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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

JUL 15 2010

In Reply Refer To:
13410-2009-F-0221
13410-2009-F-0356
13410-2009-F-0343

Colonel Michael McCormick
Seattle District, Corps of Engineers
Environmental Resources Section
ATTN: Dillon, Laufle, Ebel, McClain
P.O. Box 3755
Seattle Washington 98124-3755

Dear Colonel McCormick:

Subject: Batched Nooksack Levee Repair Projects
(Hovander Slough, Ferndale, Guide Meridian, Deming, and
Sande-Williams Levees)

This document transmits the U.S. Fish and Wildlife Service's Biological Opinion (Opinion) and concurrence for four levee repair projects in the Lower Nooksack River in Whatcom County, Washington, and their effects on bull trout (*Salvelinus confluentus*) and bull trout critical habitat. This consultation is being conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

The U.S. Army Corps of Engineers (Corps) submitted three consultation requests covering seven separate levee repair projects under your Public Law 84-99 emergency repair program: two separate individual consultations, and one batched consultation that addressed five separate projects. Your April 2, 2009, letter requested after-the-fact formal consultation on adverse effects to bull trout and bull trout critical habitat for the Deming Levee Emergency Rehabilitation Project at Deming, Washington. Your May 27, 2009, letter requested our concurrence with your determination of "may affect, not likely to adversely affect" for the bull trout and bull trout critical habitat for the repair and reconstruction of the Sande-Williams levee downstream of the first project. Your letters and Biological Assessments (Assessments) for these actions were received in our office on April 6 and May 27, 2009, respectively.

TAKE PRIDE® IN AMERICA

Your May 21, 2009, letter requested initiation of consultation for five proposed levee repair actions in the Nooksack River Basin. Specifically, you requested consultation for repair of the following levees: Rainbow Slough Levee (River Mile [RM] 0.3), Hovander Levee (RM 3.5), Ferndale Levee (RM 5.5), River Road Levee (RM 13.5), and Guide Meridian Levee (RM 16.3). You requested our concurrence with your determination of "may affect, not likely to adversely affect" for the bull trout and bull trout critical habitat for the River Road levee repair project, and requested formal consultation for the Ferndale and Guide Meridian levee repair projects. The Corps made a “no effect” determination for listed resources under our purview for the Rainbow Slough and Hovander levee repair projects. Your letter, Memorandum for the Services, and Assessment were received in our office on May 22, 2009.

Prior to receiving your consultation requests, we coordinated with you and received additional information via email and teleconference on several occasions, including coordination via email and teleconferences on April 7 and 8, 2009. After receiving and reviewing the Assessments submitted for each of the projects, we determined that a comprehensive evaluation of the projects in a single consultation would be most appropriate in terms of evaluating effects of multiple actions at a watershed scale. This approach is also more efficient in terms of workload. We discussed this with you via a telephone conversation on July 24, 2009. During our call, you indicated that the Corps wanted to initiate construction on the River Road and Hovander proposed actions during the 2009 work window, and requested that we move forward with the review of these two projects separately from the other projects, which could then be batched. We requested additional information on several of the projects and received a response on July 30, 2009. Per your request, we completed consultation on the River Road proposed action on August 12, 2009, and completed coordination via email on the Hovander project on August 4, 2009. Additionally, you requested via email on August 4, 2009, that we defer further consultation on the Rainbow Slough proposed action until more details were available. Therefore, the River Road, Hovander, and Rainbow Slough Levee Repair Projects will not be further addressed in this correspondence.

On May 19, 2010, the Corps requested conferencing on proposed bull trout critical habitat, based on our recommendations. The proposed rule to revise the designation of bull trout critical habitat
(75 FR 2270 [January 14, 2010]) listed a new Primary Constituent Element (non-native predatory and/or competitive species). We agreed to conference on proposed bull trout critical habitat, and have addressed this resource in the attached Opinion.

Based on the information provided in the consultation packages for the remaining projects, we concur with the Corps’ determination of “may affect, likely to adversely affect” for the bull trout for the Deming, Guide-Meridian, and Ferndale levee projects. However, we do not concur with the “may affect, not likely to adversely affect” determination for bull trout critical habitat for these proposed actions. We also do not concur with the “may affect, not likely to adversely affect” determinations the Corps made for bull trout and bull trout critical habitat for the Sande-Williams levee project. The enclosed Opinion addresses the adverse effects to bull trout and bull trout critical habitat associated with repairs for the following levees: Deming, Sande-Williams, Guide-Meridian, and Ferndale levees.

If you have any questions about this letter or our joint responsibilities under the Endangered Species Act, please contact Karen Myers at (360) 753-9098 or Martha Jensen at (360) 753-9000.

Sincerely,

Ken S. Berg, Manager
Washington Fish and Wildlife Office

Attachments

cc:
WDFW, Mill Creek, WA (Region 4)
WDOE, Bellevue, WA (R. Padgett)

Endangered Species Act - Section 7 Consultation

Biological Opinion

Batched Consultation for

Nooksack River Levee Repair Projects
Whatcom County, Washington:

Deming, Sande-Williams, Guide-Meridian,
And Ferndale Levees

U.S. Fish and Wildlife Service Reference Numbers

13410-2009-F-0221
13410-2009-F-0356
13410-2009-F-0343

Agency: U.S. Army Corps of Engineers
Seattle District

Consultation Conducted By: U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office

Ken S. Berg, Manager
Washington Fish and Wildlife Office

7/15/2010
Date

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LIST OF ACROYNMS AND ABBREVIATIONS

Act	Endangered Species Act
Assessment	Biological Assessment
BMPs	Best Management Practices
Corps	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
cfs	cubic feet per second
DBH	Diameter at Breast Height
Ecology	Washington State Department of Ecology
ft	Feet
FMO	Foraging, Migration, And Overwintering
HCP	Habitat Conservation Plans
IGDO	Inter-Gravel Dissolved Oxygen
LFA	Limiting Factors Analysis
LWD	Large Woody Debris
m	meter
MHHW	Mean Higher High-Water
MLLW	Mean Lower Low-Water
Mm	millimeters
NMFS	National Marine Fisheries Service
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
NTU	Nephelometric Turbidity Unit
PCEs	Primary Constituent Elements
PIRs	Project Information Reports
PL	Public Law
RCW	Revised Code of Washington
RM	River Mile
RPMs	Reasonable and Prudent Measures
Service	U.S. Fish and Wildlife Service
SPLs	Sound Pressure Levels
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area
WDFW	Washington Department of Fish and Wildlife
WSDNR	Washington State Department of Natural Resources

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INTRODUCTION

Between 2006 and 2009, heavy rainfall events and other winter conditions contributed to moderate to severe flooding at several sites in the Nooksack River basin. As a result of this flooding, several levees protecting agricultural fields, infrastructure for the City of Deming, and other properties were damaged throughout the lower Nooksack River basin, prompting emergency actions by the local partners and/or the U.S. Army Corps of Engineers (Corps) under their Public Law (PL) 84-99 authority for each of the damaged levees during and after the flooding events.

CONSULTATION HISTORY

In Spring 2009, the Corps contacted the U.S. Fish and Wildlife Service (Service) and other agency staff to coordinate on several levee repair and/or rehabilitation actions in the lower Nooksack River watershed in Whatcom, County, Washington. During the next several months, the Corps submitted requests for consultation for these and other levee repair projects in the lower Nooksack watershed. The projects included a completed emergency project, as well as several proposed actions. The consultation requests were submitted in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (Act).

The consultation history for this and other associated levee repair projects is outlined in the cover letter.

This Biological Opinion (Opinion) addresses the adverse effects to bull trout and bull trout critical habitat associated with repairs that were conducted on the Deming levee and are anticipated to occur during repairs that will be conducted on the Sande-Williams, Guide-Meridian, and Ferndale levees. It does not cover any other repair activities associated with previous or subsequent flood fights or other actions completed by the Corps or local sponsor(s) for the proposed actions.

BIOLOGICAL OPINION

DESCRIPTION OF THE ACTIONS

The Corps has already completed the emergency repairs on the Deming levee as described in the Biological Assessment (Assessment), and plans to conduct repairs to the remaining levees in the lower Nooksack River beginning in 2010. Certain aspects of the actions are similar, although there are some differences in design components, and the projects are located along different reaches of the lower mainstem. The project descriptions below are based on information in the Project Information Reports (PIRs) provided during pre-consultation coordination, Assessments, additional information provided in the consultation packages, and/or additional information received from the Corps during consultation. The project locations are shown below in Figure 1.

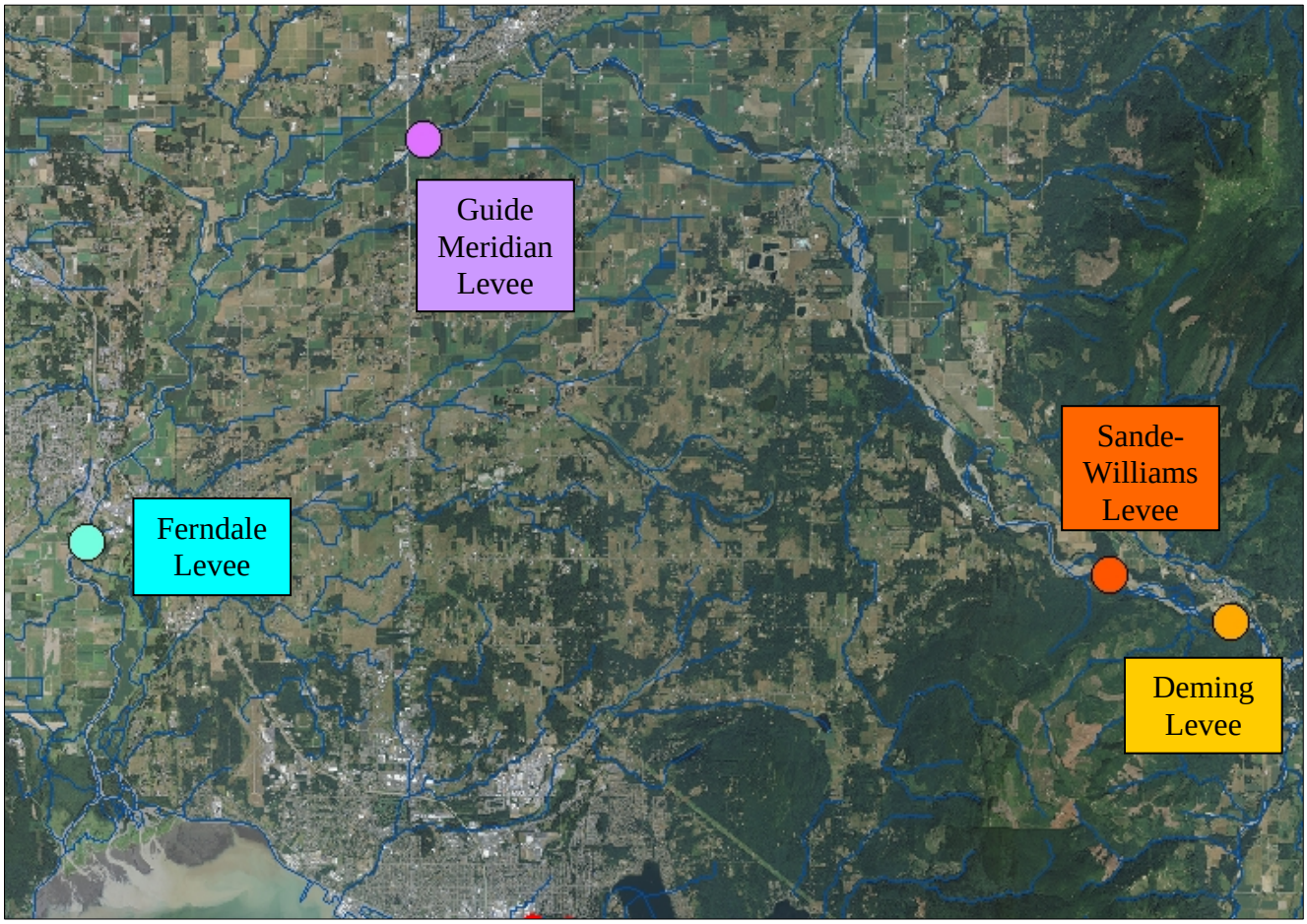

Figure 1. Approximate locations of the Deming, Sande-Williams, Guide Meridian, and Ferndale Levee Repair Projects in the Lower Nooksack River, Whatcom County, Washington.

During the flood fights for each action, the local sponsor and/or the Corps performed temporary repairs to the levees to maintain flood control and/or integrity of the levee until longer-term fixes could be implemented. As noted above, the flood fight activities are not considered part of the actions covered by this Opinion, and are addressed in the Environmental Baseline section of this document.

The combined length of the four levees described in this Opinion is approximately 40,000 linear ft. Taken together, the actions would repair or rehabilitate approximately 5,600 ft of these levees. For the Deming project, repairs were performed along most of the length of the structure, while repairs at the remaining projects will include smaller proportions of each levee. The following paragraphs describe each of the actions covered by this Opinion.

Deming Levee (Completed Action)

The Deming levee is a 3,130-ft-long earthen flood protection structure located along the right bank of the Nooksack River between River Mile (RM) 36.6 and 36.0 and adjacent to the town of Deming. The levee was constructed to provide flood protection from recurring flooding of the town. Approximately 1,300 ft of the levee is adjacent to the river, while the remaining upstream portion of the levee (approximately 1,800 ft) abuts a high flow side channel, which sometime serves as the main channel of the stream.

Repairs to the Deming levee were performed by the Corps between September 1 and October 10, 2008, and consisted of the removal of the rock placed during previous emergency response activities, reestablishment of the levee toe, and repair of the levee face. These repairs were designed to withstand a 15-year flood event.

For repair purposes, the levee was divided into four sections (A, B, C, and D). In sections A and B, the Corps reestablished a launch-able toe along 1,300 ft, and regraded the waterward face of the levee to a 2H:1V slope to increase the stability of the structure. Missing rock was replaced on the waterward face using Class V riprap, and 2- to 4-ton rocks were used in installation of the toe materials. In sections C and D, a weighted toe was reestablished along approximately 1,800 ft using Class V riprap, and the waterward face of the levee was graded to a 2H:1V slope. In all sections except D, willows (*Salix* spp.) were planted on 6-inch centers on 1-ft soil lifts above the Ordinary High Water Mark (OHWM). The Corps also placed several deciduous trees and shrubs, primarily 1- to 3-inch-diameter at breast height (DBH), into the channel to add cover for fish. The vegetation had been previously removed from the levee by the project sponsor prior to the Corps' construction activities. All staging and stockpiling of materials was limited to the levee footprint. Construction access used existing roads with minimal upgrades to allow the transport of heavy equipment. All in-water work occurred from September 1 to September 15, 2008. Work continued until October 1 in sections C and D, but the side channel was dry, and no in-water work was necessary at these sites. The Corps visually assessed turbidity impacts during in-water work, and reported no observed or recorded exceedance.

Sande-Williams Levee (Proposed Action)

The Sande-Williams levee is located along the right bank of the Nooksack River at RM 33, downstream of the Deming levee described above. The structure is approximately 7,600 linear ft in length (Charles Ebel, Corps, *in litt.* 2010). With the non-federal sponsor, Whatcom County Diking District 2, the Corps proposes to repair two sections of the levee that were damaged during several recent flood events (November 2006, December 2007, November 2008, and January 2009). The proposed work would include repairs along two noncontiguous sections of levee in the project area: an upstream stretch 578 ft in length (upstream site), and a 400-ft-long stretch downstream (downstream site). In addition the work described below, the Corps will plant willows on 6-inch centers in 1-ft-thick lifts of soil to just above the OHWM along both the upstream and downstream site reaches. In-water work would occur during the recommended fish work window (June 15 to August 15) for the project area.

Construction at the upstream site would result in the creation of a 200-ft long section of riprap

armoring set back as a “dog-leg” from the stream. The remaining 378-ft long section will be repaired in its current location adjacent to the river. The dog-leg section would replace existing features (i.e., buried trench and flood fight rock) installed in a previous attempt to halt erosion of the shoreline. The construction of this section of the levee would include the installation of a buried toe set back from the water’s edge and placement of an anchored large woody debris (LWD) structure. The dog-leg section would be constructed landward of the existing shoreline to allow for greater flow capacity than the existing rock structure, buried trench, and other measures installed in previous years. Riprap remaining onsite from the November 2008 flood fight would be used in the creation of the toe, although additional rock may also be needed. The proposed LWD structure would be constructed in the dry, landward of the existing shoreline, and stabilized by logs anchored into the ground using excavation or pile installation equipment. Additional wood pieces would be added to simulate a natural log jam that would eventually be in contact with the wetted portion of the stream. Some disturbance to existing upland vegetation may occur as a result of the proposed activities. All disturbed areas will be hydroseeded with native grasses after construction. No in-water work would be required for the dog-leg section.

The setback has been designed to allow for reduced or, at minimum, deferred damage from the erosive energy of the stream. This section of the river is dynamic and has shifted frequently over the past several seasons. During a site visit on April 9, 2010, we observed that the reach of the river immediately upstream of the proposed repairs had shifted appreciably landward since a previous visit conducted by the Corps. We anticipate that the river may abut the setback relatively soon after construction, depending on how it moves within its floodplain over the next several years.

The remaining stretch of levee adjacent to the river at the upstream site would require in-water work to reestablish the levee toe to 10 ft. The waterward side of this portion of the levee would be armored to the top of the bank with Class IV to Class V riprap. The slope would be pulled landward to allow increased conveyance potential during higher flows. As with the dog-leg section, existing on-site riprap would be used, with additional rock imported as necessary. No large trees would be removed and the levee would not be expanded waterward of the existing structure.

At the downstream site, the Corps would create a 10-ft-wide by 16-ft-high toe by pulling the slope landward of its current position. The existing slope would be reworked, using on-site riprap and supplementing with additional rock, as necessary. Approximately 8 to 10 trees of various sizes and species would be removed to access and construct the repairs. After removal, the trees would be placed in the stream either as individual structures or as small logjams along this reach. Exact locations and configurations have not been finalized.

The Corps would implement a suspended sediment monitoring plan, as needed, for all sediment-generating activities (including but not limited to excavation below the OHWM) at the upstream and downstream sites. The monitoring plan would consist of the following measures:

- The Corps would establish background turbidity levels each day during sediment-generating activities. The levels would be reconfirmed if river clarity changes.
- The Corps would monitor turbidity immediately downstream of sediment-generating activities and within the visible plume. Monitoring would occur at one-third and two-thirds water depth twice at a 15 minute interval, then once every 3 hours if no exceedance above the following values are seen:
    - Between 0-1 hours, Nephelometric Turbidity Unit (NTU) levels must not exceed 32 NTUs above background turbidity levels.
    - Between 1-3 hours, NTU levels must not exceed 12 NTUs above background turbidity levels.
    - For 3 or more hours, NTU levels must not exceed 12 NTUs above background turbidity levels.
- If, after a minimum of one to two full days, the monitoring results verify that turbidity from sediment generating activities are remaining consistent with the above values, turbidity monitoring may be reduced or discontinued. Monitoring would be resumed during sediment-generating activities if precipitation events or any other changes (e.g., flow levels, stream turbidity, or project implementation) would result in higher or lower background and/or project-related turbidity.
- If sediment-generating activities exceed the above values, such activities will cease. The Corps will then take actions to avoid or reduce further exceedances, then resume activities and monitoring as described above
- The Corps will provide a monitoring report upon completion of the construction.

Guide-Meridian Levee (Proposed Action)

The Guide-Meridian levee is a 14,250-ft-long earthen flood protection structure located along the right bank of the Nooksack River at RM 16.8 at Lynden, Washington. The existing levee includes rock along the waterward face of the levee, except along the upper setback section of the levee. A narrow vegetated bench is present between the levee and the Nooksack River.

The Guide-Meridian levee was damaged by flooding during a 15-year flood event in January 2009. The flood damage affected three sites along the levee, resulting in toe- and overtopping scour, loss of slope materials, and breaching. The breach occurred at Site 1, and resulted in damage to a 200-ft-long section that was closed during the flood fight. Site 2 includes a 250-ft-long area of toe scour and slope loss, while Site 3 includes a 250-ft-long eroded area on the backside of the levee as a result of overtopping.

The levee repairs would occur in six phases. First, the Corps would establish access routes and prepare the site for construction. A 1.2-mile-long temporary road would be created to provide vehicle access to the site. The Corps would excavate sloughed materials from the levee toe and regrade the levee to achieve a 2H:1V slope. The levee toe would be excavated to provide for a weighted toe that would not encroach beyond the extent of the pre-flood footprint. During this

phase, 8 to 10 deciduous trees and approximately 0.13 acre of shrubs will be removed. Large armor rock will be placed at the toe, using a hydraulic excavator. The toe will be approximately 8-ft thick and will extend vertically to the OHWM. Additional rock will be placed vertically up the bank to approximately 5 ft above the toe to form a sloped surface. A 12-inch (minimum) thick layer of quarry spalls will be placed along the levee at Site 2 to the top of the levee on top of willow cuttings and the slope will be regraded to 2H:1V to prevent further erosion and scour. According to the PIR (although not described in the Assessment), the Corps would also place ten 20-ft-long logs (15- to 18-inch in diameter) in the toe structure along Site 1, with the root balls angled upstream. Finally, embankment materials will be placed on the land-ward side of the levee at Sites 2 and 3 to reestablish the levee slope and crown. The Corps intends to use excavated materials for this activity, although some imported materials may also be necessary. Any excavated materials that are not reused will be disposed of off site at a location determined by the local sponsor and the Corps. Three 12-inch lifts of soil will be placed at Site 2 along the waterward side of the levee. Willows or other riparian vegetation will be planted on approximately 1-ft centers, in staggered rows resulting in about 1 cutting every 6 inches. In the final phase, the Corps will place additional soil on the landward side of the levee at Sites 2 and 3 where notable overtopping damage has occurred. Disturbed sites, staging areas, and temporary access roads will be re-seeded with native grasses when construction has been completed.

All work will occur during the recommended fish work window for the project area (June 15 to August 15). The Corps would also implement the turbidity monitoring plan (as described for the Sande-Williams project above) for all sediment-generating activities associated with this project.

Ferndale Levee (Proposed Action)

The Ferndale levee is a 15,000-ft-long earthen flood protection structure located along the right bank of the Nooksack River at RM 5.5 at Ferndale, Washington. The existing levee includes rock along its waterward face and a weighted toe.

The Ferndale levee was damaged during flooding in January 2009, during a 25- to 30-year flood event (as described above for the Guide-Meridian levee). The flooding affected two sites along the levee, resulting in the loss of toe material along 450 ft at Site 1 (downstream site), and seepage of floodwater and corresponding back-slope deterioration extending 410 ft at Site 2 (upstream site).

The levee repairs would occur in four phases. First, the Corps would establish access routes and prepare the site for construction. Existing roads would allow vehicle access to the site, although a new temporary access road/ramp would be created to the upstream end of the toe. Excavated materials would be placed along 410 ft of the backslope to eliminate seepage at the upstream site. During this phase, 4 to 6 deciduous trees and approximately 0.08 acre of shrubs (including invasive species) will be removed. Large armor rock (Class IV) will placed along the toe, using a hydraulic excavator. The toe will be approximately 12 ft wide. The final toe elevation will be below the OHWM. A 36-inch-thick layer of quarry spalls will be placed along the face of levee at selected spots. Armoring will be placed until it is flush with the revetment crown. Disturbed sites, staging areas, and temporary access roads will be re-seeded with native grasses when

construction has been completed.

All work will occur during the recommended fish work window for the project area (June 15 to August 15). The Corps would also implement the turbidity monitoring plan (as described for the proposed actions above) for all sediment-generating activities associated with this project.

Conservation Measures

The Corps implemented[1] or plans to implement a number of conservation measures to avoid or reduce the potential for the adverse impacts from project construction on listed species, their prey species, and habitat. Such measures include but are not limited to the following:

<u>Completed Levee (Deming Levee)</u>

1. Turbidity was monitored visually and work was to be halted if turbidity exceeded required thresholds.

2. Biodegradable hydraulic fluids were used in the machinery at the site.

3. Refueling occurred in the staging area on the landward side of the levee.

4. A minimum of one fuel spill kit with absorbent pads was onsite at all times.

5. Drive trains of equipment did not operate in the water.

6. Proper disposal of removed invasive plant species was implemented.

7. Willow stakes were planted on the waterward face of the structure.

8. Work at Sections C and D occurred when minimal or no flows were present in the adjacent side channel. No additional measures were required to avoid sediment releases in the main channel.

[1] Descriptions of activities taken (e.g., conservation measures *implemented*) refer to the completed Deming Levee project throughout the remainder of the Opinion. Proposed activities (e.g., *proposed* levees) refer to the remaining proposed actions (Sande-Williams, Guide Meridian, and Ferndale levees).

Proposed Levees (Sande-Williams, Guide Meridian, and Ferndale)

1. All work will occur during the recommended fish work window for the project area.

2. A turbidity monitoring and response plan will be implemented during all sediment-generating activities to avoid appreciable suspended sediment levels in the stream.

3. Biodegradable hydraulic fluids will be used in machinery at the site.

4. Drive trains will not operate in the water.

5. An Emergency Spill Response Plan will be implemented to address accidental spills or leaks. At least one fuel spill kit with absorbent pads will be onsite at all times (Attachment 1).

6. Refueling will occur in the staging area on the backside of the levee or other suitable areas that would avoid the potential for spills or leaks into the shoreline areas or wetted width of the stream.

7. Willow stakes will be planted on the waterward face of the structure.

8. *For Sande-Williams only*: The Corps will place LWD in the stream adjacent to the structure at both the upstream and downstream ends of the repair site. Any additional wood present at the site and any cleared vegetation will be placed along the shoreline adjacent to the levee, in a location determined by Whatcom County or Corps engineers and biologists during construction.

9. *For Guide Meridian only*: The Corps will place LWD (logs) in the toe of the levee along 250 ft at Site 1 (as described previously).

ACTION AREA

The action area is defined as all areas that are affected directly or indirectly by a Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). In delineating the action areas for each of the projects (collectively, "action areas"), we evaluated the farthest reaching physical, chemical, and biotic effects of each of the actions on the environment.

The downstream extent of potential sediment impacts has generally been considered the lower boundary of the farthest reaching effects for levee repair and maintenance projects. However, in this Opinion, we will also consider the long-term effects of precluding the establishment of mature riparian vegetation due to levee maintenance and Corps performance standards. While the actions include placement of willows, current Corps levee standards do not allow large conifers or deciduous trees to grow on or immediately adjacent to the levee. As the continued existence and maintenance of the levees would preclude recruitment of large riparian vegetation, they also preclude inputs of LWD debris into the stream. Under natural conditions, LWD that is recruited into a stream moves downstream over time during high flow events, with individual logs or other components becoming integrated into log jams, and eventually reaching the mouth

of the Lower Nooksack River. Therefore, we have delineated the action area for each of the projects as extending from the project site to the mouth of the Lower Nooksack River (see Figure 2 below).

The upstream extent of effects is anticipated to be the next upstream meander bend for the proposed actions, shown in their approximate locations for each of the respective projects, as shown in Figure 2. For the Deming Levee, the upstream extent is to the confluence of the forks of the Nooksack River. The upper extent for each of these actions was chosen as the anticipated upstream limit of geomorphic changes in the stream from the long-term existence of the armored bank at the project sites, should such effects occur. Some of the project repairs are adjacent to additional rock armoring, and this may often be assumed to temper erosive forces under certain conditions. However, we do not anticipate that the presence of adjacent armoring will necessarily be a reliable assumption on which to base the upstream extent of effects. In fact, effects may be shifted to the opposite bank as a result of the armoring, or high flows or other factors may influence the stability of the adjacent rock. As a reach analysis has not been performed on any of these sites to inform any of these assumptions, and several of these sites have had numerous repairs over the years to various sections of the levee, we have attempted to exercise caution in determining the upstream extent so as not to underestimate the potential for erosion, headcutting, or other shoreline effects.

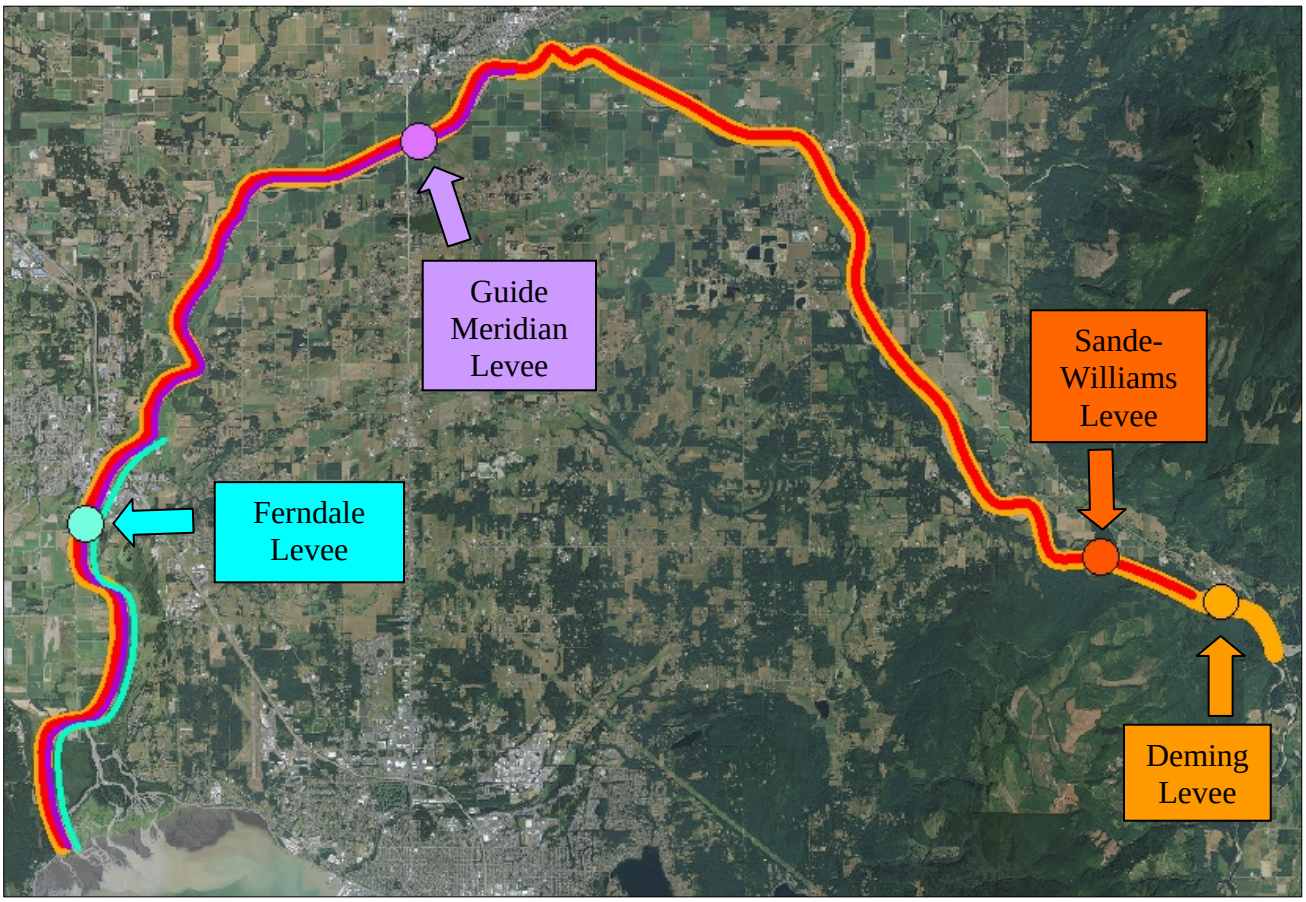

Figure 2. Approximate action areas for the Deming, Sande-Williams, Guide-Meridian, and Ferndale Levee Repair projects.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this Opinion for each of the actions relies on four components: (1) the Status of the Species, which evaluates the bull trout's range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the Environmental Baseline, which evaluates the condition of the bull trout in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the bull trout; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the bull trout; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the bull trout.

In accordance with policy and regulation, the jeopardy determination for each of the actions is made by evaluating the effects of the proposed Federal action in the context of the bull trout's current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the bull trout in the wild.

The jeopardy analysis in this Opinion for each of the actions emphasizes consideration of the range-wide survival and recovery needs of the bull trout and the role of the action area in the survival and recovery of the bull trout. It is within this context that we evaluate the significance of the effects of the proposed Federal actions, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

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

In accordance with policy and regulation, the adverse modification analysis for each of the actions in this Opinion relies on four components: 1) the Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; 2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; 3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and 4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal actions on bull trout critical habitat are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the bull trout.

The analysis in this Opinion places an emphasis on using the intended range-wide recovery function of bull trout critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal actions, taken together with cumulative effects, for purposes of making the adverse modification determination.

STATUS OF THE SPECIES (BULL TROUT)

Discussion of the rangewide status of bull trout is provided in Appendix A.

STATUS OF THE SPECIES IN THE CORE AREAS

Nooksack Core Area

The Nooksack core area comprises the Nooksack River and its tributaries, including the North, Middle, and South Fork Nooksack Rivers. Fluvial, anadromous and, possibly, resident life history forms of bull trout occur in the Nooksack core area. Bull trout spawning occurs in the North, Middle, and South Fork Nooksack Rivers and their tributaries. Post dispersal rearing and subadult and adult foraging probably occur throughout accessible reaches below barriers to anadromous fish. Overwintering likely occurs primarily in the lower mainstem reaches of the three forks and in the mainstem Nooksack River.

Bull trout and Dolly Varden co-occur in the Nooksack core area, but the level of interaction between the two species and degree of overlap in their distributions is unknown. However, limited genetic analysis and observational data suggest Dolly Varden in this core area inhabit stream reaches above barriers to anadromous fish, while bull trout primarily occupy the accessible stream reaches below the barriers.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004).

<u>Number and Distribution of Local Populations</u>

Ten local populations have been identified: 1) Lower Canyon Creek, 2) Glacier Creek, 3) Lower Middle Fork Nooksack River, 4) Upper Middle Fork Nooksack River, 5) Lower North Fork Nooksack River, 6) Middle North Fork Nooksack River, 7) Upper North Fork Nooksack River, 8) Lower South Fork Nooksack River, 9)Upper South Fork Nooksack River, and 10) Wanlick Creek. Spawning areas in the local populations apparently are small and dispersed. With 10 local populations, the bull trout in this core area is considered at intermediate risk of local extirpation and adverse effects from random naturally occurring events (see "Life History").

<u>Adult Abundance</u>

The Nooksack core area probably supports fewer than 1,000 adults. Eight of the local populations likely have fewer than 100 adults each, based on the relatively low number of migratory adults observed returning to the core area. The Glacier Creek local population has approximately 100 adults, based on incidental redd counts and available spawning habitats. The Upper North Fork Nooksack River local population may support 100 adults, based on the number of persistent, small numbers of spawning adults observed in tributaries and available side channel

habitat. The Nooksack core area bull trout population is considered at risk of genetic drift. Although the deleterious effects of inbreeding are minimized in these two local populations, the other eight local populations with few adults are considered at risk of inbreeding depression.

Productivity

The bull trout in the Nooksack core area is considered at increased risk of extinction until sufficient information is collected to properly assess productivity.

Connectivity

There is connectivity among most of the local populations, except for the Middle Fork Nooksack River, which has poor fish passage. There are road culvert barriers in several local populations. Consequently, the bull trout in the Nooksack core area is considered at intermediate risk of extirpation from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Nooksack core area have resulted in harm to, or harassment of, bull trout. These actions include statewide Federal restoration programs that include riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling and indirect mortality during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Nooksack core area.

The number of non-Federal actions occurring in the Nooksack core area since the bull trout listing is unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout.

Threats

Threats to bull trout in the Nooksack core area include:

- Past timber harvest and harvest-related activities, such as roads, have caused the loss or degradation of a number of spawning and rearing areas within local populations, as well as foraging, migration, and overwintering habitats.
- Bellingham Diversion has significantly reduced, if not precluded, connectivity of the Upper Middle Fork Nooksack River local population with the rest of the core area.
- Agricultural practices, residential development, the transportation network and related stream channel and bank modifications have caused the loss and degradation of foraging, migration, and overwintering habitat in mainstem reaches of the major forks and in a number of tributaries.

- Marine foraging habitats have been, and continue to be, greatly affected by urbanization along nearshore habitats in Bellingham Bay and the Strait of Georgia.
- The potential for brook trout and brook trout/Dolly Varden hybrids, detected in many parts of the Nooksack core area, to increase their distributions is a significant concern.

Lower Skagit Core Area

The Lower Skagit core area comprises the Skagit basin downstream of Seattle City Light's Diablo Dam, including the mainstem Skagit River and the Cascade, Sauk, Suiattle, White Chuck, and Baker River including the lake systems (Baker Lake and Lake Shannon) upstream of upper and lower Baker Dams.

Bull trout, which occur throughout the Lower Skagit core area, include fluvial, adfluvial, resident, and anadromous life history forms. Resident life history forms, found in several locations in the core area, often occur with migratory life history forms. Adfluvial bull trout occur in Baker, Shannon, and Gorge Lakes. Fluvial bull trout forage and overwinter in the larger pools of the upper portion of the mainstem Skagit River and, to a lesser degree, in the Sauk River (WDFW et al. 1997; Kraemer 2003).

Many bull trout extensively use the lower estuary and nearshore marine areas for extended rearing and subadult and adult foraging. Key spawning and early rearing habitat, found in the upper portion of much of the basin, is generally on federally protected lands, including North Cascades National Park, North Cascades Recreation Area, Glacier Peak Wilderness, and Henry M. Jackson Wilderness Area.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004).
Number and Distribution of Local Populations

Nineteen local populations were identified in the draft recovery plan (USFWS 2004): 1) Bacon Creek, 2) Baker Lake, 3) Buck Creek, 4) Cascade River, 5) Downey Creek, 6) Forks of Sauk River, 7) Goodell Creek, 8) Illabot Creek, 9) Lime Creek, 10) Lower White Chuck River, 11) Milk Creek, 12) Newhalem Creek, 13) South Fork Cascade River, 14) Straight Creek, 15) Sulphur Creek, 16) Tenas Creek, 17) Upper South Fork Sauk River, 18) Upper Suiattle River, and 19) Upper White Chuck River. Although initially identified as potential local populations in the draft recovery plan (USFWS 2004), Stetattle Creek and Sulphur Creek (Lake Shannon), each now meets the definition of local population based on subsequent observations of juvenile bull trout and prespawn migratory adult bull trout (Jim Shannon, *in litt*., 2004; R2 Resource Consultants and Puget Sound Energy 2005). With 21 local populations, the bull trout in the Lower Skagit core area is at diminished risk of extirpation and adverse effects from random naturally- occurring events (see "Life History").

Adult Abundance

The Lower Skagit core area, with a spawning population of migratory bull trout that numbers in the thousands, is probably the largest population in Washington (Kraemer 2001). Consequently, the bull trout population in this core area is not considered at risk from genetic drift.

The majority of local populations in the core area include 100 adults or more; therefore, they are at a diminished risk of extirpation. However, some local populations probably have fewer than 100 adults and may be at risk from inbreeding depression. There is some risk of extirpation of the following local populations due to their lower numbers of adults; however, other factors, such as stable or increasing population trends may reduce this risk. Fewer than 100 migratory adults and a limited number of resident fish use the Forks of the Sauk River; however, the migratory component appears abundant and is increasing (Kraemer 2003). Fewer than 100 adults probably occur in Tenas Creek, but this local population is presumed to be increasing. The Straight Creek local population includes fewer than 100 migratory adults and an unknown number of resident fish (Kraemer 2001), but the migratory component appears stable. The Lime Creek local population probably has fewer than 100 migratory adults, but resident and migratory components are considered abundant. The South Fork Cascade River local population probably has fewer than 100 migratory adults(Kraemer 2001); however, resident and migratory components are considered stable. Based on recent observations, the Sulphur Creek local population in the Lake Shannon system also has fewer than 100 adults(R2 Resource Consultants and Puget Sound Energy 2006). Prior to 2004, Goodell Creek supported more than 100 adult spawners. In October 2003, a large landslide in Goodell Creek blocked access to the majority of spawning habitat for migratory bull trout in the Goodell Creek local population. Adult counts of migratory bull trout in 2004 and 2005 have been fewer than 100 individuals (Downen 2006) in this local population. In the Baker Lake local population, annual peak counts of 85 adults have been recorded between 2001 and 2005 (R2 Resource Consultants and Puget Sound Energy 2006). Since the most upstream accessible habitat was not surveyed in these efforts, and bull trout typically spawn as far upstream as they can within a stream system, this would suggest that on average there may be at least 100 adults in this local population. Total adult abundances in Newhalem and Stettatle Creek local populations are unknown.

Productivity

Long-term redd counts in the index areas of the Lower Skagit core area generally indicate stable to increasing population trends(USFWS 2004). Therefore, this core area is not considered at risk of extirpation at this time. Recent declines in redd counts may indicate a potential change to this long-term trend (Downen 2006). Redd counts conducted by WDFW between 2002 and 2005 show a significant downward trend in Bacon, Goodell, and Illabot Creeks, and the Sauk River. However, Downey Creek had a significant increase in the reported redd counts between these years. The reason for these changes is unknown.

Connectivity

The presence of migratory bull trout in most of the local populations indicates the bull trout in the Lower Skagit core area has a diminished risk of extirpation from habitat isolation and fragmentation. However, the lack of connectivity of the Baker Lake and Sulphur Creek local populations in the Baker River system and Stetattle Creek local population in the Gorge Lake system with other local populations in the core area is a concern with respect to long-term persistence, life history expression, and refounding. In addition, there is currently only partial connectivity within the Baker Lake system, with no upstream passage for adults within Lake Shannon at upper Baker Dam.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Lower Skagit core area have caused harm to, or harassment of, bull trout. These actions include statewide Federal restoration programs that include riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have negatively directly affected bull trout in the Lower Skagit core area.

The number of non-Federal actions occurring in the Lower Skagit core area since the bull trout listing is unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably have negatively affected bull trout and parts of their forage base.

Threats

Threats to bull trout in the Lower Skagit core area include:

- Gorge and Baker Dams restrict connectivity of the Stetattle Creek, Baker Lake, and Sulphur Creek (Lake Shannon) local populations with the majority of other local populations in the core area due to impaired fish passage.
- Operations of the Lower Baker Dam occasionally have significantly affected water quantity in the lower Baker and Skagit Rivers.
- Agricultural practices, residential development, and the transportation network, with related stream channel and bank modifications, have caused the loss and degradation of foraging, migration, and overwintering habitats in mainstem reaches of the major forks and in a number of the tributaries.
- Estuarine nearshore foraging habitats have been, and continue to be, negatively affected by agricultural practices and development activities.

Upper Skagit Core Area

The Upper Skagit core area includes the Skagit basin upstream of Diablo Dam, as well as Diablo Lake and the majority of Ross Lake. The upper Skagit River is a transboundary system that flows south from British Columbia to the United States. A significant portion of the upper Skagit drainage lies within Canada (USFWS 2004). Much of the habitat in the core area is undisturbed as large portions of the watershed are located in largely undeveloped North Cascades National Park and Pasayten Wilderness Area, Washington, and Skagit Valley Provincial Park, British Columbia, Canada.

The Upper Skagit core area supports both bull trout and Dolly Varden. Generally, populations of Dolly Varden in the upper Skagit River drainage have been found to be spatially segregated from bull trout, with Dolly Varden typically residing upstream of those areas possessing resident and migratory bull trout (McPhail and Taylor 1995). Although hybridization between the two species does occur, size-dependent differences in spawning behavior and habitat choice appear to play an important role in isolating the two species and therefore, maintaining their distinct genomes in these areas of sympatry (Taylor et al. 2001). Adfluvial, fluvial, and potentially resident life history forms of bull trout are present in the Upper Skagit core area. Bull trout occur throughout most of the system, utilizing the majority of accessible tributaries to spawn and rear. Adfluvial bull trout in the core area primarily use either Ross Lake or Diablo Lake to forage and overwinter but occasionally enter Ross Lake tributaries to forage. Fluvial bull trout within British Columbia likely use the upper mainstem reaches of the Skagit River to forage and overwinter. It is unknown whether fluvial migrants are present in the United States' tributaries to Ross Lake, in particular Ruby and Lightning Creeks.

The status of a bull trout core population can be described by four key elements: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004).

Number and Distribution of Local Populations

At least 13 local populations are known to occur in the Upper Skagit River core area (USFWS 2004). Given there are greater than 10 local populations, the Upper Skagit core area is considered to be at diminished risk of local extirpation. Seven of the local populations occur largely within the United States (i.e., Big Beaver Creek, Little Beaver Creek, Panther Creek, Pierce Creek, Ruby Creek, Silver Creek, and Thunder Creek) and one is transboundary with Canada (i.e., Lightning Creek). All others are wholly within British Columbia.

Adult Abundance

In the Upper Skagit core area, including those portions of the drainage in British Columbia, the adult abundance likely exceeds 1,000 spawners (USFWS 2004). However, no comprehensive redd or adult surveys have been conducted for this core area. This core area is currently not considered to be at risk from genetic drift. There are likely at least 100 adult spawners in the Ruby Creek and Lighting Creek local populations based on the available habitat and number of adults observed staging at their mouths. Therefore, the risk of inbreeding depression is

considered low for these two local populations. Adult abundance in the remaining local populations within the core area is currently unknown, so the risk of inbreeding depression for these local populations is considered unknown.

Productivity

Due to the current lack of long-term, comprehensive trend data, the bull trout population in the Upper Skagit core area is considered at increased risk of extirpation until sufficient information is collected to properly assess productivity.

Connectivity

Migratory bull trout persist in most of the local populations in the Upper Skagit core area and therefore, are considered to be at a diminished risk of extirpation. However, there is no connectivity between the Thunder Creek local population in the Diablo Lake system and the other local populations within the Ross Lake system due to the upstream migration barrier created by Ross Dam. If connectivity between the Thunder Creek local population and the remaining areas of the Upper Skagit core area cannot be adequately addressed at Ross Dam, the establishment of additional local populations may be needed to ensure the persistence of the Thunder Creek local population.

Changes in Environmental Conditions and Population Status

Since the listing of bull trout, Federal actions have occurred in the Upper Skagit core area and may have resulted in harm to or harassment of bull trout. These actions include a fire management plan on national park land, statewide federal restoration programs, which include riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects and federally-funded transportation projects involving repair and protection of roads and bridges. Available information indicates few section 10(a)(1)(A) permits and no 10(a)(1)(B) permits have been issued in the Upper Skagit core area.

It is unknown how many non-Federal actions may have occurred in the Upper Skagit core area since the listing of the bull trout. The majority of the core area occurs within Federal ownership; therefore it is unlikely there have been many non-Federal actions within this core area.

Threats

Threats to bull trout in the Upper Skagit core area include:

- Ross Dam currently restricts connectivity between the Thunder Creek local population and the majority of the core area.
- Past forest practices have some lingering impacts to bull trout local populations within the United States. Past and ongoing forest practices in Canada remain a significant threat to some local populations in this country.

- Past commercial and present recreational mining activities continue to impact instream habitats within the Ruby Creek system.
- Brook trout are established in a number of tributaries to Ross Lake that are also used by bull trout. Because of their early maturation and competitive advantage over bull trout in degraded habitats, there presence is of greatest concern in bull trout spawning and rearing streams. In some tributaries (e.g., Hozemeen Creek), brook trout appear to have completely replaced or displace bull trout.
- Legal and illegal fishing continues to impact bull trout within Ross Lake and its tributaries. Large adults are easily targeted, and their direct or incidental mortality has the most significant impact to the population.

Snohomish-Skykomish Core Area

The Snohomish-Skykomish core area comprises the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout occur throughout the Snohomish River system downstream of barriers to anadromous fish. Bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River.

Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish River/Skykomish core area. A large portion of the migratory segment of this population is anadromous. There are no lake systems within the basin that support an adfluvial population. However, anadromous and fluvial forms occasionally forage in a number of lowland lakes connected to the mainstem rivers.

The mainstems of the Snohomish, Skykomish, North Skykomish, and South Fork Skykomish Rivers provide important foraging, migrating, and overwintering habitat for subadult and adult bull trout. The amount of key spawning and early rearing habitat is more limited, in comparison with many other core areas, because of the topography of the basin. Rearing bull trout occur throughout most of the accessible reaches of the basin and extensively use the lower estuary, nearshore marine areas, and Puget Sound for extended rearing.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004).

<u>Number and Distribution of Local Populations</u>

Four local populations have been identified: (1) North Fork Skykomish River (including Goblin and West Cady Creeks), (2) Troublesome Creek (resident form only), (3) Salmon Creek, and (4) South Fork Skykomish River. With only four local populations, bull trout in this core area are considered at increased risk of extirpation and adverse effects from random naturally occurring events (see "Life History").

Adult Abundance

The Snohomish-Skykomish core area probably supports between 500 and 1,000 adults. However, this core area remains at risk of genetic drift. Most of the spawners in the core area occur in the North Fork Skykomish local population. Redd counts within the North Fork Skykomish local population peaked at over 530 in 2002 (USFWS 2004), but have recently declined to just over 240 in 2005 and 2006 (WDFW 2007). This is one of two local populations in the core area (the other is South Fork Skykomish River) that support more than 100 adults, which minimizes the deleterious effects of inbreeding. The Troublesome Creek population is mainly a resident population with few migratory fish. Although adult abundance is unknown in this local population, it is probably stable due to intact habitat conditions. The Salmon Creek local population likely has fewer than 100 adults. Although spawning and early rearing habitat in the Salmon Creek area is in good to excellent condition, this local population is at risk of inbreeding depression because of the low number of adults. Monitoring of the South Fork Skykomish local population indicates increasing numbers of adult migrants. This local population recently exceeded 100 adults (Chad Jackson, Washington Department of Fish and Wildlife, *in litt*. 2004) and is not considered at risk of inbreeding depression. Fishing is allowed in this system.

Productivity

Long-term redd counts for the North Fork Skykomish local population indicate increasing population trends. Productivity of the Troublesome Creek and Salmon Creek local populations is unknown but presumed stable, as the available spawning and early rearing habitats are considered to be in good to excellent condition. In the South Fork Skykomish local population, new spawning and rearing areas are being colonized, resulting in increasing numbers of spawners. Sampling of the North Fork and South Fork Skykomish local population areas indicates the overall productivity of bull trout in the Snohomish-Skykomish core area is increasing.

Connectivity

Migratory bull trout occur in three of the four local populations in the Snohomish-Skykomish core area (North Fork Skykomish, Salmon Creek, and South Fork Skykomish). The lack of connectivity with the Troublesome Creek local population is a natural condition. The connectivity between the other three local populations diminishes the risk of extirpation of the bull trout in the core area from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Snohomish-Skykomish core area have caused harm to, or harassment of, bull trout. These actions include statewide Federal restoration programs that include riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of section

6 and section 10(a)(1)(A) permits have directly affected bull trout in the Snohomish-Skykomish core area.

The number of non-Federal actions occurring in the Snohomish-Skykomish core area since the bull trout listing is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout.

Threats

Threats to bull trout in the Snohomish-Skykomish core area include:

- Past timber harvest and harvest-related activities, such as roads, have degraded habitat conditions in the upper watershed.
- Agricultural and livestock practices, including blocking fish passage, altering stream morphology, and degrading water quality in the lower watershed (FMO habitat), have significantly affected the floodplain and bull trout habitat.
- Illegal harvest or incidental hooking mortality may occur at several campgrounds where recreational fishing is allowed by the Washington Department of Fish and Wildlife.
- Water quality has been degraded by municipal and industrial effluent discharges and development.
- Nearshore foraging habitat has been, and continues to be, affected by development activities.

STATUS OF BULL TROUT CRITICAL HABITAT

Discussion of the Status of Bull Trout Critical Habitat is described in Appendix B.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area of each project. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action areas that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Setting

The Nooksack River watershed is located in Whatcom (88 percent) and Skagit (6 percent) counties within the United States, and in British Columbia, Canada (6 percent), and is the fourth largest tributary to Puget Sound. The Nooksack River watershed drains approximately 2,036 square kilometers (786 square miles) of land, of which 127 square kilometers (49 square miles) is in British Columbia, and consists of two hydrologic provinces: the uplands where streams have steep gradients and cut through bedrock, and the lowlands where streams have low gradients and cut through glacial and interglacial sediments and alluvium (Service 2004; p. 28).

In the uplands east of the Deming, the Nooksack River has three major forks: the North Fork, Middle Fork, and South Fork. The North and Middle Forks originate from the glaciers and snowfields of Mount Baker and are typically turbid with moderate summer flows due to glacial melt. The Middle Fork enters the North Fork at RM 40.5. The South Fork drains snowpack from the Twin Sisters Mountain, with low flows during the summer, and meets the North Fork to form the mainstem at RM 36.6 and has a mean annual discharge† of 746 cubic feet per second (cfs) (near Wickersham, Washington; water years 1934 to 1977) (USGS 2001). The North Fork generally experiences peak flows in June and low flows in March, while the South Fork most frequently peaks in May and December, with low flows in August, resulting in divergent flow and water temperature patterns. Mean annual discharge of the North Fork downstream from Cascade Creek is 781 cfs (water years 1938 to 2001) (USGS 2001). The mean annual discharge for the Middle Fork is 495 cfs (15 water years from 1921 to 2001) (USGS 2001). Water temperatures in the North Fork are colder than the South Fork.

Streamflows in each of the forks combine just east of Deming, forming the mainstem of the Nooksack River. Here, the mean annual discharge is 3,331 cfs (59 water years from 1936 to 2001) (USGS 2001). The mainstem Nooksack River flows to Bellingham Bay in Puget Sound at Bellingham Bay. All of the actions occur in this reach of the river. In the lowlands, tributaries such as Anderson, Smith, Fishtrap, and Tenmile Creeks, and many others discharge into the Nooksack River. Natural vegetation within the basin includes western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), Sitka spruce (*Picea sitchensis*), black cottonwood (*Populus balsamifera*), Douglas-fir (*Pseudotsuga menziesii*), and grand fir (*Abies grandis*). Zoned land use for the Nooksack watershed is about 40 percent Federal, 33 percent forestry, 12 percent agriculture, 11 percent rural, 3 percent urban, 0.7 percent commercial and industrial, and 0.2 percent water and open space (Blake and Peterson 2002). Uses of surface waters from the Nooksack River system include agriculture, industry, municipal water supply, and recreation (USGS 2003).

The surface-water system of the Nooksack Basin lowlands has been extensively altered. In its natural condition, large areas of the lowlands were wetlands. Drainage systems have been installed to lower the water table and dry the land ever since farming by settlers started in the area, in about 1850. Parts of the drainage systems consist of open ditches that are easily identified, while other parts consist of underground structures not visible from the surface. Other alterations to the surface-water system include the diking, leveeing, and redirecting of the Nooksack River, to minimize damage from periodic flooding (USGS 2003). While many of the levees and other armoring present in the watershed were independently constructed, many of the

structures were connected over time and are maintained and repaired as needed due to flooding or other damage to the structures. Much of the lower Nooksack River has some type of armoring to provide flood protection or other similar function, forming a relatively interconnected system of levees and other armoring on the lower Nooksack River. Figure 3 below shows the estimated extent of the levee system, although additional data from other sources suggests that armoring is present along much of the lower Nooksack River (Ned Wright, Service, i*n litt.* May 20, 2010; Whatcom County Department of Public Works 1999; pp. 3-4, 3-5, and 3-10). One estimate indicates that perhaps as much as 65 percent of the lower Nooksack River has some form of armoring present along its shoreline (Ned Wright, Service, *in litt.* June 14, 2010), with most of the unarmored shorelines found in the upper reaches of the lower Nooksack River below the forks. While some of the repairs to sections of individual levees and other armoring have been consulted on under the Act on a site-by-site basis since the bull trout was listed, the overall long-term effect of maintaining all of the levees has never been adequately addressed through consultation.

Historically, the Nooksack delta included distributaries (natural branches from the main channel) to both Lummi Bay and Bellingham Bay, with extensive estuarine and riverine-tidal freshwater wetlands, especially on the side of Lummi Bay (Collins and Sheikh 2002 in Service 2004). The Lummi Bay distributary was formerly the major channel, and it was closed off from the river in the mid-1880s. Dikes closed delta distributaries and blind tidal channels, meanders were cut off in the lower river, and tributary creeks were ditched (Collins and Sheikh 2002 in Service 2004). Much of the Lummi Bay wetlands were diked and drained for agriculture, and most of the wetlands in Bellingham Bay were filled as well (WSCC 2002). The mainstem and lower South Fork Nooksack River historically had very large, full spanning logjams, and the upper mainstem and much of the forks have been transformed from anastomosing channel patterns (a channel which has major distributaries that branch and then rejoin it) to much wider, braided channels (Collins and Sheikh 2002 in Service 2004).

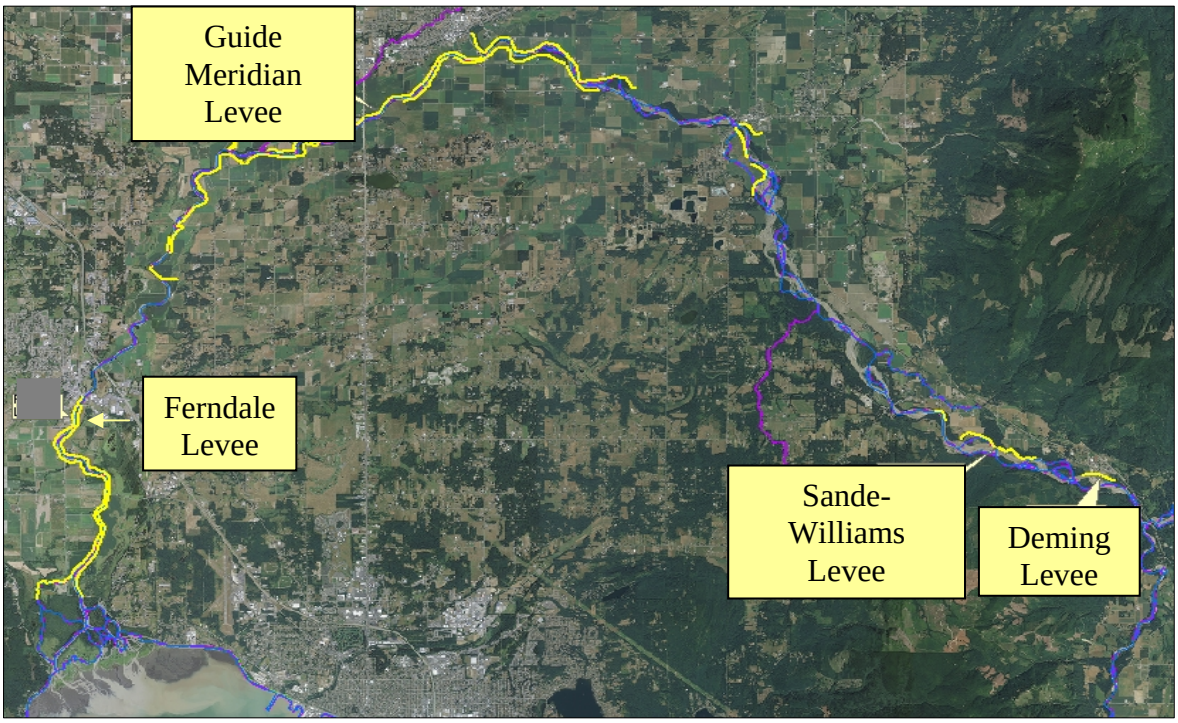

Figure 3. Approximate extent of levees (yellow lines) in lower Nooksack River (as provided by the Corps), showing the location of the Deming and proposed actions (N. Wright, Service, personal communication).

This layer primarily shows the extent of levees that are eligible for Corps maintenance, although it may also include levees that are ineligible.

Agriculture is pronounced in the Nooksack River core area, where farming activities comprise almost 12 percent of the entire watershed and extend at least 69 kilometers (43 miles) up the mainstem and another 16 kilometers (10 miles) up the South Fork Nooksack River (Service 2004; p. 168). Riparian conditions are highly degraded in agricultural zoned areas, with overall near-term large woody debris recruitment potential being low in 84.9 percent, moderate in 12.3 percent, and high in only 2.8 percent of the areas sampled (Coe 2001 in Service 2004). Most of this land use is along the mainstem Nooksack River, lower South Fork, and along the larger tributaries (Coe 2001 in Service 2004). Several streams in these areas are listed on the Washington Department of Ecology (Ecology) 303(d) list as water quality impaired for parameters including temperature, dissolved oxygen, and instream flow. In many cases hydrology has also been altered and streams include appreciable areas with straightened channels that lack habitat complexity. The freshwater forage base for migrating subadults and adults is considered to be substantially reduced from historical conditions (Service 2004; p. 169). Livestock production often impacts water quality with nutrients while large quantities of pesticides are often applied to crops such as potatoes, berries, and row crops, which can leach into the water table and enter streams from surface water runoff (Rao and Hornsby 2001; Spence *et al*. 1996). A number of pesticides have been detected in small streams and sloughs within agricultural and urban sites tested within Puget Sound (Bortleson and Davis 1997). In addition, elevated nutrient concentrations from animal manures and agricultural fertilizer application can

contribute to excessive growth of aquatic plants and reduced levels of dissolved oxygen in Puget Sound waterbodies, which can adversely affect fish (Embrey and Inkpen 1998). In Puget Sound watersheds, the Nooksack and Samish Rivers were reported to receive the largest nutrient inputs from animal manures and agricultural fertilizers (Service 2004; p. 167).

Urban development also has impacted the lower Nooksack River basin, through effects to water quality and quantity from transportation corridors, wastewater, stormwater runoff, impervious surfaces, and water withdrawals. Population centers in Whatcom County are primarily in Bellingham, Blaine, Everson, Ferndale, Lynden, Nooksack, and Sumas, although smaller communities exist throughout the County. Populations of these urban centers have grown steadily since their incorporation, with the highest estimates for Lower Nooksack River Basin cities and towns in Lynden and Ferndale (Washington State Office of Financial Management, i*n litt.* 2002). Whatcom County is revising their Comprehensive Plan, and the latest draft (Whatcom County 2009; p. 2-4) estimates that the population in the County will grow by over 55,000 over their 20-year planning period (ending 2031).

Previous Activities at the Project Sites

Emergency flood fight actions were conducted at each of the sites by the local sponsors (and/or the Corps) to address failure or other significant damage to some of the levee sections during and/or soon after storms/flood events occurred. As noted previously, this Opinion does not cover any of these or other repair activities associated with previous or subsequent flood fights or other actions completed by the Corps or local sponsor(s) at the project sites. While the proposed work at these sites is covered in later sections of the Opinion, this section addresses past impacts that are likely to have occurred due to the previous emergency work.

Deming Levee

The Deming levee was damaged during a 1.5 year peak flood event in December 2007. In response, the project sponsor, Whatcom County Public Works Department, completed emergency repairs during the flood fight, placing 650 tons of rock above the OHWM to prevent additional slope erosion. The repairs performed by the project sponsor included the placement of 650 tons of riprap above the OHWM, waterward side of one section of the levee in an effort to prevent additional slope erosion. The Corps' Assessment (p. 1) noted that the added weight of the riprap may have resulted in the loss of slope rock.

The additional rock placed on the levee provided a temporary repair to the levee in its current configuration until more complete repairs could be undertaken. While the repairs were not intended to provide a long-term fix for the damage, they have nonetheless maintained the degraded conditions present in this reach of the lower Nooksack River adjacent to the project site until the more permanent repairs could be undertaken. The long-term effects from maintaining the existence of the levee will be described more fully in the Effects of the Action section later in the Opinion.

Sande-Williams Levee

The levee was constructed to protect agricultural lands, roads, and structures from recurring flood flows, and consists of several levee segments that were interconnected over time to form a single contiguous segment. Over the past several years, relatively frequent repairs and/or maintenance activities have been implemented by various entities to maintain the integrity of the levee. As a result of the recent flood events, rock was placed on the levee during several of the flood fights.

As with the Deming levee project, the temporary flood fight repairs to the levee at this project location would have maintained the degraded conditions present in this reach of the lower Nooksack River adjacent to the project site until the more permanent repairs could be undertaken.

Guide-Meridian Levee

The flood damage at this project location resulted in toe- and overtopping scour, loss of slope materials, and breaching of the levee. The Assessment did not include information on site conditions during the breach, or report whether the potential existed for fish to access the area behind the levee during the breach. In the absence of this information, we assume that an unknown number of bull trout individuals may have become trapped behind the levee during or after the flood fight and closure of the breach. Because there is no stream habitat immediately landward of the breach site, we anticipate that any bull trout that may have become stranded behind the breach likely would have been preyed upon by opportunistic scavengers.

As with the previous projects, the temporary flood fight repairs to the levee at this project location would have maintained the degraded conditions present in this reach of the lower Nooksack River adjacent to the project site until the more permanent repairs could be undertaken. Previous repairs under the PL-84-99 program were conducted in 1995 and 2002.

Ferndale Levee

The flood damage at this site resulted in the loss of toe material and seepage of floodwater and back-slope deterioration. As with the previous projects, the temporary flood fight repairs to the levee at this project location would have maintained the degraded conditions present in this reach of the lower Nooksack River adjacent to the project site until the more permanent repairs could be undertaken. Previous repairs under the PL-84-99 program were conducted in 1996.

Status of the Species in the Action Areas

The action areas for the projects are located in the Nooksack Core Area for bull trout, which contains 10 local populations. We anticipate that fluvial and/or anadromous individuals[2] from one or more of these local populations and from other nearby systems (e.g., Skagit and

[2] As each fluvial individual has the potential to become anadromous in the future and vice versa, we assume that any individual in the Nooksack River may be anadromous for a portion of its life history.

Snohomish Rivers) may be present in the action areas of these projects during and after construction. Core Areas represent the closest approximation of a biologically functioning unit for bull trout and consist of habitat that could supply all the necessary elements for every life stage of bull trout (e.g., spawning, rearing, migration, overwintering, foraging). Core areas have one or more local populations of bull trout, and are also the basic units upon which to gauge recovery within a bull trout interim recovery unit.

Conservation Role of the Action Areas for Bull Trout

The action areas are within the Puget Sound Management Unit, which is considered important for bull trout recovery (Service 2004; p. 20). The Nooksack River core area supports fluvial and anadromous bull trout and provides foraging, migration, and overwintering habitat in the lower reaches and spawning and rearing habitat in the upper watershed. These spawning areas are believed to be limited to the forks and their tributaries, well upstream of the action areas of the project. The action areas provide foraging, migrating, and overwintering habitat for fluvial and anadromous individuals from the Nooksack Core Area, but also for anadromous individuals from other Core Areas (e.g., Lower Skagit, Upper Skagit, and Snohomish-Skykomish Core Areas).

No spawning has been documented or is anticipated to occur in the action areas. Consequently, we do not anticipate eggs, early-rearing juveniles, or spawning adults to be present in the action areas. However, we do anticipate pre-spawning fluvial or anadromous adults to migrate through the action areas as they travel upstream to their spawning areas. Suitable foraging, migration, and overwintering habitat exists within the action areas, and bull trout outmigrants have been reported in the lower Nooksack River in late spring and summer (Service 2004; p. 59).

We anticipate that three life history stages of fluvial or anadromous bull trout may have been or will be present in the action areas during construction and over the life of the project: adults, subadults, and larger juveniles that have moved downstream into the lower Nooksack River from their natal streams. Based on observations of bull trout in other systems in Puget Sound, we would expect most fluvial and/or anadromous bull trout to migrate downstream from their natal areas at age 2 or older (Service 2004; p. 3). Bull trout in some Puget Sound watersheds are reported to mature at approximately age 4, although some fish may mature at age 3 or 5.

For the purposes of this Opinion, we assume the following: 1) most of the juveniles in the action areas are more than 100 mm in length, 2) subadults (approximately 200 to 400 mm) are generally larger than juveniles, and 3) adults are generally 400 mm or greater in size and may or may not spawn each year. These approximations do not distinguish between fluvial or anadromous life history forms, although it is generally accepted that anadromous bull trout tend to be larger than fluvial bull trout.

Recovery Actions in the Nooksack River Basin

The Bull Trout Draft Recovery Plan has described a number of recovery actions that are needed in the Nooksack River watershed (Service 2004; p. 237). These include actions in the upper watershed as well as the mainstem Nooksack River, and include (but are not limited to) the following:

- Identify and improve or remove unstable or problem roads causing sediment delivery (Measure 1.1.1)
- Implement measures to restore natural thermal regime (Measure 1.1.3)
- Practice non-intrusive flood control and flood repair activities (Measure 1.3.4)
- Monitor water quality and meet water quality standards for temperature, nutrient loading, dissolved oxygen and contaminants (Measure 1.1.6)
- Identify, restore, and protect groundwater and hyporheic sources (Measure 1.1.7)
- Reduce anthropogenic sediment and contaminant sources generate from agricultural practices (Measure 1.1.8)
- Provide adequate fish passage around diversions and dams (Measure 1.2.2)
- Restore and protect riparian areas (Measure 1.3.1)
- Reduce stream channel degradation and increase channel complexity (Measure 1.3.4)

Recent projects in the watershed have been implemented or planned to address some of the recovery actions outlined in the Bull Trout Draft Recovery Plan. Examples include the Corps' proposed setbacks of portions of the Hovander and Rainbow Slough levees mentioned in the cover letter to this Opinion. A levee along Bertrand Creek, a major tributary to the lower Nooksack River, was lowered in 2006 to allow overtopping and partially setback from the main channel (Whatcom County *in litt.* 2006, Project Spotlight: Bertrand Creek Levee Setback Project). Each of these levee repairs included measures to reduce impacts from flood control in the lower Nooksack River watershed. Whatcom County's Comprehensive Management Plan also includes a section describing measures of avoiding flooding risk, impacts to water quality and quantity, and other related issues (Whatcom County 2009; p. 2-10). Other restoration plans for the watershed also have identified specific restoration, enhancement, and/or mitigation projects that would address several of these recovery actions, at least in part. The timeline for implementing many of these actions is dependent on funding availability, land acquisition, opportunities, and other factors.

Status of Bull Trout Critical Habitat in the Action Areas

The final rule designating bull trout critical habitat (70 FR 56212 [September 26, 2005]) identifies eight PCEs essential for the conservation of the species. The proposed rule to revise the designation of bull trout critical habitat (75 FR 2270 [January 14, 2010]) listed a new PCE (non-native predatory and/or competitive species). All of the levee repair sites are within designated critical habitat and/or we anticipate that the effects of the actions would extend into critical habitat downstream of the project sites.

Conservation Role of the Action Areas for Bull Trout Critical Habitat

The Service has designated the lower Nooksack River as critical habitat for bull trout. The action areas are within the Coastal-Puget Sound IRU and include the Nooksack River Basin (Unit 28). According to the Bull Trout Draft Recovery Plan, maintaining viable populations of the bull trout is essential to the conservation of species within each of the core areas, the interim recovery units, and the coterminous listing. To maintain or restore the likelihood of long-term persistence of self-sustaining, complex, interacting groups of bull trout within the action area, the Service (Service 2004) has identified the following needs: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in abundance of bull trout, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

Foraging, migration and overwintering areas are central to the survival and recovery of the bull trout. The Bull Trout Draft Recovery Plan states that although use of foraging, migration and overwintering habitat by bull trout may be seasonal or very brief (as in some migratory corridors), it is a critical habitat element.

The intended recovery function of critical habitat is to support the core areas and ensure that the habitat requirements of bull trout are met, now and in the future. The primary constituent elements provide a measure of the habitat conditions and are essential components of critical habitat. Consequently, we will analyze effects to critical habitat from construction and operation of the proposed actions.

Primary Constituent Elements

Seven of the designated Primary Constituent Elements (PCEs) and eight of the proposed PCEs are present within each of the action areas, and the baseline is described below in terms of each applicable PCE. The omitted PCE is related to spawning habitat for bull trout and is not included in the discussion due to the presumed absence of suitable bull trout spawning areas in the action areas.

Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 ºF (0 to 22 ºC) but are found more frequently in temperatures ranging from 36 to 59 ºF (2 to 15 ºC). 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.

The Limiting Factors Analysis (LFA) that was conducted in 2002, states that warm water temperatures are a problem in the mainstem Nooksack River. Water temperatures in the Nooksack River near North Cedarville (RM 30.9) 167 were rated as “poor” (warmer than 16 ºC) for 54 percent of the samples in 1996 and 1997 (data from USGS 2001). Conditions worsen downstream near Everson (RM 23.2) where 65 percent of the samples are warmer than 16 ºC, and the peak temperature was 19 ºC. Near the mouth (RM 3.4), 60 percent of the samples were

warmer than 16 ^{o}C in July and August of 1996 and 1997. The entire length of the mainstem Nooksack River has a severely degraded riparian area, which contributes to water quality exceedance. Shade levels were remarkably poor with no mainstem reaches achieving more than 40 percent of target shade levels, and most reaches had percent canopy cover in the 0 to 20 percent range. Other causes include the surrounding agricultural, residential, and urban land use and the increased sedimentation from upstream sources. All of these water quality problems pose serious impacts to salmonids and result in a "poor" water quality rating for the mainstem Nooksack River (WCC 2002, p. 166).

Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structure.

Channelization has straightened, confined, and simplified the river channel to such an extent in the lower Nooksack River that floodplain connectivity and function has virtually been eliminated along most the mainstem. The channelization, levees, and other armoring have also reduced river processes that form pools, side channels, and other habitat features that add habitat complexity. The LFA also rates the stream channel conditions in the mainstem as "poor" for habitat complexity, side/off channel rearing areas, pools, large wood, and floodplain connectivity (WSCC 2002).

Historically, the lower reaches of the mainstem Nooksack River flowed through a broad, gentle sloping valley; channel patterns were relatively straight from RM 5 to 11 and meandering from RM 5 to 24. Upstream of Everson, the valley narrowed and steepened and the channel pattern shifted to anastomosing (branching) channels with stable, forested riparian areas. Wetlands were common, especially along the lower mainstem. Dikes and levees have converted nearly all of the mainstem Nooksack River to a single channel, resulting in a major loss of slough, side-channel, and off-channel habitat. In addition to channel confinement, wetlands have been filled, compounding the loss. The LFA states that floodplain impacts associated with channelization (levees and dikes) is the greatest problem for salmonid habitat downstream of the Forks (WSCC 2002, p. 82).

According to the analysis, 50 percent of the entire Nooksack Basin riparian areas rated "low" for near-term LWD recruitment potential with the worst conditions in the lower mainstem (action areas). The worst land use categories were agriculture and urban.

In agricultural lands, 85 percent of the riparian areas were rated low for near-term LWD recruitment potential while riparian buffers in urban lands consisted of 77 percent low recruitment potential (WSCC 2002 p.146)

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.

The Nooksack River is a dynamic water body with a natural hydrograph, including peak, high,

low, and base flows within historic ranges. The Middle and North Fork Nooksack are glacial-fed systems and contribute moderate peak flows to the mainstem in May and June. Besides the constraining effects that levees have on flows, one of the most apparent impacts to stream flow is the diversion dam at RM 7.2 on the Middle Fork of the Nooksack River. The dam was constructed in 1960 to divert surface water to Lake Whatcom for the City of Bellingham's water supply. In the past, up to 80 percent of the summer water input to Lake Whatcom originated from the Middle Fork Nooksack River (WSCC 2002). Beginning in 1998, the amount of water that was being diverted from the Middle Fork Nooksack River has been reduced to help maintain instream flows. While currently the impact of the diversion dam on stream flows has been greatly reduced, the dam is still affecting flows, sediment and LWD transport and the extent of levees and other armoring (approximately 65 percent armoring in the Lower Nooksack River; Ned Wright, Service, *in litt* June 14, 2010) in the mainstem has altered the natural hydrograph and is affecting peak and low flows in the river.

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

The action areas are assumed to contain springs, seeps, groundwater sources, and/or subsurface water in the hyporheic zone that provide cold water to the river. Additionally, the North and Middle Fork above the mainstem Nooksack River are glacial fed and contribute a significant amount of cold water. Bull trout use the lower Nooksack River year-round for foraging, migrating, and overwintering. Juvenile, subadult, and adult bull trout are expected to utilize areas of localized groundwater input, as refugia from high temperatures in the lower Nooksack River. Cold water refugia in the foraging, migration, and overwintering habitats of the action areas are also expected to provide critical "stepping stones" to upstream spawning grounds.

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.

The mainstem Nooksack River is an essential migratory corridor for bull trout. No physical or biological impediments to migratory corridors occur within the aquatic action areas of the projects. However, summer maximum water temperatures could impede or delay bull trout attempting to move through the action areas, resulting in seasonal water quality impediments.
An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

The construction of levees and other shoreline armoring in the action areas and their maintenance and retention has decreased the contribution of prey organisms to the river by reducing the amount of functioning riparian vegetation, large wood, and through other impacts to stream habitat such as reduced wetlands and floodplain connectivity.

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

Portions of the Nooksack River and/or its tributaries are on the 303 (d) List for impaired water bodies (category 5) for temperature, dissolved oxygen, and fecal coliform (DOE 2008). The mainstem Nooksack River is classified as core salmonid spawning, rearing, and migration habitat (DOE 2006). The numeric surface water temperature criteria for the lower mainstem river is 16 °C with seasonal criteria of 13 °C upstream of the forks to protect trout and salmon spawning and rearing. Based on long-term water quality monitoring data conducted by Ecology, 7-day average maximum temperatures at Cedarville (station 01A120 at RM 32) and near Ferndale (station 01A050 at RM 4) are around 18 °C during the summer months, which exceeds the numeric temperature standard. Water quality impacts in the lower Nooksack River are seasonal and have not precluded bull trout use of the stream.

The LFA states that, compared to other rivers in the Puget Sound region, the Nooksack River near Ferndale has among the highest levels of nitrogen (including ammonia and nitrate), phosphorous, turbidity, and suspended solids (WCC 2002, p. 166). From 1979 to 1991, turbidity has increased between 1 to 2 percent per year in the lower mainstem Nooksack River. Increased turbidity can impair growth and rearing, and high levels of ammonia can be toxic to salmonids. The lower Nooksack River also has elevated levels of metals and fecal coliform due to agriculture, highway runoff, surface mining, and solid waste disposal.

Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass; inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.

The presence of brook trout in portions of the Nooksack core area (e.g., Wells Creek, tributary to the North Fork Nooksack River; Service 2004; p. 60) and their potential to further increase in distribution is of significant concern given the level of habitat degradation that has occurred within the core area. The detection of brook trout/Dolly Varden hybrids further emphasizes this threat to bull trout.

Summary

Adult, subadult, and older juvenile bull trout use the action areas for foraging, migration, and overwintering. The action areas of the projects have been channelized and simplified to varying degrees by levees and other armoring, resulting in the widespread loss of complex habitat-forming processes that form the off-channel and side-channel habitats needed by bull trout. Lack of mature riparian habitat in the action areas reduces habitat for aquatic and terrestrial macro-invertebrates and prevents the accumulation of LWD and the habitat complexity it provides. Rural development and agricultural production in the action areas continues to occur causing increased inputs of pollutants into the aquatic system, water withdrawals, and impervious surface coverage that reduces groundwater and subsurface recharge. A number of negative impacts to the aquatic and riparian habitat have occurred in the action areas due to past human activities, and the effects of these past activities are expected to continue into the future.

At the basin scale, a number of factors have affected bull trout and bull trout critical habitat in this watershed. Past forest practices and related road networks and mass wasting have had some of the most significant impacts to bull trout habitat within this core area. These have resulted in the loss or degradation of spawning and rearing areas within local populations, as well as foraging, migration, and overwintering habitats. Bellingham Diversion has significantly reduced, if not precluded, connectivity of the Upper Middle Fork Nooksack River local population with the rest of the core area. The Bellingham Diversion currently prevents most anadromous and fluvial bull trout returning to the Middle Fork Nooksack River from reaching spawning and rearing habitats in the upper watershed. As stated above, agriculture practices, residential development, the transportation network and related stream channel and bank modifications have resulted in the loss and degradation of foraging, migration, and overwintering habitats in mainstem reaches of the major forks, as well as in a number of tributaries. Marine foraging habitats for this core area have and continue to be greatly impacted by urbanization along nearshore habitats in Bellingham Bay and Strait of Georgia. The Bull Trout Draft Recovery Plan (Service 2004; p. 237) identifies and recommends a number of recovery actions for bull trout in the Nooksack River Basin. However, as mentioned before, implementation of these actions is likely to be sporadic, isolated, and/or infrequent without sufficient funding and/or opportunity.

EFFECTS OF THE ACTIONS

The Act regulations define “effects of the action” as “the direct and indirect effects of an action on the species or habitat 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).

Effects to Bull Trout

The proposed actions are expected to affect fluvial and anadromous juvenile, subadult, and adult bull trout that use the action areas for foraging, migration, and overwintering. The extent of adverse effects to listed species, and to bull trout in particular, are difficult to quantify, in part because of the limited data available regarding: 1) life history and local/core area population size and composition for bull trout in the Nooksack River, and 2) numbers of individuals anticipated to use the area for foraging, migration, and overwintering. Consequently, we have made a number of assumptions concerning these effects based on the limited observations and data available for this basin and bull trout studies and observations in other systems. The following paragraphs describe the potential direct and indirect effects to bull trout and their critical habitat from the actions.

Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from the action and include the effects of interrelated and interdependent actions. The primary potential direct effects of the actions on bull trout would be: 1) generation of suspended sediment, 2) disturbance associated with construction-related activities below or adjacent to the

OHWM, 3) exposure to contaminants from use of heavy equipment in or adjacent to the stream channel, and 4) crushing from placement of materials in the wetted width of the stream. Direct effects may result in disturbance, injury, and/or mortality of adult, subadult, and juvenile bull trout, and are described in greater detail below.

Generation of Suspended Sediment

The introduction of sediment in excess of natural amounts can have multiple adverse effects on bull trout and their habitat (Rhodes et al. 1994, pp. 16-21; Berry, Rubinstein, Melzian, and Hill 2003, p. 7). The effect of sediment beyond natural background conditions can be fatal at high levels. Embryo survival and subsequent fry emergence success have been highly correlated to percentage of fine material within the streambed (Shepard et al. 1984, pp. 146, 152). Low levels of sediment may result in sublethal and behavioral effects such as increased activity, stress, and emigration rates; loss or reduction of foraging capability; reduced growth and resistance to disease; physical abrasion; clogging of gills; and interference with orientation in homing and migration (McLeay et al. 1987a, p. 671; Newcombe and MacDonald 1991, pp. 72, 76, 77; Barrett, Grossman, and Rosenfeld 1992, p. 437; Lake and Hinch 1999, p. 865; Bash et al. 2001n, p. 9; Watts et al. 2003, p. 551; Vondracek et al. 2003, p. 1005; Berry, Rubinstein, Melzian, and Hill 2003, p. 33). The effects of increased suspended sediments can cause changes in the abundance and/or type of food organisms, alterations in fish habitat, and long-term impacts to fish populations (Anderson et al. 1996, pp. 1, 9, 12, 14, 15; Reid and Anderson 1999, pp. 1, 7-15). No threshold has been determined in which fine-sediment addition to a stream is harmless (Suttle et al. 2004, p. 973). Even at low concentrations, fine-sediment deposition can decrease growth and survival of juvenile salmonids.

A summary of effects from suspended sediment is listed in Table 2, and a more detailed discussion of effects is included in Appendix C.

Table 1. Summary of adverse effects to fish resulting from elevated sediment levels.

Sediment Impacts to Fish	**Summary of Adverse Affects Related to Sediment Impacts**
Gill trauma	Clogs gills which impedes circulation of water over the gills and interferes with respiration
Prey base	Disrupts both habitat for and reproductive success of macroinvertebrates and other salmonids (bull trout prey) that spawn and rear downstream of the construction activities
Feeding efficiency	Reduces visibility and impacts feeding rates and prey selection
Habitat	Fills pools, simplifies and reduces suitable habitat
Physiological	Increases stress, resulting in decreased immunological competence, growth and reproductive success
Behavioral	Results in avoidance and abandonment of preferred habitat

Because the Middle and North Forks of the Nooksack River are glacially-fed, the mainstem has naturally higher levels of turbidity compared to other rivers in the Puget Sound area that are not glacially fed. Aquatic organisms have adapted to the natural variation in sediment load that

occurs seasonally within the stream (ACMRR/IABO Working Party on Ecological Indices of Stress to Fishery Resources 1976, pp. 13, 15; Birtwell 1999, p. 7). Field experiments have found a thirty-fold increase in salmonids' (coho salmon) tolerance to suspended solids between August and November when naturally occurring concentrations are expected to be high (Cederholm and Reid 1987, p. 388).

Concentrations in excess of natural background turbidity levels could adversely affect bull trout, especially during the summer when the natural defenses that protect the fish are at lower levels than during the winter. Lethal effects are not expected from this project due to the lack of bull trout spawning habitat in the action area, the proposed Best Management Practices, and the proposed methods of construction.

Based on the research cited above, we anticipate that excavation or other sediment-generating activities during the summer low flow period may result in bull trout avoidance of high concentrations of suspended sediments. Such activities may also result in potential reductions in feeding, feeding efficiency, and/or growth rates, resulting in disruptions in bull trout foraging behaviors. Bull trout would generally be expected to move away from areas of increased levels of turbidity. In extreme cases, such as gill trauma or physiological stress, bull trout may be significantly impaired, resulting in injury or mortality.

The Service assumes that all construction activities associated with the completed and proposed actions will comply with water quality standards (RCW 940.48 and WAC 173-201A) set forth by the Ecology. These regulations set forth mixing zone standards for the temporary increases in turbidity. In addition, turbidity monitoring will be conducted during excavation and/or other sediment-generating activities using the previously described protocol, to avoid levels of elevated suspended sediments that would measurably affect bull trout.

As a result of the inclusion of these measures, we anticipate that sediment generated during excavation and other activities is not be anticipated to result in significant disruptions of normal foraging, migrating, or overwintering behaviors of bull trout.

Construction-Related Disturbance

At the Deming project site, placement of riprap within the wetted width of the stream may have directly affected bull trout. Operation of heavy equipment in close proximity to the river channel may have affected bull trout in the vicinity of the project (i.e., within a few hundred meters) by exposing them to sudden movements, vibrations, and noises, resulting in behavior changes. Bull trout were likely displaced from the project sites when appreciably disturbed and likely would have avoided the area while construction activities were being conducted in or adjacent to the stream. Consequently, we anticipate that these activities resulted in significant disruptions to normal foraging, migrating, or overwintering behaviors for the Deming action.

We anticipate similar pathways for effect and bull trout response for the Sande-Williams, Guide Meridian, and Ferndale projects. Increased turbidity, sound, vibration, and noise may result in significant disruption of migrating behaviors of individual bull trout in the vicinity of the project site, and these behavior alterations, including displacement and avoidance, are also likely to occur during the proposed actions. Furthermore, if the Corps completes more than one project per construction window, individual bull trout may be exposed to these stressors multiple times.

At the Sande-Williams project site, bull trout may also be affected during installation of the LWD structures. The proposed installation of LWD structures requires logs to be driven into the sediment in the upland portions of the project site, using excavation or pile installation equipment. The work would occur in the uplands, where the effects of underwater sound pressure levels[3] are not anticipated to result in injury to bull trout. If pile driving equipment is used, we anticipate that installation of the anchor logs may result in elevated underwater sound pressure levels analogous to that of installation of wood piles. However, the logs would be installed in the uplands, and we expect that, as the sound travels through substrate, both its waveform and its intensity will be altered. Thus, we anticipate that sound pressures that propagate through substrate (in the dry) will be less intense and/or will exhibit longer rise times when they reach the water column and will not be injurious. The potential area for behavioral effects for use of an impact pile driver in the dry may extend across the stream and for an undetermined distance up and downstream from each of the project sites. However, the installation time would likely be very short (a few hours). Bull trout would be expected to leave the area in which the disturbance would occur until the disturbance subsided. We anticipate that, along with the other construction-generated disturbance, installation of the logs with an impact pile driver would result in significant disruption of normal foraging, migration, and overwintering behaviors.

Based on the effects described above, we anticipate that these activities may result in significant disruptions to normal foraging, migrating, or overwintering behaviors for the Sande-Williams, Guide Meridian, and Ferndale actions during construction. We anticipate that these effects were/would be short term and temporary during installation of the logs, and that exposed bull trout would likely resume their normal behavior when installation of these logs is completed.

Contaminants

Use of heavy equipment along and adjacent to waterways increases the risk for introduction of fuels, lubricants, coolant, and hydraulic fluids into the riparian zone or water where they can injure or kill aquatic organisms. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons, which can be acutely toxic to salmonids at high levels of exposure and can also cause lethal or acute and chronic sublethal effects on aquatic organisms (Neff 1985 in Eisler 1987, p. 4; Eisler 1987, p. 38). No observed fuel leaks were observed during the emergency work for the Deming action, and the remaining actions will implement a spill control plan to reduce the potential for accidental fuel leaks or spills to occur. Based on the fact that equipment will not be operating in the water,

[3] For a more detailed analysis of the expected effects from the use of an impact pile driver on wood piles, refer to Attachment 2.

biodegradable fuels and lubrication will be used, and precautions will be taken to avoid accidental leaks, it is extremely unlikely that bull trout will be exposed to chemicals during the remaining work. Therefore, potential exposure to chemicals associated with the proposed actions is not expected to result in significant disruptions to normal foraging, migrating, or overwintering behaviors.

Crushing

During the course of heavy equipment operation and placement of large rock in the Deming action, some bull trout may have been crushed or injured. Outmigrants have been documented in the lower Nooksack River during the summer months, and it is possible that small bull trout may have been in the project area during the Deming action or may enter the area during construction of the remaining projects. Goetz et al. (2004) indicate that bull trout as small as 100 mm have been observed in lower reaches of the Snohomish River and estuary. We anticipate that bull trout life histories and migration patterns in the Nooksack River would not be appreciably different than those found in the Snohomish River. Therefore, it is reasonable to assume that juvenile bull trout of similar sizes may be found in the lower Nooksack River and in the action areas for all of the projects discussed in this Opinion. However, we anticipate that the number of small juvenile bull trout is likely to be low, based on the sizes of bull trout observed in Goetz et al.' (2004) study areas.

Rock placed on top of the substrate in these areas may have resulted in injury or mortality in the Deming project to smaller juvenile bull trout, which we anticipate would be more likely than larger fish to seek refuge in the substrate instead of swimming away. We expect that the likelihood of crushing was low, because most of the fish in the construction area would have left the immediate area due to noise and vibration associated with the activities. Similar effects may occur in the proposed projects (Sande-Williams, Guide-Meridian, and Ferndale) that would place rock along the levee. We anticipate that this placement of rock may have resulted in significant impairment of behavior associated with crushing of very small numbers of juvenile bull trout for the Deming project. We anticipate similar effects to small bull trout for the remaining proposed actions that would place rock in the wetted width of the stream. For larger bull trout, we anticipate that effects would be similar to those described above for sound and visual disturbance, and would not result in significant disruptions to normal foraging, migration, or overwintering behaviors.

Indirect Effects

Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur (50 CFR 402.02). Indirect effects from the existence of the levees are expected to continue in perpetuity and include the continuing degradation of habitat, precluding riparian vegetation and LWD recruitment, and sustaining reduced prey abundance for bull trout. Additionally, for the Sande-Williams project, there is also the potential for periodic elevated levels of suspended sediment downstream of the project, as described below.

All Actions

The Deming project and most of the remaining proposed actions have been designed to repair the levees in their current footprint. The Sande-Williams and Guide Meridian projects have been designed with components (e.g., LWD, set-back of the new dog-leg section) that are proposed to at least temporarily alleviate some of the habitat impacts of the continuing presence of the levee and provide some level of fish habitat, and we appreciate the Corps' efforts to try to address some of these issues at these two sites. All of the projects, however, appear to have been designed in the absence of reach-based analyses. A reach-based analysis would help to identify: 1) the specific cause(s) of the erosion and other damage, and 2) the range of solution(s) at each site and possibly at other upstream/downstream locations that could be implemented to alleviate flood damage without deflecting the problem elsewhere.

Bank stabilization, as its primary purpose, stops natural processes that form and maintain functioning riparian habitat along stream corridors. The rock revetment will continue to degrade bull trout habitat quantity and quality within the vicinity of the project sites. The repairs will maintain constriction of the river at the project locations, locking in the direction of the flows in such a way that would reduce the ability of the river to readjust its meander to reach equilibrium in the channel migration zone in the reaches near the project site. The constriction of the river at these sites will continue to limit the formation of natural river features, such as alcoves and side-channels, and other complex stream habitat. Bull trout and other salmonids would use such areas for refugia during high flows and to seek prey. Although large rock can provide some habitat features used by bull trout, fish densities at rocked banks are low compared to natural banks (Schmetterling et al. 2001, p. 6; Peters et al. 1998, p. 26). Peters et al. (1998, p. 26) found that salmon densities are usually lower at stabilized banks than natural banks with the exception of those bank stabilization projects that used only LWD.

The armoring, which will use riprap and other rock for repair of the levees, is also anticipated to maintain the degraded conditions of the riparian corridor at and adjacent to most of the project sites. Riprap can preclude the establishment of natural streamside vegetation which is important to streambank integrity and healthy fish habitat (Schmetterling et al. 2001, p. 7; Bjornn and Reiser 1991, p. 135) and prevents the recruitment and retention of large wood (Schmetterling et al. 2001, p. 7). The lack of habitat complexity in areas with riprap is expected to directly relate to the reduced abundance of bull trout in those areas.

Riparian vegetation links terrestrial and aquatic ecosystems, influences channel processes, contributes organic debris to streams, stabilizes banks, and modifies water temperatures (Gregory *et al.*. 1991, pp 547-548). Use of rock for streambank stabilization without hardwood or conifer trees will delay or even preclude the natural establishment of larger riparian vegetation in the action areas. The sustained loss of LWD inputs from reduced recruitment reduces the structural component of instream habitat that creates pools, refugia, and cover from predators. Large wood also enhances invertebrate production and abundance due to the complex range of habitats available for colonization and the retention of fine organic debris (Gurnell et al. 2002, p.603).

The natural complexity of wood (i.e., root wad vs. single log) is also correlated with juvenile fish abundance, as abundance is greater in root wad cover than in single logs (Beamer and Henderson 1998, p. 13).

An additional proposed conservation measure for each of the projects includes planting the slope with willows. Over time, it is expected that this vegetation will become established on the reconstructed bank and that the habitat will be lower quality than natural shorelines but will be improved over time relative to the rock revetment (Figure 3). Planting willows along the riverbank will accelerate the process to restore some of the usefulness of the area for bull trout, but there still be a temporal loss of habitat value until the vegetation matures. In the short-term, shade and cover will increase and provide habitat for invertebrate forage items (e.g., fall-out insects). However, due to current restrictions, the Corps (and/or the project sponsor) would likely thin or cut the willows once they reach a maximum DBH (i.e., 4 in), and/or 4-ft-diameter aggregations of willows on 30-ft centers. Consequently, the willows would be extremely unlikely to reach a size that would offer substantial multi-functional benefits to the stream.

Figure 4. Deming Levee project site at Deming, Washington.
At left, levee riprap and plantings, looking upstream; at right, close-up of willow plantings on waterward side of levee. (Photo by K. Myers, U.S. Fish and Wildlife Service.)

Preventing large hardwoods and mature conifer from becoming established along the shoreline precludes the potential for the riparian areas to function adequately to provide shade (e.g., for cooler temperatures), habitat-forming processes (e.g., LWD recruitment), fallout insects for prey contribution and food web support, and nutrient contributions. Because the Deming, Sande-Williams, and Guide Meridian projects are located on the north side of the stream, the riparian vegetation on these levees provides less shading potential than vegetation along south or westerly oriented riverbanks would provide. Nonetheless, the remaining functions of the riparian areas will continue to be affected by precluding establishment of mature vegetation.

The inclusion of LWD along the Sande-Williams and Guide Meridian sites will provide some structure and complexity that may be used by bull trout (e.g., for refugia) if the structures remain intact over the long-term and functions as expected. However, we are uncertain how long the structures will remain intact or what benefits they would provide over the long-term, since no reach-based analysis was used to determine their design, location, and effects to downstream and upstream habitats from the larger suite of proposed repairs at the site.

Repairs of levees are intended to prevent the failure of the larger levee structures they comprise (until additional high flow or other damage occurs that would require future repairs). Although the stream reaches adjacent to the project sites will continue to function as migratory corridors for bull trout, the repairs will maintain the degraded baseline condition for the foreseeable future. This suite of effects can decrease salmonid growth, development, and fitness, and may increase bull trout mortality rates for those fish that would forage in the action areas, though admittedly in degrees that are difficult, if not impossible, to describe based on the complex nature of such ecological relationships. Although these impacts are not considered to be insignificant to bull trout, but we do not anticipate that the effects would result in measurable disturbance of foraging, migrating, and overwintering bull trout.

Sande-Williams Action

For the Sande-Williams project, the configuration of the repaired levee and the addition of the dog-leg section may direct flows toward the opposite bank. An eroding landform (Clay Banks) is present at this downstream location on the opposite bank (Whatcom County Department of Public Works 1999), outside of the project site. This area may have been eroding prior to the construction of the Sande-Williams levee as suggested by the apparent channel migration zone and surrounding landforms. However, the Shared Strategy for Puget Sound (2006; p. 14) noted in the Water Resource Inventory Area (WRIA) 1 watershed work plan (that the hooked-shape configuration of the right bank levee structure directs stream flow to the eroding Clay Banks, exacerbating the slide that is present at the site. It is unclear whether this redirection occurs consistently or only during certain flows or with particular stream conditions. For example, the intensity or periodicity of the effect may vary depending on where the thalweg of the river is located within the channel. This reach of the Nooksack River is highly dynamic, and we expect that the thalweg may shift over the next several decades. In the absence of a reach-based analysis, it is reasonable (and prudent in our analysis) to assume that the existing levee orientation may indeed be contributing to increased erosion and instability at the Clay Banks. Consequently, we assume that another indirect effect of the action may be the additional elevated levels of suspended sediment released into the stream at a level or periodicity that is greater than if the levee were not directing the flows in this manner. Any elevated suspended sediment levels that indirectly result from these conditions would be expected to affect spawning habitat and sensitive life stages for salmonids (e.g., NMFS, *in litt.* 2009).

As noted previously, we do not anticipate that bull trout would be spawning in the action area for the Sande-Williams project, or that their redds, eggs, or alevins would be affected by periodic generation of elevated levels suspended sediments, should it occur as a result of this project. However, if the project does result in elevated suspended sediment levels as described above, bull trout using the action area for foraging, migrating, or overwintering may encounter turbidity

and other effects related to these levels, as described in the Direct Effects section above. The degree and duration of effects would depend on a number of factors, including flow stage, duration, and flood flow timing, as well as bull trout life history stage during exposure, and would probably be highly variable from one event to another. We anticipate that, from time to time, bull trout in the action of the area of the stream may encounter turbidity that would affect their behavior. However, neither the Corps nor the local sponsor has proposed to measure the amount of additional amount of sediment generated as a result of the potential redirection of flows. While we anticipate that such sediment generation would directly affect bull trout as described above, we do not anticipate that this would significantly disrupt normal foraging, migration, or overwintering behaviors of individual bull trout.

Elevated levels of suspended sediment may also indirectly affect bull trout through trophic level effects. The effects are expected to be pronounced if suspended sediments impacts spawning habitat for bull trout prey species (e.g., salmon), or smother eggs or alevins of salmon spawning in the reach below the Clay Banks. Smothering or disturbance of aquatic macroinvertebrates may also result from elevated levels of sediment. We anticipate that, from time to time, such sediment generation will impact and perhaps reduce bull trout prey resources from the project site downstream to an area in which the sediment would settle out. This degree and duration of such effects is likely to be variable, again depending on flows and volume of excess sediments suspended from this erosion. Over time, we anticipate that these events may result in periodic reductions in prey productivity downstream of the project site. However, the area in which the prey reduction is likely to occur is localized when compared to the extent of the Lower Nooksack River and potential prey production. Consequently, we do not anticipate that this effect alone will result in a significant disruption of normal foraging behaviors for bull trout.

Effects to Bull Trout Critical Habitat

All of the completed and proposed actions are anticipated to result in both short- and long-term effects to designated and proposed critical habitat. The actions, accumulatively, are anticipated to affect the following PCEs:

Water temperatures that support bull trout use.

As described previously, the existing levees in the Lower Nooksack River contribute to degraded water temperatures through impacts to floodplain connectivity and reduction of shade. Repairs at the Deming, Sande-Williams, Guide Meridian, and Ferndale levee are anticipated to contribute to the degraded condition of this PCE in the Lower Nooksack River into the future. The Ferndale levee repair site is located on the west side of the river, and will likely continue to contribute to reduced shading potential along the length of the levee. The remaining actions are located on the north side of the stream and may reduce shading potential to a limited degree based on the angle of the sun throughout the day. However, all the actions will continue to limit floodplain connectivity, contributing to higher stream temperatures at the project sites over time, and these impacts are anticipated to occur for the life of the projects. While we do not expect that full restoration of the project sites would restore adequate water temperatures that support bull trout use throughout the lower Nooksack River, the actions accumulatively are expected to measurably degrade water temperatures during the summer.

Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structure.

Construction activities associated with the actions are not expected to appreciably affect this PCE because they will not result in a direct impact to side channels, pools, or other complex stream channel or habitat features. Consequently, construction-related effects to this PCE from these projects are considered insignificant.

However, these habitat conditions are generally lacking in areas with extensive levees, and the continued operation and maintenance of the levees would continue to affect these features in the project areas. For example, each of the projects would continue to preclude the establishment of large hardwood and conifer trees along the shorelines at project sites, limiting future LWD recruitment at the site. The Sande-Williams and Guide Meridian projects incorporate LWD structures, which may enable some level of instream structure development for as long as the LWD remains in the system. However, without a site- and reach-based analysis, we cannot determine whether placement of the LWD would be expected to appreciably improve the stream complexity at this site over the long term. If the LWD does not remain onsite and/or intact, we anticipate some limited (but relatively unquantifiable) benefits to downstream reaches where the wood may be recruited into the system, but onsite benefits would be lost.

Overall, impacts to this PCE from the Deming and proposed actions are considered to be appreciable, although the LWD placement at the Sande-Williams and Guide Meridian sites may provide some benefit to habitat structure over the short-term. Additionally, the operation and maintenance of these levees would also maintain degraded stream complexity by significantly limiting the ability of the stream to move within its floodplain or form pools and side channels. Because the emergency and proposed actions contribute to maintaining the degraded channel condition and will preclude the development of complex habitat in the future, the accumulative effects to this PCE from the completed and proposed actions are expected to be measurable.

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.

The continued operation and maintenance of these levees will, accumulatively, maintain the altered natural historic hydrologic conditions. The river will continue to be precluded from spreading out onto the floodplain during high flow events, resulting in higher flows through the stream sections at and immediately adjacent to the project sites. Consequently, we anticipate the effects associated with continued maintenance of levees will appreciably alter the peak flows of the lower Nooksack River from their historic ranges. Therefore, effects to this PCE from the actions are expected to be measurable.

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

The aquatic action areas of these projects are assumed to contain springs, seeps, groundwater sources, and/or subsurface flows adjacent to the channel, which likely would provide uninterrupted cold water to the river if unconstrained by the levees. Cold water refugia are critical for bull trout, especially during the summer when adults are migrating to upstream spawning grounds. The North and Middle Forks are glacial-fed and provide cold water to the mainstem Nooksack. The Deming project and the proposed actions are not anticipated to reduce the cold water sources to the stream beyond what has already occurred due to the prior existence of the levees. However, the repair and maintenance of these levees is expected to contribute to the currently degraded condition at the project sites by continuing to limit connectivity to subsurface waters landward of the levees. If these subsurface waters were allowed to connect periodically with the stream, they would likely buffer the warmer stream temperatures, especially in the summer. The long-term indirect effects of the proposed action may impact the ability of this PCE to contribute to the conservation function of critical habitat in the action area. Because operation and maintenance of the levees will continue to impact groundwater inflow to the river, effects to this PCE from the completed and proposed actions are likely to be measurable.

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.

The action areas are used by bull trout for migrating between lower reaches of the stream and/or Puget Sound and their spawning areas in the upper watershed. The Deming action may have resulted in physical and water quality impediments to bull trout migration during construction, and may have similar effects during construction of the proposed action. Impacts are also expected during operation and maintenance of the each of the levees.

During construction, this PCE is likely to be affected by minor impacts to the migratory corridor through disturbance or water quality through increased sound, vibrations, visual disturbance, spills, leaks, and/or increased turbidity levels. These stressors may impede bull trout migration through the site, and bull trout may be displaced or avoid the project site during the associated activities. These activities are not expected to preclude bull trout from migrating through the area, although it may delay migrations for short periods of time. Additionally, based on the inclusion of a sediment monitoring plan, and other conservation measures described earlier in this Opinion, we do not anticipate that impacts to water quality from these stressors would measurably affect this PCE. Furthermore, we anticipate that these stressors are temporary, and would not result in long-term impacts to water quality.

After construction, the Deming action and the other proposed actions will maintain the degraded condition of the migratory corridors in the vicinity of the project sites by maintaining the integrity of the levees and their contributive effects on this PCE. As described in previous sections of this Opinion, the levees will continue to contribute to the degraded water quality conditions in the lower Nooksack River, which affects the migratory corridor for bull trout. At the Sande-Williams site, suspended sediment from exacerbation of downstream erosion of the

Clay Banks shoreline (as described above) may periodically affect the migratory corridor, although these impacts are likely to be short-term and infrequent.

Overall, impacts from operation and maintenance of the completed and proposed actions are not expected to prevent migration of bull trout through the action areas. However, accumulatively, they are likely to measurably affect this PCE.

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

Repair of the Deming levee and proposed actions at the other levees is expected to result in short-term impacts to the food base of bull trout through a variety of pathways. Riparian vegetation provides a source of terrestrial prey items, such as insects. The removal of riparian vegetation associated with construction activities would affect the prey base of bull trout through the reduction in terrestrial food base. Construction is also anticipated to crush, smother, and/or displace other prey items, such as aquatic macroinvertebrates and small fish that seek cover or are unable to escape.

Furthermore, the operation and maintenance of the levees is expected to maintain the degraded conditions of this PCE. The levees will continue to limit the availability of prey organisms to bull trout by precluding establishment of large hardwood and conifer trees in the riparian zone that supply fallout insects and other prey items. The lack of LWD recruitment will limit habitat-forming processes that support the food web for bull trout and salmonids in the Nooksack River. While the inclusion of willows may provide some level of inputs for these resources, they will not reach the size or dimensions of mature riparian buffers. We also anticipate that the willows will be thinned and pruned during maintenance to meet Corps standards for eligible levees, further limiting their full potential to contribute these resources to the stream. The Sande-Williams project may further impact the food base of the bull trout (as described above) by exacerbating downstream erosion of the Clay Banks shoreline. The suspended sediments that may be periodically generated may smother or displace bull trout prey items. Therefore, effects to this PCE from the completed and proposed actions, accumulatively, are likely to be measurable.

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

The completed and proposed actions will continue to affect water quality through impacts to water temperatures, as described above. The long-term effects of the actions, when considered separate from each other and other stressors in the basin, are not anticipated to raise water temperatures to a level that would preclude use of the action areas by bull trout. As described above, however, the levees will continue to contribute to the degraded water temperature conditions in the lower Nooksack River, which impacts the normal reproduction, growth, and survival of bull trout. We recognize that complete restoration of the shoreline along the project sites would not fully restore water temperatures in the lower mainstem. However, we anticipate that precluding the development of mature vegetation at each of the project sites will contribute

to the elevated summer water temperatures in perpetuity. Therefore, effects to this PCE from the completed and proposed actions, accumulatively, are likely to be measurable.

Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass; inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.

The completed and proposed actions are not anticipated to result in the introduction of nonnative predatory, inbreeding, or competitive species into the action areas of the projects. The proposed actions would not remove any barriers or otherwise expose bull trout to these species. Therefore, effects to this PCE from the proposed actions are considered insignificant.

Summary

The projects are anticipated to result in adverse effects to bull trout both during construction and over the life of the project. During construction, disturbance is expected to occur from the use of heavy equipment and other activities adjacent to or below the OHWM, and a few small bull trout may be crushed during placement of rock. Over the long term, the actions are anticipated to continue to preclude channel migration, side channel habitat formation, and formation of complex habitat features for foraging, refugia, and other purposes in the vicinity of the project site. The action will also preclude the establishment of mature riparian vegetation and large woody debris inputs in the vicinity of the project site, which would have provided instream habitat over a long period of time as the wood made its way to the mouth of the river and estuary. Each of these indirect effects are expected to result in adverse effects to bull trout, although the effects to individual bull trout may be difficult to measure, and may not rise to level of a significant disruption of normal foraging behaviors for bull trout.

The long-term effects of the maintaining the levees in their existing footprints are also anticipated to appreciably affect several bull trout critical habitat PCEs. The actions would continue to contribute to impacts to water quality (primarily elevated temperatures), and would result in limited riparian vegetation and LWD recruitment and stream constriction. Each of these stressors is anticipated to maintain the degraded critical habitat conditions that are currently present at the project sites. These actions will also contribute to the sustained degraded critical habitat conditions in the lower Nooksack River, although the degree to which they affect critical habitat in the lower watershed as a whole cannot be determined on a site level basis.

The Deming, Sande-Williams, Guide-Meridian, and Ferndale levee repairs, in combination with other armoring in the basin, will maintain the degraded habitat conditions in perpetuity, limiting the ability of the river to move freely in the floodplain and reach equilibrium in the absence of the structures. When considered together, this system of armoring significantly disrupts normal foraging, migration, or overwintering behaviors of bull trout at the scale of the lower Nooksack watershed.

Some of these projects, as well as other projects[4] that have been planned or implemented in the lower Nooksack basin, may include features that provide localized improvements to habitat

[4] These include, but are not limited to the River Road, Hovander, Rainbow Slough projects

through setbacks or other enhancement features (such as willow plantings and placement of LWD). However, without a widespread, landscape-scale approach, the levees and other armoring present in the basin will effectively maintain the degraded conditions found in the watershed in perpetuity. All anadromous individuals in the Nooksack populations must travel through the lower Nooksack River, and would therefore be impacted by these degraded conditions during foraging and migration. Since the scale of this consultation (as well as past and expected future consultations) is limited to individual project sites, the consultation process as currently implemented is unlikely to ever adequately consider or address the accumulative effects of repairs of these structures in perpetuity.

INTERRELATED AND INTERDEPENDENT ACTIONS

Interrelated and interdependent actions are actions that would not occur but for the proposed action under consultation. An interrelated action is an action that is part of the proposed action and depends on the proposed action for its justification. An interdependent action is an action that has no independent utility apart from the proposed action. We anticipate no interrelated or interdependent actions would be associated with the completed or proposed projects.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action areas considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

As demonstrated by the response to damage done in the 2006, 2007, 2008, and 2009 flood events on the Nooksack River, it is reasonably certain that the levees considered in this Opinion will be maintained in the future by the local sponsors in order to prevent and/or repair flooding of the land, roads, and buildings located landward of the levees. Future activities that would not require a federal permit or funding or otherwise have a Federal nexus may include rock placement above the OHWM or other upland actions undertaken by one or more of the non-Federal project sponsor that would prevent and/or repair the overtopping or breaching of the levees. Furthermore, we anticipate that such actions would not be limited to the project sites covered by this Opinion, but will occur throughout the lower Nooksack River and its tributaries during or after storms and other high flow conditions where levees, revetments, or other armoring are present.

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described in the cover letter to this Biological Opinion.

The cumulative effects of non-Federal maintenance of the disjunct, but largely contiguous, system of bank hardening prevalent in the lower Nooksack River Basin are expected to maintain the existing degraded shoreline and habitat conditions prevalent in the basin. These conditions are expected to continue to preclude the formation of habitat conditions that have been identified as necessary for bull trout recovery in the lower Nooksack River.

Climate Change

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing and that this will continue for at least the next several decades (Intergovernmental Panel on Climate Change 2007). There is also consensus within the scientific community that this warming trend will alter current weather patterns and patterns associated with climatic phenomena, including the timing and intensity of extreme events such as heat- waves, floods, storms, and wet-dry cycles.

Recent observations and modeling for Pacific Northwest aquatic habitats suggest that bull trout and other salmonid populations will be negatively affected by ongoing and future climate change. Rieman and McIntyre (1993) listed several studies which predicted substantial declines of salmonid stocks in some regions related to long-term climate change. More recently, Battin et al. (2007) modeled impacts to salmon in the Snohomish River Basin related to predictions of climate change. They suggest that long-term climate impacts on hydrology would be greatest in the highest elevation basins, although site specific landscape characteristics would determine the magnitude and timing of effects. Streams which acquire much of their flows from snowmelt and rain-on-snow events may be particularly vulnerable to the effects of climate change (Battin et al. 2007). In the Pacific Northwest region, warming air temperatures are predicted to result in receding glaciers, which in time would be expected to seasonally impact turbidity levels, timing and volume of flows, stream temperatures, and species responses to shifting seasonal patterns. Changing climatic conditions are expected to similarly affect the Nooksack River basin (e.g., Donnell 2007, Pelto 2008).

Battin et al. (2007) suggest that salmonid populations in streams affected by climate change may have better spawning success rates for individuals that spawn in lower-elevation sites, especially where restoration efforts result in improved habitat. Higher elevation spawners would be more vulnerable to the impacts of increased peak flows on egg survival. They further note that juvenile salmonids spending less time in freshwater streams before out-migrating to the ocean would be less impacted by the higher temperatures and low flows than juveniles that rear longer in the streams. Bull trout generally spawn in cold headwater streams, and juveniles may spend 1 to 3 years rearing before moving downstream to large river reaches (such as the lower Nooksack River) or estuarine/marine habitats. Therefore, bull trout would be less likely than other salmonids to be able to adjust their spawning habitat needs related to water temperature. Connectivity between lower and upper reaches of the Nooksack River and Puget Sound may become even more critical for the growth and survival of fluvial and anadromous individuals that access this area for foraging, migrating, and overwintering purposes.

If the current climate change models and predictions for Pacific Northwest aquatic habitats are relatively accurate, bull trout in the Nooksack River basin are likely to be impacted through at least one or more of the following pathways:

- Changes in distribution of bull trout within the core area, such as reduced spawning habitat, and/or seasonal thermal blockage in the migratory corridors associated with increased stream temperatures.
- Disturbance or displacement of eggs, alevins, juveniles, and adults of resident and/or migratory adults during winter flooding events
- Short-term or long-term changes in habitat and prey species due to stochastic events during winter floods
- Changes in flow/out-migration timing in the Spring for bull trout and their prey species
- Increased migration stressors from lower stream flows and high stream temperatures during spawning migrations

INTEGRATION AND SYNTHESIS

In the Environmental Baseline, Status of the Species, Status of Bull Trout Critical Habitat, Effects of the Action, and Cumulative Effects sections of the Opinion, we established that the effects of past and ongoing activities in the Nooksack River watershed would maintain the existing degraded habitat conditions that are prevalent in the action areas. The Bull Trout Draft Recovery Plan (Service 2004; pp. 189-90) lists several reasons for the decline of bull trout in the Nooksack River core area and describes impacts that affect different life stages of bull trout. Spawning and rearing areas have been affected by dams, forest practices, road networks, and mass wasting. Foraging, migration, and overwintering habitats have been impacted by agricultural practices, residential development, the transportation network, and stream channel/bank modifications. Additionally, marine foraging areas have been impacted by urbanization along the marine shoreline, which is expected to directly affect anadromous bull trout and their prey species in the nearshore. Finally, the presence of brook trout in portions of the upper watershed is also expected to impact bull trout through competition, hybridization, or both. While some of activities listed above occur outside of the action areas for the projects, their additive impacts influence the ability of the bull trout using the action areas to be resilient to sustained or increased habitat degradation.

The action areas are used by individuals from local bull trout populations in the Nooksack River Basin and other watersheds, and are essential to individuals that use the lower Nooksack River to forage, overwinter, or migrate between habitats. As noted previously, bull trout in the Nooksack core area are at an intermediate risk of local extirpation and adverse effects from random, naturally occurring events and anthropogenic activities. The Service expects that the actions addressed in this opinion would adversely affect bull trout, their prey species, and their critical habitat via several pathways. The continued constriction of the river in its floodplain, preclusion of large of mature riparian vegetation, and preclusion of natural LWD recruitment are expected to maintain and likely exacerbate the degraded conditions in the lower Nooksack River basin for the foreseeable future. These activities will also maintain low stream channel complexity and

high summer stream temperatures that negatively influence migration and spawning success of bull trout (e.g., due to lower pre-spawning fitness) and other salmonids. The completed and proposed actions will, at minimum, contribute to maintaining the existing highly degraded riparian and floodplain habitat conditions in the lower Nooksack River. We recognize that the actions covered by this Opinion are not solely responsible for the degraded aquatic habitat conditions in the lower watershed. Nonetheless, they are part of the extensive armored shoreline system in the lower Nooksack River.

Numerous past flood fights indicate that the levees will likely require periodic repairs into the foreseeable future either at the sites identified in the Assessments, or at adjacent or nearby reaches. While future repairs that would have a Federal nexus are not considered in this Opinion, we assume that repairs without a Federal nexus that are performed by local sponsors, private landowners, or other non-Federal stakeholders would continue to occur when levees are damaged. Such repairs will likely spur repetitive or similar actions at the same sites or at nearby sites, resulting in the addition of new rock to replace lost armor rock. In some cases, the repairs and/or continued existence from repairs of the levee may exacerbate upstream or downstream erosion and may even displace effects to the opposite bank or to an adjacent reach.

Past and present land-use activities that are enabled through the existence and continued maintenance of the levee system are expected to maintain existing uses as well as encourage further development in and adjacent to the floodplain of the lower Nooksack River. Future development, particularly in and adjacent to urban centers of the watershed, would result in further degradation of aquatic and riparian habitats through additional stormwater and wastewater releases and their release of contaminants. As more land in and adjacent to the floodplain is developed, we anticipate there will be an intensifying dependence on flood control to protect human infrastructure, reinforcing this cycle and its associated impacts to bull trout foraging, survival, migration, and thus indirectly to spawning success.

The effects of the actions on the likelihood of survival and recovery of bull trout must be also be considered in light of short-term and long-term climate cycles and trends, which may either temper or exacerbate the overall effects to bull trout and the aquatic and terrestrial systems on which they depend. A number of mitigation, enhancement, and restoration projects have been planned and/or implemented in the basin, and these projects may offset some of these effects by improving aquatic and terrestrial habitats. For example, projects may provide localized benefits to aquatic biota and their habitats through increases in floodplain function (e.g., levee setbacks and addition of log jams or other LWD). However, without landscape-level planning and implementation of projects, it is unlikely that the benefits these and other projects provide will be sufficient to mitigate the full extent of impacts to bull trout, their prey base, and their habitat caused by the combined impacts of past, present, and future development and potential climate change trends in this basin.

Changes in climate have been identified that are occurring now or will occur over the next 50 to 100 years (Mote *et al.* 2005, p. 4; Glick *et al.* 2007, p. iii). The predicted changing precipitation patterns are expected to result in more frequent severe weather events and warmer temperatures (Mote *et al.* 2005, p. 13). Glaciers in the Cascades and Olympics Mountains have been retreating during the past 50-150 years in response to local climate warming. Regional warming

can result in reduced winter snowpack, earlier occurrence of peak runoff, and reduced summer flows (Snover *et al*. 2005, p.18). With higher winter temperatures, more winter precipitation will fall as rain rather than snow in mid-elevation areas increasing the chance of flooding along the rivers. If winter precipitation increases, as some models suggest, the risk of flooding would be compounded (Snover *et al*. 2005, p.18). Levee and riverbank stabilization projects along the Nooksack River may be susceptible to more erosion, and the amount of large rock and riprap being washed into the river channel would increase, making the habitat less suitable for bull trout. We assume this will occur in the action areas of the projects, as well as throughout the lower Nooksack River basin.

The Nooksack core area, along with the Lower Skagit, Stillaguamish, Snohomish-Skykomish and Puyallup core areas, is particularly critical for maintaining the distribution of the anadromous life history form of the Coastal-Puget Sound Interim Recovery Unit (Service 2004; p. 137).
Both fluvial and anadromous life history strategies are important components of the local and core area populations, providing a greater degree of resilience for these populations. Additionally, anadromous individuals tend to have larger body sizes, and they are likely to produce more eggs than resident and fluvial bull trout. McPhail and Baxter (1996) noted that fecundity is a function of body size, with larger female bull trout able to produce more eggs and use a wider range of spawning habitats. With their likely greater fecundity, the anadromous individuals of the local populations are critical to the resilience of the core populations, particularly with the ongoing and future anticipated effects of climate change.

The actions are expected to result in a slight decrease in the number of bull trout individuals and/or their fitness in the Nooksack core area's local populations. A small number of larger juvenile bull trout may have been crushed in the Deming action, and may be crushed during construction of the proposed actions. However, the loss of a small number of individual juvenile bull trout is not anticipated to measurably affect the Nooksack Core Area's local populations. Impacts to bull trout from construction-related disturbance, while measurable, are likely to be short term. In the long-term, the actions will continue to contribute to maintaining the existing degraded habitat conditions. However, it would be extremely difficult to attribute appreciable declines in the numbers of bull trout in the Nooksack core area directly to long-term habitat impacts from the actions addressed in this Opinion, due to the relatively small extent of each of the repairs. Thus, the impacts from these actions are not expected to appreciably reduce the survival and recovery of the Nooksack core area population, the Coastal-Puget Sound Interim Recovery Unit, and the coterminous range of the species for the following reasons:

- Potential injury and/or mortality associated with construction-related effects would impact so few individual bull trout that any reduction in the likelihood of persistence at the core area scale is not likely to be measurable.
- The short-term, sub-lethal effects from construction are not expected to measurably reduce productivity at the scale of the Nooksack core area.
- The long-term, habitat-related effects from maintenance and operation of the actions are not expected to measurably reduce productivity at the scale of the Nooksack core area.

- Because direct and indirect effects of these specific actions, in isolation, will not be discernable at a core area scale, we do not expect effects of the actions to reduce the likelihood of survival and recovery of bull trout at the Interim Recovery Unit, or the coterminous U.S. population.

Bull trout critical habitat in the lower Nooksack River would be affected by the actions over the long term by maintaining the existing degraded conditions. The actions are expected to result in sustained elevated stream temperatures and lack of LWD inputs due to the preclusion of the recruitment of shading conifers and other large trees along the shorelines of the project areas. The levees will continue to constrict the river in its floodplain, inhibit the development of stream complexity, and limit input of LWD in the action areas and the project sites. We recognize that the Deming site currently includes a side channel on the right bank of the stream, and the dynamic nature of the Sande-Williams reach may allow for periodic access to side channel habitat that currently exists or that may become accessible depending on stream flows and location of the thalweg. While the actions will maintain the current degraded baseline, they are not expected to destroy or adversely modify critical habitat by altering the PCEs to such an extent that critical habitat in Critical Habitat Unit 28 (Puget Sound) would not remain functional to serve the intended conservation role for the species for the following reason:

- Although construction and operation of the levees will contribute to maintaining the degraded baseline conditions, the PCEs, and therefore designated and proposed critical habitat within the action areas, will continue to serve the intended conservation role for the species at the scale of the core area, interim recovery unit, and coterminous range.

CONCLUSION

After reviewing the current status of the Coastal-Puget Sound bull trout, the environmental baseline for the action areas, the effects of the Deming, Sande-Williams, Guide Meridian, and Ferndale levee repair and rehabilitation projects, and the cumulative effects, it is the Service's biological opinion that these actions, as proposed, are not likely to jeopardize the continued existence of the Coastal-Puget Sound bull trout, and are not likely to destroy or adversely modify designated or proposed critical habitat.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* is defined by the Service as an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which

include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). 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 Corps so that they become binding conditions of any grant or permit issued by the Corps, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: 1) fails to assume and implement the terms and conditions or 2) fails to require its staff and contractors to adhere to 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 Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

For the proposed and completed actions, the Service anticipates the following extent of incidental take occurred and/or is likely to occur:

The Service anticipates that bull trout were and could be taken as a result of the levee repair actions. Some forms of incidental take will be difficult to detect or quantify for the following reasons:

1. the low likelihood of finding dead or injured individuals;
2. delayed mortality; and
3. the relationship between habitat conditions and the distribution and abundance of individuals is imprecise such that a specific number of affected individuals cannot be practically obtained. Where this is the case, we use post-project habitat conditions as a surrogate indicator of take.

The following incidental take is anticipated:

Deming Action

- Incidental take of bull trout in the form of **harm** is anticipated to have occurred during construction resulting from significant impairment of behavior associated with crushing of individual bull trout during placement of rock and inwater construction activities. Given the location of the project and the time of year that work was conducted, the Service anticipates that one juvenile/subadult bull trout may have been injured or killed during repair work at the Deming project.

Proposed Actions

- Incidental take of bull trout in the form of **harassment** in the vicinity of each of the proposed actions is anticipated to occur over the short-term due to significant disruption of bull trout foraging, migrating, and overwintering behaviors resulting from avoidance of construction areas due to disturbance and long-term negative effects to prey base and habitat from the removal of trees and other habitat modifications during construction. We anticipate that all bull trout that are be present in the action areas during the time when these activities are conducted (June 15 to August 15) would be harassed. The extent of construction-related disturbance and habitat modification for each action is defined as the stream reach adjacent to each project site.

- Incidental take of bull trout in the form of **harm** is anticipated to occur during construction resulting from placement of rock and large woody debris structures due to significant impairment of foraging, migrating, and overwintering behaviors resulting from crushing of individual juvenile bull trout. The extent of take is expected to be one bull trout for each project, for a total of three bull trout.

EFFECT OF THE TAKE

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

REASONABLE AND PRUDENT MEASURES

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

1. Reduce impacts to riparian habitat and associated LWD recruitment potential along the shoreline in each of the project areas to address long-term effects to bull trout foraging, migration, and overwintering habitat from removal of trees during construction.

2. Monitor the implementation and effectiveness of all conservation measures described in the project description of the Opinion, as well as the aforementioned RPM and its accompanying Terms and Conditions.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following Terms and Conditions are required for the implementation of RPM 1:

1. The Corps shall replace removed native conifers and other native riparian trees with like or similar species (i.e., conifers and other large-growing species) on the landward side of the levee at the Ferndale, Guide-Meridian, and Sande-Williams project sites at a minimum 2:1 ratio (2 replacement trees for each 1 removed). The plantings should be sited as near to each of the levees as is permitted under the regional variance for levee vegetation management guidelines, and in a location in which their eventual recruitment to the stream would be likely.

2. Where native trees are present in the riparian zone, the Corps shall coordinate with the local sponsor and/or landowner to create a site-specific management plan for retention of fallen trees in the riparian zone immediately adjacent to the levee to ensure that these trees will be actively recruited to the stream and would not be harvested, cut, or otherwise removed from the riparian zone.

3. All native trees removed during construction shall be placed in the wetted width of the stream in the vicinity of the project site such that it can either be naturally moved by the river (e.g., single logs), or to provide habitat-forming structures (e.g., logjams). The Corps shall provide numbers of trees and placement locations on as-built drawings submitted as part of the monitoring report described below.

4. A monitoring plan shall be implemented for at least 5 years for all plantings of trees and shrubs associated with the project to ensure planting success, and will meet the following minimum requirements:

    a. Replacement of trees and shrubs will occur as needed each year,

    b. 100 percent survival annually for all shrubs and trees during the first 3 years;

    c. 100 percent survival of trees and at least 80 percent survival of shrubs at the end of 5 years.

The following Terms and Conditions are required for the implementation of RPM #2:

1. The Corps shall submit a monitoring report by no later than 90 days after the completion of each action and include, at a minimum, the following: (a) dates and times of in-water construction activities; (b) turbidity monitoring results; sample times, locations, and measured turbidities (in NTUs); (c) summary of in-water construction activities and measured turbidities associated with those activities; (d) summary of corrective actions taken to reduce sediment/turbidity, and (e) documentation and effectiveness of implementing RPMs and associated Terms and Conditions as outlined in the Opinion.

The Service is to be notified within 3 working days upon locating a dead, injured, or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care

should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

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

Recovery of bull trout will require efforts to restore natural stream processes in degraded habitats and to improve industrial, development, forestry, and agricultural practices affecting water quality and flows. Increased pressure of urbanization will require adequate restrictions to development in floodplains. Levee removals and setbacks can provide areas for flood waters to dissipate energy, reducing damage to levees and/or the properties they protect. Levee removals and setbacks also provide opportunities for habitat restoration projects to reduce impacts to foraging and migratory habitats from rock stabilization and channel confinement.

We anticipate that the levees discussed in this Opinion will be exposed to future flooding conditions that will damage levee sections, and that repairs will continue into the future. Based on past history of some of these sites, at least some of the repairs are likely to be proposed as emergency actions under PL-84-99. If the actions are similar to those described in this Opinion, we also assume that a site- and reach-based analysis would not be conducted, that LWD and other habitat features would be limited or not included, and that opportunities for levee setbacks would rare. We also expect that such limitations on design would be proposed for repairs in other levee sections that are adjacent to these levees or are located elsewhere in the Nooksack River Basin. If these assumptions are correct, the extensive levee system and other shoreline armoring in the lower Nooksack River Basin would continue to contribute to the existing degraded conditions in the watershed in perpetuity.

We recognize that these project sites are a small yet integral proportion of the larger levee system throughout the lower Nooksack River. The extant levee system has resulted in significant degradation of the Nooksack River below the forks, affecting bull trout and their foraging, migratory, and overwintering habitat, as well as other aquatic biota. We anticipated that most (if not all) of these levees in the larger levee system will be maintained for the foreseeable future. Consequently, the long-term effects of maintaining the levee system are unlikely to ever be adequately evaluated through consultation under section 7 of the Act.

We are making the following recommendations to the Corps for the lower Nooksack River Basin

as well as other watersheds in which the Corps conducts levee and other armoring repairs. We offer these recommendations to assist you in meeting your obligations to implement the recovery plan for bull trout during future emergency repairs and to decrease the adverse impacts of river channelization and rock stabilization methods. We recommend that the Corps:

1. Engage in a programmatic consultation with the Service (and the National Marine Fisheries Service [NMFS], if amenable) for all of the levees and other armoring in a given watershed that are likely to be damaged by floods and for which structural repairs would be proposed. The current piece-mealing of these projects, does not adequately address the landscape-level degradation of many of these watersheds from shoreline armoring and levees, and associated effects on the recovery of bull trout in this core area.

2. With stakeholder cooperation, identify suitable areas for levee removal, restoration, and enhancement activities that would serve as conservation banks within a given watershed.

3. Once these areas are identified, work with stakeholders (including the Service and NMFS) to establish the conservation banks. An in-lieu fee system may be one method for funding the acquisition and restorative actions.

4. Coordinate with the Service, NMFS, and other stakeholders on a watershed approach to addressing the levee system and shoreline armoring in each watershed. For example, levees and other hard shorelines within the Nooksack River Basin that can be removed or set back should be identified, and removal and setbacks should be implemented as funding is sought and becomes available. Removal and setback actions would improve stream and floodplain function, which may also help to alleviate flooding concerns in certain areas and would improve habitat conditions for listed species, their prey, and other aquatic biota. While project sponsors and/or the Corps may find it more economical in the short term to repair a project in its existing footprint, the long-term costs should also be considered, both in terms of repair costs and impacts to the floodplain and to aquatic biota. We recommend that the following actions be implemented:

    - Identify sections of the levees and revetments throughout each basin where repeated damage has occurred or is expected to occur and conduct in-depth reach assessments for these river sections in preparation for future flood repairs.
    - Develop alternative designs, including setbacks and bio-engineering methods, for repeat damage sections.
    - Have bio-engineered alternative plans designed and ready to use in and/or immediately after the next flood event. We recommend including LWD in the footprint of the repairs, designed and oriented in such a way to improve fish habitat and reduce damage to the levee. Such designs should be determined by the site- and reach-based analyses mentioned above.
    - Create more stream complexity in project designs, using information gathered from the site- and reach-based analyses.
    - Work with stakeholders to seek and implement options to limit development in flood

prone areas, particularly where such development would necessitate flood protection that would maintain or exacerbate shoreline, riparian, and stream degradation.

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

REINITIATION NOTICE

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

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Appendix A: Status of the Species (Bull Trout)

STATUS OF THE SPECIES (Bull Trout)

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 generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 2; Brewin and Brewin 1997, p. 215; Cavender 1978, pp. 165-66; Leary and Allendorf 1997, pp. 716-19).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, pp. 6672-73; Rieman et al. 2007, p. 1552). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> 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.

Current Status and Conservation Needs

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 (USFWS 2002a, pp. iv, 2, 7, 98; 2004a, Vol. 1 & 2 p. 1; 2004b, p. 1). Each of

these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the Service's draft recovery plans for the bull trout (USFWS 2002a, pp. iv-viii; 2004a, Vol. 2, pp. iii-x; 2004b, pp. iii-xii).

The conservation needs of bull trout are often 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 coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002a, pp. 49-50; 2004a, Vol. 1 & 2 pp. 12-18; 2004b, pp. 60-86) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002a, pp. 53-54; 2004a, Vol. 1 pp. 210-18, Vol 2. pp. 61-62; 2004b, pp. 15-30, 64-67). 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. Each of the interim recovery units listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002a, pp. 6, 48, 98; 2004a, Vol. 1 p. vi, Vol. 2 pp. 14, 134; 2004b, pp. iv, 2; 2005, p. ii).

Jarbidge River Interim Recovery Unit

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004d). The draft bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of

the bull trout. An estimated 270 to 1,000 spawning bull trout 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 2004c).

Klamath River Interim Recovery Unit

This interim recovery unit currently contains three core areas and seven 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 interim recovery unit face a high risk of extirpation (USFWS 2002a). The draft Klamath River bull trout recovery plan (USFWS 2002a) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002a).

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997, p.1177). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game *in litt*. 1995). The draft Columbia River bull trout recovery plan (USFWS 2002c) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; 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 Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005; pp. 2, Map A, and pp. 73-83)

Coastal-Puget Sound Interim Recovery Unit

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 interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004a). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery 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, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002b). Currently, bull trout are widely distributed in the St. Mary-Belly River drainage and occur 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 2002b). 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 2002b). The draft St. Mary-Belly River bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, pp.1-18). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989, p. 1; Goetz 1989, pp. 15-16). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, pp. 135-37; Goetz 1989, pp. 22-25), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978, pp. 139, 165-68; McPhail and Baxter 1996, p. 14; WDFW et al. 1997, pp. 17-18, 22-26). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, pp. 135-37; Leathe and Graham 1982, p. 95; Pratt 1992, p. 6; Rieman and McIntyre 1996, p. 133).

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, pp. 29-32; Pratt 1984, p. 13). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 7). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, pp. 137, 141; Goetz 1989, pp. 19-26; Bond *in* Hoelscher and Bjornn 1989, p. 57; Howell and Buchanan 1992, p. 1; Pratt 1992, p. 6; Rich 1996, pp. 35-38; Rieman and McIntyre 1993, pp. 4-7; Rieman and McIntyre 1995, pp. 293-94; Sedell and Everest 1991, p. 1; Watson and Hillman 1997, pp. 246-50). Watson and Hillman (1997, pp. 247-249) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn

and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 7), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997, p. 1560).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Mike Gilpin *in litt*. 1997, pp. 4-5; Rieman et al. 1997, p. 1114; Rieman and McIntyre 1993, p. 7). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 7; Spruell et al. 1999, pp. 118-20). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall (Fraley and Shepard 1989, p. 133; Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Baxter et al. 1997, pp. 426-27; Pratt 1992, p. 6; Rieman et al. 1997, p. 1117; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (Buchanan and Gregory 1997, pp. 121-122; Goetz 1989, pp. 22-24; McPhail and Murray 1979, p. 41, 50, 53, 55). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C (52 °F to 54 °F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, pp. 121-22; Fraley and Shepard 1989, pp. 135-37; Rieman et al. 1997, p. 1114; Rieman and McIntyre 1993, p. 2; Rieman and McIntyre 1995, p. 288). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart L. Gamett, Salmon-Challis National Forest, pers. comm. June 20, 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, pp. 135-37; Goetz 1989, pp. 22-25; Hoelscher and Bjornn 1989, p. 54; Pratt 1992, p. 6; Rich 1996, pp. 35-38; Sedell and Everest 1991, p. 1; Sexauer and James 1997, pp. 367-69; Thomas 1992, pp. 4-5; Watson and Hillman 1997, pp. 247-49). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, p. 7). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, pp. 367-369). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, pp. 135-37; Pratt 1992, p. 6; Pratt and Huston 1993, pp. 70-72). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 135). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, p. 15; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 8). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, pp. 5-6; Ratliff and Howell 1992 *in* Howell and Buchanan 1992, pp. 10, 15).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep 1996, pp. 54-55). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Brenkman and Corbett 2005, pp. 1073, 1079-80; Frissell 1993,

p. 350; Goetz et al. 2004, pp. 45, 55, 60, 68, 77, 113-114, 123, 125-26). 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 Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 15-16; MBTSG 1998, p. iv, 48-50; Rieman and McIntyre 1993, pp. 18-19; USFWS 2004a, Vol. 2 p. 63). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger fish with higher fecundity is lost (Rieman and McIntyre 1993, pp. 1-18).

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 239-43; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Brown 1994, p. 21; Donald and Alger 1993, p. 242; Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95). Bull trout of all sizes other than fry have been found to eat fish up to half their length (Beauchamp and VanTassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 114; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model" ; Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman

and Corbett 2005, p. 1079; Goetz et al. 2004, pp. 36, 60).

Changes in Status of the Coastal-Puget Sound Interim Recovery Unit

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCP) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP (now Green Diamond Resources), 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources (WSDNR) State Trust Lands HCP, 6) West Fork Timber HCP, and 7) WSDNR Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

Changes in Status of the Columbia River Interim Recovery Unit

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, Storedahl Daybreak Mine HCP, and WSDNR Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Changes in Status of the Klamath River Interim Recovery Unit

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-Dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary-Belly River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

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Appendix B: Status of Bull Trout Critical Habitat

STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete the following analysis with respect to critical habitat.

Legal Status

Current Designation

The Service 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 Saint Mary-Belly River population segments (also considered as interim recovery units). Rangewide, the Service designated 143,218 acres of reservoirs or lakes and 4,813 stream or shoreline miles as bull trout critical habitat (Table 2).

Table 2. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by state.

State	Stream/shoreline Miles	Stream/shoreline Kilometers	Acres	Hectares
Idaho	294	474	50,627	20,488
Montana	1,058	1,703	31,916	12,916
Oregon	939	1,511	27,322	11,057
Oregon/Idaho	17	27		
Washington	1,519	2,445	33,353	13,497
Washington (marine)	985	1,585		

Although critical habitat has been designated across a wide area, some critical habitat segments were excluded in the final designation based on a careful balancing of 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 balancing 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.

Proposed Revised Critical Habitat Designation

The Service published a proposed rule revising critical habitat in the Federal Register on January 14, 2010, with a final designation due by September 30, 2010. This proposal is different from the 2005 final designation in that it does not exclude any areas that have been determined to be essential to the conservation of the species. In the 2005 final designation, nearly all Federal lands covered by management plans such as the Northwest Forest Plan were excluded, as well as military lands, certain tribal lands, waters impounded behind dams and all waters in the Federal Columbia River Power System. In the proposed revision, we propose exempting military lands that have approved conservation plans (i.e., Integrated Natural Resource Plans) in place. Also, we will review many existing Habitat Conservation Plans, tribal resource management plans, and other conservation agreements.

The proposed revision, if finalized, would increase the amount of stream miles designated as bull trout critical habitat by 79 percent and the amount of acres of lakes and reservoirs in the designation by 74 percent. It would also designate 929 miles (about 4 percent of the total designation) of unoccupied habitat that has been determined to be essential for the conservation of the species. No unoccupied habitat was included in the 2005 designation. An additional Primary Constituent Element was also proposed, as described below.

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 (FMO) 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, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-15; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-22; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

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

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, or sheltering. Note that only PCEs 1, 6, 7, and 8 apply to marine nearshore waters identified as critical habitat; and all except PCE 3 apply to FMO 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 32º to 72 ºF (0º to 22 ºC) but are found more frequently in temperatures ranging from 36º to 59 ºF (2º to 15 ºC). 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 an 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.
>
> (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.

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

The revised PCE's are similar to those currently in effect. The most significant modification is the addition of a ninth PCE to address the presence of nonnative predatory or competitive fish species. Although this proposed PCE applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

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

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

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

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic 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 2004, Vol. 1. pp. 140-193, Vol. 2. pp. 69-114). The Service's 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, pp. 4-39). 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 Saint Mary-Belly River population segments.

Current Condition Rangewide

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

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) 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 (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 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, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 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 FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

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Appendix C: Biological Effects of Sediment on Bull Trout and Their Habitat

BIOLOGICAL EFFECTS OF SEDIMENT ON BULL TROUT AND THEIR HABITAT

Introduction

As a stream or river flows downslope, it transports sediment and dissolved matter (Skinner and Porter 2000, p. 252). A stream has a natural amount of sediment that is transported through the system that varies throughout the year in response to natural hydrological changes (Galbraith et al. 2006, p. 2488). The amount of sediment that a stream can transport annually is based on numerous factors: precipitation, surface water transport, erosion, topography, geology, streamflow, riparian vegetation, stream geomorphologic characteristic, human disturbance, atmospheric deposition, etc. (Bash et al. 2001o, p. 7;Berry et al. 2003, p. 7). Therefore, different watersheds will have different levels or concentrations of turbidity and suspended sediment. A glaciated stream will have higher sediment levels than a spring fed stream (Uehlinger et al. 2002, p. 1;Ahearn 2002, p. 2).

Many watersheds are subject to anthropogenic disturbances that can produce substantial inputs of sediments into streams (Barrett et al. 1992, p. 437). Turbidity, suspended solids, sediment, and siltation have been consistently listed as impairments in the U.S. Environmental Protection Agency's (EPA) 305(b) water quality reports in rivers and streams, lakes, reservoirs, ponds, wetlands, and oceans shoreline waters (Berry, Rubinstein, Melzian, and Hill 2003, p. 4). The EPA's 305(b) list provides the U.S. Congress and the public a means of determining or assessing the current condition of water quality within each individual state. Excessive sedimentation, natural and anthropogenic, has been estimated to occur in 46 percent of all streams and rivers in the U.S. and is considered the most important factor limiting fish habitat and causing water quality impairment (Judy et al. 1984 as cited in Henley et al. 2000, p. 126;Berry, Rubinstein, Melzian, and Hill 2003, pp. 4, 7). One of the most pervasive influences of land-use activities on stream ecosystems is an increase in sediment yield resulting from point source discharges associated with in-stream activities (Suren and Jowett 2001, p. 725).

Aquatic organisms have adapted to the natural variation in sediment load that occurs seasonally within the stream (ACMRR/IABO Working Party on Ecological Indices of Stress to Fishery Resources 1976, pp. 13, 15;Birtwell 1999, p. 7). Field experiments have found a thirty-fold increase in salmonids' (coho salmon) tolerance to suspended solids between August and November when naturally occurring concentrations are expected to be high (Cederholm and Reid 1987, p. 388).

The introduction of sediment in excess of natural amounts can have multiple adverse effects on bull trout and their habitat (Rhodes et al. 1994, pp. 16-21;Berry, Rubinstein, Melzian, and Hill 2003, p. 7). The effect of sediment beyond natural background conditions can be fatal at high levels. Embryo survival and subsequent fry emergence success have been highly correlated to percentage of fine material within the streambed (Shepard et al. 1984, pp. 146, 152). Low levels of sediment may result in sublethal and behavioral effects such as increased activity, stress, and emigration rates; loss or reduction of foraging capability; reduced growth and resistance to disease; physical abrasion; clogging of gills; and interference with orientation in homing and migration (McLeay et al. 1987a, p. 671;Newcombe and MacDonald 1991, pp. 72, 76, 77;Barrett,

Grossman, and Rosenfeld 1992, p. 437;Lake and Hinch 1999, p. 865;Bash et al. 2001n, p. 9;Watts et al. 2003, p. 551;Vondracek et al. 2003, p. 1005;Berry, Rubinstein, Melzian, and Hill 2003, p. 33). The effects of increased suspended sediments can cause changes in the abundance and/or type of food organisms, alterations in fish habitat, and long-term impacts to fish populations (Anderson et al. 1996, pp. 1, 9, 12, 14, 15;Reid and Anderson 1999, pp. 1, 7-15). No threshold has been determined in which fine-sediment addition to a stream is harmless (Suttle et al. 2004, p. 973). Even at low concentrations, fine-sediment deposition can decrease growth and survival of juvenile salmonids.

Aquatic systems are complex interactive systems, and isolating the effects of sediment to fish is difficult (Castro and Reckendorf 1995d, pp. 2-3). The effects of sediment on receiving water ecosystems are complex and multi-dimensional, and further compounded by the fact that sediment flux is a natural and vital process for aquatic systems (Berry, Rubinstein, Melzian, and Hill 2003, p. 4). Environmental factors that affect the magnitude of sediment impacts on salmonids include duration of exposure, frequency of exposure, toxicity, temperature, life stage of fish, angularity and size of particle, severity/magnitude of pulse, time of occurrence, general condition of biota, and availability of and access to refugia (Bash et al. 2001m, p. 11). Potential impacts caused by excessive suspended sediments are varied and complex and are often masked by other concurrent activities (Newcombe 2003, p. 530). The difficulty in determining which environmental variables act as limiting factors has made it difficult to establish the specific effects of sediment impacts on fish (Chapman 1988, p. 2). For example, excess fines in spawning gravels may not lead to smaller populations of adults if the amount of juvenile winter habitat limits the number of juveniles that reach adulthood. Often there are multiple independent variables with complex inter-relationships that can influence population size.

The ecological dominance of a given species is often determined by environmental variables. A chronic input of sediment could tip the ecological balance in favor of one species in mixed salmonid populations or in species communities composed of salmonids and nonsalmonids (Everest et al. 1987, p. 120). Bull trout have more spatially restrictive biological requirements at the individual and population levels than other salmonids (USFWS (U.S. Fish and Wildlife Service) 1998, p. 5). Therefore, they are especially vulnerable to environmental changes such as sediment deposition.

Bull trout are apex predators that prey on a variety of species including terrestrial and aquatic insects and fish (Rieman and McIntyre 1993, p. 3). Fish are common in the diet of individual bull trout that are over 110 millimeters or longer. Large bull trout may feed almost exclusively on fish. Therefore, when analyzing impacts of sediment on bull trout, it is very important to consider other fish species that are part of their prey base. While sediment may not directly impact bull trout, the increased sediment input may affect the spawning and population levels of Chinook and coho salmon, cutthroat trout, and steelhead, or other species that are potential prey for bull trout. The following effects of sediment are not specific to bull trout alone. All salmonids can be affected similarly.

This document identifies the biological effects of sediment on fish and their habitat including the different life stage(s) affected by sediment input. It also provides an analysis to determine the level of sediment concentrations and duration that results in adverse effects to bull trout (and all salmonids) and their habitat.

Sediment Classifications and Definitions

Sediment within a stream can be classified into a variety of categories: turbidity, suspended sediment, bedload, deposited sediment, and wash load (Waters 1995, pp. 13-14;Bash et al. 2001l, pp. 3-4). Sediment category definitions include:

- Turbidity - Optical property of water which results from the suspended and dissolved materials in the water. This causes light to be scattered rather than transmitted in straight lines. Turbidity is measured in NTUs. Measurements of turbidity can quickly estimate the amount of sediment within a sample of water.
- Suspended sediment - Represents the actual measure of mineral and organic particles transported in the water column. Suspended sediment is measured in mg/L and is an important measure of erosion, and is linked to the transport of nutrients, metals, and industrial and agricultural chemicals through the river system.
- Bedload - Consists of larger particles on the stream bottom that move by sliding, rolling, or saltating along the substrate surface. Bedload is measured in tons/day, or tons/year.
- Deposited sediment - The intermediate sized sediment particles that settle out of the water column in slack or slower moving water. Based on water velocity and turbulence, these intermediate size particles may be suspended sediment or bedload.
- Wash load - Finest particles in the suspended load that are continuously maintained in suspension by the flow turbulence. Therefore significant quantities are not deposited in the bed.

Suspended sediment, turbidity, and deposited sediment are not associated with specific particle sizes, as there will be considerable overlap depending on velocity, turbulence, and gradient (MacDonald et al. 1991, p. 98;Waters 1995, p. 14). Turbidity cannot always be correlated with suspended solid concentrations due to the effects of size, shape and refractive index of particles (Bash et al. 2001k, p. 5). Turbidity and suspended sediment affect the light available for photosynthesis, visual capability of aquatic animals, gill abrasion, and physiology of fish. Suspended and deposited sediment affect the habitat available for macroinvertebrates, the quality of gravel for fish spawning, and the amount of habitat for fish rearing (Waters 1995, p. 14).

The size of particles within the stream is also important. The quantity of “fines” within a stream ecosystem is usually associated with the degree of fish population declines (Castro and Reckendorf 1995c, p. 2).

Particle diameters less than 6.4 mm are generally defined as “fines” (Bjornn et al. 1977c, p. 1;Shepard, Leathe, Waver, and Enk 1984, p. 148;Hillman et al. 1987, p. 185;Chapman 1988, p. 14;Bjornn and Reiser 1991, p. 103;Rieman and McIntyre 1993, p. 6;Castro and Reckendorf 1995b, p. 2;MBTSG (The Montana Bull Trout Scientific Group) 1998a, p. 8).

Biological Effects of Sediment on Bull Trout

Classification of Sediment Effects

In the absence of detailed local information on population dynamics and habitat use, any increase in the proportion of fines in substrates should be considered a risk to the productivity of an environment and to the persistence of associated bull trout populations (Rieman and McIntyre 1993, p. 6). Specific effects of sediment on fish and their habitat can be put into three classes that include (Newcombe and MacDonald 1991, pp. 72-73;Waters 1995, pp. 81-82;Bash et al. 2001j, p. 10):

Lethal: Direct mortality to any life stage, reduction in egg-to-fry survival, and loss of spawning or rearing habitat. These effects damage the capacity of the bull trout to produce fish and sustain populations.

Sublethal: Reduction in feeding and growth rates, decrease in habitat quality, reduced tolerance to disease and toxicants, respiratory impairment, and physiological stress. While not leading to immediate death, may produce mortalities and population decline over time.

Behavioral: Avoidance and distribution, homing and migration, and foraging and predation. Behavioral effects change the activity patterns or alter the kinds of activity usually associated with an unperturbed environment. Behavior effects may lead to immediate death or population decline or mortality over time.

Direct Effects

Gill trauma

High levels of suspended sediment and turbidity can result in direct mortality of fish by damaging and clogging gills (Curry and MacNeill 2004, p. 140). Fish gills are delicate and easily damaged by abrasive silt particles (Bash et al. 2001i, p. 15). As sediment begins to accumulate in the gill filaments, fish excessively open and close their gills to expunge the silt. If irritation continues, mucus is produced to protect the gill surface, which may impede the circulation of water over the gills and interfere with fish respiration (Bash et al. 2001h, p. 15). Gill flaring or coughing abruptly changes buccal cavity pressure and is a means of clearing the buccal cavity of sediment. Gill sediment accumulation may result when fish become too fatigued to continue clearing particles via the cough reflex (Servizi and Martens 1991a, p. 495).

Fish are more susceptible to increased suspended sediment concentrations at different times of the year or in watersheds with naturally high sediment such as glaciated streams. Fish secrete protective mucous to clean the gills (Erman and Ligon 1985, p. 18). In glaciated systems or during winter and spring high flow conditions when sediment concentrations are naturally high, the secretion of mucous can keep gills clean of sediment. Protective mucous secretions are inadequate during the summer months, when natural sediment levels are low in a stream system. Consequently, sediment introduction at this time may increase the vulnerability of fish to stress and disease (Bash et al. 2001g, p. 12).

Spawning, redds, eggs, and alevins

The effects of suspended sediment, deposited in a redd and potentially reducing water flow and smothering eggs or alevins or impeding fry emergence, are related to sediment particle sizes of the spawning habitat (Bjornn and Reiser 1991, p. 98). Sediment particle size determines the pore openings in the redd gravel. With small pore openings, more suspended sediments are deposited and water flow is reduced compared to large pore openings.

Survival of eggs is dependent on a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987, p. 384;Anderson, Taylor, and Balch 1996, p. 13). Eggs and alevins are generally more susceptible to stress by suspended solids than are adults. Accelerated sedimentation can reduce the flow of water and, therefore, oxygen to eggs and alevins. This can decrease egg survival, decrease fry emergence rates (Cederholm and Reid 1987, p. 384;Chapman 1988, pp. 12-16;Bash et al. 2001f, pp. 17-18), delay development of alevins (Everest, Beschta, Scrivener, Koski, Sedell, and Cederholm 1987, p. 113), reduce growth and cause premature hatching and emergence (Birtwell 1999, p. 19). Fry delayed in their emergence are also less able to compete for environmental resources than fish that have undergone normal development and emergence (intra- or interspecific competition) (Everest, Beschta, Scrivener, Koski, Sedell, and Cederholm 1987, p. 113). Sedimentation fills the interstitial spaces and can prevent alevins from emerging from the gravel (Anderson, Taylor, and Balch 1996, p. 13;Suttle, Power, Levine, and McNeely 2004, pp. 971-972).

Several studies have documented that fine sediment can reduce the reproductive success of salmonids. Natural egg-to-fry survival of coho salmon, sockeye and kokanee has been measured at 23 percent, 23 percent and 12 percent, respectively (Slaney et al. 1977, p. 33). Substrates containing 20 percent fines can reduce emergence success by 30-40 percent (MacDonald, Smart, and Wissmar 1991, p. 99). A decreases of 30 percent in mean egg-to-fry survival can be expected to reduce salmonid fry production to extremely low levels (Slaney, Halsey, and Tautz 1977, p. 33).

Indirect Effects

Macroinvertebrates

Sedimentation can have an effect on bull trout and fish populations through impacts or alterations to the macroinvertebrate communities or populations (Anderson, Taylor, and Balch 1996, pp. 14-15). Increased turbidity and suspended sediment can reduce primary productivity by decreasing light intensity and periphytic (attached) algal and other plant communities (Anderson, Taylor, and Balch 1996, p. 14;Henley, Patterson, Neves, and Lemly 2000, p. 129;Suren and Jowett 2001, p. 726). This results in decreased macroinvertebrates that graze on the periphyton.

Sedimentation also alters the habitat for macroinvertebrates, changing the species density, diversity and structure of the area (Waters 1995, pp. 61-78;Anderson, Taylor, and Balch 1996, pp. 14-15;Reid and Anderson 1999, pp. 10-12;Shaw and Richardson 2001, p. 2220). Certain groups of macroinvertebrates are favored by salmonids as food items. These include mayflies, caddisflies, and stoneflies. These species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest, Beschta, Scrivener, Koski, Sedell, and Cederholm 1987, p. 115;Waters 1995, p. 63). Increased sediment can affect macroinvertebrate habitat by filling of interstitial space and rendering attachment sites unsuitable. This may cause invertebrates to seek more favorable habitat (Rosenberg and Snow 1975, p. 70). With increasing fine sediment, invertebrate composition and density changes from available, preferred species (i.e., mayflies, caddisflies, and stoneflies) to non-preferred, more unavailable species (i.e., aquatic worms and other burrowing species) (Reid and Anderson 1999, p. 10;Henley, Patterson, Neves, and Lemly 2000, pp. 126, 130;Shaw and Richardson 2001, p. 2219;Suren and Jowett 2001, p. 726;Suttle, Power, Levine, and McNeely 2004, p. 971). The degree to which substrate particles are surrounded by fine material was found to have a strong correlation with macroinvertebrate abundance and composition (Birtwell 1999, p. 23). At an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995, p. 66).

Increased turbidity and suspended solids can affect macroinvertebrates in multiple ways through increased invertebrate drift, feeding impacts, and respiratory problems (Cederholm and Reid 1987, p. 384;Shaw and Richardson 2001, p. 2218;Berry, Rubinstein, Melzian, and Hill 2003, pp. 8, 11). The effect of turbidity on light transmission has been well documented and results in increased invertebrate drift (Waters 1995, p. 58;Birtwell 1999, pp. 21, 22). This may be a behavioral response associated with the night-active diel drift patterns of macroinvertebrates. While increased turbidity results in increased macroinvertebrate drift, it is thought that the overall invertebrate populations would not fall below the point of severe depletion (Waters 1995, p. 59). Invertebrate drift is also an important mechanism in the repopulation, recolonization, or recovery of a macroinvertebrate community after a localized disturbance (Anderson, Taylor, and Balch 1996, p. 15;Reid and Anderson 1999, pp. 11-12).

Increased suspended sediment can affect macroinvertebrates by abrasion of respiratory surface and interference with food uptake for filter-feeders (Anderson, Taylor, and Balch 1996, p. 14;Birtwell 1999, p. 21;Shaw and Richardson 2001, p. 2213;Suren and Jowett 2001, pp. 725-

726;Berry, Rubinstein, Melzian, and Hill 2003, p. 11). Increased suspended sediment levels tend to clog feeding structures and reduce feeding efficiencies, which results in reduced growth rates, increased stress, or death of the invertebrates (Newcombe and MacDonald 1991, p. 73). Invertebrates living in the substrate are also subject to scouring or abrasion which can damage respiratory organs (Bash et al. 2001e, p. 25).

Feeding Efficiency

Increased turbidity and suspended sediment can affect a number of factors related to feeding for salmonids, including feeding rates, reaction distance, prey selection, and prey abundance (Barrett, Grossman, and Rosenfeld 1992, pp. 437, 440;Henley, Patterson, Neves, and Lemly 2000, p. 133;Bash et al. 2001d, p. 21). Changes in feeding behavior are primarily related to the reduction in visibility that occurs in turbid water. Effects on feeding ability are important as salmonids must meet energy demands to compete with other fishes for resources and to avoid predators. Reduced feeding efficiency would result in lower growth and fitness of bull trout and other salmonids (Barrett, Grossman, and Rosenfeld 1992, p. 442;Sweka and Hartman 2001, p. 138).

Distance of prey capture and prey capture success both were found to decrease significantly when turbidity was increased (Berg and Northcote 1985, pp. 1414-1415;Sweka and Hartman 2001, p. 141;Zamor and Grossman 2007, pp. 168, 170, 174). Waters (1995, p. 83) states that loss of visual capability, leading to reduced feeding, is one of the major sublethal effects of high suspended sediment. Increases in turbidity were reported to decrease reactive distance and the percentage of prey captured (Sweka and Hartman 2001, p. 141;Bash et al. 2001c, pp. 21-23;Klein 2003, pp. 1, 21). At 0 NTUs, 100 percent of the prey items were consumed; at 10 NTUs, fish frequently were unable to capture prey species; at 60 NTUs, only 35 percent of the prey items were captured. At 20 to 60 NTUs, significant delay in the response of fish to prey was observed (Bash et al. 2001b, p. 22). Loss of visual capability and capture of prey leads to depressed growth and reproductive capability.

To compensate for reduced encounter rates with prey under turbid conditions, prey density must increase substantially or salmonids must increase their active searches for prey (Sweka and Hartman 2001, p. 144). Such an increase in activity and feeding rates under turbid conditions reduces net energy gain from each prey item consumed (Sweka and Hartman 2001, p. 144).

Sigler et al. (1984, p. 150) found that a reduction in growth occurred in steelhead and coho salmon when turbidity was as little as 25 NTUs. The slower growth was presumed to be from a reduced ability to feed; however, more complex mechanisms such as the quality of light may also affect feeding success rates. Redding et al. (1987, p. 742) found that suspended sediment may inhibit normal feeding activity, as a result of a loss of visual ability or as an indirect consequence of increased stress.

Habitat Effects

Compared to other salmonids, bull trout have more specific habitat requirements that appear to influence their distribution and abundance (Rieman and McIntyre 1993, p. 7). All life history

stages are associated with complex forms of cover including large woody debris, undercut banks, boulders, and pools. Other habitat characteristic important to bull trout include channel and hydrologic stability, substrate composition, temperature, and the presence of migration corridors (Rieman and McIntyre 1993, p. 5).

Increases in sediment can alter fish habitat or the utilization of habitats by fish (Anderson, Taylor, and Balch 1996, p. 12). The physical implications of sediment in streams include changes in water quality, degradation of spawning and rearing habitat, simplification and damage to habitat structure and complexity, loss of habitat, and decreased connectivity between habitat (Anderson, Taylor, and Balch 1996, pp. 11-15;Bash et al. 2001a, pp. 1, 12, 18, 30). Biological implications of this habitat damage include underutilization of stream habitat, abandonment of traditional spawning habitat, displacement of fish from their preferred habitat, and avoidance of habitat (Newcombe and Jensen 1996, p. 695).

As sediment enters a stream it is transported downstream under normal fluvial processes and deposited in areas of low shear stress (MacDonald and Ritland 1989, p. 21). These areas are usually behind obstructions, near banks (shallow water) or within interstitial spaces. This episodic filling of successive storage compartments continues in a cascading fashion downstream until the flow drops below the threshold required for movement or all pools have reached their storage capacities (MacDonald and Ritland 1989, p. 21). As sediment load increases, the stream compensates by geomorphologic changes in increased slope, increased channel width, decreased depths, and decreased flows (Castro and Reckendorf 1995a, p. 21). These processes contribute to increased erosion and sediment deposition that further degrade salmonid habitat.

Loss of acceptable habitat and refugia, as well as decreased connectivity between habitats, reduces the carrying capacity of streams for salmonids (Bash et al. 2001p, p. 30). This loss of habitat or exclusion of fish from their habitat, if timed inappropriately, could impact a fish population if the habitat within the affected stream reach is critical to the population during the period of the sediment release (Anderson, Taylor, and Balch 1996, p. 12;Reid and Anderson 1999, p. 13). For example, if summer pool habitat used by adults as holding habitat prior to spawning is a limiting factor within a stream, increased sediment and reduced pool habitat during the summer can decrease the carrying capacity of the stream reach and decrease the fish population. In systems lacking adequate connectivity of habitats, fish may travel longer distances or use less desirable habitats, increasing biological demands and reducing their fitness.

The addition of fine sediment (less than 6.4 mm) to natural streams during summer decreased abundance of juvenile Chinook salmon in almost direct proportion to the amount of pool volume lost to fine sediment (Bjornn et al. 1977b, p. 31). Similarly, the inverse relationship between fine sediment and densities of rearing Chinook salmon indicates the importance of winter habitat and high sediment loads (Bjornn et al. 1977a, pp. 26, 38, 40). As fine sediments fill the interstitial spaces between the cobble substrate, juvenile Chinook salmon were forced to leave preferred habitat and to utilize cover that may be more susceptible to ice scouring, predation, and decreased food availability (Hillman, Griffith, and Platts 1987, p. 194). Deposition of sediment on substrate may lower winter carrying capacity for bull trout (Shepard, Leathe, Waver, and Enk 1984, p. 153). Food production in the form of aquatic invertebrates may also be reduced. Juvenile bull trout densities are highly influenced by substrate composition (Shepard, Leathe,

Waver, and Enk 1984, p. 153;Rieman and McIntyre 1993, p. 6;MBTSG (The Montana Bull Trout Scientific Group) 1998b, p. 9). During the summer, juvenile bull trout hold positions close to the stream bottom and often seek cover within the substrate itself. When streambed substrate contains more than 30 percent fine materials, juvenile bull trout densities drop off sharply (Shepard, Leathe, Waver, and Enk 1984, p. 152). Any loss of interstitial space or streambed complexity through the deposition of sediment would result in a loss of summer and winter habitats (MBTSG (The Montana Bull Trout Scientific Group) 1998c, p. 9). The reduction of rearing habitat will ultimately reduce the potential number of recruited juveniles and therefore reducing population numbers (Shepard, Leathe, Waver, and Enk 1984, pp. 153-154). In fact, Johnston et al. (2007, p. 125) found that density-dependent survival during the earliest of the juvenile stages (between egg and age-1) regulated recruitment of adult bull trout in the population.

Although an avoidance response by fish to increased sediment may be an initial adaptive survival strategy, displacement from cover could be detrimental. It is possible that the consequences of fish moving from preferred habitat, to avoid increasing levels of suspended sediment, may not be beneficial if displacement is to sub-optimal habitat, because they may be stressed and more vulnerable to predation (Birtwell 1999, p. 12).

In addition to altering stream bed composition, anthropogenic input of sediment into a stream can change channel hydrology and geometry (Owens et al. 2005, pp. 694-695). Sediment release can reduce the depth of pools and riffle areas (Anderson, Taylor, and Balch 1996, p. 12). This can reduce available fish habitat, decrease fish holding capacity, and decrease fish populations (Anderson, Taylor, and Balch 1996, pp. 12, 14).

Physiological Effects

Sublethal levels of suspended sediment may cause undue physiological stress on fish, which may reduce the ability of the fish to perform vital functions (Cederholm and Reid 1987, p. 388, 390). Stress is defined as a condition perceived by an organism which threatens a biological function of the organism, and a set of physiological and behavioral responses is mounted to counteract the condition (Overli 2001, p. 7). A stressor is any anthropogenic or natural environmental change severe enough to require a physiological response on the part of a fish, population, or ecosystem (Anderson, Taylor, and Balch 1996, pp. 5-6;EPA (U.S. Environmental Protection Agency) 2001a, pp. 1-2;Jacobson et al. 2003, p. 2). At the individual level, stress may affect physiological systems, reduce growth, increase disease, and reduce the individual's ability to tolerate additional stress (Anderson, Taylor, and Balch 1996, p. 7;Bash et al. 2001q, p. 17). At the population level, the effects of stress may include reduced spawning success, increased larval mortality, reduced recruitment to succeeding life stages and, therefore, overall population declines (Bash et al. 2001r, p. 17).

Upon encountering a stressor, the fish responds through a series of chemical releases in its body. These primary chemical and hormonal releases include catecholamine (e.g. epinephrine, norepinehprine) in the circulatory system, corticosteroids (e.g. cortisol) from the interregnal tissue, and hypothalamic activation of the pituitary gland (Gregory and Wood 1999, p. 286;Schreck et al. 2001, p. 5;Barton 2002, p. 517;Davis 2006, p. 116). Primary chemical

releases result in secondary releases or changes in plasma, glucose, tissue ion, metabolite levels, and hematological features. These secondary responses relate to physiological adjustments in metabolism, respiration, immune and cellular function (Mazeaud et al. 1977, p. 201;Barton 2002, p. 517;Haukenes and Buck 2006, p. 385). After secondary responses, continued stress results in tertiary stress responses which affect whole-animal performance such as changes in growth, condition, resistance to disease, metabolic scope for activity, behavior, and ultimately survival (Pickering et al. 1982, p. 229;Barton 2002, p. 517;Portz et al. 2006, pp. 126-127).

Stress in a fish occurs when the homeostatic or stabilizing process in the organism exceed the capability of the organism to compensate for the biotic or abiotic challenge (Anderson, Taylor, and Balch 1996, p. 5). The response to a stressor is an adaptive mechanism that allows the fish to cope with the real or perceived stressor in order to maintain its normal or homeostatic state (Barton 2002, p. 517). Acclimation to a stressor can occur if compensatory physiological responses by the fish are able to re-establish a satisfactory relationship between the changed environment and the organism (Anderson, Taylor, and Balch 1996, p. 5). The ability of an individual fish to acclimate or tolerate the stress will depend on the severity of the stress and the physiological limits of the organism (Anderson, Taylor, and Balch 1996, p. 5). In a natural system, fish are exposed to multiple chemical and physical stressors which can combine to cause adverse effects (Berry, Rubinstein, Melzian, and Hill 2003, p. 4). The chemical releases from each stressor results in a cumulative or additive response (Barton et al. 1986, pp. 245, 247;EPA (U.S. Environmental Protection Agency) 2001b, pp. 3, 25;Cobleigh 2003, pp. 16, 39, 55;Milston et al. 2006, p. 1172).

Stress in fish results in extra cost and energy demands. Elevated oxygen consumption and increased metabolic rate result from the reallocation of energy to cope with the stress (Barton and Schreck 1987, pp. 259-260;Contreras-Sanchez et al. 1998, pp. 439, 444;McCormick et al. 1998, pp. 222, 231). An approximate 25 percent increase in metabolic cost, over standard metabolism requirements, is needed to compensate for a perceived stress (Barton and Schreck 1987, p. 260;Davis 2006, p. 116). Stressed fish would thus have less energy available for other life functions such as seawater adaptation, disease resistance, reproduction, or swimming stamina (Barton and Schreck 1987, p. 261;Contreras-Sanchez, Schreck, Fitzpatrick, and Pereira 1998, p. 444).

Tolerance to suspended sediment may be the net result of a combination of physical and physiological factors related to oxygen availability and uptake by fish (Servizi and Martens 1991b, p. 497). The energy needed to perform repeated coughing (see Gill trauma section) increases metabolic oxygen demand. Metabolic oxygen demand is related to water temperature. As temperatures increase, so does metabolic oxygen demand, but concentrations of oxygen available in the water decreases. Therefore, a fish's tolerance to suspended sediment may be primarily related to the capacity of the fish to perform work associated with the cough reflex. However, as sediment increases, fish have less capability to do work, and therefore less tolerance for suspended sediment (Servizi and Martens 1991c, p. 497).

Once exposed to a stressor, the primary chemical releases can take one-half to twenty-four hours to peak (Schreck 1981, p. 298;Barton 2002, p. 520;Quigley and Hinch 2006, p. 437). Recovery or return of the primary chemical release to normal or resting levels can take two hours to two

weeks (Mazeaud, Mazeaud, and Donaldson 1977, pp. 205-206;Schreck 1981, p. 313). In a study of handling stress, chemical release of cortisol peaked at two hours and returned to normal in four hours. However, complete recovery took 2 weeks (Pickering, Pottinger, and Christie 1982, pp. 236, 241). Fish exposed to two or more stresses require longer recovery times than fish exposed only to one stressor indicating the cumulative effects of stress (Sigismondi and Weber 1988, pp. 198-199).

Redding el al.(1987, pp. 740-741) observed higher mortality in young steelhead trout exposed to a combination of suspended sediment (2500 mg/L) and a bacteria pathogen, than when exposed to the bacteria alone. Physiological stress in fishes may decrease immunological competence, growth, and reproductive success (Bash et al. 2001s, p. 16).

Behavioral effects

Increased turbidity and suspended sediment may result in behavior changes in salmonids. These changes are the first effects evoked from increased levels of turbidity and suspended sediment (Anderson, Taylor, and Balch 1996, p. 6). These behavioral changes include avoidance of habitat, reduction in feeding, increased activity, redistribution and migration to other habitats and locations, disruption of territoriality, and altered homing (Anderson, Taylor, and Balch 1996, p. 6;Bash et al. 2001t, pp. 19-25;Suttle, Power, Levine, and McNeely 2004, p. 971). Many behavioral effects result from changes in stream habitat (see Habitat effects section). As suspended sediment concentration increases, habitat may be lost which results in abandonment and avoidance of preferred habitat. Stream reach emigration is a bioenergetic demand that may affect the growth or reproductive success of the individual fish (Bash et al. 2001u, p. 12). Pulses of sediment result in downstream migration of fish, which disrupts social structures, causes downstream displacement of other fish and increases intraspecific aggression (McLeay et al. 1987b, pp. 670-671;Bash et al. 2001v, pp. 12, 20;Suttle, Power, Levine, and McNeely 2004, p. 971). Loss of territoriality and the breakdown of social structure can lead to secondary effects of decreased growth and feeding rates, which may lead to mortality (Berg and Northcote 1985, p. 1416;Bash et al. 2001w, p. 20).

Downstream migration by bull trout provides access to more prey, better protection from avian and terrestrial predators, and alleviates potential intraspecific competition or cannibalism in rearing areas (MBTSG (The Montana Bull Trout Scientific Group) 1998d, p. 13). Benefits of migration from tributary rearing areas to larger rivers or estuaries may be increased growth potential. Increased sedimentation may result in premature or early migration of both juveniles and adults or avoidance of habitat and migration of nonmigratory resident bull trout.

High turbidity may delay migration back to spawning sites, although turbidity alone does not seem to affect homing. Delays in spawning migration and associated energy expenditure may reduce spawning success and therefore population size (Bash et al. 2001x, p. 29).

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Attachment 1. U.S. Army Corps of Engineers Fuel and Spill Response Plan

Attachment 1. Corps' Fuel and Spill Response Plan

Vehicle Fueling and Spill Response Plan

Equipment will operate below ordinary high water to excavate existing fill and place riprap. Work below OHWM will not translate into work below the summer low water line. Potential contaminants include discharges to receiving waters from substrate disturbance, and fuels, lubricants and hydraulic fluid from the equipment. Work under the OHWM will require isolation and monitoring to ensure no pollutants enter the water in accordance with the BMPs described below.

1.1 Vehicle Fueling

Fueling conditions will exist on the project site as detailed below:

1) To the maximum extent possible, haul vehicles will be fueled offsite.
2) Onsite equipment working above the OHWM will not be fueled within 50 feet of the waters edge. Fueling will occur on an area sloping away from the river.

All fueling will be done with auto-shutoff nozzles. Absorbent pads will be placed immediately under the fueling point to catch any spilled liquids and serve as a barrier to the fuel's release. A spill response kit will be available onsite. These conditions will be implemented across the entire duration of the project.

1.1.2 Fueling Checklist

1. Equipment will be shut off.
2. Absorbent pad will be placed under fill point of machine.
3. Fueling hose will be brought from fueling vehicle to equipment. NOTE: At no time will hose be left unattended.
4. Fueling process will start and be completed with hose attended at all times.
5. Upon completion fuel attendant will check for any leaks or drips. Appropriate correction action will be taken as required, if necessary.
6. Fuel hose will be returned to fueling vehicle.
7. Absorbent pads will be removed.
8. Process will be repeated on next piece of equipment.

1.2 Spill Prevention and Control Plan

The following spill prevention BMP's will be practiced to eliminate spills before they happen.

1.2.1 Equipment Staging and Maintenance

- Equipment shall be staged in the designated laydown areas.
- Onsite maintenance of equipment will be minimized to the maximum extent possible.
- Secondary containments shall be utilized whenever there is a potential for spillage.
- Use proper equipment (pumps, hoses, dispensers, and funnels) equipped with auto-shutoff nozzles to transfer fluids.
- Spill kits shall be readily accessible.
- Equipment inspections shall be done on all site equipment. Incoming vehicles shall be checked for leaking oil and fluids
- Inspect equipment routinely for leaks and spills
- Repair equipment immediately, if necessary
- Implement a preventative maintenance schedule for equipment and vehicles

1.2.2 Fueling Area

- Perform onsite fueling only with proper containment and controls in place.
- Use secondary containment during all fueling operations to catch spills
- Use proper equipment (pumps, hoses, dispensers, and funnels) to transfer fluids with auto-shutoff nozzles.
- Spill kits shall be readily accessible.
- Inspect fueling and laydown area routinely for leaks and spills.

1.2.3 Hazardous Material Staging Area

- Reduce the amount of hazardous materials by substituting non-hazardous or less hazardous materials.
- Hazardous materials will be kept to an absolute minimum onsite.
- A MSDS shall be required for any Hazardous Material brought on site. The MSDSs shall be maintained on site.
- Hazardous materials stored onsite will be kept in the Hazmat locker at the site trailer well away from waterside activities.
- Hazardous materials shall be stored in covered containers with proper labeling.
- Keep a spill kits readily accessible near the hazardous material storage areas

1.2.4 Spill Containment

The following discussion identifies the types of secondary containment that will be used in the event of a spill.

- **Equipment Staging and Maintenance Area.** Any equipment leak from a fuel tank, equipment seal, or hydraulic line will be contained within a spill containment cell placed beneath all stationary potential leak sources. An undetected leak from parked equipment will be cleaned up using hand shovels and containerized in a 55-gallon steel drum for off site disposal.
- **Fueling Area.** Fueling will be performed with a secondary containment placed immediately below the fueling area. A small spill during fueling operations will be contained using fuel absorbent pads at the nozzle. A spill response kit will be staged for each fueling operation.
- **Oil Containment Boom.** An oil containment boom will surround all in-water work activities. Additional oil containment boom will be staged immediately adjacent to the work area and deployed in the event of a release.

1.2.5 Spill Countermeasures

Every preventative measure shall be taken to keep contaminated or hazardous materials contained. If a release occurs, the following actions shall be taken:

1. **Stop the Spill:** Take action to immediately stop the source of the spill.

2. **Warn Others:** Notify co-workers and supervisory personnel of the release. Notify emergency responders if appropriate. For site personnel an alarm system will consist of three one second blasts on an air horn or an equipment horn sounded by the person discovering a spill or fire. In the event of any spill the General Superintendent as well as the Government On-Site Representative shall be notified immediately.

3. **Isolate the Area:** Prevent public access to the area and continue to minimize the spread of the material. Minimize personal exposure throughout emergency response actions.

4. **Containment:** Isolate spills using spill kits, containments, and/or oil containment boom. For larger spills wait for the arrival of emergency response personnel and provide directions to the location of the emergency

5. **Reporting:** The designated government representative shall be notified in the event of a spill. The Contractor will notify Ecology of any oil or other toxic material spills immediately to Ecology's 24-hour Spill Response Team at 1800-258-5990, and within 24 hours to Ecology's 401/CZM Federal Project Manager at the following phone numbers:

   Phone: (425) 649-7129
   Phone: (425) 649-7000
   Fax: (425) 649-7098

1.3 Allowable Non-Stormwater Discharges

Allowable Discharges

The following non-storm water discharges are anticipated to occur on the site:

- Water used to control dust.

The amount of water sprayed for dust control shall be the minimum necessary to prevent airborne dust and sediment and shall not create runoff.

Attachment 2. Underwater Sound Pressure Level Analysis Discussion

Attachment 2. Underwater Sound Pressure Level Analysis Discussion

The effects of impact installation of wood piles are not well documented or understood. Carlson et al. (2001) conducted hydroacoustic monitoring during impact installation of wood piles. This monitoring demonstrated that impact installation of 12-in-diameter wood piles can result in sound pressure levels (SPLs) of 195 dB_{peak}. Limited data (Rodkin and Donavan 2004) indicate that impact installation of wood piles results in a slower accumulation of energy and generally lower SPLs compared to installation of steel piles. Data from studies of blasting indicate that the shape of the sound pressure wave is an important factor in determining whether an organism may be physically injured by the pressure wave (Hastings and Popper 2005). Pressure waveforms where the initial peaks are steep and rise quickly are considered more likely to cause potential injury compared to pressure waveforms with slower rise times on the initial peak (Yelverton et al. 1975, p. 27; Wardle et al. 2001; Hastings 2002).

Therefore, one might assume that installation of wood piles may be less injurious than installation of steel piles. It is important to reiterate that it is difficult to compare data from blasting to pile driving for many reasons. One notable difference between the two is that blasting presents a single impulse while pile driving is repetitive.

Monitoring data from impact driving of steel piles demonstrates that there is an additive effect from repetitively striking a pile and that the sound energy increases throughout the pile-driving event (Abbott et al. 2002). Hydroacoustic monitoring of wood pile installation on one project revealed that the pile was struck at a rate of two blows per second (Carlson et al. 2001) indicating that impulses are repeatedly within close succession to each other.

It is possible that impact installation of wood piles could result in behavioral responses potentially affecting bull trout migratory and foraging patterns. Salmonids are thought to have optimal hearing at frequencies of 150 Hz (Hawkins and Johnstone 1978). However they are known to detect sounds at frequencies of up to 600 Hz (Mueller et al. 1998), and as low as 10 Hz (Knudsen et al. 1997). In laboratory tests, exposure to sounds at 10Hz evoked flight and avoidance responses in Pacific salmonids (Knudsen et al. 1997).

The sound generated by impact installation of wood piles includes a very low frequency component which may be due to lateral movement of the pile after it is hit with the hammer (Carlson et al. 2001). Although the majority of the energy of the impulse for wood piles in this study was contained at frequencies around 200 Hz and higher (Carlson et al. 2001), the low frequency component is within the range shown to trigger a behavioral response (Knudsen et al. 1997). These behavioral responses could disrupt normal feeding and/or migratory behavior. There may be a long-term effect if feeding is impeded.

Elevated SPLs from pile driving may prevent fish from hearing biologically relevant sounds. As a result, a fish may be more vulnerable to predation, or conversely, decrease their ability to find prey (Popper 2003). Because fish gain important environmental information from sound, anything that hampers the ability to detect biologically relevant signals could have a deleterious effect on the survival of fish and the health of fish populations (Popper 2003). Factors to consider in evaluating the potential behavioral effects of wood pile installation include the

duration of the work, diurnal timing, and location (e.g., near a forage fish base). To date, this office assumes that, because the sound pressure wave generated from impact pile driving of wooden piles is different from steel piles, and since no fish kills have been documented during their installation, significant physical effects to fish are not occurring from installation of wood piles.

We anticipate that installation of the anchor logs may result in elevated underwater sound pressure levels analogous to that of installation of wood piles. However, the logs would be installed in the uplands, and we expect that, as the sound travels through substrate, both its waveform and its intensity will be altered. Thus, we anticipate that sound pressures that propagate through substrate (in the dry) will be less intense and/or will exhibit longer rise times when they reach the water column and will not be injurious. The potential area for behavioral effects for use of an impact pile driver in the dry may extend across the stream from each project site and for an undetermined reach of the stream (both upstream and downstream from the project sites). However, the installation time would likely be of very short duration (a few hours). Bull trout would be expected to leave the area in which the disturbance would occur, until the disturbance subsided. We anticipate that these effects would be short term and temporary, and that exposed bull trout would likely resume their normal behavior when installation of these logs is completed.

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