to be affected by the proposed action, and the condition of this population is evaluated in terms of "subpopulation" indicators in the Matrix (USFWS 1999). The Service uses these hierarchical scales to structure its evaluation of baseline condition as well as its subsequent analysis of project effects and jeopardy analysis.

The format of this BO will deviate from most Service BOs because the Project activities, with few exceptions, do not include land use or river alteration. In this BO the Service will use the Matrix as the standard analysis approach and checklist, but as appropriate certain components will receive more attention and others less. According to the information in the BA, most Project effects are anticipated to be experienced by individual bull trout (capture, handling, etc.). In contrast, the habitat for bull trout is anticipated to be unaffected by most Project activities.

In the following analysis of baseline conditions, most information for the core area scale is drawn from the *Draft Bull Trout Recovery Plan* (USFWS 2002b) with updates from a variety of other sources. Habitat information for the basin, watershed, and reach scales is drawn primarily from detailed descriptions in the a limiting habitat factors analysis developed for the Yakima basin (WSCC 2001), the Yakima subbasin plan (YBFWPB 2004), and in the draft Yakima salmon recovery plan (YBFWRB 2005).

3.1 Environmental Baseline for the Yakima River Core Area

The Yakima River basin is located in south central Washington and contains a diverse landscape of rivers, ridges, and mountains totaling just over 6,100 square miles. Along the western portion of the basin, the glaciated peaks and deep valleys of the Cascade Mountains exceed 8,000 feet. East and south from the Cascade crest, the elevation decreases to the broad valleys and the lowlands of the Columbia Plateau. The lowest elevation in the basin is 340 feet at the confluence of the Yakima and Columbia Rivers at Richland. Precipitation is highly variable across the basin, ranging from approximately 7 inches per year in the eastern portion to over 140 inches per year near the crest of the Cascades. Total runoff from the basin averages approximately 3.4 million acre-feet per year, ranging from a low of 1.5 to a high of 5.6 million acre-feet (YBFWPB 2004).

The basin contains a variety of aquatic habitats including the large mainstem of the Yakima River, medium-size rivers such as the upper Yakima, Cle Elum, and Naches, and many smaller tributaries, such as the Little Naches River, Satus, Ahtanum, and Taneum creeks, and the headwaters above the basin's reservoirs. The Yakima River Subbasin consists of two very different physiographic and geologic regions. The Cascade Mountains occupy roughly the western third of the subbasin, while the Columbia Plateau extends from the Cascade foothills to the eastern border of the subbasin. The mountains consist of continental formations of Eocene-age sandstone, shale and some coal layers, and pre-Miocene volcanic, intrusive, and metamorphic formations. Tertiary and quaternary age andesite and dacitic lavas, tuff, and mudflows form a broad north-south arch along the western edge of the subbasin. The upper mainstem Yakima and Naches rivers and several tributaries occupy valleys excavated by glaciers. Lowlands typical of landforms associated with the Columbia Plateau are found along the lower half of the Yakima River (YBFWPB 2004).

Private ownership totals over 1.2 million acres of the nearly 4 million acres in the Yakima subbasin. The single largest landowner is the U.S. Government with 1.5 million acres, or 38 percent of the land area. Most of the federal land is within the Wenatchee National Forest. Other large federal land holdings include the U.S. Army Yakima Training Center, a portion of

the Department of Defense Hanford Nuclear Reservation, and Bureau of Land Management lands. Other public ownership (state, county, and local governments) total over 400,000 acres. The entire Yakima Basin lies within areas either ceded to the United States by the Yakama Nation or areas reserved for the use of the Yakama Nation. The Yakama Reservation occupies about 40 percent of Yakima County and about 15 percent of the basin (YBFWPB 2004).

Six major reservoirs are located in the subbasin and form the storage component of the federal Yakima Project, managed by the Bureau of Reclamation (BOR). None of these reservoirs have fish ladders. Total storage capacity of all reservoirs is approximately 1.07 million acre feet, total diversions average over 2.5 million acre feet. The construction and operation of the irrigation reservoirs have significantly altered the natural seasonal hydrograph of all downstream reaches of the mainstem and some tributaries. Historically, the hydrologic cycle in this basin was characterized by extensive and complex exchange of water between the surface, hyporheic (shallow groundwater made up of downwelling surface water) and groundwater zones. Under pre-1850s conditions, vast alluvial flood plains were connected to complex webs of braids and distributary channels. These large hydrological buffers spread and diminished peak flows, promoting infiltration of cold water into the underlying gravels. Side channels and sloughs provided a large area of edge habitat and a variety of thermal and velocity regimes. For salmonids, these side channel complexes increased productivity, carrying capacity, and life history diversity by providing suitable habitat for all freshwater life stages in close physical proximity (YBFWPB 2004).

In addition to land-use changes, BOR adjusts reservoir releases annually in a "flip-flop" operation which results in a discharge regime which is not within the natural range of variability. This involves reducing spring flows and increasing summer flows above the normative hydrograph in the upper Yakima River via reservoir storage and then release at Cle Elum, Kachess, and Keechelus Dams, and simultaneously reducing the spring and summer hydrograph in the Naches River at Bumping and Tieton Dams by storing water. In late summer, the opposite occurs when Naches releases rise dramatically and upper Yakima releases are reduced (YBFWPB 2004).

3.1.1 *Yakima Core Area – Bull Trout Abundance and Distribution*

Historically, bull trout occurred throughout the Yakima River basin, but are now fragmented into isolated populations, most of which are located above impassable BOR reservoirs, and therefore cannot freely access most of their historic habitat. Bull trout in the Yakima Core Area are currently found in 16 local populations including: the mainstem Yakima River (Keechelus to Easton Reach); Ahtanum Creek (North, South, and Middle Forks); three Naches River tributaries (American River, Rattlesnake Creek, and Crow Creek); two Rimrock Lake tributaries (South Fork Tieton River and Indian Creek); Bumping Lake and Deep Creek; Teanaway River; two Kachess Lake tributaries (Box Canyon Creek and upper Kachess River); Keechelus Lake (Gold Creek); the upper Cle Elum River; Waptus River, and the North Fork Tieton River. Taneum Creek, in the upper Yakima River basin, is the location where the one population is being considered for reintroduction (USFWS 2002b).

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.

3.1.2 *Reasons for Decline*

The following six paragraphs are copied from the draft Yakima Subbasin Salmon Recovery Plan (YBFWRB 2005):

The 2004 Yakima Subbasin Plan and its antecedent documents describe, in some detail, the array of habitat modifications that currently affect the quantity and quality of salmonid habitat within the Yakima subbasin. The most prominent and deleterious changes are the results of flow regulation and irrigation, and development in floodplain, riparian, and upland areas. Generally, land management and water development have: 1) reduced connectivity (*i.e.,* the flow of energy, organisms, and materials) between streams and adjacent riparian areas, floodplains, and uplands; 2) elevated fine sediment yields, degrading spawning and rearing habitat; 3) reduced large woody material that traps sediment, stabilizes streambanks, and helps form pools; 4) reduced vegetative canopy that minimizes solar heating of streams; 5) modified streams to become straighter, wider, and shallower, reducing rearing habitat and increasing water temperature fluctuations; 6) altered peak flow volume and timing, leading to channel changes and potentially altering fish migration behavior; and 7) altered floodplain function, water tables and base flows (Henjum et al. 1994; McIntosh et al. 1994; Rhodes et al. 1994; Wissmar et al. 1994; National Research Council 1996; Spence et al. 1996; and Lee et al. 1997). Specifically, irrigation and development have had the following effects on the environmental baseline: 1) adversely affected water quality, 2) adversely affected instream flows, 3) degraded floodplain and channel morphology and function, and 4) detached portions of the Yakima River and its tributaries from their historical floodplains creating impaired floodplain function 5) loss of access to habitats due to physical obstruction, reduced flow or elevated temperature regimes in migration, spawning and rearing habitats.

The Yakima, Cle Elum, Tieton, Bumping, and Naches rivers are manipulated to maximize winter reservoir storage and summer irrigation deliveries according to the seasonal needs of irrigators. These operations result in streamflows across the subbasin that are mostly out of phase with the lifehistory requirements of native salmonids. Reservoir operations combined with diversions across the Yakima Basin have inverted and truncated the natural pattern of streamflow so that river systems are now spatially and temporally discordant with their surrounding watersheds. The biota of these systems have also suffered because flow regulation patterns are, at best, less than optimal for native salmonids (Fast et al. 1991; Stanford et al. 2002) and floodplain riparian species (Braatne and Jamieson 2001). Summer and fall drawdown of Lake Kachess, Lake

Keechelus, and Rimrock Lake (Tieton Reservoir) obstructs or prevent access to tributaries by adult bull trout on spawing migrations and strands juvenile bull trout.

Water quality conditions throughout the Yakima subbasin, largely because of flow regulation, irrigated agriculture, and general floodplain development, are severely impaired along many reaches of the Yakima River and its tributaries (Rinella et al. 1992a; 1992b; Morace et al. 1999). The Washington State Department of Ecology (WDOE) has placed 72 watercourse segments throughout the Yakima Basin on the most recent 303(d) list (1998) of threatened and impaired waterbodies (WDOE 1998). Primary impairments leading to these listings included increased temperatures, high agricultural pollutant concentrations (*e.g.,* 4,4'-DDE, DDT, dieldrin, 4,4'-DDD, chlorpyrifos, endosulfan, and PCB), dissolved oxygen deficits, and a host of other water quality constituents (*e.g.,* arsenic, mercury, silver, fecal coliform, pH, ammonia, chlorine, turbidity, and phosphorous) that are generally detrimental to fish health and persistence (Johnson et al. 1986; Rinella et al. 1993; 1999; Morace et al. 1999).

Throughout the irrigation season, the lower Yakima River (downstream from Granger, RM 82) receives large volumes of warm, sediment- and pollutant-laden water from irrigation effluents (Johnson et al. 1986; Rinella et al. 1992a; 1992b). Diminished instream flows in the Lower Yakima and Naches rivers during the irrigation season, combined with high air temperatures, degraded riparian vegetation, and floodplain development, contribute to extended river reaches with water temperatures that exceed the physiological tolerances of native salmonids. These conditions are well tolerated by native and non-native predatory fish and serve to increase their efficiency. Additionally, poor water quality conditions in the Lower Yakima River can lead to increased mortality rates in steelhead and other native anadromous smolts from water-borne pathogens (BPA 1990; Thomas and Pearsons 2001). High water temperatures persist in the lower Yakima River throughout the irrigation season. Migrating adult steelhead must hold on the Columbia River near the mouth of the Yakima River until irrigation diversions and effluents cease and the river cools.

Passage impediments challenge native salmonids across the Yakima subbasin. Access to upstream tributary habitats can be blocked by constructed barriers such as road or pipeline crossings and diversion dams, or by depleted stream flow below diversions. At some diversions with fish ladders (Roza, Sunnyside, and Prosser dams), seasonal operations at can hinder adult upstream movement during critical migration periods, or completely block access when upstream storage is predicted to be insufficient (Easton Dam). Furthermore, hydropower wasteways such as Roza Power Plant Wasteway, and irrigation drainage features such as Sulphur Creek Wasteway, Moxee and Granger Drains, which are connected to the Yakima River and its tributaries, discharge false attraction flows that can entrain or confuse migrating adult steelhead. Exposure to adverse water quality constituents for fish entrained into these watercourses might significantly decrease their chances of spawning successfully later (Scholz et al. 2000; Brewer et al. 2001).

Forest practices, agriculture, urbanization, flow regulation, along with diking and streambank protection have simplified stream channels, damaged riparian habitat, and impaired the ability of

streams to interact with their floodplains and aquifers across the Yakima subbasin. Gravel resources have been mined up to the river's edge, urban development has encroached into the river corridor, and floodplain and riparian habitat has become tracts of agricultural land.

Other factors identified in the *draft bull trout Recovery Plan* (USFWS 2002b) affecting habitat in more site specific portions of basin include the following:

- Past timber harvest and related activities (such as road construction and maintenance), have degraded habitat conditions in the Yakima Core Area, especially in the upper Yakima River, Cle Elum River, Taneum River, Ahtanum Creek, Teanaway River, Naches River, and the Tieton River.
- Livestock practices have degraded bull trout habitat in the Yakima Core Area, especially in Ahtanum Creek, Teanaway River, and the Tieton River.
- Placer suction dredging and hard rock mining occur on a limited scale in several watersheds including the Little Naches and Cle Elum.
- The combination of hatchery-stocked rainbow trout, large catch limits, use of bait, and easy public access has resulted in high angling pressures that may negatively affect bull trout. In addition, poaching has been identified as a serious concern in Gold Creek, Box Canyon Creek, Deep Creek, South Fork Tieton River, and Indian Creek.
- Introduction of non-native species including brook trout, brown trout, lake trout, bass, catfish, bluegill, sunfish, and crappie have affected bull trout populations through a combination of hybridization, competition, and predation.

3.1.3 *Core Area Summary*

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).

Overall, most bull trout populations in the Yakima core area persist at low or extremely low abundance. A combination of historical activities, ongoing federal programs, and residential and agricultural development limit population recovery. Almost every bull trout population in the Yakima core area has been affected by extensive changes in habitat conditions, especially disconnectivity due to large storage reservoirs without fish ladders, and non-normative hydrographs in the mainstem upper Yakima and Naches Rivers. Other problems include a complete lack of anadromous prey in areas where salmon once migrated before construction of the reservoirs, and drawdowns of those reservoirs which inhibit or prevent bull trout spawning

migrations upstream of the reservoirs. These four conditions make the situation in the Yakima core area unique among bull trout populations in the DPS.

3.2 Environmental Baseline for Critical Habitat

Critical habitat has been designated in streams and rivers both upstream and downstream of the Project throughout the Yakima River basin, which is the only core area within this Critical Habitat Unit. Critical habitat in the Yakima River core area supports 16 local populations, one potential local population, and feeding, migrating and overwintering (FMO) habitat throughout the core area. The majority of designated critical habitat lies within the lower portions of the larger river systems. Spawning and rearing critical habitat has been designated within the following local populations: Ahtanum Creek, Box Canyon Creek, Bumping River, Cle Elum River, Gold Creek, Kachess River, Naches River, North Fork Tieton River, Rattlesnake Creek, Teanaway River, Tieton River, and the mainstem Yakima River. It has also been designated in FMO habitat in the mainstem Ahtanum Creek, Naches River, Tieton River, Teanaway River, Cle Elum River, Kachess River, and mainstem Yakima River. Several Project elements will occur within designated FMO critical habitat.

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 described in detail in the previous section. 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 in the basin currently lack fish passage and block access to most spawning and rearing 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. 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. However, most legacy threats from past forest practices will likely continue to be a threat for decades. Within the Yakima Critical Habitat Unit, PCEs 1, 2, 4, 5, 6, 7, and 8 have experienced some degree of degradation.

In the Middle Columbia River Basin Critical Habitat Unit, spawning and rearing critical habitat segments 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 FMO critical habitat segments in this core area were ranked at high risk of becoming non-functional.

3.3. Factors Affecting the Species' Environment in the Action Area

The Project occurs at the Core Area scale, which includes most of the Yakima basin. A suite of Yakima basin-wide habitat changes was described above. These kinds of habitat impacts typically affect more than one local population of bull trout. Some of the watershed-specific habitat problems which affect individual local populations were also described above.

3.3.1 *Numbers, Population Trends, and Distribution for Bull Trout in the Action Area*
None of the bull trout habitat and subpopulation indicators are considered to be properly functioning in the Yakima basin core area, which, for this Project, also defines the action area. Subpopulation status evaluation reflects redd surveys yielding low estimates of total population size and reproductive trends reflecting low productivity, and the absence of migratory connectivity within the basin which is essential in order to reverse these threats.

Because of anthropogenic changes and the lack of migratory connectivity between most local populations in the Yakima basin, the 16 existing local populations currently function as, at most, nine reproductively isolated populations. All of these populations, including the two largest populations in the basin (South Fork Tieton and Indian Creek), have effective population sizes which are small enough to categorize as being at high risk of deleterious genetic effects associated with small populations over the medium and long-term. Redd counts are so low for all populations in the upper Yakima arm (especially the Teanaway), that they are at high risk of extirpation in the short-term. See Appendix A for more information about small population effects. Redd count data collated by WDFW is presented in Table 1.

Table 1: Redd counts for bull trout populations in the Yakima basin, 1996 - 2006

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Upper Yakima River Keechelus to Easton Reach					2	1		1			3
Ahtanum Creek											
N.F. Ahtanum Cr.	5	7	5	7	11	20	17	12	8	6	7
M.F. Ahtanum Cr.	1	1		0	10	1	6	8	11	5	6
S.F. Ahtanum Cr.					5	14	13	7	5	3	4
Naches River											
Rattlesnake Cr.	38	46	53	44	45	57	69	54	32	15	40
American R.	25	24	31	30	44	36	27	30	40	35	55
Crow Cr.				19	26	6	9	9	6	4	8
Rimrock Lake											
S.F. Tieton R.	226	177	142	161	144	158	141	178	178	205	189
Indian Cr.	193	193	212	205	226	117	100	101	50	91	106
N.F. Tieton (above Clear Lk)									1		1
Bumping Lake											
Deep Cr.	46	126	98	107	147	51	120	57	97	73	95
Bumping River (upper)					0				0		
N.F. Teanaway River											
NF Teanaway/DeRoux Cr.	2									2	1
Kachess Lake											
Box Canyon Cr.	8	10	16	17	10	14	15	8	19	8	8
Kachess R (upper)			0		15	14	0	16	8	3	0
Keechelus Lake											
Gold Cr.	51	31	36	40	19	15	31	9	20	7	8
Cle Elum & Waptus Lakes											
Cle Elum R. & Waptus R	0	0	0		0	0	0	0			0
Summary	595	615	593	630	704	504	548	490	475	457	531

3.3.2 *Likelihood of Species Presence in the Action Area*

Bull trout in the Yakima core area spawn in the upper portions of several tributaries, as well as in the uppermost reach of the mainstem Yakima River below Easton Dam. None of the activities in the Project will occur in these areas. All Project activities will occur in locations downstream from spawning and rearing habitat, both in the mainstem Naches and Yakima Rivers, as well as their smaller tributaries. Most Project activity locations will occur in areas where bull trout are not known to exist and where the habitat appears to be sub-optimal for bull trout survival. However, many Project locations include areas that are used for migration, feeding, and possibly overwintering by adult and sub-adult bull trout, and in these locations some Project activities may temporally overlap with transient bull trout activity in the area. For site specific locations, see Appendix C.

Although it is likely that historically bull trout used nearly all portions of accessible river habitat the Yakima basin during at least part of the year, including the lower river corridor, currently most bull trout activity in the basin occurs upstream of the 6 large reservoirs near the headwaters. There are less than five verified reports of bull trout activity in the lower Yakima River below Yakima since their ESA listing in 1998 (unpublished data on file with the Service; D. Morgan, pers. comm., 2007). According to the BA, at Rosa Dam, located in the middle Yakima River near Ellensburg, every year between 1997 and 2006 between one and four bull trout were captured in the adult ladder, and zero juvenile adult were collected in the juvenile fish trap.

Another source of recent data about bull trout activity in the Yakima basin comes from WDFW's radio telemetry study to track the movement of approximately 80 bull trout in the Naches River. The results showed that bull trout migrated throughout the Naches River, including the lower river in the winter. Upstream movements to the spawning grounds began in July. Two tagged fish moved briefly out of the Naches River into the Yakima, but they did not wander far from the confluence, and quickly returned to the Naches River (E. Andersen, WDFW, pers. comm., 2007).

In summary, because bull trout spawning and rearing occurs upstream of Project activities, with the possible exception of a limited number of Project activities such as snorkeling and redd surveys, juvenile bull trout are not expected to be affected. The Service anticipates that there will be some adult migratory fish who move downstream of those locations, and they will be exposed to Project activities at dams and other fish monitoring stations such as crew traps. Some project monitoring activities have the potential to temporarily disturb individual bull trout.

3.4 Conservation Role of the Yakima Core Area for the Recovery Unit

The Yakima core area may play a central role in the conservation of the Columbia River interim recovery unit of the bull trout. Not all of the information necessary to definitively determine the appropriate conservation role of this core area is available, but a reasonable working hypothesis can be deduced from what is known. Geographically, this core area is the largest in the Columbia River interim recovery unit in Washington State, and among the largest in the entire unit. Simply by virtue of its large size, the Yakima core area plays an important role in maintaining the spatial distribution of bull trout within the unit.

Not only is this core area large in size, it is also located at a major intersection in the Columbia basin, where the upper Columbia and lower Snake River evolutionary groups meet. This location raises the likelihood that the Yakima core area may have a distinctive genetic background, containing elements from both of these adjacent lineages. If the Yakima core area proves to be a repository of rare alleles or unusual combinations of loci from different lineages, this core area could be essential for maintaining genetic diversity within the unit.

From a demographic perspective, the Yakima River was historically among the most productive sub-basins for anadromous salmon in the Columbia basin. Before 1850, an estimated 500,000 to 900,000 salmon and steelhead returned annually to the Yakima basin (YSF&WPB 2004). Since that time, sockeye, summer Chinook, and coho salmon have been extirpated, coho have been reintroduced, and in the last 10 years, the largest total runs including all species have been less than 30,000 fish (YSF&WPB 2004). No estimates of historic bull trout abundance are available, but high productivity of anadromous salmon and the presence of several natural lakes that could support adfluvial life-history strategies suggests that migratory bull trout populations historically were also large and prolific.

The Yakima core area had the biological potential to serve as a source population exporting migratory emigrants to smaller and less stable core areas in both the upper Columbia and lower Snake River basins. Movements of this scale are within the range of migration distances documented by recent telemetry studies in central Washington (e.g., BioAnalysts 2004). Providing gene flow between the major evolutionary lineages and demographic support to less productive core areas in the vicinity may have been the historic roles of the Yakima core area in the unit. This hypothesized reference condition could suggest the appropriate conservation objective for the Yakima core area in the recovery of the Columbia River interim recovery unit.

If these hypothesized roles of the Yakima core area are correct, extirpation or functional extirpation of bull trout from this core area could have negative consequences for the distribution, numbers, and reproduction of the unit. For example, a large gap between the closest functioning bull trout populations would be present at a central location in the unit. This gap (from the lower Snake to the upper Columbia) would exceed the distance that bull trout typically move during migration. Natural recolonization of the Yakima core area would require simultaneous movements by multiple fish from surrounding core areas, making management intervention (reintroduction) the only option for restoring bull trout to the Yakima with a reasonable likelihood of success in the foreseeable future. If native Yakima bull trout have unique genotypes, extirpation would reduce genetic diversity. If native Yakima bull trout are also locally adapted, reintroduced fish may not be as productive as the native population, or achieving successful reintroduction may be challenging. Genetic exchange between the upper Columbia and lower Snake lineages would be curtailed, and would only occur through management intervention, such as translocating spawners. Core areas within migratory distance of the Yakima that may historically have benefited from demographic support from this population would now be more isolated and deprived of demographic and genetic inputs, likely diminishing the probability of persistence of these core areas. All of these outcomes are contrary to the recovery goals and objectives in the Services draft recovery plan.

4 Effects of the Action

The Service regulations for implementing the Act define "effects of the action" as "the direct and indirect effects of an action on the species together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline" (50 C.F.R. 402.02). "Indirect effects" are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

To assess potential Project effects, the USFS uses the Service 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" (USFWS 1999). This format, adapted from the 1996 National Marine Fisheries Service format of a similar name, includes a decision matrix with pathways and indicators (Matrix or MPI) designed to describe a baseline of subpopulation and habitat conditions and effects of the proposed action on these conditions. The Service evaluates project effects in the context of the environmental baseline in the action area. The Service considers proximity, distribution, timing (duration, frequency), type, intensity, and severity of effects in order to evaluate the degree of effect resulting from project implementation (USFWS and NMFS 1998). The Service typically expresses degree of effect in terms of impacts to individual fish and fish populations and deviations of habitat indicators in the MPI from their baseline condition.

For projects which involve land management activities or habitat manipulation the Service typically refers to data about habitat characteristics both before and after the proposed action in order to complete the MPI and to help determine impacts to bull trout from the proposed project. Appendix C provides a listing of the impacts to baseline indicators for each element of the proposed project. Based on information complied in the Yakima Subbasin Plan (YBFWPB 2004) and the Yakima Salmon Recovery Plan (YBFWRB 2005), the current condition of habitat in most of the Yakima basin is "not properly functioning" as described by the Matrix.

Due to the fact that almost all of the proposed actions would have no effect on physical habitat conditions, attempts were not made to characterize whether each watershed affected was "properly functioning," "at risk," or "not properly functioning" for each indicator. Instead, the potential for each action to change existing conditions was determined. Two baseline indicators could be affected by the proposed project: the Physical Barrier indicator, and the Growth and Survival indicator. None of the actions were determined to be significant enough to move any of the baseline indicators from their existing condition into a new condition (e.g., to "degrade" or to "improve" the indicator).

For example, as shown in Appendix C, in Cowiche Creek a small rack will be erected temporarily in the fall in order to contain about 20 adult coho to encourage them to spawn nearby. This action will prevent bull trout movement in the stream for up to 6 weeks. Because of the timing and location the consequence of this action is likely to be minor for individual bull trout.

As previously mentioned, most Project elements are not expected to cause habitat effects. Exceptions to this will be noted and analyzed separately. The effects of most Project elements are expected to be limited to direct and indirect effects on individual bull trout. The following is a brief description of the major components of the four different salmon programs (spring, summer, and fall Chinook, plus coho salmon) which comprise the Project, as well as the anticipated effects on bull trout. For more details, see Appendix C, or for a complete Project description, see the BA.

4.1 Effects of the Spring Chinook Salmon Program

- Hatchery releases: this activity has the potential for adverse effects in the form of interactions between bull trout and the 270,000 spring Chinook smolts released each year as they migrate out of the acclimation sites on their journey to the ocean. These three facilities (Clark Flat and Easton on the mainstem Yakima River, and Jack Creek in the Teanaway River) are located downstream of areas where bull trout spawn and rear. This should minimize the potential for adverse effects on bull trout. Several years of ecological interaction studies conducted in the Yakima basin have not detected adverse effects on bull trout (Temple et al 2006). While the Service has no information to dispute this hypothesis, the Service also notes that the number of bull trout collected in these studies was very small, which would make it very difficult to detect possible effects, if they were indeed present.
- Broodstock collection: this activity is known to result in the handling off bull trout in the ladder at Roza dam (one to four fish per year since 1997). This activity is not known to result in significant long-term adverse effects on bull trout. However, stress or injury could result from this activity, and a short-term delay in their migration is certain. Because of the temporal overlap in the adult migration period for spring Chinook and bull trout, these bull trout could be on their way to spawn upstream. Since the delay in the collection facility is brief (minutes to hours) the Service assumes minor adverse effects will be temporary.
- Juvenile rearing: adults collected at Rosa will be brought to the Cle Elum supplementation hatchery for spawning. Eggs will be incubated and juveniles will be reared at this location for about 18 months. This activity will have no effect on bull trout. The habitat effects of the hatchery itself will be described elsewhere.
- Spawning surveys: this activity does not spatially overlap with bull trout spawning or rearing. Individual migratory bull trout may be encountered. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Juvenile collection: at Rosa Dam and the Chandler monitoring facility (lower Yakima River) during the winter and spring small numbers of juveniles will be collected and tagged. No bull trout have ever been collected during this activity since 1998. Individual juvenile bull trout may be encountered in the future, and would be released immediately. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Electrofishing surveys: monthly boat electrofishing surveys in the spring are planned in

the lower Yakima River up to RM 103 (just below Ahtanum Creek) to census pikeminnow. An experimental design that combines stomach samples and mark-recapture population estimates will estimate the impact of predation on Yakima River salmon and steelhead smolts. Very few bull trout have been documented in this area in recent times. All surveys will be conducted following the guidelines in the NMFS electrofishing guidelines (NMFS, 1998), and all work will be conducted in a manner that minimizes electrofishing injury to stream salmonids. Nevertheless, adverse effects, including mortality, could occur as a result. The Service expects no more than one bull trout per year to be affected.

- Non-target taxa (NTT) and residual competition monitoring: evaluating the population status of NTT necessitates a wide array of sampling techniques and locations. In Yakima River tributary streams, mark-recapture electrofishing protocols will be used in several locations. With the exception of some sites in the Tenaway River, all of these sites are in the mid to lower Yakima basin where bull trout are very rare or not present. Since 1990 when monitoring began, bull trout observations have been infrequent during NTT and competition surveys, and if any are encountered, they will be returned to the stream unharmed with minimal handling. Nevertheless, adverse effects, including mortality, could occur as a result. The Service expects no more than one bull trout per year to be affected.
- Domestication research: approximately 10 wild female and 10 wild male adult spring Chinook salmon will be collected annually in the Naches River drainage to provide offspring for ongoing domestication research, generally between September 1 and September 15, using tangle nets and dip nets. Fish will be visually identified (snorkeling or above surface) and captured using drift net techniques such that there is minimal or no incidental catch of other salmonid species. When nets are used in deep water habitats (e.g., pools), the area is first surveyed by snorkeling to ensure that no bull trout are present. If bull trout are observed, the area will not be sampled. If no bull trout are present, up to three snorkelers remain in the water for the entire length of time the net is set to assist in the capture of Chinook broodstock. The tangle nets have a 4-inch mesh size, which would allow any juvenile or subadult bull trout to pass through unharmed. Tangle nets will not be left unattended and will not generally be in the water for more than two minutes per drift. No bull trout have been incidentally captured during these types of collections to date (2003-2006) and the Service expects none will be captured during future collections.
- Sedimentation monitoring: Stream sediment loads associated with the operation of dams and other anthropogenic factor (e.g., logging, agriculture, and road building) will be monitored. This work is conducted jointly by the YN, U.S. Forest Service, and others. Gravel samples are collected from streams in the Little Naches and upper Yakima River watersheds. Gravel samples are then processed in the lab. This activity is expected to have no effect on bull trout.

4.2 Effects of the Summer Chinook Salmon Program

- Broodstock collection: this activity will collect 25 pairs of Chinook at Wells Dam (located on the Columbia River RM 535) during July and August. These 25 fish will be in addition to the hundreds of summer Chinook that are collected at that location for a pre-existing program in that area. Given the time of year and location this activity is not expected to result in significant long-term adverse effects on bull trout. However, stress or injury could result from this activity, and a short-term delay in their migration is certain. Because of the general lack of overlap in the adult migration period for summer Chinook and bull trout, bull trout spawning migration would probably not be affected. Since the delay in the collection facility is brief (minutes to hours) the Service assumes minor adverse effects will be temporary.
- Juvenile releases: embryonic fish raised at Wells will be transferred at the "eyed eggs" live stage to the Prosser facility. These 100,000 fish will be acclimated and volitionally released near Sunnyside Dam in the lower Yakima River, or the lower Naches River at Stiles Pond at RM 3.4, in April. These three facilities are located far downstream of areas where bull trout spawn and rear. This should minimize the potential for adverse effects on bull trout. Several years of ecological interaction studies conducted in the Yakima basin have not detected adverse effects on bull trout (Temple et al 2006). While the Service has no information to dispute this hypothesis, the Service also notes that the number of bull trout collected in these studies was very small, which would make it very difficult to detect possible effects, if they were indeed present.
- Juvenile collection: at the Chandler monitoring facility (RM 47) during the winter and spring small numbers of juveniles will be collected and tagged. No bull trout have ever been collected during this activity since 1998. Individual juvenile bull trout may be encountered in the future, and would be released immedaitely. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Spawning surveys: this activity, which will occur in the lower to mid Yakima River and the lower Naches River, does not spatially overlap with bull trout spawning or rearing. Individual migratory bull trout may be encountered. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.

4.3 Effects of the Fall Chinook Salmon Program

- Broodstock collection: this activity will rely mostly on fish collected from Chandler Canal during the fall when the Bureau of Reclamation drains the canal for maintenance, and fish collected at the Denil ladder located on the right bank fish ladder of Prosser Dam. Approximately 490 fall Chinook would be collected typically occur from the second week in September through the third week in November. In addition about 50 fish will be collected from Marion Drain. Fall Chinook that will be collected from the Chandler Canal are fish that will have fallen back at Prosser Dam and become entrained into the canal. All species of salmonids will be beach seined out of the canal. Given the

time of year and location this activity is not expected to result in significant long-term adverse effects on bull trout. However, stress or injury could result from this activity, and a short-term delay in their migration is certain. Because of the lack of overlap in the adult migration period for fall Chinook and bull trout, bull trout spawning migration would not be affected. Since the delay in the collection facility is brief (minutes to hours) the Service assumes minor adverse effects will be temporary.

- Juvenile releases: this activity will range between 250,000-1,000,000 smolts for release at Prosser Hatchery and 75,000 from Marion Drain between April and mid-May. Additional experimental releases involve acclimation in earthen ponds above Sunnyside Dam in both the Yakima and Lower Naches rivers. These facilities are located far downstream of areas where bull trout spawn and rear. This should minimize the potential for adverse effects on bull trout. Several years of ecological interaction studies conducted in the Yakima basin have not detected adverse effects on bull trout (Temple et al 2006). While the Service has no information to dispute this hypothesis, the Service also notes that the number of bull trout collected in these studies was very small, which would make it very difficult to detect possible effects, if they were indeed present.
- Juvenile collection: at the Chandler monitoring facility and Marion Drain during the winter and spring small numbers of juveniles will be collected and tagged. No bull trout have ever been collected during this activity since 1998. Individual juvenile bull trout may be encountered in the future, and would be released immedaitely. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Spawning surveys: this activity, which will occur in the lower to mid Yakima River and the lower Naches River, does not spatially overlap with bull trout spawning or rearing. Individual migratory bull trout may be encountered. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.

4.4 Effects of the Coho Salmon Program

- Broodstock collection: In the past coho broodstock collection occured at Prosser Dam. Beginning in the fall of 2007, coho broodstock will be taken from Roza Dam for the upper Yakima group and Cowiche Dam for the Naches group. Coho collected at these locations will have traveled approximately 100 miles farther than adults being collected at the Prosser Dam and, therefore, have a higher level of fitness in their life history. Up to approximately 600 adult coho will be collected throughout the run from the first week of September through the first week of December. All non-target fish intercepted during broodstock collection at Cowiche and Roza dams will be immediately passed back to the river to minimize stress and potential mortality. During the broodstock collection operation, up to 200 adult coho will be radio tagged, including all fish released into Lake Cle Elum and Bumping Reservoir. These fish would be released and tracked to determine their spawning locations and timing (see monitoring section below). The Bureau of Reclamation is planning to retrofit Wapatox Dam with an adult trap in the near

future. When that is completed, broodstock will be collected there instead of at Cowiche Dam. Given the time of year and location this activity is not expected to result in significant long-term adverse effects on bull trout. However, stress or injury could result from this activity, and a short-term delay in their migration is certain. Because of the lack of overlap in the adult migration period for fall Chinook and bull trout, bull trout spawning migration would not be affected. Since the delay in the collection facility is brief (minutes to hours) the Service assumes minor adverse effects will be temporary.

- Adult releases and outplanting: Adults will be racked into Taneum Creek for up to two weeks. Up to 120 female and 160 male adult coho will be placed in three different 200 meter sections of Taneum Creek. These three sections have been sampled by WDFW for approximately 12 years, and will allow research to be done on spawning conditions, impacts to native fish, and overall spawning success. The racks will be constructed of heavy metal tubing and will be bolted to one another. The spaces in the racks will be wide enough to allow juvenile fish to pass, but will prevent adults from moving through them. The racks will be in the creek up to two weeks and will be checked daily to process carcasses and check for debris. In addition, up to 20 pairs of adults will be outplanted in other select tributaries including Cowiche Creek, Pile Up Creek, Ahtanum Creek, Nile Creek, Wilson Creek, Reecer Creek, Quartz Creek, and Toppenish Creek. Wooden framed racks, each approximately 5 feet high and 5 feet wide with 3-inch hardware cloth screens attached, will be placed in each creek. The frames will be attached to one another and left in place for only 24 hours before being removed. Of all these waterbodies, only Ahtanum Creek is used by bull trout, and bull trout are normally many miles upstream of this trap location. Although it is unlikely that bull trout would get caught in the screens, the time of year could overlap with normal bull trout post-spawning migration to winter habitat. Based on redd counts in Ahtanum, and the expectation that impingement on the racks is unlikely, the Service anticipates that each year up to one adult bull trout could be impinged on the racks and possibly killed.

- Juvenile releases: The program will release up to 1,000,000 smolts annually, including up to 500,000 produced from Yakima basin broodstock, with the remaining 500,000 smolts coming from out of basin hatcheries. Smolts will be acclimated and released from La Salle High School on lower Ahtanum Creek, Lost Creek Pond and Stiles Pond in the lower Naches River, and Holmes, Boone, Easton, Brunson, and Hundley Ponds in the upper Yakima River. Aside from the upper Yakima locations, these facilities are located far downstream of areas where bull trout spawn and rear. This should minimize the potential for adverse effects on bull trout. Several years of ecological interaction studies conducted in the Yakima basin have not detected adverse effects on bull trout (Temple et al 2006). While the Service has no information to dispute this hypothesis, the Service also notes that the number of bull trout collected in these studies was very small, which would make it very difficult to detect possible effects, if they were indeed present.

- Stream seeding: this activity will test mobile acclimation units for 3 years on Toppenish Creek, Ahtanum Creek, and Cowiche Creek. The units will hold up to 10,000 smolts and will be placed near the streams in areas that have existing disturbance (such as spur roads), and plumbed into the creek. Once the smolts are released, the units will be

removed until the following season. The stream seeding may reduce flows to a small portion of each creek; however, this activity would take place during the winter and spring when stream flows are relatively high and would not cause dewatering of any stream reaches. This activity is expected to have effects to bull trout that are similar to juvenile releases mentioned above.

- Juvenile collection: at Rosa Dam and the Chandler monitoring facility (lower Yakima River) during the winter and spring small numbers of juveniles will be collected and tagged. No bull trout have ever been collected during this activity since 1998. Individual juvenile bull trout may be encountered in the future, and would be released immediately Three small rotary and box traps will also be used in lower Ahtanum Creek, Toppenish Creek, and the lower Naches River. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Spawning surveys: this activity, which will occur in mid Yakima River and the lower Naches River, does not spatially overlap with bull trout spawning or rearing. Individual migratory bull trout may be encountered. Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Snorkel surveys: spot checks will be conducted near acclimation release sites and throughout both entire river systems from spring through fall to determine whether coho have residualized Because of the standard procedures used to minimize disturbance on all salmonids during this activity, the Service does not expect adverse effects to occur.
- Redd capping: Redd caps are large nets that are buried around a selected redd. It is possible that redd capping may be done on all 14 tributaries. However, it is impossible to know before the adult coho are racked into the spawning areas, whether the cap is feasible in the tributary. Redd caps will be checked daily and used to assess percent survival of dug redds in tributaries. Redd caps will not overlap in areas where bull trout spawn, and are not expected to impact other species of fish.
- Over winter survival studies: Up to 3,000 PIT-tagged summer parr will be released into 14 select tributaries in early August. The coho survival for each tributary will be monitored using the PIT tag detectors on the mainstem Yakima River and Columbia River dams. Late summer snorkeling and shocking will also occur to look for presence and absence of these coho. In addition, summer parr will be released into the Upper Cle Elum River and Bumping Lake. The spillway on Lake Cle Elum has been retrofitted to surface spill water through two PIT tag detectors. Bumping Lake has no such detectors; however, engineering plans are currently being drawn for downstream juvenile monitoring sites using PIT tag detectors on mainstem dams in the Yakima and Columbia rivers. Both Lake Cle Elum and Bumping Lake coho activities will be done in conjunction with the Bureau of Reclamation and their feasibility studies of providing upstream and downstream passage at the two projects. All surveys will be conducted following the guidelines in the NMFS electrofishing guidelines (NMFS, 1998), and all work will be conducted in a manner that minimizes electrofishing injury to stream salmonids. Nevertheless, adverse effects, including mortality, could occur as a result. Because most of these sites will not overlap with bull trout distribution, the Service

expects no more than ten bull trout per tributary per year to be affected.

- Non-target taxa studies: Interaction evaluations will be conducted on Taneum Creek, Quartz Creek, and Nile Creek. Adult coho will be racked into these monitoring areas to assess changes in resident fish populations. Evaluations will be conducted in the summer by electrofishing and snorkeling monitoring reaches. Bull trout have not been observed in these creeks, and no effects on bull trout are anticipated.
- Carcass distribution: Approximately 400-500 adult coho and fall Chinook broodstock fish carcasses (sterilized) will be distributed in tributaries where coho are known to overwinter. In addition, carcasses will be put into side channels and beaver ponds of the Upper Yakima River, Naches River and Little Naches River. Carcasses will be put out in late winter (January and February) and distributed either by foot or boat. No adverse effects on bull trout are expected.

4.5 Habitat Effects Not Previously Described

There are two Project components which may affect physical habitat conditions not previously mentioned. These are the two hatchery facilities located within the Yakima basin at Cle Elum (RM 184) and Prosser (RM 47). The description below is a summary of these habitat effects. For more information, refer to the BA.

These facilities do not include some of the features associated with older-style fish hatcheries and therefore their habitat effects are minor. For example, there is no weir or dam at the Cle Elum hatchery, and unlike many hatcheries, no adult broodstock are collected at this facility. The Prosser hatchery is located adjacent to the Prosser Dam (a.k.a Chandler Diversion). That pre-existing dam structure has three ladders, at least two of which operate at all times. Neither of these facilities blocks bull trout migration, although passage through the ladder(s) at Prosser may result in a minor delay, as previously described.

Both hatchery facilities use a combination of ground water and surface water. The amount of surface water is less, and sometimes zero, during summer months, when river flow diminishes and wells supply most or all water needs. During other times of year the Cle Elum hatchery uses up to 18 cfs of surface water plus up to 14 cfs from the wells. Prosser uses up to 30 cfs of surface water and up to 7 cfs of well water during non-summer months.

Effects on in-stream flow are minimal because affected reaches are short. For example, at the Cle Elum facility, the outfall is adjacent to the hatchery, and that water is returned to the river via a natural side channel. At Prosser, surface water is diverted out of the Chandler Canal and returned to the Yakima River about 350 meters below the diversion. Because these reaches are very short the habitat consequences are insignificant. Furthermore, because bull trout activity at these locations is limited to transient migratory adult and sub-adult fish, consequences on individuals is probably negligible.

According to the information provided in the BA, there are no known water quality violations at either facility. This suggests but does not necessarily confirm that hatchery effluent, especially

phosphorus, does not impair fish habitat via eutrophication. As previously noted, there are several sections of the Yakima River where water quality indicators are out of compliance with water quality regulations. But these regulations are not necessarily based on fish habitat per se, and the total load of phosphorus or any other indicator reflects the cumulative effects of all sources in the watershed. Based on a recent consultation (FWS # 13260-2006-P-0010) at a larger and older hatchery facility located in a watershed where eutrophication was identified as a concern by regulatory agencies, hatchery effluent can be problematic for aquatic organisms. However, the Service believes that situation is not analogous to the Project because in the other situation the amount and proportion of the total load from the hatchery was much higher, and the design of that facility was much older. Based on the available information, the Service believes that water quality impacts from the Project are minor.

4.6 Effects on Designated Critical Habitat

In the Middle Columbia River Critical Habitat Unit, the effects of the action to the habitat conditions or PCEs are anticipated to be low. It is likely that PCEs 6 (migratory corridors) and 7 (food base) would be affected to some extent.

As previously described, broodstock collection, juvenile trapping, and other Project activities could result in temporary blockage or delay in bull trout movement patterns, particularly for foraging or overwintering. No bull trout spawning habitat or rearing will be adversely affected by the Project. As a result, this project may adversely affect the Migratory Connectivity PCE (PCE 6). However, this effect is expected to be very small and will not lead to an appreciable reduction in the amount of overall migratory connectivity in the Yakima Basin. The release of juvenile salmon from the hatchery program may beneficially affect the Food Base PCE (PCE 7). We do not expect that the Project would alter the function and conservation role of the Critical Habitat Unit.

4.7 Effects of Interrelated and Interdependent Actions

No effects of interrelated and interdependent actions were described in the BA. This BO does not cover the effects of several dams or hatcheries (other than the Cle Elum and Prosser facilities) which are used during the Project. Each of these pre-existing facilities has independent utility apart from the Project. For example, Rosa Dam, an irrigation diversion structure owned and operated by BOR, has a fish trap which will be used in the Project. The effects of using the trap have been analyzed in this BO, but other effects of the dam are not. A similar example is that eggs and fry will be incubated and raised at several pre-existing hatcheries outside of the Yakima basin on a space-available basis. Those facilities have independent utility, are not funded by BPA, and would continue to operate in essentially the same manner regardless of the Project. Therefore they are not interdependent or interrelated.

4.8 Effects Summary

Based on Project timing and location, the life stages most likely to be exposed to the Project are: 1) migratory adults, and 2) sub-adult emigrants. We do not anticipate any effects to spawning adults, redds with incubating eggs, or juveniles, based on the known distribution of spawning in the Yakima River and its tributaries.

A small number of bull trout may be temporarily disrupted from their normal behavior during Project activities such as monitoring and adult broodstock collection. Based on past experience in earlier phases of this Project, we do not expect death or significant injury to occur from most Project activities. We estimate that the number of bull trout temporarily affected to be up to 20 individuals per year. This number is approximately twice the number of bull trout encountered in ladders, traps, etc. over the previous phase of the Project. Certain new activities, for example stream racking for the Coho program, are new and therefore effects on bull trout are uncertain. Based on the BA, the Service anticipates that up to two bull trout may be injured or killed every year by the Project. The effects on population indicators for the Yakima core and Recovery Unit are likely to be negligible

4.9 Concurrent Effects

The Service is currently aware of one other project with substantive aquatic effects that will occur in the Yakima watershed during implementation of the proposed Project. The BOR ongoing activities began decades ago and are likely to continue relatively unchanged for the foreseeable future. These ongoing activities affect bull trout in several ways, especially via migratory blockages and hydrograph alteration. Section 7 consultation has not been completed for this activity.

5 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 BO. 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.

The Service is not aware of any other future actions that are reasonably certain to occur in the Yakima River watershed, which are likely to contribute to cumulative effects on bull trout. 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 some habitat indicators continuing to function at risk or at unacceptable risk.

As the human population in Washington State 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 housing and road construction, levee building, bank armoring, and campsite development on private lands. These activities tend to remove riparian vegetation (which reduces stream shade, increases stream temperature and reduces the opportunity for large woody debris recruitment), disconnect rivers from their floodplains, interrupt groundwater-surface water interactions, and reduce off-channel rearing habitat. Each subsequent action by itself may have only a small incremental effect, but taken together they may have a substantive effect that will further degrade the watershed's environmental baseline and undermine the improvements in 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.

6 Conclusion

The Service has reviewed the current status of the bull trout, the environmental baseline, the effects of the proposed Project, and cumulative effects. Based on this review, it is the Service's opinion that the Project, as proposed, is not likely to jeopardize the continued existence of the Columbia River interim recovery unit of the bull trout, when considering the impacts to their numbers, reproduction, and distribution. Significant effects to designated critical habitat are not expected to occur.

The environmental baseline for the Yakima core area indicates that although bull trout are widely distributed, abundance is generally low and productivity highly variable. Numerous historic and ongoing factors continue to limit the potential for population recovery at the core-area scale. In the Yakima River watershed most habitat pathways are not properly functioning.

The proposed Project will have minimal consequences on habitat pathways. Project effects are expected to result from activities which may affect individual fish and temporarily disrupt movement patterns. Therefore incidental take of bull trout may occur. Direct effects on individuals may lead to death or more likely injury such as physiologic effects that reduce survival and productivity of some individuals. These are unlikely to change the status of habitat or bull trout population indicators at the watershed or any larger scales. Overall, the proposed 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 the Columbia River interim recovery unit.

INCIDENTAL TAKE STATEMENT

1 Introduction

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 BPA so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in Section 7(o)(2) to apply. The BPA has a continuing duty to regulate the activity covered by this incidental take statement. If the BPA fails to assume and implement the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the BPA must report the progress of the action and its impact on the species to the Service as specified in this Incidental Take Statement [50 CFR §402.14(i)(3)].

2 Anticipated Amount or Extent of Take of Bull Trout

In the Effects of the Action section of the accompanying BO, the Service estimated the number of bull trout that would be exposed to adverse effects from this Project after making several simplifying assumptions. The rationale for these assumptions is also presented in the Effects of the Action section. These assumptions necessarily decrease the accuracy and precision of this incidental take estimate.

The primary mechanisms of incidental take of bull trout will be 1) temporary movement restrictions of adults and emigrating sub-adults due to ladders, traps, and similar devices; and 2) disruption of normal behavior patterns including feeding and sheltering due to monitoring activities such as snorkel surveys, electrofishing, and other field procedures. The secondary mechanism of incidental take will be injury or death associated with impingement on racks or other temporary barriers. The Service determined the amount of incidental take expected to occur based on the number of bull trout from different life stages exposed to project effects. These include:

- exposure of adults and sub-adult bull trout to temporary barriers and physical disturbance (sub-lethal; 10 individuals per year);
- exposure of sub-adult bull trout to electrofishing activities (sub-lethal; 10 individuals per year); and
- exposure of adult and sub-adult bull trout to racks or other temporary barriers (lethal or sub-lethal; 2 individuals per year).

All incidental take discussed here will occur in the Yakima River core area, within the Columbia River interim recovery unit.

The Service acknowledges that the amount of incidental take of the bull trout resulting from the project will be difficult to detect due to: 1) relatively low density of individuals in the action area; 2) primarily nocturnal activity patterns, tendency to hide in or near the substrate, small body size and cryptic coloration and behavior of sub-adult fish, and the need to use snorkeling techniques to achieve a high likelihood of detecting bull trout; 3) the low likelihood of finding an injured or dead individual in the relatively complex habitats in the action area, and 4) high rate of removal of injured individuals by predators or scavengers. Given these difficulties, the Service appreciates all reports of detections of incidental take. These reports enable the Service to

develop better methods for avoiding and minimizing incidental take, and to further refine estimates of incidental take for future projects of a similar nature in similar contexts.

3 Effect of the Take

In the accompanying BO, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species.

4 Reasonable and Prudent Measures

The Service believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize take of bull trout.

RPM 1. Minimize incidental take resulting from adult collection activities.
RPM 2. Minimize incidental take resulting from adult release activities.
RPM 3. Minimize incidental take resulting from juvenile collection activities.
RPM 4. Minimize incidental take resulting from field monitoring activities.

5 Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the Act, the BPA must comply with the following terms and conditions (T&Cs), which implement the RPMs described above, and are designed to minimize impacts to bull trout. These terms and conditions are mandatory.

To implement RPM 1:

T&C 1. During collection activities at Cowiche, Prosser, Roza, and Wapatox Dams, operate the fish ladder and sorting facility around the clock for the duration of collection activity. Release bull trout as quickly as possible upstream of the dam. Record all observations of bull trout, and report this information to the Service on an annual basis.

To implement RPM 2:

T&C 2. Monitor the Ahtanum Creek rack daily to check for impinged bull trout. If bull trout are observed on or near the racks, contact the Service at 509-665-3508 as soon as possible to discuss whether to modify or terminate this activity.

To implement RPM 3:

T&C 3. Minimize holding time of all juvenile bull trout, unless otherwise directed by the Service. Check traps daily at Roza Dam, Ahtanum Creek, and Wapatox Diversion. Record all observations of bull trout, and report this information to the Service on an annual basis.

To implement RPM 4:

T&C 4. During spring Chinook spawning activities, avoid bull trout and their redds, if present. Record all observations of bull trout and redd locations, and report this information to the service on an annual basis.

T&C 5. During electrofishing activity, record all observations of bull trout, and report this information annually. Do not collect stomach samples from bull trout. Minimize holding time of all bull trout, unless otherwise directed by the Service. Record all observations and locations of bull trout, and report this information to the service on an annual basis. If the Service determines that unexpected numbers of bull trout are being affected by this activity (more than one fish per tributary, or reach if referring to mainstem Naches or Yakima Rivers), this activity may require modification the following year.

T&C 6. During gill or tangle net activities, wade and or snorkel prior to deploying the net upstream and downstream of the site at least 30 meters. If bull trout are observed in that area, do not conduct the activity that day. Record all observations and locations of bull trout, and report this information to the service on an annual basis.

6 Reporting Requirements

In order to monitor the impacts of implementation of the reasonable and prudent measures, the BPA shall prepare a report describing the progress of the proposed Project, including implementation of the associated Ts&Cs, and impacts to the bull trout (50 CFR § 402.14(I)(3)). The report, which shall be submitted to the CWFO on or before January 1 of each year of the Project, shall comply with the T&Cs above.

Upon locating a dead, injured, or sick specimen of an endangered or threatened species, initial notification must be made to the nearest Service Law Enforcement Office (Redmond, Washington; telephone: 425.883.8122). 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 reasonable and prudent measures, 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, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiating of consultation and review of the reasonable and prudent measures provided. The BPA must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures. Because incidental take for this Project is difficult to estimate and detect, the Service recommends contacting the CWFO if construction plans change from those described in this BO.

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 (CRs) are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends that the BPA:

CR 1. Collect fin clips from bull trout less then 300mm long encountered during Project snorkel surveys for genetic analysis. Contact the Service regarding the "genetics kit" and collection protocols.

CR 2. During juvenile anadromous PIT tagging activities at Roza and Chandler, insert PIT tags in bull trout as well and monitor their movements along with the anadromous fish the Project will already be tracking.

CR 3. After developing a protocol with USFWS and WDFW, implant radio tags in suitably large bull trout encountered at dams during Project adult salmon collection activities so that the agencies can track these fish later.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any CRs.

RE-INITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR §402.16, reinitiating 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 BO; 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 BO; 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 reinitiating.

LITERATURE CITED

BioAnalysts, Inc., 2004. Movement of Bull Trout in the Mid-Columbia River and Tributaries, 2001-2004. Report prepared for Chelan, Douglas, and Grant PUDs.

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, Oregon.

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.

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

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.

Muhfeld, C. C. and B. Marotz. 2005. Seasonal movement and habitat use by subadult bull trout in the upper Flathead River system, Montana. North American Journal of Fisheries Management. 25(3):797-810.

National Marine Fisheries Service (NMFS). 1998. Backpack Electrofishing Guidelines. National Marine Fisheries Service, Portland, Oregon.

Rhodes, J. J., McCullough, D.A., and F.A. Espinosa. 1994. A coarse screen process for potential application in ESA consultations. Columbia River Inter-Tribal Fish Commission, Portland, Oregon. 127 pp. and Appendices.

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.

Schmetterling, D.A. and M.H. Long. 1999. Montana anglers' inability to identify bull trout and other salmonids. Fisheries 24(7):24-27.

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

USFWS (United States Fish and Wildlife Service). 2005. Draft movement patterns of adult bull trout in the Wenatchee River basin, Washington. U.S. Fish and Wildlife Service, Leavenworth and Wenatchee, Washington.

USFWS (United States Fish and Wildlife Service). 2004a. Draft Recovery Plan for the Jarbidge River Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 132 + xiii pp.

USFWS (United States Fish and Wildlife Service). 2004b. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Volume I (of II): Puget Sound Management Unit, Portland, Oregon. 389 + xvii pp.

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

USFWS (United States Fish and Wildlife Service). 2002b. Chapter 2, Middle Columbia Recovery Unit, Washington. *In*: Bull trout (*Salvelinus confluentus*) draft recovery plan. U. S. Fish and Wildlife Service, Portland, Oregon. 113 pp.

USFWS (United States Fish and Wildlife Service). 1999. Draft. A Framework to Assist in Making Endangered Species Act Determinations of Effect for individual of Grouped Actions at the Bull Trout Subpopulation Watershed Scale. June 1999. 46 pp.

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

Temple, G. M., T. N. Pearsons, C. L. Johnson, and T. D. Webster. 2006. Results of non-target taxa monitoring after the seventh release of hatchery salmon smolts in the upper Yakima Basin. Pages 6-33 *in* T. N. Pearsons and 4 co-authors, 2006. Ecological Interactions Between Non-target Taxa of Concern and Hatchery Supplemented Salmon, Annual Report 2005. Bonneville Power Administration, Portland, Oregon. DOE/BP-00022370-1.

WSCC (Washington State Conservation Commission). 2001. Salmon and steelhead habitat limiting factors, Yakima River Watershed. Water Resource Inventory Areas 37 – 39, Final Report. Washington State Conservation Commission, Olympia, Washington.

WSOFM (Washington State Office of Financial Management). 2000. Washington state census. Accessed at: www.ofm.wa.gov/census 2000.

YBFWPB (Yakima Basin Fish and Wildlife Planning Board). 2004. Yakima Subbasin Plan. Yakima, Washington.

YBFWRB (Yakima Basin Fish and Wildlife Recovery Board). 2006. Yakima Salmon and Bull Trout Recovery Plan. Yakima, Washington.

Personal Communications

Brewer, D., USFWS, Fish and Wildlife Biologist, Montana Ecological Services Field Office, 585 Shepard Way, Helena, Montana 59601

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

Morgan, David, USFWS, Fish and Wildlife Biologist, Central Washington Field Office, 215 Melody Lane, Suite 119, Wenatchee, Washington 98801

APPENDIX A: Bull Trout Life History and Population Dynamics

1. Historic and Current Range

Bull trout are native to northwestern North America, historically occupying a large geographic range extending from California north into the Yukon and Northwest Territories of Canada and east into western Montana and Alberta (Cavender 1978). They are generally found in interior drainages, but also occur on the Pacific Coast in Puget Sound and in the large drainages of British Columbia.

The historic range of the bull trout is likely to have contracted and expanded over time in relation to natural environmental and climate changes; the distribution of the species was likely patchy even in pristine environments. Despite uncertainty about the exact historical range, the number and size of historical populations, and the role of natural factors in the status of the species, there is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and continue to pose significant risks of further extirpations of local populations.

Bull trout currently occur in rivers and tributaries in Montana, Idaho, Washington, Oregon (including the Klamath River basin), Nevada, two Canadian Provinces (British Columbia and Alberta), and several cross-boundary drainages in extreme southeast Alaska. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta, and the MacKenzie River system in Alberta and British Columbia (Cavender 1978; McPhail and Baxter 1996; Brewin and Brewin 1997). The remaining distribution of bull trout is highly fragmented.

The distribution of bull trout has shrunk in the Pacific Northwest and northern California. The distribution of bull trout has been reduced by an estimated 55 percent in the Klamath River DPS and 79 percent in the Columbia River DPS since pre-settlement times, due primarily to local extirpations, habitat degradation, and isolating factors (Quigley and Arbelbide 1997). Within the Puget Sound basin, bull trout distribution is similar to historic distributions, but population abundance has significantly decreased (Chan, J., USFWS, pers. comm., 2003). In California, bull trout were historically found only in the McCloud River, which represented the southernmost extension of the species' range. The last confirmed report of bull trout in the McCloud River was in 1975, and this population is now considered to be extirpated (Rode 1990).

2. Life History

Bull trout populations exhibit three different life-history types: resident, migratory, and anadromous. Resident and migratory forms exist throughout the range of the bull trout (Rieman and McIntyre 1993) and spend their entire lives in freshwater. The anadromous life-history form is currently only known to occur in the Coastal-Puget Sound region within the coterminous United States (Volk, 2000; Kraemer 1994; Mongillo 1993). Multiple life-history types may be expressed in the same population, and diversity of life-history types is considered important to the stability and viability of bull trout populations (Rieman and McIntyre 1993).

Life history type determines where the majority of the growth and maturation occurs. Anadromous bull trout growth and maturation mostly occurs in estuarine and marine waters. Migratory bull trout mostly grow and mature in lakes, reservoirs, and large river systems. Resident bull trout populations are generally found in small headwater streams where the fish remain for their entire lives.

Juveniles of migratory bull trout typically rear in tributary streams for 1 to 3 years before migrating downstream into a larger river, lake, or estuary and/or nearshore marine area to mature (Rieman and McIntyre 1993). In some lake systems, age 0+ fish may migrate directly to lakes (Riehle *et al.* 1997). Juvenile and adult bull trout frequently inhabit side channels, stream margins and pools with suitable cover (Sexauer and James 1993) and areas with cold hyporheic zones or groundwater upwellings (Baxter and Hauer 2000).

2.1 Freshwater Habitat

Bull trout have more specific habitat requirements than other salmonids (Rieman and McIntyre 1993). Growth, survival, and long-term persistence are dependent upon several habitat characteristics, including: cold water, complex instream habitat, a stable substrate with a low percentage of fine sediments, high channel stability, and stream/population connectivity. Stream temperature and substrate type, in particular, are critical factors for the sustained long-term persistence of bull trout. Spawning is often associated with the coldest, cleanest, and most complex stream reaches within basins. However, bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1995), and should not be expected to occupy all available habitats at the same time (Rieman *et al.* 1997a).

Although bull trout clearly prefer cold waters and nearly pristine habitat, they can occur in degraded habitats. Given the depressed status of some subpopulations, it is likely that individuals in degraded rivers are using less than optimal habitat because that may be all that is available. In basins with high productivity, such as the Skagit River basin, bull trout may be using marginal areas when optimal habitat becomes fully occupied (Kraemer, C., WDFW, pers. comm. 2002). Bull trout have been documented using habitats that may be atypical or characterized as likely to be unsuitable (personal observation).

2.1.1 Temperature. Bull trout are typically associated with the coldest stream reaches within basins. For long-term persistence, bull trout populations need a stream temperature regime that ensures sufficient amounts of cold water are present at the locations and during the times needed to complete their life cycle. Temperature is most frequently recognized as the factor limiting bull trout distribution (Dunham *et al.* 2003; Dunham and Chandler 2001; Rieman and McIntyre 1993), which partially explains their generally patchy distribution within watersheds (Fraley and Shepard 1989; Rieman and McIntyre 1995). When maximum daily temperatures did not exceed approximately 11 to 12°C, the probability of occurrence for juvenile bull trout in Washington was high (75 percent) (Dunham *et al.* 2001). The most productive bull trout habitat in several Oregon streams had temperatures which seldom exceeded 15°C (Buckman *et al.* 1992; Ratcliff 1992; Ziller 1992).

Stream temperatures must drop below 9 or 10°C before spawning occurs (McPhail and Murray 1979; Riehle 1993). Water temperature also seems to be an important factor in determining early survival, with cold water temperatures resulting in higher egg survival and faster growth rates for fry and juveniles (Pratt 1992). Optimum incubation temperatures range from 2° to 6°C, while at 8°C to 10°C, survival ranged from 0 to 20 percent (McPhail and Murray 1979). Stream temperatures for tributary rearing juvenile bull trout are also quite low, ranging from 6° to 10°C (Buchanan and Gregory 1997; Goetz 1989; Pratt 1992; McPhail and Murray 1979).

Although bull trout require a narrow range of cold water temperatures to rear, migrate, and reproduce, they are known to occur in larger, warmer river systems that may cool seasonally, and which provide important migratory corridors and forage bases. For migratory corridors, bull trout typically prefer water temperatures ranging between 10° to 12°C (McPhail and Murray 1979; Buchanan and Gregory 1997). When bull trout migrate through stream segments with higher water temperatures they tend to seek areas offering thermal refuge such as confluences with cold tributaries (Swanberg 1997), deep pools, or locations with surface and groundwater exchanges in alluvial hyporheic zones (Frissell 1999).

Increases in stream temperatures can cause direct mortality, increased susceptibility to disease or other sublethal effects, displacement by avoidance (McCullough *et al.* 2001, Bonneau and Scarnechia 1996), or increased competition with species more tolerant of warm stream temperatures (Rieman and McIntyre 1993; Craig and Wissmar 1993 cited in USDI (1997); MBTSG 1998). Brook trout, which can hybridize with bull trout, may be more competitive than bull trout and displace them, especially in degraded drainages containing fine sediment and higher water temperatures (Selong *et al.* 2001; Leary *et al.* 1993). Recent laboratory studies suggest bull trout are at a particular disadvantage in competition with brook trout at temperatures >12° C (McMahon *et al.* 2001; Selong *et al.* 2001).

2.1.2 Substrate. Bull trout show a strong affinity for stream bottoms and a preference for deep pools in cold water streams (Goetz 1989; Pratt 1992). Stream bottom and substrate composition are highly important for spawning site selection and juvenile rearing (Rieman and McIntyre 1993; Graham *et al* 1981; McPhail and Murray 1979). Fine sediments can influence incubation survival and emergence success (Weaver and White 1985; Pratt 1992) but may also limit access to substrate interstices that are important cover during rearing and over-wintering (Goetz 1994; Jakober 1995). Rearing densities of juvenile bull trout have been shown to be lower when there are higher percentages of fine sediment in the substrate (Shepard *et al.* 1984). Due to this close connection to substrate, bed load movements and channel instability can negatively influence the survival of young bull trout.

2.1.3 Cover and Stream Complexity. Bull trout of all age classes are closely associated with cover, especially during the day (Baxter and McPhail 1997; Fraley and Shepard 1989). This association appears to be more important for bull trout than for other salmonids (Pratt 1992; Rieman and McIntyre 1993). Cover may be in the form of overhanging banks, deep pools, turbulence, large wood, or debris jams. Young bull trout also use interstitial spaces in the substrate for cover. Bull trout distribution and abundance are positively correlated with pools

and complex forms of cover, such as large or complex woody debris and undercut banks, but may also include coarse substrates (cobble and boulder) (Rieman and McIntyre 1993; Jakober 1995; MBTSG 1998).

Large pools, consisting of a wide range of water depths, velocities, substrates, and cover, are characteristic of high quality aquatic habitat and are an important component of channel complexity. Large wood in streams creates pools and undercut banks, deflects streamflow, retains sediment, stabilizes the stream channel, increases hydraulic complexity, and improves feeding opportunities (Murphy 1995). All these functions of large wood enhance the quality of habitat for salmonids and contribute to channel stability (Bisson *et al.* 1987). By forming pools and retaining sediment, large wood also helps maintain water levels in small streams during periods of low stream flow (Lisle 1986).

Reduction of wood in stream channels, either from present or past activities, generally reduces pool frequency, quality, and channel complexity (Bisson *et al.* 1987; House and Boehne 1987; Spence *et al.* 1996). Studies conducted with Dolly Varden, a species similar to bull trout, showed that population density declined with the loss of woody debris after clear cutting or the removal of logging debris from streams (Bryant 1983; Dolloff 1986; Elliott 1986; Murphy *et al.* 1986).

2.1.4 Channel and Hydrologic Stability. Maintaining bull trout habitat requires stream channel and flow stability (Rieman and McIntyre 1993). Bull trout are exceptionally sensitive to activities that directly or indirectly affect stream channel integrity. Juvenile and adult bull trout frequently inhabit areas of reduced water velocity, such as side channels, stream margins, and pools that are easily eliminated or degraded by management activities (Rieman and McIntyre 1993).

Channel dewatering caused by low flows and bed aggradation (accumulation of rock and sediment) can block access for spawning fish, resulting in year class failures (Weaver 1992). Aggradation of the streambed can be accelerated by management activities that increase the frequency of landslides (e.g., road building and timber harvest) or that constrict stream channels (e.g., undersized culverts at stream crossings).

Patterns of stream flow and the frequency of extreme flow events that influence substrates may be important factors in population dynamics (Rieman and McIntyre 1993). With lengthy overwinter incubation and a close tie to the substrate, embryos and juveniles may be particularly vulnerable to flooding and channel scour associated with the rain-on-snow events that are common in some parts of the range (Rieman and McIntyre 1993).

2.1.5 Migration and Habitat Connectivity. Bull trout are highly migratory. The persistence of migratory bull trout populations requires intact migration corridors. Migration corridors link wintering areas with foraging, spawning, and rearing areas used at different times of the year, and by different life-history stages (MBTSG 1998, Rieman and McIntyre 1993). In the Coastal-Puget

Sound DPS, migratory corridors may link marine and freshwater habitats as well as linking lake, river, and tributary complexes that are necessary for bull trout to complete their life cycle.

Bull trout migratory movements include both spawning migrations and downstream emigration of juveniles from headwater rearing areas to feeding and maturation areas. Migratory bull trout may begin their spawning migrations as early as April and have been known to migrate upstream as far as 250 kilometers (155 miles) to spawning grounds (Fraley and Shepard 1989). Current radio-telemetry work being done in the upper Columbia River basin is revealing movement patterns of migratory bull trout that extend over 160 kilometers (100 miles), from the headwaters of the Wenatchee and Methow basins to the Columbia River and the pools formed by Rocky Reach, Rock Island, and Wells Dams (De La Vergne, J., USFWS, pers. comm.). During these long migrations, bull trout use a wide variety of habitats. Compared to spawning migration, relatively little published information is available about juvenile emigration. Age of emigration varies from one to three years old (Rieman and McIntyre 1993), and annual timing of emigration is highly variable and can extend from spring until winter.

Stream habitat alterations that restrict or eliminate bull trout migration corridors include degradation of water quality (especially increasing temperatures and increased amounts of fine sediments), alteration of natural stream flow patterns, impassable barriers (such as dams and culverts), and structural modification of stream habitat (such as channelization or removal of cover). Dam and reservoir construction and operations have altered major portions of bull trout habitat throughout the Columbia River basin. Dams without fish passage create barriers to fluvial and adfluvial bull trout which isolates populations. The operations of dams and reservoirs alter the natural hydrograph, thereby affecting forage, water temperature, and water quality (USDI 1997). Many populations of "resident" bull trout that are isolated above artificial barriers to migration are remnants of populations that once supported larger, more fecund, migratory forms.

2.2 Marine Phase

Anadromous bull trout forage and mature in the nearshore marine habitats on the Washington coast and in Puget Sound. The marine and estuarine residency period for bull trout is poorly understood. Thorpe's (1994) review found little evidence in the literature that the estuary was used for physiological adjustment or as a refuge from predation, but he did find clear evidence of a trophic advantage to estuarine residency (abundant prey). While in the estuary, native char can grow very quickly. Subadults grow from 20 to 40 mm per month and reach a length of 250 to 350 mm before their upstream migration in late summer and early fall (Kraemer 1994). During their marine residency, subadults from Dolly Varden populations on Vancouver Island gained 74 mm and adults gained 45 mm in length (Smith and Slaney 1979).

Kraemer (1994) speculated that the distribution of native char in marine waters may be closely tied to the distribution of bait fish and coincident with their spawning beaches. Char from Puget Sound have been found to prey on surf smelt, Pacific herring, Pacific sand lance, pink salmon smolts, chum salmon smolts, and a number of invertebrates (Kraemer 1994). The Quinault Indian Nation documented smelt as a prey item for native char in the Queets River. Kraemer

(as cited in Nightingale and Simenstad 2001) observed that native char in estuaries typically foraged in water less than 3 meters deep and were often seen foraging in water less than 0.5 meters deep.

Anadromous migrations of bull trout have been studied in rivers of the Olympic Peninsula in Washington. Radio-tagged bull trout from the Hoh River have migrated out into the marine environment and then back into a number of other coastal drainages, including the Queets and Quinault Rivers, and have shown complex movement patterns within and between rivers (Brenkman and Corbett 2005). In Alaska and British Columbia, downstream migration of Dolly Varden occurs in spring and early summer and upstream migration occurs from late spring through early winter (ADFG 1963; Armstrong 1965; Smith and Slaney 1979). In southeast Alaska, Dolly Varden spent an average of 116 days in marine waters (Armstrong 1965). Armstrong (1965) also reported that Dolly Varden migrated directly to saltwater and did not backtrack or linger in the river.

Anadromous char undertake fairly extensive marine migrations. Anadromous Dolly Varden typically stay close to the shoreline, but sometimes move up to 30 miles off shore (e.g., ADFG 1963). Dolly Varden move extensive distances in salt water, and may enter freshwater streams that are far from their natal streams (DeCicco 1992; Thorpe 1994). Kraemer (1994) has documented fish in Puget Sound as far as 25 miles from their natal stream. Marking studies used to investigate migratory patterns of Dolly Varden in southeast Alaska found marked fish in 25 different stream systems as far as 72 miles from their natal stream (Armstrong 1965). About forty percent of the marked fish appeared to migrate to other streams during the winter, but most fish remained within tens of miles of their natal streams.

Nearshore marine habitats have been significantly altered by human development (PSWQAT 2000). Construction of bulkheads and other structures have modified the nearshore areas and resulted in habitat loss that has directly affected forage fish for bull trout. Other impacts to the marine environment include alterations to water quality resulting from fish pathogens, nutrients and toxic contaminants, urbanization, and stormwater runoff from basins that feed Puget Sound. Global changes in sea level and climate may also have more widespread ramifications on these habitats, and on the Puget Sound ecosystem as a whole (Klarin *et al.* 1990; Thom 1992).

2.3 Food Habits

Like many fish, different life stages of bull trout feed at different trophic levels. Adult bull trout are apex piscivores, and require a large prey base and home range. Adult and subadult migratory bull trout feed primarily on various trout and salmon species, whitefish (*Prosopium* spp.), yellow perch (*Perca flavescens*), and sculpin (*Cottus* spp.). Subadult and adult migratory bull trout move throughout and between basins in search of prey. Anadromous bull trout in the Coastal-Puget Sound DPS also feed on ocean fish such as surf smelt (*Hypomesus pretiosus*) and sandlance (*Ammodytes hexapterus*). Resident and juvenile bull trout prey on terrestrial and aquatic insects, macrozooplankton, amphipods, mysids, crayfish, and small fish (Wyman 1975; Rieman and Lukens 1979 in Rieman and McIntyre 1993; Boag 1987; Goetz 1989; Donald and

Alger 1993). A recent study in the Cedar River Watershed of western Washington found bull trout diets also include aquatic insects, crayfish, and salamanders (Connor *et al.* 1997).

2.4 Reproductive Biology

Bull trout become sexually mature between 4 and 9 years of age, and may spawn in consecutive or alternate years (Shepard *et al.* 1984; Pratt 1992). Spawning typically occurs from August through December in cold, low-gradient 1st- to 5th-order tributary streams, over loosely compacted gravel and cobble having groundwater inflow (Shepard *et al.* 1984; Brown 1992; Rieman and McIntyre 1996; Swanberg 1997; MBTSG 1998; Baxter and Hauer 2000). Surface/groundwater interaction zones, which are typically selected by bull trout for redd construction, have high dissolved oxygen, constant cold water temperatures, and increased macro-invertebrate production. Spawning sites frequently occur near cover (Brown 1992).

Hatching occurs in winter or early spring, and alevins may stay in the gravel for up to three weeks before emerging. The total time from egg deposition to fry emergence from the gravel may exceed 220 days.

Post-spawning mortality, longevity, and repeat-spawning frequency are not well known (Rieman and McIntyre 1996), but life spans may exceed 10 to 13 years (McPhail and Murray 1979; Pratt 1992; Rieman and McIntyre 1993). Adult adfluvial bull trout may live as long as 20 years, and may require as much as 20 months in the lake or reservoir habitat to facilitate adequate energy storage and gamete development before they return to spawn again (67 FR 71236).

Migratory bull trout are highly visible during spawning due to their large size and location in relatively small streams during periods of low flow. Channel complexity and cover are important components of spawning habitat to reduce both predation risk and potential for poaching.

3. Population Dynamics

Bull trout are considered to display complex metapopulation dynamics (Dunham and Rieman 1999). Size of suitable habitat patches appears to play an important role in the persistence of bull trout populations, along with habitat connectivity and human disturbance, especially road density. Analyses of spatial and temporal variation in bull trout redds indicates weak spatial clustering in patterns of abundance through time (Rieman and McIntyre 1996). Spatial heterogeneity in patterns of abundance was high, however, at a regional scale. This combination of patterns suggests that maintenance of stable regional populations may require maintenance of connected patches of high quality habitat where dispersal and demographic support can occur readily among patches (Rieman and McIntyre 1996).

The importance of maintaining the migratory life-history form of bull trout, as well as migratory runs of other salmonids that may provide a forage base for bull trout, is repeatedly emphasized in the scientific literature (Rieman and McIntyre 1993; MBTSG 1998; Dunham and Rieman 1999; Nelson *et al.* 2002). Isolation and habitat fragmentation resulting from migratory barriers have negatively affected bull trout by: 1) reducing geographical distribution (Rieman and McIntyre

1993; MBTSG 1998); 2) increasing the probability of losing individual local populations (Rieman and McIntyre 1993; MBTSG 1998; Nelson *et al.* 2002; Dunham and Rieman 1999); 3) increasing the probability of hybridization with introduced brook trout (Rieman and McIntyre 1993); 4) reducing the potential for movements in response to developmental, foraging, and seasonal habitat requirements (MBTSG 1998; Rieman and McIntyre 1993); and 5) reducing reproductive capability by eliminating the larger, more fecund migratory form from many subpopulations (MBTSG 1998; Rieman and McIntyre 1993). Therefore, restoring connectivity and restoring the frequency of occurrence of the migratory form will reduce the probability of local and subpopulation extinctions. Remnant populations, that lack connectivity due to elimination of migratory forms, have a reduced likelihood of persistence (Rieman and McIntyre 1993; Rieman and Allendorf 2001).

Lakes and reservoirs provide important refugia for bull trout. In general, lake and reservoir environments are relatively more secure from catastrophic natural events than stream systems (67 FR 71236). They provide a sanctuary for bull trout, allowing them to quickly rebound from temporary adverse effects to spawning and rearing habitat. For example, if a major wildfire burns a drainage and eliminates most or all aquatic life (a rare occurrence), bull trout sub-adults and adults that survive in the lake may return the following year to repopulate the burned drainage. This underscores the need to maintain migratory life forms and habitat connectivity in order to increase the likelihood of long-term population persistence.

4. Threats and Conservation Needs

4.1 Reasons for Listing

Factors contributing to the decline of bull trout populations were described in the final rules for listing. They include restriction of migratory routes by dams and other unnatural barriers; forest management, grazing, and agricultural practices; road construction; mining; introduction of non-native species; and residential development resulting in adverse habitat modification, over-harvest, and poaching (Bond 1992; Thomas 1992; Rieman and McIntyre 1993; Donald and Alger 1993; WDFW 1997).

Extensive habitat loss and fragmentation of subpopulations have been documented for bull trout in the Columbia River basin and elsewhere within its range (Rieman and McIntyre 1993). Road construction, grazing, and agricultural practices in the Columbia River basin have degraded habitat conditions by contributing to elevated stream temperatures, increased sedimentation and channel embeddedness, and reductions in the extent of riparian vegetation. Mining activities have compromised habitat conditions by discharging waste materials into streams and diverting and altering stream channels. Residential development has threatened water quality by introducing domestic sewage and altering riparian conditions. Dams of all sizes (e.g., mainstem hydropower and tributary irrigation diversions) have severely limited migration of bull trout in the Columbia River basin. Competition from and hybridization with non-native trout are also considered threats to bull trout (USDI 1998; 1999).

Wildfire in the dry forests of the interior Columbia Basin also presents a substantive threat to bull trout populations. Although bull trout evolved with wildfire, and can benefit from it, fire

suppression in some areas has altered fire regimes so drastically that they no longer resemble historic fire regimes in which bull trout evolved (Rieman *et al.* 1997b; Rieman and Clayton 1997; Gresswell 1999). Species that have narrow habitat requirements, such as bull trout, that inhabit degraded and fragmented aquatic systems are considered vulnerable to fire and fire-related disturbance (Dunham *et al.* 2003). In this context, wildfire could threaten long-term persistence of bull trout because it exerts selection pressures different than those that produced the phenotypes and genotypes present today.

4.2 New Threats

No new threats since listing have been specifically identified at the range-wide scale, but previously identified threats, or new threats at the local scale, may not have been fully appreciated. Examples include the proposed introduction of northern pike (*Esox lucius*) as a sport fish in Montana and expansion of the range of whirling disease (*Myxobolus cerebralus*).

4.3 Conservation Needs

Conservation needs are measures necessary to redress the threats that led to the listing of a species. As described in the "habitat" sections above, the habitat conservation needs of bull trout are often generally expressed as the need to provide the four "Cs"--cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality 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. These habitat conditions are necessary to promote long-term persistence.

In addition to habitat conservation needs, other needs are associated with sustaining population dynamics. These conservation needs include: 1) maintain and restore multiple, interconnected populations in diverse habitats across the range; 2) preserve the diversity of life-history strategies; and 3) maintain genetic and phenotypic diversity across the range. Each of these needs is described below in more detail. These conservation needs apply to bull trout at multiple scales ranging from the coterminous listing down to subpopulations.

4.3.1 *Interconnected Populations*. Maintaining multiple bull trout populations distributed and interconnected throughout their current range will also provide a mechanism for spreading the risk of extinction from stochastic events (Rieman and McIntyre 1993; Rieman and Allendorf 2001; Spruell *et al.* 1999; Healey and Prince 1995; Hard 1995). Bull trout still occur widely, but in reduced numbers, across most portions of their historical range. Within this broad distribution, significant declines and local extinctions have occurred. Current patterns in distribution and other empirical evidence indicate that further declines and local extinctions are likely (Rieman *et al.* 1997a; Spruell *et al.* 2003; Rieman and Allendorf 2001; Dunham and Rieman 1999). Maintenance of widespread and interconnected populations improves the chances that declining populations can be "rescued" from extinction by immigrants from more robust populations, or if local extinctions occur, that recolonization will occur.

Preservation of interconnected populations and multiple life histories enable bull trout to persist through natural disturbance events, such as large fires. Bull trout evolved under historic fire regimes in which disturbance to streams from forest fires resulted in a mosaic of diverse habitats. However, forest management and fire suppression over the past century have increased homogeneity of terrestrial and aquatic habitats, increasing the likelihood of large, intense forest fires in some areas. Because the most severe effects of fire on native fish populations can be expected where populations have become fragmented by human activities or natural events, an effective strategy to ensure persistence of native fishes in habitats susceptible to large fires may be to restore aquatic habitat structure and life-history complexity of populations in these areas (Gresswell 1999).

The spatial diversity and complexity of aquatic habitats strongly influence the effects of large disturbances on salmonids (Rieman and Clayton 1997). For example, Rieman *et al.* (1997b) studied bull trout and redband trout (*Oncorhynchus mykiss*) responses to large, intense fires that burned three watersheds in the Boise National Forest in Idaho. Although the fires were the most intense on record, there was a mix of severely burned to unburned areas left after the fires. Fish were apparently eliminated in some stream reaches, whereas others contained relatively high densities of fish. Within a few years after the fires, after areas within the watersheds had experienced debris flows, fish became reestablished in many reaches. In some instances, fish densities were higher than those present before the fires even in streams that were not burned (Rieman *et al.* 1997b). These responses were attributed to spatial habitat diversity that supplied refuge areas for fish during the fires, and the ability of bull trout and the redband trout to move among stream reaches. For bull trout, the presence of migratory fish within the system was also important (Rieman and Clayton 1997; Rieman *et al.*1997b).

In terms of conserving bull trout, the appropriate strategy to reduce the risk of fires on bull trout habitat is to emphasize the restoration of watershed processes that create and maintain habitat diversity, provide bull trout access to habitats, and protect or restore migratory life-history forms of bull trout. Both passive (e.g., encouraging natural riparian vegetation and floodplain processes to function appropriately) and active (e.g., reducing road density, removing barriers to fish movement, and improving habitat complexity) actions offer the best approaches to protect bull trout from the effects of large fires.

4.3.2 *Life-History Diversity*. Bull trout populations exhibit multiple life-history forms, including migratory forms, throughout the range of the species (Rieman and McIntyre 1993). Migratory forms 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 1997). For example, multiple life-history forms (e.g., resident and fluvial) and multiple migration patterns have been noted 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 of the Snake River. Such multiple life-history strategies help to maintain the stability and persistence of bull trout populations in the face of environmental changes. Migratory bull trout may enhance persistence of metapopulations due to their high fecundity,

large size, and dispersal across space and time, which promotes recolonization should resident populations suffer a catastrophic loss (Frissell 1997; Rieman and McIntyre 1993; MBTSG 1998).

4.3.3 *Genetic and Phenotypic Diversity*. Genetic diversity promotes both short-term fitness of populations and long-term persistence of a species by increasing the likelihood that the species is able to survive changing environmental conditions. This beneficial effect can be displayed both within and among populations. Within a genetically diverse local population of bull trout, different individuals may have various alleles that confer different abilities to survive and reproduce under different environmental conditions (Leary *et al.* 1993; Spruell *et al.* 1999; Hard 1995). If environmental conditions change due to natural processes or human activities, different allele combinations already present in the population may be favored, and the population may persist with only a change in allele frequencies. A genetically homogeneous population that has lost variation due to inbreeding or genetic drift may be unable to respond to environmental change and be extirpated. The prospect of local extirpation highlights the importance of genetic diversity among local populations. Recolonization of locations where extirpations have occurred may be promoted if immigrants are available that possess alleles that confer an advantage in variable environmental conditions. Extending this reasoning to the entire range of the species, reduction in rangewide genetic diversity of bull trout through the loss of local populations can reduce the species ability to respond to changing conditions, leading to a higher likelihood of extinction (Rieman and McIntyre 1993; Leary *et al.* 1993; Spruell *et al.* 1999; Hard 1995; Rieman and Allendorf 2001).

Barriers to migration are an important factor influencing patterns of genetic variability in bull trout (Spruell *et al.* 2003; Costello *et al.* 2003). Although barriers increase the vulnerability of isolated populations to stochastic factors, they also insulate these populations from the homogenizing effects of gene flow. If isolated populations were founded by ancestors with rare alleles, genetic drift, unimpeded by gene flow, can lead to fixation of these rare alleles. Subsequent downstream migration from these isolated populations may be important in maintaining the evolutionary potential of metapopulations, because they provide inputs of genetic diversity (Costello *et al.* 2003).

The amount of genetic variation necessary for a population to adapt to a changing environment can be estimated using the concept of effective population size (N_e). Effective population size is the average number of individuals in a population which are assumed to contribute genes equally to the succeeding generation. Effective population size provides a standardized measure of the amount of genetic variation that is likely to be transmitted between generations within a population.

Specific benchmarks for bull trout have been developed concerning the minimum N_e necessary to maintain genetic variation important for short-term fitness and long-term evolutionary potential. These benchmarks are based on the results of a generalized, age-structured, simulation model, called VORTEX (Miller and Lacy 1999), used to relate effective population size to the number of adult bull trout spawning annually under a range of life histories and environmental conditions (Rieman and Allendorf 2001). Using the estimate that N_e for bull trout is between 0.5 and 1.0

times the mean number of adults spawning annually, Rieman and Allendorf (2001) concluded that 1) an average of 100 adults spawning each year would be required to minimize risks of inbreeding in a population, and 2) an average of 1,000 adults is necessary to maintain genetic variation important for long-term evolutionary potential. This latter value of 1,000 spawners may also be reached with a collection of local populations among which gene flow occurs.

Bull trout populations tend to show relatively little genetic variation within populations, but substantial divergence among populations (e.g., Spruell *et al.* 2003). For example, Spruell *et al.* (1999) found that bull trout at five different spawning sites within a tributary drainage of Lake Pend Oreille, Idaho, were differentiated based on genetic analyses (microsatellite DNA), indicating fidelity to spawning sites and relatively low rates of gene flow among sites. This type of genetic structuring indicates limited gene flow among bull trout populations, which may encourage local adaptation within individual populations (Spruell *et al.* 1999; Healey and Prince 1995; Hard 1995; Rieman and McIntyre 1993).

Current information on the distribution of genetic diversity within and among bull trout populations is based on molecular characteristics of individual genes. While such analyses are extremely useful, they may not reflect variability in traits whose expression is dependent on interactions among many genes and the environment (Hard 1995, Reed and Frankham 2001; but see Pfrender *et al.* 2000). Therefore, the maintenance of phenotypic variability (e.g., variability in body size and form, foraging efficiency, and timing of migrations, spawning, and maturation) may be best achieved by conserving populations, their habitats, and opportunities for the species to take advantage of habitat diversity (Healey and Prince 1995; Hard 1995).

Local adaptation may be extensive in bull trout because populations experience a wide variety of environmental conditions across the species' distribution, and because populations exhibit considerable genetic differentiation. Thus, conserving many populations across their range is essential to adequately protect the genetic and phenotypic diversity of bull trout (Hard 1995; Healey and Prince 1995; Taylor *et al.*1999; Rieman and McIntyre 1993; Spruell *et al.* 1999; Leary *et al.* 1993; Rieman and Allendorf 2001). If genetic and phenotypic diversity is lost, changes in habitats and prevailing environmental conditions could increase the likelihood of bull trout suffering reductions in numbers, reproductive capacity, and distribution.

Based on this information about the life history and conservation needs of bull trout, the Service concludes that each subpopulation or local population is an important genetic, phenotypic, and geographic component of its respective interim recovery unit. Adverse effects that compromise the persistence of a bull trout subpopulation or local population can reduce the distribution, as well as the phenotypic and genetic diversity of the unit.

4.4 Recovery Planning

Recovery plans developed by the Service typically contain the most detailed articulation of the conservation needs of listed species. The goal of the draft recovery plan for bull trout is to ensure the long-term persistence of self-sustaining, complex interacting groups (or multiple local

populations that may have overlapping spawning and rearing areas) of bull trout distributed across the species' native range.

The recovery of bull trout will depend on the reduction of the adverse effects from dams, logging, agricultural practices, road building, urbanization, fisheries management, and by remedying legacy effects from past activities. Other general conservation needs described in the draft recovery plan, but not mentioned in the preceding paragraphs, include:

- Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout;
- Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve those goals; and
- Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout (USFWS 2002).

Literature Cited

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, Oregon. 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.

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., University of Washington, Institute of Forest Resources : 143-190.

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, Oregon.

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, eds. Friends of the bull trout conference proceedings.

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.

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.

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, (Salvelinus confluentus) (Suckley), from the American Northwest. Calif. Fish and Game 64(3):139-174.

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, Washington.

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

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.

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., B. Rieman, and G. Chandler. 2003. 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.

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. Rieman, and G. Chandler. 2001. Development of field-based models of suitable thermal regimes for Interior Colombia Basin salmonids. Interagency agreement #00-IA-11222014-521, Final report to EPA, Seattle Washington.

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.

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.

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, Montana.

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, Montana.

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, Oregon.

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.

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

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

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.

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

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, Montana.

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.

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. Washington Department of Wildlife. Draft.

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.

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.

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, Montana.

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, Washington.

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 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, British Columbia

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, British Columbia (as referenced in USDI, 1997).

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, Minnesota.

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.

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.

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, Washington State Department of Transportation, Washington State Transit Center (TRAC), Seattle, Washington. 133 pp + appendices.

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.

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.

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, technical editors. 1997. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins: Volume III. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, Oregon.

Quinault Indian Nation. 1995. Unpublished charr seining data.

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.

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. 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, Idaho. Idaho Department of Fish and Game. 105 pp.

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. 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. 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., 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.

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, California.

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.

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, Washington, 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.

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, British Columbia 56 p.

Soule' M.E. 1987. Viable Populations for Conservation. Cambridge University Press, Cambridge, United Kingdom. 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, Oregon. Available from the National Marine Fisheries Service, Portland, Oregon.

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.

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.

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.

USDI (United States Department of Interior). 1998. 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). 1999. Endangered and threatened wildlife and plants; determination of threatened status for bull trout in the coterminous United States; final rule. Notice of intent to prepare a proposed special rule pursuant to section 4(d) of the Endangered Species Act for the bull trout; proposed rule. Fish and Wildlife Service. November 1, 1999. Federal Register Vol. 64:58910.

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.

USFWS (United States Fish and Wildlife Service). 2002. Chapter 1, Introduction. *In*: Bull trout (*Salvelinus confluentus*) draft recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. 137 pp.

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

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, Washington.

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, Washington.

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.

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, Montana.

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 Communications

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

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

APPENDIX B: Projects subject to prior section 7 consultation that may have had effects on bull trout in the Yakima basin watershed.*

Title	FWS Reference Number	Date
I-90 East Expansion Geotechnical Surveys	13260-207-I-0175	Aug 16, 2007
Cle Elum River Floodplain Restoration	13260-2007-I-0150	July 31, 2007
Yakima Training Center Armed Forces Reserve Center	13260-2007-I-0162	Jul 30, 2007
BPA-Cowiche Creek Schneider Project	13260-2007-I00136	Jun 26, 2007
Camp Prime Time	1320-2007-I-0135	Jun 26, 2007
Little Naches Log Jam LOC	13260-2007-I-0144	Jul 9, 2007
2007 Cle Elum Conifer Release	13260-2007-I-0138	Jul 6, 2007
Williams Creek Peltola Pump Screen	13260-2007-I-0137	Jul 2, 2007
Swauk Creek Fish Screens	13260-2007-I-0118	May 22, 2007
Rimrock Dust Dodgers Race	13260-2007-I-0117	May 18, 2007
Canteen Ecosystem Restoration	13260-2007-I-0113	May 11, 2007
YTID Diversion #3	13260-2007-I-0085	Apr 19, 2007
Rattlesnake Creek Boyd Brown Diversion Removal	13260-2007-I-0083	Apr 12, 2007
Manastash Ditch Diversion Screening	13260-2007-I-0084	Apr 12, 2007
BPA Pump Screening- YTAHP	13260-2007-I-0069	Mar 22, 2007
Yakima-Tieton Diversion Dam Fish Passage	2007-I-0054	Mar 7, 2007
Naches and Ramblers Park Levee Repair	13260-2007-IE-0053	Feb 28, 2007
Salmon La Sac Road Stabilization	13260-2007-I-0055	Feb 27, 2007
Lmuma Creek Habitat Restoration- Eaton	13260-2007-I-0052	Feb 27 2007
YTC Aerial Fire Suppression Modification	13260-2007-I-0040	Feb 20, 2007
Naches-Cowiche Fish Ladder Modification	13260-2007-F-0027	Feb 13, 2007
YTID Fish Passage Improvement	13260-2007-I-0032	Feb 3, 2007
Recreation Residence Permit Renewal	13260-2007-I-025	Jan 9, 2007
Tieton Complex Allotment Management Plan	13260-2007-I-0024	Dec 20, 2006
Upper Lust Fish Barrier Removal	13260-2007-I-0012	Nov, 20, 2006
Upper Yakima Bank Protection	13260-2007-I-0008	Nov 16, 2006
Parke Creek Fish Screen	13260-2006-I-0308	Oct 10, 2006
Diversion 31 Modifications and Screens	13260-2006-I-0307	Sep 28, 2006
Polallie Ridge Fire Emergency	13260-2006-FE-0255	Sep 7, 2006
Little Naches Recreation Management	13260-2006-I-0227	Jul 11, 2006
Hwy 410 Power Line Corridor Maintenance	13260-2006-I-0245	Jul 27, 2006
Wenas and Cowiche Creeks Fish Screens	13260-2006-I-0238	Jul 26, 2006
Cle Elum Diversion Channel Maintenance	13260-2006-I-0232	Jul 17, 2006
Little Naches Recreation Management	13260-2006-I-0227	Jul 11, 2006
BPA Irrigation Screen Improvements (3) in Kittitas County	13260-2006-I-0215	May 31, 2006
Faulks North Fork Teanaway Bank Restoration	13260-2006-I-0133	May 18, 2006
Fogarty Ditch Fish Screen Replacement	05-0215	Apr 28, 2005

Parker Garage Replacement	13260-2006-I-0118	Apr 7, 2006
YTID Fish Ladder Passage	13260-2006-I-0117	Apr 7, 2006
Yakima Indian Nation Fuels Reduction	13260-2006-I-0107	Mar 14, 2006
Yakima Tieton Diversion Dam Fish Passage	13260-2006-I-0100	Mar 10, 2006
Acquisition of Richardson Property	05-0140	Mar 5, 2005
Box Canyon Road Improvement	13260-2006-F-0056	Feb 7, 2006
Manastash Ditch Phase 1	13260-2006-I-0036	Feb 3, 2006
Jolly Mountain Trail Relocation	13260-2006-I-0040	Jan 5, 2006
Reece Rock Placement	13260-206-I-0019	Nov 29, 2005
Yakima Airport	13260-2006-I-0005	Nov 13, 2005
Lake Anne LLC Easement	1-09-2005-F-0362	Nov 1, 2005
US 12 Naches River Reach Project	1-09-05-F-061	Oct 12, 2005
Nile Creek Stream Restoration	13260-2006-I-0003	Oct 6, 2005
Gold Creek Floodplain Restoration	1-09-2005-I-W0378	Sep 9, 2005
Emergency Fish Passage Box Canyon Crek	1-09-2005-I-0538	Aug 27, 2005
YTC Hanson Creek Erosion Control	1-09-2005-I-W0336	Aug 4, 2005
Salmon La Sac Campground Improvement	1-09-2005-I-W0318	Jul 27, 2005
Ahtanum Creek Barrier Removal	05-0330	Jul 27, 2005
Wildhorse Day Use Site Renovation	1-09-2005-I-W0319	Jul 27, 2005
Indian Creek #10 Summer Homes Hazard Tree	1-09-2005-I-W0288	Jul 6, 2005
Sleepy Hallow #17 Tree Removal	1-09-2005-I-W0294	Jun 22, 2005
Camp Ghormely Meadows Premitted Vegetation	1-09-2005-I-W0260	Jun 8, 2005
Zarahemla Water System Maintenance	1-09-2005-I-W0259	Jun 7, 2005
Puget Sound Energy Natural Gas Pipeline	1-9-2005-I-W0247	May 23, 2005
Tieton River White Water Rafting	1-09-2005-I-W0236	May 16, 2005
1146 Wasteway Watercraft Barrier Modifications	1-09-2005-I-0214	Apr 27, 2005
Bumping Road Fuel Break	1-09-2005-I-W0184	Apr 14, 2005
Tucker Creek Adult Fish Passage Enhancement	1-09-2005-I-0149	Mar 15, 2005
Camp Grace Brethren Hazard Tree Treatment	1-09-03-I-W0102	Mar 4, 2005
Snug Harbor Hazard Tree Treatment	1-09-2005-I-W0147	Mar 4, 2005
Silver Cover Hazard Tree Treatment	1-09-2005-I-W0146	Mar 4, 2005
Camp Prime Time Hazard Treatment	1-09-2005-I-W0154	Mar 4, 2005
Indian Creek Hazard Tree Treatment	1-09-2005-I-W0148	Mar 4, 2005
Cedar Springs Summer Home Hazard Trees	1-09-2005-I-W0131	Feb 16, 2005
Cliffdel Summer Home Hazard Trees	1-09-2005-I-W0132	Feb 16, 2005
Gold Creek Summer Home Hazard Trees	1-09-2005-I-W0130	Feb 16, 2005
Craig #10 Summer Home Hazard Trees	1-09-03-I-W0102	Feb 16, 2005
Gamblin and Lamb Bank Stabilization	1-09-2005-I-0128	Feb 16, 2005
Acquisition of Richardson Property	05-0114	Feb 4, 2005
BPA – YKFP Vegetation Management	1-09-2005-I-0098	Jan 24, 2005
Silver Cover Resort Campground Hazard Tree	1-09-2005-I-W0084	Dec 22, 2004
Hazard Tree Treatment at Camp Zarahemla	1-09-2005-I-W0064	Dec 15, 2004
Hazard Tree Treatment at South Fork Tieton	1-09-2005-I-W0062	Dec 15, 2004

Hazard Tree Treatment at Bear Cover	1-09-2005-I-W0054	Dec 10, 2004
Ahtanum Creek Side Channel Restoration	04-0840	Sep 23, 2004
Taneum Water Company Water Rights	04-I-0473	Aug 20, 2004
Pellicer Barrier Removal	04-0419	Jul 28, 2004
Tapteal Bend Resoration	04-0450	Jul 28, 2004
Tieton Diversion Dam Bridge Installation	04-TA-0437	Jul 15, 2004
Roslyn Wastewater Treatment Facility Interconnect	1-04-0388	Jun 18, 2004
Tillman Creek Wetlands Mitigation Project	1-04-0383	Jun 10, 2004
Forest Road 1800 Tree Removal	1-9-04-W0304	May 10, 2004
Snowdragon Adventure Shots	1-9-04-I-W0244	Mar 25, 2004
Russell Ridge Fuel Break	1-9-2004-I-W0198	Mar 1, 2004
Mt. Clement Archers Traditional 3D Shoot	1-9-04-I-W0186	Feb 19, 2004
Maravia Corporation Vendor Activities	1-9-04-I-W0189	Feb 19, 2004
Sunstation Mounted Drill Team Ride Project	1-9-04-I-W0185	Feb 19, 2004
Dust Dodgers Annual Rimrock Grand Prix	1-9-04-I-W0190	Feb 19, 2004
Bachelo-Hatton Fish Bypass Outfall	04-I-0160	Feb 3, 2004
Yakima KOA Land Purchase	04-0139	Jan 13, 2004
Camp Fife Stream Channel Restoration	01-09-2004-I-0050	Nov 12, 2003
North Fork Tieton River Staff Gage Replacement	03-I-W0371	Sep 18, 2003
Gaging Station Repairs at 16th Avenue	03-I-W0378	Sep 17, 2003
Reconstruction of the Simcoe Creek Diversion	03-I-W0361	Sep 11, 2003
Windy Point Toilet Replacement	1-9-03-I-W0341	Aug 12, 2003
Teanaway Basin Sites Fuels Reduction	1-09-2003-I-W0102	Jul 25, 2003
14th Virginia Cavalry Reenactment	1-9-03-I-W0327	Jul 24, 2003
South Fork Tieton Recreation Site Restoration	1-9-2003-I-W0290	Jun 17, 2003
Rattle Timber Sale	1-3-02-I-1933	Oct 2, 2002
Touch America/ AT&T Fiber Optic Project	1-3-02-I-0389	Dec 19, 2001
Elderberry Timber Sale	1-3-01-I-1404	Jun 27, 2001
Closure of reservoir beds to mudding	Not analyzed – beneficial effect	2000
Repin Mine 5-Year Plan of Operation	1-3-00-I-1435	Jul 13, 2000
A.J. Barkis Placer Mining Project	1-3-00-I-1149	June 7, 2000
Plum Creek Land Exchange	1-03-1999-F-0742	Dec 23, 1999
Taneum-Manastash Ongoing Activities	1-3-99-I-1360	Oct 12, 1999
South Fork Tieton Dispersed Site Restoration and Smokey Mountain Timber Sale	1-3-99-I-0946	Jul 20, 1999
Naches Basin Ongoing Activities	1-3-99-I-0325 to 0330	Apr 29, 1999
Bald Eagle Road Closure	1-03-1996-I-0431	July 22, 1996

APPENDIX C:

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Broodstock Collection									
Roza Dam	Yakima River RM 128	Capture up to 200 female and 200 male fish. Annually, April 15 through September 15.			Collect up to 1470 adult coho (distributed between Prosser, Roza and Cowiche Dams). 830 fish for broodstock development and 640 for outplanting. Annually, September through early December.	Migrating Adult	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7- Migratory Corridor:** *Maintain*: existing barrier.	LAA Due to harassment during capture, genetic sampling and tagging activities.
Wells Hatchery (Columbia River)	Columbia River RM 515.8		Collect up to 25 pairs of adult fish. Annually, July through August.			Migrating Adult	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout (1-4 per year), low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7- Migratory Corridor:** *Maintain*: existing barrier.	LAA Due to harassment during capture, genetic sampling and tagging activities.
Chandler Canal	Yakima River RM 47			Collect up to 490 fish by beach seine (490 total fish between Chandler Canal and Prosser Dam). Annually, mid September through late November.		Not Present	NA	No CH	NE
Prosser Dam	Yakima River RM 48			Collect up to 490 fish by Denil ladder (490 total fish between Chandler Canal and Prosser Dam). Annually, mid September through late November.	Collect up to 600 adult coho (distributed between Prosser, Roza and Cowiche Dams). 830 fish for broodstock development and 640 for outplanting. Annually, September through early December.	Not Present	NA	No CH	NE
Marion Drain	Marion Drain RM 8			Collect up to 42 fish using fish wheel. Annually, mid September through late November.		Not Present	NA	No CH	NE
Cowiche Dam	Naches River RM 3				Collect up to 600 adult coho (distributed between Prosser, Roza and Cowiche Dams). 830 fish for broodstock development and 640 for outplanting. Annually, September through early December.	Migrating Adult	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout (1-4 per year), low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7-Migratory Corridor:** *Maintain*: existing barrier	LAA Due to harassment during capture and release.
Wapatox Dam	Yakima River RM 17				Wapatox Dam will be substituted for Cowiche Dam after the Bureau of Reclamation completes construction of a new adult trap at the dam.	Migrating Adult	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout (1-4 per year), low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7-Migratory Corridor:** *Maintain*: existing barrier	LAA Due to harassment during capture and release.
Adult Release									
Taneum Creek	Taneum Creek RM 3-12				Release 120 adult females and 160 adult males and rack stream. Annually, mid October through December.	Not Present	NA	No CH	NE
Wilson Creek	Wilson Creek RM 3-8				Release 20 pairs of adults and rack stream. Annually,	Not Present	NA	No CH	NE

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
					mid October through December.				
Reecer Creek	Reecer Creek RM 0-3				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Not Present	NA	No CH	NE
Ahtanum Creek	Ahtanum Creek RM 0-20				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Adult Sub Adult	**>Physical Barrier:** *Maintain (-)*: may temporarily impede migration by adults and sub adults for 2 weeks each year. **>Growth and Survival:** *Maintain (+)*: improved nutrient and forage base for juveniles.	**7- Migratory Corridor:** *Maintain (-)*: may temporarily impede migration by adults and sub adults for two weeks each year. **8- Food Base:** *Maintain (+)*: improved nutrient and forage base for juveniles.	NLAA
Toppenish Creek	Toppenish Creek RM 44-69				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Not Present	NA	No CH	NE
Pileup Creek	Pileup Creek RM 0-1				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Adult Sub Adult Juvenile	**>Physical Barrier:** *Maintain (-)*: may temporarily impede migration by adults and sub adults for 24 hours each year. **>Growth and Survival:** *Maintain (+)*: improved nutrient and forage base for juveniles.	No CH	NLAA
Cowiche Creek	Cowiche Creek Above RM 6				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Adult Sub Adult Juvenile	**>Physical Barrier:** *Maintain (-)*: may temporarily impede migration by adults and sub adults for 24 hours each year. **>Growth and Survival:** *Maintain (+)*: improved nutrient and forage base for juveniles.	No CH	NLAA
Nile Creek	Nile Creek RM 3-6				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Not Present	NA	No CH	NE
Quartz Creek Beaver Dam Complex	Quartz Creek RM 1-4				Release 20 pairs of adults and rack stream. Annually, mid October through December.	Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Juvenile Rearing									
Cle Elum Supplementation and Research Facility	Yakima River RM 184	Rear up to 810,000 smolts. Annually, April 15 through February.				Not Present	NA	No CH	NE

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Prosser Hatchery	Yakima River RM 47		Rear up to 100,000 smolts. Annually, December through February.	Rear up to 1,000,000 in-basin smolts. Annually, October through mid April.	Rear up to 500,000 smolts. Annually, September through March.	Not Present	NA	No CH	NE
Marion Drain Hatchery	Marion Drain RM 8			Rear up to 75,000 smolts. Annually, October through mid April.		Not Present	NA	No CH	NE
Lower Columbia Hatcheries (out of basin)	Eagle Creek (Oregon) Washougal River (Washington)				Rear 500,000 to 1,000,000 fry/smolts. Annually, September through March Eagle Creek National Fish Hatchery, and Washougal Fish Hatchery (WDFW).	Not Present	No Effect	No CH	NA
Acclimation and Juvenile Releases									
Clark Flat Pond	Yakima River RM 167	Pond, PIT tag and release 270,000 smolts. Annually, February (ponding), volitional release mid May, forced release end of May.				Adults Sub Adults	**>Growth and Survival:** *Improve*: improved forage base for adults and subadults.	**8- Food Base:** *Improve*: improved forage base for adults and subadults.	NLAA
Easton Pond	Yakima River RM 202	Pond, PIT tag and release 270,000 smolts. Annually, February (ponding), volitional release mid May, forced release end of May				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	**8- Food Base:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	NLAA
Jack Creek	Jack Creek RM 5.9	Pond, PIT tag and release 270,000 smolts. Annually, February (ponding), volitional release mid May, forced release end of May.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	**8- Food Base:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	NLAA
Stiles Pond	Lower Naches River RM 3.4		PIT tag and release up to 100,000 smolts. Annually, February (ponding), volitional release mid April.			Migrating Adult	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA
Prosser Hatchery	Yakima River RM 47			PIT Tag and Release up to 1,000,000 smolts. Annually, volitional release mid April or mid May		Not Present	NA	No CH	NE
Yakima and Lower Naches River Ponds	Lower Naches River RM 3.4 and Yakima River RM 112			Some of the 1,000,000 smolts from Prosser are released here. Annually, February (ponding), volitional release mid May.		Migrating Adult	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA
Marion Drain Hatchery	Marion Drain RM 8			PIT Tag and Release up to 75,000 smolts. Annually, volitional release mid April.		Not Present	NA	No CH	NE
Lake Cle Elum	In net pens within ¼ mile of dam				Acclimate and release 12,000 smolts for dam passage study. Annually, early April.	Adults Sub Adults	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA
Holmes Pond	Yakima River RM 165				Acclimate and release up to 250,000 smolts, PIT tag 1,250 smolts. Annually, February through early April.	Migrating Adults	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Hundley Pond	Yakima River RM 191				Acclimate and release up to 250,000 smolts, PIT tag 1,250 smolts. Annually, February through early April.	Adults Subadults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	**8- Food Base:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	NLAA
Brunson Pond	Wilson Creek RM 6.8				Acclimate and release up to 250,000 smolts, PIT tag 1,250 smolts. Annually, February through early April.	Not Present	NA	No CH	NE
Boone Pond	Yakima River RM 183				Acclimate and release 100,000 smolts, PIT tag 1,250 smolts. Annually, February through early April.	Not Present	NA	No CH	NE
Lost Creek	Lost Creek RM 38				Acclimate and release up to 250,000 smolts, PIT tag 1,250 smolts. Annually, February through early April.	Migrating Adult	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA
Stiles Pond	Naches River RM 3.4				Acclimate and release up to 250,000 smolts, PIT tag 1,250 smolts. Annually, February through early April.	Migrating Adults	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA
Other Sites TBD	TBD				Site used for smolt release in lieu of Lost Creek and Stiles Pond (no net increase in fish released). Annually, early April.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	**8- Food Base:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	NLAA
Easton Ponds	Yakima River RM 202				Alternate smolt release site. Annually, early April.	Not Present	NA	NO CH	NE
Keechelus Easton Reach	Yakima River RM 214				Release and PIT tag 1,250 smolts. Annually, early April.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Toppenish Creek	Toppenish Creek RM 44				Release 5,000 to 10,000 smolts from mobile acclimation unit (PIT tag 1,250), Release and PIT tag 3000 parr. Annually, early April (smolts), late July (parr).	Not Present	NA	No Ch	NE
Cowiche Creek	Cowiche Creek Above RM 6				Release 5,000 to 10,000 smolts from mobile acclimation unit (PIT tag 1,250), Release and PIT tag 3000 parr. Annually, early April (smolts), late July (parr).	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Ahtanum Creek	Ahtanum Creek RM 4-12				Release 5,000 to 10,000 smolts from mobile acclimation unit (PIT tag 1,250), Release and PIT tag 3000 parr. Annually, early	Migrating Adults Sub Adults	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
					April (smolts), late July (parr).				
La Salle High School (Ahtanum Creek)	Ahtanum Creek RM 2.8				Rear and scatter plant 17,000 parr, PIT tag 1,250 parr. Annually, February through early April.	Migrating Adults Sub Adults	**>Growth and Survival:** *Maintain (+)*: improved forage base for adults and subadults.	**8- Food Base:** *Maintain (+)*: improved forage base for adults and subadults.	NLAA
Crystal Springs/ Easton Keechelus Reach	Yakima River RM 213				Release and PIT tag 3,000 parr. Annually, late July.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Big Creek	Big Creek RM 1-3				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
Upper Cle Elum River	Cle Elum River RM 29.6				Release and PIT tag 3,000 parr. Annually, late July.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA.
Wilson Creek	Wilson Creek RM 6-20				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
Reecer Creek	Reecer Creek RM 1-3				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
North Fork Little Naches River	North Fork Little Naches River RM 13				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
Little Naches River	Little Naches River RM 9				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
Bumping Lake	Bumping River (base of dam) RM 19 Bumping River (top of Lake) RM 21.1				Release and PIT tag 3,000 parr. Annually, late July.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Quartz Creek Beaver Dam Complex	Quartz Creek RM 1-4				Release and PIT tag 3,000 parr. Annually, late July.	Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Nile Creek	Nile Creek RM 3-6				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
Blow Out Creek	Blow Out Creek RM 1				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE
Little Rattlesnake Creek	Little Rattlesnake Creek RM 1				Release and PIT tag 3,000 parr. Annually, late July.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: improved forage base for adults and subadults. Direct and indirect competition with juveniles.	No CH	NLAA
Swauk Creek	Swauk Creek RM 0-18				Release and PIT tag 3,000 parr. Annually, late July.	Not Present	NA	No CH	NE

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Juvenile Collection									
Roza Dam	Yakima River RM 127	Collect and PIT tag juveniles in juvenile fish trap. Daily, April 1 through May 1.			Collect and PIT tag wild and hatchery coho juveniles. Daily, April 1 through May 1.	Migrating Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout (1-4 per year), low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7- Migratory Corridor:** *Maintain*: existing barrier.	LAA Due to harassment during capture, genetic sampling and tagging activities.
Chandler Juvenile Monitoring Facility	Yakima River RM 47	Collect and PIT tag juveniles in juvenile fish trap. Daily, November 15 through July 15.	Collect and PIT tag juveniles in juvenile fish trap. Daily, November 15 through July 15.	Collect and PIT tag juveniles in juvenile fish trap and two screw traps. Daily, November 15 through July 15.	Collect and PIT tag juveniles in juvenile fish trap and two screw traps. Daily, November 15 through July 15.	Not Present	NA	No CH	NE
Yakima River (Richland, Granger, Union Gap)	Yakima River RM 4-8.4 RM 83 RM 107.1 to 111			Seine net and PIT tag wild fall Chinook juveniles 3-5 times. Weekly, April 1 through mid June.		Not Present	NA	No CH	NE
Marion Drain	Marion Drain RM 2			Collect and mark wild fall Chinook juveniles with four foot screw trap. 3 times, daily, March 1 through mid June.		Not Present	NA	No CH	NE
Ahtanum Creek	Ahtanum Creek RM 2.8				Collect juveniles in screw trap. Daily, December through May.	Adults Sub Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout (1-4 per year), low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7- Migratory Corridor:** *Maintain*: existing barrier.	LAA Due to harassment during capture, genetic sampling and tagging activities.
Toppenish Creek	Toppenish Creek RM 26.5				Collect juveniles in screw trap. Daily, November 15 through May.	Not Present	NA	No CH	NE
Naches River (Wapatox Diversion)	Naches River RM 18.4				Collect juveniles in box trap. 4 days/week, April 1 through May 31.	Migrating Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout (1-4 per year), low probability of lethal take. **>Physical Barrier:** *Maintain*: existing barrier.	**7- Migratory Corridor:** *Maintain*: existing barrier.	LAA Due to harassment during capture, genetic sampling and tagging activities.
Radio Tracking									
Prosser Dam	Yakima River RM 47				Fixed point radio telemetry tracking survey. Constantly, mid September through November.	Migrating Adults	NA	No PCE's affected	NE
Roza Dam	Yakima River RM 127				Fixed point radio telemetry tracking survey. Constantly, mid September through November.	Migrating Adults	NA	No PCE's affected	NE
Cowiche Dam	Naches River RM 3				Fixed point radio telemetry tracking survey. Constantly, mid September through November.	Migrating Adults	NA	No PCE's affected	NE
Wapatox Dam	Yakima River RM 17				Fixed point radio telemetry tracking survey. Constantly, mid September	Migrating Adults	NA	No PCE's affected	NE

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
					through November.				
Juvenile Surveys									
Some or all **coho** juvenile release areas listed above	--				Snorkel spot checks, redd capping, electrofishing, beach seining, and collecting and PIT tagging wild coho.	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No CH	NLAA
Spawning Surveys									
American River	American River RM 0-24	Foot spawning surveys. Weekly, late July through late September.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No CH	NLAA
Little Naches River	Little Naches River RM 0-13	Foot spawning surveys. Weekly, late July through late September.				Not Present	NA	No CH	NE
Bumping River	Bumping River RM 0-19	Foot/boat spawning surveys. Weekly, late July through late September.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Rattlesnake Creek	Rattlesnake Creek RM 0-23	Foot spawning surveys. Weekly, late July through late September.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Naches River	Naches River RM 0-44	Boat spawning surveys. Weekly, late July through late September.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Teanaway River	Teanaway River RM 0-10	Foot spawning surveys. Weekly, late August through early October.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Cle Elum River	Cle Elum River RM 0-34	Boat spawning surveys. Weekly, late August through early October.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Yakima River	Yakima River RM 127-214	Boat spawning surveys. Weekly, late August through early October.				Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Yakima River between Prosser Dam and Roza Dam	Yakima River RM 47-127		Foot/boat spawning surveys. Weekly, mid September through mid October.	Foot/boat spawning surveys. Weekly, mid October through mid November.		Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Lower Naches River	Naches River RM 0-17.5		Foot /boat spawning surveys. Weekly, mid September through mid October.	Foot/boat spawning surveys. Weekly, mid October through mid November.		Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Marion Drain	Marion Drain RM 0-19			Foot spawning surveys. Weekly, mid October through mid November.		Not Present	NA	No CH	NE
Ahtanum Creek	Ahtanum Creek RM 0-20				Foot spawning surveys. Weekly, mid September through November.	Adults Sub Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Upper Cle Elum River	RM 7-34				Foot spawning surveys. Weekly, mid September through November.	Adults Sub Adults	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Upper Bumping River	Bumping River RM 21.1-24				Foot spawning surveys. Weekly, mid September through November.	Adults Sub Adults	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Cowiche Creek	Cowiche Creek RM 0-9				Foot spawning surveys. Weekly, mid September through November.	Adults Sub Adults Juveniles	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Wide Hollow Creek	Wide Hollow Creek RM 0-1				Foot spawning surveys. Weekly, mid September through November.	Not Present	NA	No CH	NE
Satus Creek	Satus Creek RM 0-15				Foot spawning surveys. Weekly, mid September through November.	Not Present	NA	No CH	NE
Naches River (Yakima River to Cowiche Dam)	Naches River RM 0-3				Boat spawning surveys. Weekly, mid September through November.	Migrating Adults	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Yakima River (Selah to Union Gap	Yakima River RM 123-98				Boat spawning surveys. Weekly, mid September through November.	Migrating Adults	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Stream reaches near acclimation sites	See specific acclimation sites				Foot/boat spawning surveys. Weekly, mid September through November.	Migrating Adults	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Other basin stream reaches as conditions warrant	To be determined				Foot/boat spawning surveys. Weekly, mid September through November	Adults Sub Adults Juveniles	>Growth and Survival: *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Predator Surveys									
Yakima River	9 locations between RM 0-103	Boat electrofishing predator mark-recapture/stomach sampling surveys. Monthly, March through June.				Migrating Adults	>Growth and Survival: *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No CH	LAA Due to harassment during capture and release.
Non-Target Taxa Monitoring									
Cabin Creek	Cabin Creek RM 0-4	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Cowiche Creek	Cowiche Creek RM 0-16	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Jungle Creek	Jungle Creek RM 0-2.5	Electrofishing mark-recapture sampling. Annually, July through August.				Adults Sub Adults Juveniles (None have been encountered	>Growth and Survival: *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No PCE's affected	LAA Due to harassment during capture and release.

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
						during electrofishing sampling)			
Manastash Creek	Manastash Creek RM 0-22.5	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Middle Fork Teanaway River	Middle Fork Teanaway River RM 0-6	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Main stem Teanaway River	Teanaway River RM 0-10.56	Electrofishing mark-recapture sampling. Annually, July through August.				Migrating Adults (none have been encountered during sampling)	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No PCE's affected	NLAA
North Fork Teanaway River	North Fork Teanaway River RM 0-17	Electrofishing mark-recapture sampling. Annually, July through August.				Migrating Adults; Juveniles upstream from RM 7.08 (few individuals have been encountered during electro-fishing)	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take. Bull trout only present in highest stream reaches	No PCE's affected	LAA Due to harassment during capture and release.
Stafford Creek	Stafford Creek RM 0-2.54	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Swauk Creek	Swauk Creek RM 0-18	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Taneum Creek	Taneum Creek RM 0-15	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Umtanum Creek	Umtanum Creek RM 0-5	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
West Fork Teanaway River	West Fork Teanaway River RM 0-8	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE
Wilson Creek	Wilson Creek RM 22.99	Electrofishing mark-recapture sampling. Annually, July through August.				Not Present	NA	No CH	NE

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Yakima River	Yakima River RM 116-165	Boat electrofishing resident rainbow trout abundance and size structure sampling and backpack electrofishing stream margins through determine age 0 size structure. Annually, September through October.				Adults Sub-adults (No bull trout have encountered during electro-fishing surveys since 1995)	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take. Bull trout have not been observed in these areas for 10+ years.	No PCE's affected	LAA Due to harassment during capture and release.
North Fork Teanaway River	North Fork Teanaway River RM 11.3-16.9	Snorkel surveys for bull trout/salmon distribution. Annually, September.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA.
North Fork Teanaway River	North Fork Teanaway River RM 0-7	PIT tag resident rainbow trout to determine instantaneous growth. Intermittently March through June				Possible Migrating Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during sample collection. No bull trout encountered in this reach during electrofishing.	No CH	LAA Due to harassment during capture and release.
Middle Fork Teanaway River	Middle Fork Teanaway River RM 0-7	PIT tag resident rainbow trout to determine instantaneous growth. Intermittently March through June				Not Present	NA	No CH	NE
Domestication Research									
American River	American River RM 0-14	Collect up to10 wild female and 10 wild male fish with tangle nets. Annually, September 1 through September 15.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout, low probability of lethal take. Collection areas are snorkeled during nets sets/drifts to ensure no bull trout are present.	No PCE's affected	NLAA
Naches River	Naches River RM 27-41	Collect up to 10 wild female and 10 wild male fish with tangle nets. Annually, September 1 through September 15.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout, low probability of lethal take. Collection areas are snorkeled during nets sets/drifts to ensure no bull trout are present.	No PCE's affected	NLAA
Little Naches River	Little Naches River RM 0-13	Collect up to 10 wild female and 10 wild male fish with tangle nets. Annually, September 1 through September 15.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout, low probability of lethal take. Collection areas are snorkeled during nets sets/drifts to ensure no bull trout are present.	No PCE's affected	NLAA
Yakima River	Yakima River RM 186-202.5, RM 210-214	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Migrating Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No PCE's affected	NLAA
Cle Elum River	Cle Elum River RM 0-5	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March				Adults Sub Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No PCE's affected	NLAA

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
		through May.							
Little Creek	Little Creek RM 0-2	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Big Creek	Big Creek RM 0-2	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Tucker Creek	Tucker Creek RM 0-1	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Cabin Creek	Cabin Creek RM 0-4	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Silver Creek	Silver Creek RM 0-2	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Telephone Creek	Telephone Creek RM 0-1	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Mosquito Creek	Mosquito Creek RM 0-1	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Swamp Creek	Swamp Creek RM 0-1	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May..				Not Present	NA	No CH	NE
Noble Creek	Noble Creek RM 0-1	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Price Creek	Price Creek RM 0-1	Collect rainbow trout and sculpin by hook and line or electrofishing for predation studies. Annually, March through May.				Not Present	NA	No CH	NE
Residual/Precocial Monitoring and Competition Indices									

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Upper Yakima River	Yakima River RM 131.5 – 195.5	Collect 500 juvenile Chinook and 30 rainbow trout with electrofisher and sample stomach contents. Annually, March through September.				Migrating Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No PCE's affected	LAA Due to harassment during capture and release.
Upper Yakima River	Yakima River RM 159.82-164.04, RM 129.00-131.85	Collect 240 juvenile Chinook with electrofisher and sample stomach contents. Annually, mid September through mid October.				Migrating Adults	**>Growth and Survival:** *Maintain (-)*: may harm/harass captured bull trout, low probability of lethal take.	No PCE's affected	LAA Due to harassment during capture and release.
Upper Yakima River	Yakima River RM 159.82-195.5	Snorkel surveys of 300 locations to collect habitat utilization data. Annually, July through September.				Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Cle Elum River	Cle Elum River RM 0-5	Collect data from 45 microhabitat survey transects. Twice annually, July through August and September through November.				Adults Sub Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Upper Yakima River	Yakima River RM 159.82-183.5 RM 191-195.5	Collect data from 45 microhabitat survey transects. Twice annually, July through August and September through November.				Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Cle Elum River	Cle Elum River RM 0-5	Collect 24 invertebrate drift samples. Annually, July through September.				Adults Sub Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
North Fork Teanaway River	North Fork Teanaway River RM 10.5-12.5 RM 2.7-10.5	Snorkel surveys and spot checks of 4 locations through determine Chinook abundance and distribution monthly. Annually, June through August.				Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys. No bull trout ever observed in these reaches.	No PCE's affected	NLAA
Upper Yakima River	Yakima River RM 160-202.5	Snorkel surveys of entire reach to identify precocious male abundance. Annually, June through August.				Migrating Adults	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout during surveys.	No PCE's affected	NLAA
Stream Sediment Impact Monitoring									
Mainstem Little Naches River	From confluence to North Fork (4 reaches)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
South Fork Little Naches River	(1 reach)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA
Bear Creek	(1 reach)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed,.	No PCE's affected	NLAA
West Fork of Bear Creek	(1 reach)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA
North Fork Little Naches River	(2 reaches)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA
Pyramid Creek	(1 reach)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Not Present	NA	No CH	**NE**
Upper Yakima River	Mainstem Yakima River from Cle Elum Up to Keechelus Dam RM 188-214 (5 reaches)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA

Location Name	Stream/River Name and RM	Spring Chinook Action	Summer Chinook Action	Fall Chinook Action	Coho Action	Bull Trout Presence	Matrix Indicator Affected and Effect[1]	Critical Habitat PCE Indicator Affected and Affect[1]	Effect On Bull Trout[2]
Cle Elum River	Lower Cle Elum River below the dam (2 reaches)	Collect gravel samples from streams in the fall. The core sampler takes out about 1 ft in depth and 10 inches around, with four samples being taken on 3 different riffles for a total of 12 samples from each stream sample area.				Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA
Carcass Distribution									
Coho study tributaries, side channels and beaver ponds of Upper Yakima River, Naches River, and Little Naches River				Place 400-500 adult coho and fall chinook fish carcasses by foot or boat. Annually, January-February	Place 400-500 adult coho and fall chinook fish carcasses by foot or boat. Annually, January-February	Adults Sub Adults Juveniles	**>Growth and Survival:** *Maintain*: may inadvertently harass or displace bull trout,. No redds are disturbed.	No PCE's affected	NLAA

[1]From Bull Trout Matrix of Pathways and Indicators (USFWS 1998):
Maintain = Action will not change to the indicator status.
Maintain (-) = Action may cause some localized adverse effects, but not enough to "degrade" the indicator status.
Maintain (+) = Action may cause some localized beneficial effects, but not enough to "restore" the indicator status.

[2]Effects Determination for each specific action:
NE = No Effect (shaded gray if no bull trout are present or green if bull trout are present)
NLAA = May Affect, Not Likely to Adversely Affect (shaded yellow)
LAA = May Affect, Likely to Adversely Affect (shaded)