United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

MAY 27 2011

In Reply Refer To:
13410-2010-F-0254

Colonel Anthony Wright
Seattle District, Corps of Engineers
Environmental Resources Section
ATTN: McClain, Gleason
P.O. Box 3755
Seattle Washington 98124-3755

Dear Colonel Wright:

Subject: Batched Skagit Levee Repair Projects

This document transmits the U.S. Fish and Wildlife Service's Biological Opinion (Opinion) and concurrence for 57 levee repair projects in the Lower Skagit River in Skagit 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 a batched request for consultation for numerous levee repair projects under your Public Law 84-99 emergency repair program from flooding damage in 2006-2007 and 2009-2010 to levees in the Lower Skagit River. You sent an initial consultation request in April 2010 for 35 completed and proposed levee repair sites, then requested suspension of further review on June 11, 2010, pending further review of on-site mitigation options. In January 2011, you submitted a revised Biological Assessment to address levee repairs at 57 sites in the Lower Skagit River. Your most recent letter and Biological Assessment (Assessment) for these actions were received in our office on February 7, 2011. In your correspondence, you requested our concurrence with your determination of "may affect, likely to adversely affect" for the bull trout and bull trout critical habitat for each of the levee repair projects.

TAKE PRIDE IN AMERICA

Based on the information provided in the consultation packages for the projects, we concur with the Corps' determination of "may affect, likely to adversely affect" for the bull trout and bull trout critical habitat for these actions. The enclosed Opinion addresses the adverse effects to bull trout and bull trout critical habitat associated with repairs for the 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

Enclosure

Endangered Species Act - Section 7 Consultation

Biological Opinion

Consultation for

Skagit River Levee Repair Projects
Skagit County, Washington:

Flood Damage Repairs
to Numerous Levees
In Diking Districts 1, 3, 12, 17, and 22

U.S. Fish and Wildlife Service Reference Number:
13410-2010-F-0254

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

5-27-2011
Date

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LIST OF ABBREVIATIONS AND ACROYNMS

Act	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.)
Assessment	Biological Assessment
BMP	Best Management Practices
BMPs	Best Management Practices
Corps	U.S. Army Corps of Engineers
DD	Diking District
Ecology	Washington State Department of Ecology
Group	Stakeholder Working Group
IRU	Interim Recovery Unit
KCFS	thousand cubic feet per second
Km^2	Square Kilometer
LWD	Large Woody Debris
Mi	Mi
Mi^2	Square Mile
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Units
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
PCE	Primary Constituent Elements
PL	Public Law
RM	River mile
RPM	Reasonable and Prudent Measures
Services	U.S. Fish and Wildlife Service and National Marine Fisheries Service
SRSC	Skagit River Systems Cooperative
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

INTRODUCTION

During the 2006-2007 and 2009-10 winter seasons, heavy rainfall events and other winter conditions contributed to moderate to severe flooding in the lower Skagit River basin. As a result of this flooding, numerous non-contiguous sections of levees were damaged throughout the lower Skagit River basin, prompting emergency actions by Diking Districts 1, 3, 12, 17, and 22 (DD) and the U.S. Army Corps of Engineers (Corps). Emergency flood fights and subsequent repairs at several of the levee sections were conducted under the Corps' Public Law (PL) 84-99 authority, as are the remaining proposed repairs. The extensive system of levees in the lower Skagit River, of which these sites are a part, protect agricultural fields, infrastructure for the cities of Mount Vernon and Burlington, and other residential, commercial, and public use lands.

CONSULTATION HISTORY

In April 2010 the Corps submitted a letter to the U.S. Fish and Wildlife Service (USFWS) requesting consultation for the levee repair and/or rehabilitation actions in the lower Skagit River watershed. The project sites extend from the City of Mount Vernon downstream (west and south) to Skagit Bay, Skagit County, Washington. We received the Corps' letter and Biological Assessment (Assessment) on April 2, 2010. The actions in the consultation request included a batch of 32 completed emergency projects, three of which would require additional work, as well as three additional deferred sites that have not yet been constructed. On June 11, 2010 the Corps requested via email that further review of the consultation package by the National Marine Fisheries Service (NMFS) and the USFWS (hereafter referred to as the "Services") be postponed pending the development of revised project mitigation alternatives. At the Corps' request, the Services, the Diking District Commissioners and/or their representatives, and Skagit River Systems Cooperative staff (SRSC) began coordination on the batched actions via meetings, numerous email and telephone conversations, and a site visit on October 25, 2010, to several of the repair sites. Meetings and conference calls were held on the following dates:

- 2010: August 30, September 10, 22, 27, October 13, 25, November 8, and December 9
- 2011: January 27 and February 22

In late January 2011 the Corps submitted an updated Assessment that included additional sites (for a total of 55 repair sites) damaged in the 2009-2010 winter season, and a revised mitigation strategy for the batched projects. We received the Assessment on February 7, 2011. On March 16, 2011, the Corps submitted an addendum to the Assessment for two additional repair sites (for a total of 57 sites) and other project description changes, including additional monitoring protocols. On March 18, 2011, the Corps provided an updated project description section for the Assessment. On May 25, 2011, the Corps provided a final revision via email to their project description to further reduce in-stream effects of the proposed projects. 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).

This Biological Opinion (Opinion) addresses the adverse effects to bull trout and bull trout critical habitat associated with the completed repairs and additional work that will be conducted on the lower Skagit River levees per the February 7, 2011 Assessment and subsequent Addendum. It does not cover any other actions completed by the Corps or local sponsor(s) in the lower Skagit River. The Opinion is based on information provided in the Assessment and the Addendum, as well as additional coordination with the stakeholders during the meetings, site visit, and other correspondence noted above.

BIOLOGICAL OPINION

DESCRIPTION OF THE ACTIONS

Based on the information provided in the February 7, 2011 Assessment and Addendum, most of the completed emergency repairs on the lower Skagit River mainstem were conducted in 2007 by the Corps in coordination with the Diking Districts. The Corps plans to conduct additional repairs or reworks of 29 levee sections under the PL-84-99 Program beginning in Summer 2011. Many of the construction and mitigation components of the various actions are similar, although there are some differences in design components between individual sites. Due to the large number of sites considered in this Opinion and their similarities, the project descriptions below consist of summarized information that focuses primarily on generalized activity descriptions for construction and mitigation activities applicable to the various sites. Detailed, site-specific project descriptions are provided in Appendix A and are included here by reference per the project site drawings from the Assessment and Addendum.

Levee Repair Activities

The completed and proposed levee repairs (hereafter, referred to as “Actions”) generally fall in three categories: 1) sites that were damaged during or after the 2006-2007 flood events and were subsequently repaired in 2007; 2) sites that were damaged in the 2006-2007 flood events but repairs were deferred and will be constructed beginning in 2011; and 3) sites that were identified as damaged in 2009-2010 flood events and will be constructed beginning in 2011. A list of sites by Diking District is shown below in Table 1.

Table 1. Levee repair sites in the lower Skagit River mainstem addressed in the Corps' December 2010 Revised Biological Assessment with completed and proposed mitigation measures to address edge habitat impacts of the levee sections.

Diking District (DD)	Site Number	Length of Repair (linear ft)	Status of Site Work		
			Completed in 2007	Rework (linear ft) in 2011	Proposed (or Deferred) for 2011
DD 1	1-1	207.5	Y	-	-
	1-2	200	Y	-	-
	1-3	75	-	-	Deferred
	1-4	108	Y	-	-
	1-7	257	Y	-	Y[1]
	1-13	50	-	-	Y
	1-14[2]	30	-	-	Y
DD 3	3-1	382	Y	-	-
	3-2	436	Y	-	-
	3-3	139	Y	-	-
	3-4	287	Y	-	-
	3-5	460	Y	-	-
	3-6	375	Y	Y (150)[3]	-
	3-7[2]	6110	Y	-	-
	3-8	225	-	-	Y
	3-11	200	-	-	Y
DD 12	12-1	109	Y	-	-
	12-2	261	Y	-	-
	12-3	511.5	Y	-	-
	12-4A[2]	250	-	-	Deferred
	12-4B	970	-	-	Y
	12-5	236	Y	-	-
	12-6	651	Y	Y (160)[3]	-
	12-7	170	Y	-	-
	12-8	124	Y	-	-
	12-9	1850	-	-	Y
	12-11	600	-	-	Y
	12-12	50	-	-	Y
	12-13	350	-	-	Y
	12-14	250	-	-	Y
	12-15	180	-	-	Y
	12-16	670	-	-	Y
	12-17	450	-	-	Y
DD17	17-1	400	Y	-	-
	17-2	275	Y	-	Y[1]
	17-3	159	Y	-	-
	17-4	170	Y	-	-
	17-5	1350	Y	-	-
	17-6	522	Y	-	Y[1]
	17-7	800	-	-	Y
	17-9	700	-	-	Y

Diking District (DD)	Site Number	Length of Repair (linear ft)	Status of Site Work		
			Completed in 2007	Rework (linear ft) in 2011	Proposed (or Deferred) for 2011
	17-10	200	-	-	Y
	17-12	925	-	-	Y
	17-15	125	-	-	Y
	17-16	250	-	-	Y
DD 22	22-1	395	Y	-	-
	22-2	118	Y	-	-
	22-3	273	Y	Y (110) [3]	
	22-4	246	Y	-	-
	22-5	70	Y	-	-
	22-6	259	Y	-	-
	22-7	350	-	-	Deferred
	22-8	554	Y	-	Y[1]
	22-9	338	Y	-	-
	22-10	300	-	-	Y
	22-11[2]	800	-	-	Y
	22-12[2]	360	-	-	Y

[1]The 2011 work will consist only of installation of mitigation measure(s).
[2] No in-water work was/will be performed.
[3] The 2011 work will include both repair work and installation of mitigation measure(s).

Each of the Actions include(d)[1] a suite of potential construction and mitigation design considerations and features that were/will be implemented on a site-specific basis according to the damage to and condition of each levee section. At multiple sites, scour and/or loss of rock on the levee face or toe occurred. In some cases, sloughing, seepage, and/or existing scour/sink holes will be addressed. Most of the Actions included/will include one or more of the following measures: 1) reshaping of the slope of the levee to a ratio of approximately 2H:1V (2 horizontal to 1 vertical), 2) placement of a spall rock blanket on the slope or bench, and 3) placement of large riprap on the riverward face of the levee. In most (if not all) of the Actions, construction of a buried toe was/is not planned or deemed necessary to repair the sites, although work below the Ordinary High Water Mark (OHWM) occurred will occur at some of the sites. Many of the sites included/will include placement of gravel and spall on the levee crown and access ramps to provide a driving surface, and most of the Actions resulted/will result in the disturbance of native

[1] Descriptions of activities taken (e.g., repairs *included*) refer to the completed activities throughout the remainder of the Opinion. Proposed activities (e.g., *proposed* repairs) refer collectively to the remaining proposed, deferred, and rework actions. Several sentences may be phrased as "occurred/will occur" or similar when both completed and proposed activities are indicated

and/or nonnative vegetation. At some sites, trees were/will be removed. In at least some instances, removed trees will be retained on site in mitigation activities (see below), or used at other project sites covered in this Opinion.

Some sites had specific damage that required/will require additional investigation or activities beyond the measures listed above. For example, levee damage at some of the sites (e.g., Diking District 3, Site 3-8; Diking District 22, 22-11) was/is limited to backslope damage, in which all work was/will be confined to the landward side of the levee. Examples of notable, site-specific issues include, but are not limited to:

Diking District 1:

- Site 1-3: Erosion is occurring at the downstream end of the levee, and may continue behind the armoring, unraveling the levee. If this occurs, the levee may fail and may preclude future access to Young's Bar.
- Site 1-4: A large scour hole that had developed riverward of the levee was filled with riprap during the 2007 construction.

Diking District 3:

- Site 3-6: Excess riprap was placed on the upper part of the slope during the 2007 construction season, but the resultant weight increased the load on the slope. The Corps has indicated that this may cause rotational failure of the levee, so they will remove the excess rock and reuse it to tie the levee into the bank at the downstream end of the site.
- Site 3-8: The riverward face of the existing levee section along the Tom Moore Slough does not currently contain armor rock on its face. The proposed action will add new rock along the levee face, which will reduce the relatively naturalized shoreline functions that are currently present at the site compared with adjacent rocked reaches. The site is adjacent to a 2007 repair site that is presently armored. A forested wetland is present on the landward side of the levee, and the riverward side is vegetated with both native shrubs and nonnative vegetation.
- Site 3-11: An over-steepened bank and loss of face rock has resulted in damage that includes several large sinkholes at this site within the City of Mount Vernon.

Diking District 12:

- Site 12-4A: Ground-penetrating radar indicates an anomaly below the levee that may be causing or exacerbating sloughing, seepage, and material movement. Excavation will be conducted to examine the anomaly, and the levee will be rebuilt.
- Site 12-14: This armored site constitutes a gap between two sites that were repaired in 2007. Loss of face rock will be remedied, and supplementation of toe rock may be needed.

Diking District 17:

- Site 17-7: Sink holes are present along the entire length of the levee section.
- Site 17-9: Sink holes and multiple stress cracks are present along the top of the revetment.
- Site 17-10: Sink holes and sloughing have been observed at the site.
- Site 17-16: A very deep scour hole has been reported at the toe of this structure. Additionally, this site is adjacent to a 2004 levee repair.

Diking District 22:

- Site 22-7: Located at Fir Island where the Skagit River splits into the North and South Forks, repairs at this site were deferred from the 2007 construction season. The levee section at this site has experienced toe and face scour, and the Corps anticipates that continued erosion at this site may lead to failure of the levee.
- Site 22-10: Seepage is occurring along this section of the levee, which also has an over-steepened bank. An impermeable core will be excavated and rebuilt along the centerline of the levee to reduce seepage. The condition of the willows (*Salix* spp.) and red alders (*Alnus rubra*) that are growing on the levee show signs of frequent cutting.
- Site 22-12: Sloughing along the riverward face of the levee will be repaired in the dry. The repair area is landward of a wide forested bench. Except for a 124-ft-long patch of rock, the riverward face is soft (i.e., composed of soil). The repairs would include placement of riprap along the entire 360-ft-long section of levee.

Extent of Levee Repairs

The combined length of the 57 individual levee repair sections (Figures 1 and 2) is approximately 5.2 miles (mi) of shoreline of the lower Skagit River and Tom Moore Slough. Taken together, the levee system in the lower Skagit River mainstem and its two main forks within the jurisdiction of Diking Districts extends along both sides of the river for approximately 25 mi from the City of Burlington to Puget Sound, for a total of approximately 50 mi of mainstem stream bank (Figure 3). This estimated length does not include the streambanks of tributaries and smaller distributaries (including Tom Moore Slough) of the lower Skagit River system. The proposed suite of actions addresses repairs to approximately 10 percent of the lower Skagit River levee system on the mainstem and two main forks in the lower river.

Figure 1. Skagit North: Locations of the completed and proposed levee repair projects in the lower Skagit River, Skagit County, Washington. (Map provided by U.S. Army Corps of Engineers.) The vertical red line denotes the upstream extent of the action area.

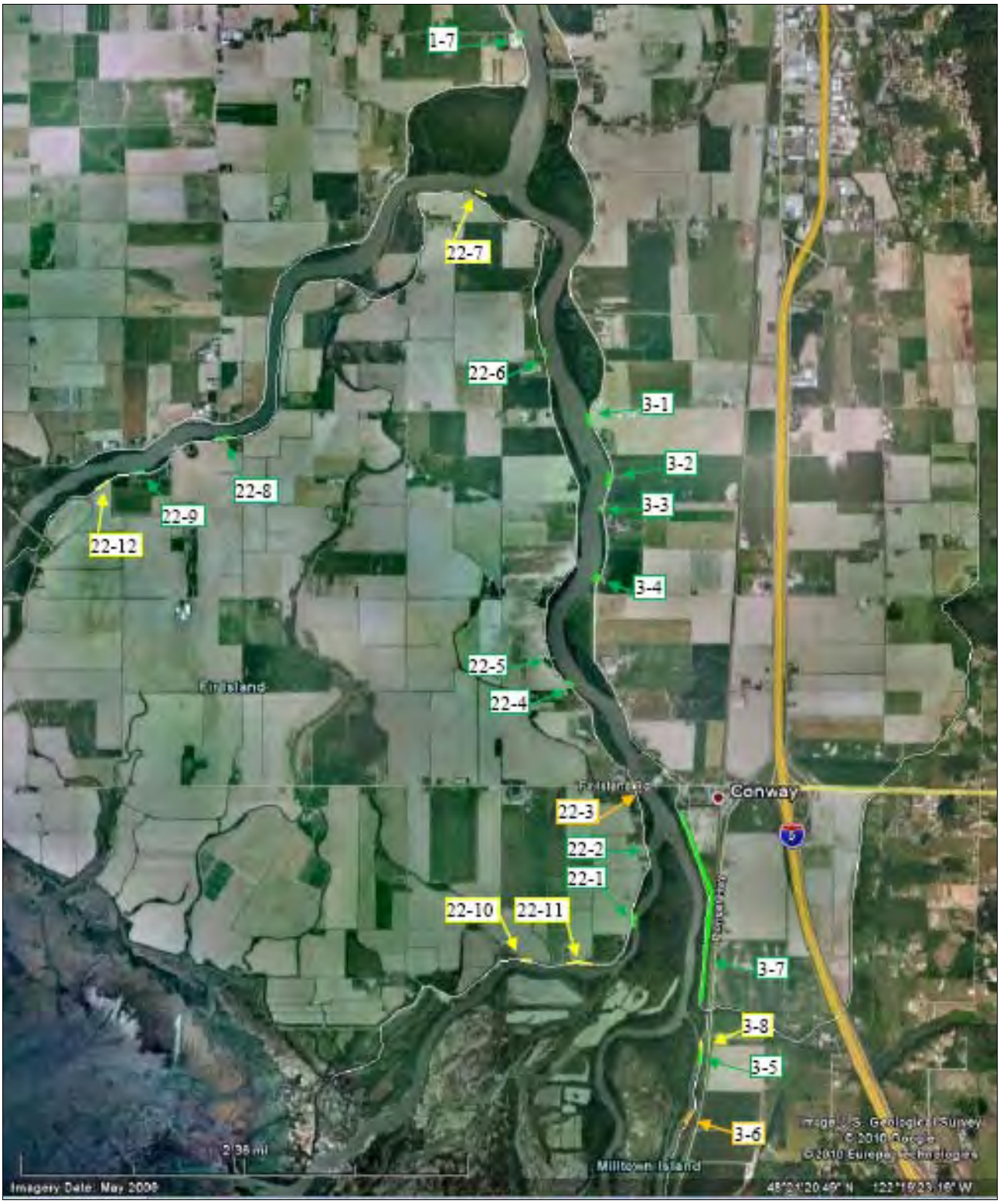

Figure 2. Skagit North: Locations of the completed and proposed levee repair projects in the lower Skagit River, Skagit County, Washington. (Map provided by U.S. Army Corps of Engineers.)

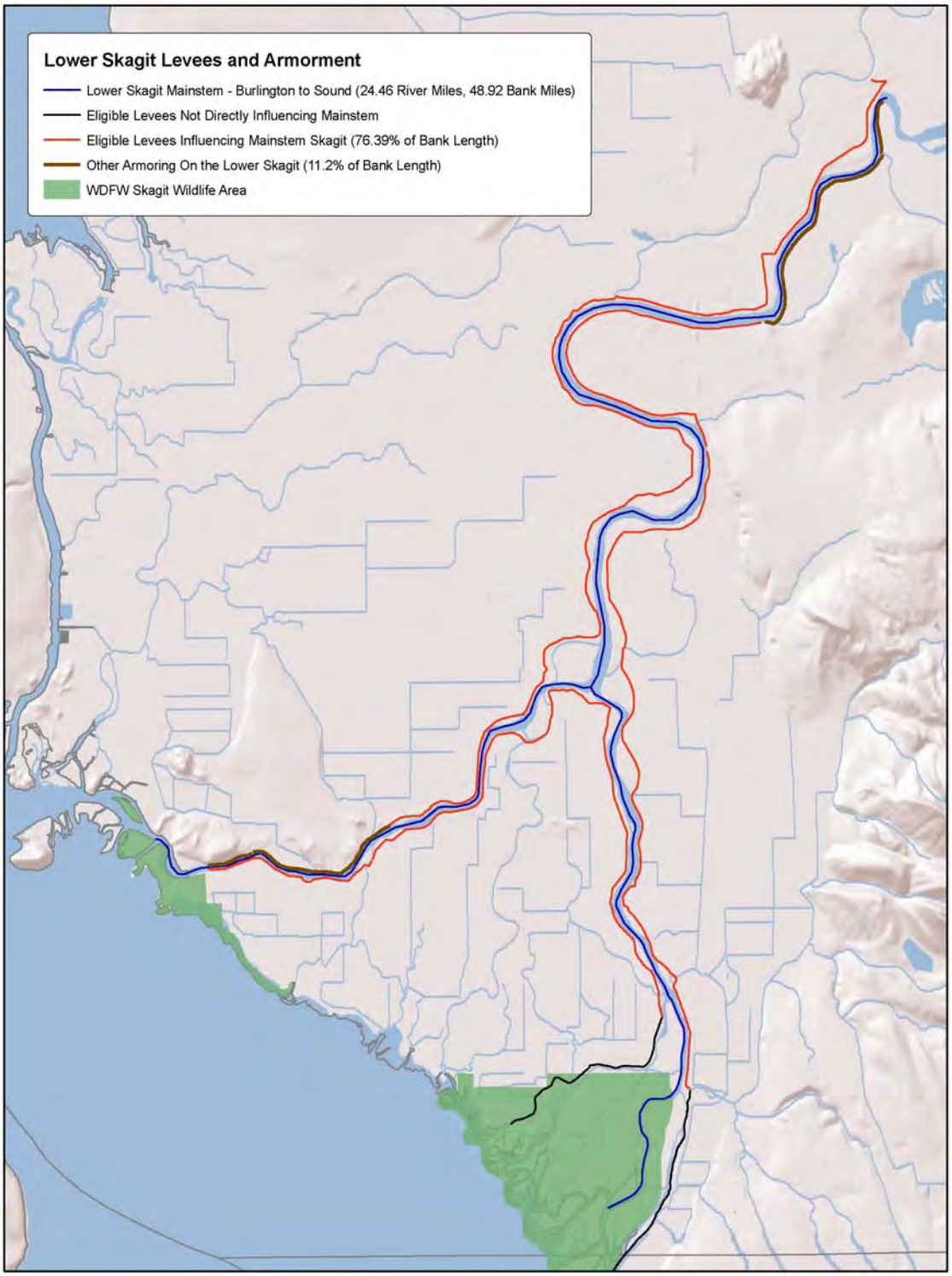

Figure 3. Approximate extent of levees (yellow lines) in lower Skagit River (as provided by the USACE) (N. Wright, Service, personal communication). This layer primarily shows the extent of levees that are eligible for USACE maintenance, although it may also include levees that are ineligible.

Mitigation Measures

Several of the construction actions that were completed in 2007 and most of the proposed work for 2011 included/includes installation of mitigation features to improve edge habitat along the shoreline. At a few of the 2011 proposed work sites, construction activities will be limited to the installation of mitigation features (with no other repair activities proposed). The following paragraphs provide a brief overview of the completed and proposed mitigation measures. For site-specific implementation of measures, see Appendix A.

Measures Implemented During 2007 Construction

Several of the sites that were constructed in 2007 included enhancement actions to provide a degree of localized habitat improvement along the levee face during construction. These activities primarily included installation of willow lifts as an upfront mitigation measure to reduce edge habitat impacts to listed salmonids. All but five of the sites constructed in 2007 incorporated willow lifts, for a total of 6,699 linear feet of shoreline, or approximately 66 percent of the total repair length.

Planted shoreline vegetation provides varying degrees of benefits to salmonids and other aquatic organisms by creating a source of allochthonous inputs such as leaf litter, insect fallout, and other nutrients that provide the forage base of the stream and its inhabitants. When willows are installed at an elevation such that the branches make appreciable contact with the water surface as they develop, the vegetation has the potential to reduce velocities and provide refugia areas for juvenile salmonids as they rear and migrate downstream.

After review of the as-built designs and subsequent site visits, the Corps determined that a number of the willow lifts were placed higher on the slope than was depicted in the designs, and in some cases 4 to 6 ft above the OHWM. While these more upland willow lifts are expected to provide a source of allochthonous materials to the stream, their elevation above the water surface makes it highly unlikely that they will be in contact with the water to provide any refuge function during juvenile salmonid out-migration.

Proposed Mitigation Measures

In the initial consultation request, the Corps proposed additional mitigation for long-term habitat impacts in the form of mitigation bank credits at the Nookachamps mitigation bank in the lower Skagit River basin. However, after additional internal review, as well as coordination with the SRSC, the Corps decided to pursue onsite mitigation alternatives to address long-term, edge habitat impacts of the actions.

Development of Onsite Proposed Mitigation Options

Beginning in late August 2010, the Corps convened a stakeholder working group (group) consisting of staff from the Corps, the Services, SRSC, and a representative of the Diking Districts to compile a list of onsite mitigation options for the batched actions. Extending over a number of months, the group's efforts were an attempt to address some of the long-term, edge

habitat impacts to listed salmonids from the repairs of the levee sections that were addressed in the Assessment.

The selection of possible options was based primarily on the habitat needs of juvenile Chinook salmon for rearing, foraging, and refuge during variable flow levels. While it was acknowledged that the lower Skagit River mainstem provides habitat for a number of native cold-water fish species at various life stages, including several listed species, little comprehensive quantitative information is available for most species and life history usage for this system. The group decided to use juvenile Chinook salmon, for which information is available in the Skagit Chinook Recovery Plan (Beamer et al 2005, p. 16) as a surrogate to address salmonid use of shoreline edge habitat in the action area. For the purposes of the analysis, the group determined that it was reasonable to assume other listed species of salmonids, including adult and subadult bull trout would benefit from the proposed habitat improvements either directly (e.g., out-migrating, foraging, or rearing juvenile salmonids) or indirectly, through improvements to their prey base and foraging, migrating, and overwintering habitat for larger fish.

Mitigation Options

The mitigation options described in the paragraphs below were acknowledged by the group as generally suitable for edge habitat impact mitigation. The list of options included a range of activities, most of which were selected for the batched actions addressed in this Opinion. The group also developed offset multiplier ratios to estimate the anticipated amount of mitigation that would be needed for the batched actions (Table 2), both at the site level and within each Diking District's jurisdiction to meet the goals of the mitigation strategy. The mitigation strategy was proposed to increase edge habitat functionality to a level that would support the higher range of current juvenile Chinook rearing and foraging in the action area. The available edge habitat annually supports approximately 4 juvenile Chinook per linear foot, while the mitigation targets are intended to increase this number to 21 juvenile Chinook per linear foot. A more in-depth discussion on the formulation of the mitigation strategy, the offset multiplier ratios, and the proposed mitigation options for each site can be found in Appendix B (Part 1).

The suite of mitigation options for each site were selected by evaluating the various site conditions as well as the overall strategy for mitigation implementation as derived by the offset ratios (see Appendix B, Part 2). Construction designs for the mitigation options for the sites were provided in the Appendices to the Corps' Assessment and the Addendum, and are included here by reference. One or more of the following measures[2] will be applied at most of the proposed sites:

[2] For the mitigation option(s) planned at each site, see Appendix A.

Layback[3] of Levee Slope: At some sites, adjacent land use and other conditions would allow for a more gradual slope and repairs to the levee can incorporate a shallower slope of at least 3H:1V. The shallower slope would extend from below the OHWM to the top of the levee or riverward bench, as applicable at a given site, without a change in position of the levee toe (Figure 4). Where laybacks are implemented, more stable bank conditions are anticipated, which would likely result in fewer future repairs and decreases in river velocities adjacent to the bank. A more gradual slope would also result in shallower water depths adjacent to the shore, which is expected to be more attractive to small juvenile salmonids. Transition zones, which have been assigned a separate mitigation ratio in Table 2 below, are intended to avoid scour by creating a gradual slope connection extending approximately 40 ft on either side of the levee section repairs between the layback and the adjacent levee segments. Laybacks and their associated transition zones are planned at two sites: DD 12-14, DD 22-7.

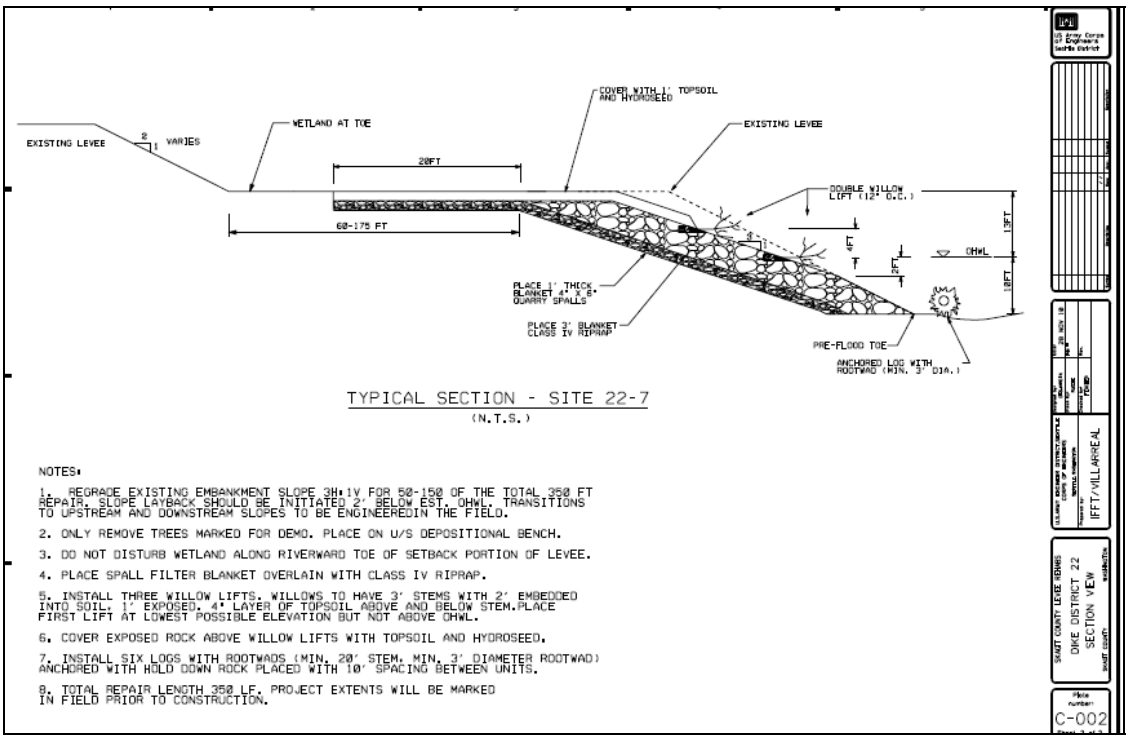

Figure 4. Example of a layback design for Skagit River levee repair projects.

Woody Debris: The Corps will incorporate a variety of wood structures in the proposed projects, ranging from logs and rootwads in the wetted channel to smaller woody debris piles that are placed onshore, upland of the OHWM. At sites where large woody debris (LWD) is installed, logs and/or rootwads will be attached in sequence or in clusters and placed with anchors in suitable locations that are expected to retain the structures under anticipated flow conditions to appreciably reduce the risk of loss of the structures over the long term (Figure 5). As of their

[3] Not to be confused with a levee setback, where the entire levee section is moved landward from its current position.

May 25, 2011 email, the Corps has determined that excavation will no longer be necessary to place the LWD and their anchors. The larger woody debris structures are intended to improve habitat complexity and provide streambank refugia for juvenile salmonids and other aquatic biota. The smaller piles of woody debris are anticipated to be more transitory, but are intended to mimic smaller wood inputs into the stream. While the degradable nature of the woody materials would not result in permanent improvements to the streambank habitat, they are expected to improve habitat features for juvenile salmonids over existing conditions at the sites where they are implemented. Woody debris piles will be unsecured at some sites where they are implemented, or interwoven into existing structures where these exist (DD 1-7 and DD 17-2). Anchored LWD (logs and/or rootwads) will be installed at the following sites: DD 1-3, DD 3-5, DD 3-6, DD 3-8, DD 12-9, DD 12-13, DD 17-6, and DD 22-7.

Figure 5. Example of attached logs with rootwads and anchors. (Photograph provided by Corps, from different site.)

Fish Bench: With this option, a ledge or bench will be created below the OHWM within the levee face, with a width of at least 9 ft. The bench will be installed at an angle, ranging from 2 ft above the OHWM at the upstream end to 2 ft below the OHWM at the downstream end, and will include a 2 percent grade sloped waterward to allow drainage and prevent fish stranding (Figure 6). The contours of the bench have been designed to provide shallow water habitat at a multiple flow levels, increasing the benefit to juvenile salmonids over standard horizontal ledge designs. A fish bench will be installed at DD 12-13.

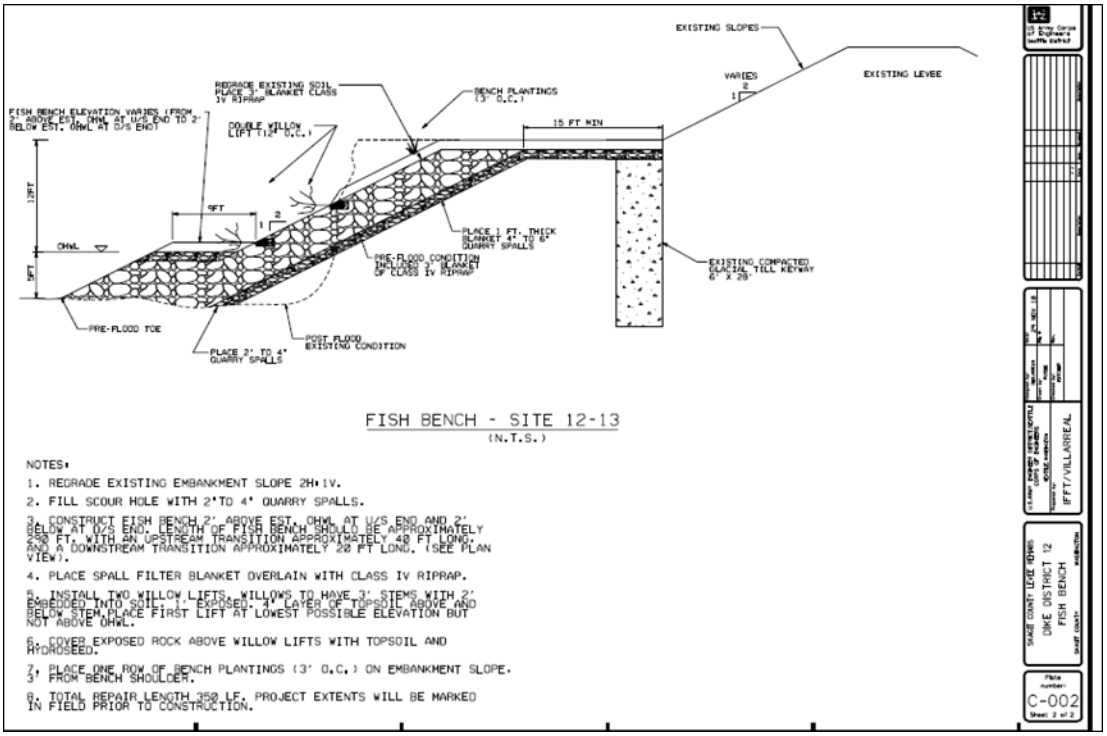

Figure 6. Fish bench mitigation design for Skagit River levee repair projects.

Habitat Weir: This option is a modified groin design, with placement of a rock protrusion upstream into the channel at a 30 degree angle. In cross section, the weir will be a pyramidal rock structure along the in-water portions of the structure (Figure 7). The structure is intended to provide hydraulic complexity at multiple flow levels, locally reducing stream velocities on the upstream side, and allowing pool formation on the downstream side. The Corps has noted in their Assessment that the weir design will require a reach analysis to avoid appreciable effects to the thalweg or other changes to the river dynamics in the vicinity of the site. A habitat weir will be installed at DD 17-16.

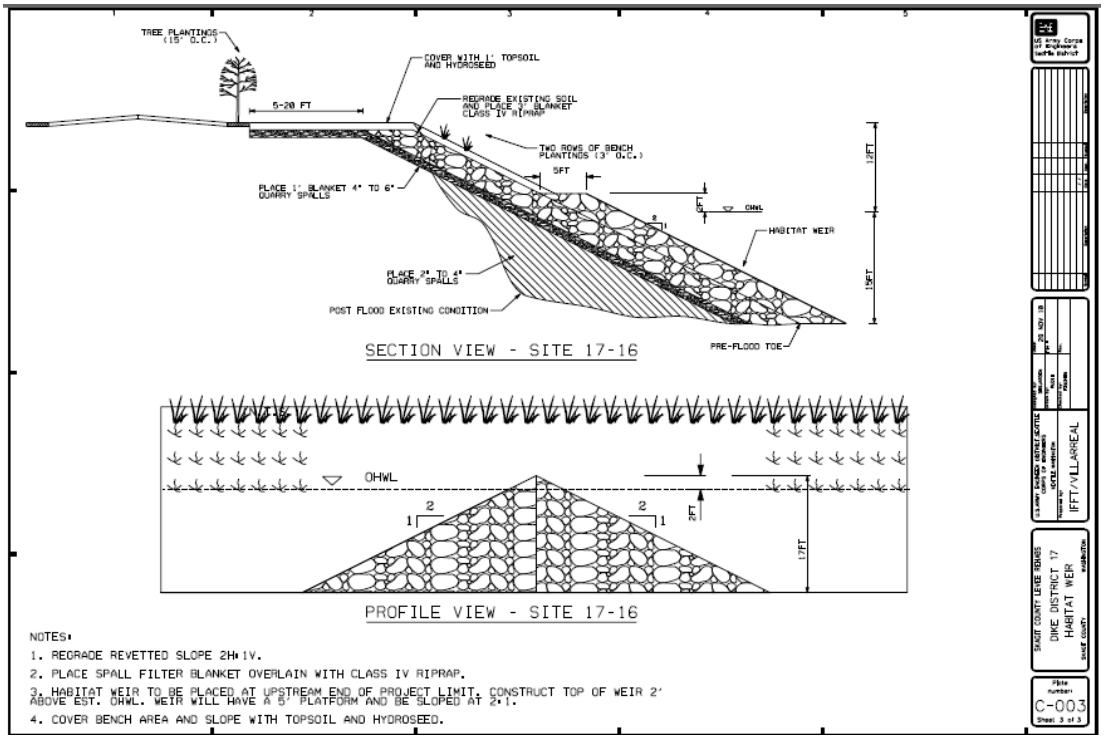

Figure 7. Habitat weir mitigation design for Skagit River levee repair projects.

Plantings. Several options were developed for incorporating native plantings at the project sites. As the current Corps levee standards do not allow large conifers or deciduous trees to grow on or immediately adjacent to the levee, the options were primarily limited to willows and shrubs incorporated on the face of the levee and/or at its crown. The individual options are:

- Willow lifts. In this option, live willow stakes will be planted in a layer of soil placed on the riprap. Willow lifts will be planted at most of the sites, either as single lifts, double lifts, or triple lifts, and installed at approximate 4 ft vertical intervals. Multiple lifts are generally anticipated to provide additional benefits at a wider range of flows, although diminishing returns may be expected beyond two or three lifts relative to the cost and effectiveness. Based on the review of the 2007 as-built designs, the Corps will ensure that the lowest lift of willows installed in 2011 will be planted at or below the OHWM so that they can provide both food base support and refugia for salmonids.
- Top of bank plantings. Small native shrubs, such as Nootka rose (*Rosa nutkana*) and common snowberry (*Symphoricarpos albus*), will be planted in soil placed on the riprap face on or near the crown of the levee. Several sites will incorporate bank plantings, which would be planted 3 ft on center and may include multiple rows at a given site. The plantings would provide allochthonous inputs, and may provide some refuge and hydraulic diversity during higher flows.
- Landward tree plantings. Where land use and site conditions allow, trees may be planted near (but not on) the levee. Tall-growing trees may be planted landward of the levee in a location where they can provide shade and other benefits to the stream when mature. Alternatively, trees can be planted waterward of the levee if a suitable bench exists

between the levee and the stream, and if the Corps determines the plantings would not decrease levee safety. Larger growing trees will be planted near the levees at DD 17-16 and DD 22-7.

Other Measures.

- Invasive plant removal. This option will include the removal of several invasive, nonnative species in the riparian zone of the project sites: Himalayan blackberry (*Rubus armeniacus*), reed canarygrass (*Phalaris arundinacea*), Canada thistle (*Cirsium arvense*), bittersweet nightshade (*Solanum dulcamara*), and Japanese knotweed (*Polygonum cuspidatum*). Where these species are removed, they will be replaced with native species as noted in the project descriptions for each site and the invasive species removal protocol (Appendix C) specified in the Addendum. In brief:
    - Himalayan blackberry and Canada thistle will be pulled during the spring and fall for 5 years and removed from the site. Native plantings will be used to shade the soil to reduce recolonization of the Himalayan blackberry over time. No chemicals would be used to control this species.
    - Reed canarygrass and bittersweet nightshade will be removed during clearing of the sites prior to construction. Willow lifts would be planted in the area previously colonized by reed canarygrass, and are expected to result in dense shade to reduce recolonization of this species. No chemicals would be used to control these species.
    - Japanese knotweed control efforts are ongoing in Skagit County, and have been undertaken by the Diking Districts using several methods combined with mapping and monitoring of the known patches. The control methods include bending of stems during spring and fall surveys and chemical treatment (mix of Imazapyr and Agridex) with hand sprayers or backpack sprayers. This species is a Class B noxious weed on the Washington State Weed List, and control is required in these areas. The Diking Districts and/or the Corps will continue the control efforts at the mitigation sites, and anticipate the control efforts will support establishment of native vegetation where Japanese knotweed is currently present to preclude its recolonization. The treatments are expected to continue the use of a mix of 1 percent Imazpyr (Polaris AQ) and 1 percent Agridex surfactant using hand or backpack sprayers from July until the first freeze in early/mid-October. The application rate will be 4 pints of Imazapyr per acre, which the Addendum notes is less than the label limit of 6 pints per acre (p. 6).
- Soil and hydroseed. After project activities are completed, the Corps proposes to place soil on the riprap and hydroseed the area. This activity is intended to provide additional terrestrial insect habitat for allochthonous inputs and reduce temperature impacts from the levee by shading the rocks so that they retain less heat that would be otherwise transferred to the air and water immediately adjacent to them.

The list of mitigation alternatives developed by the group also included other alternatives such as levee setbacks, removal of armoring and/or levee, conservation easements, mitigation and/or

conservation banks, and others that were determined to be infeasible and/or impracticable to implement for the projects covered under this Opinion based on cost, complexities associated with land acquisition, and other challenges at the present time. These options were retained in the mix of alternatives to build the framework for edge habitat mitigation implementation that may be used in subsequent consultations under the Act and are described further in the Assessment. Although these additional options are shown in Table 2 below and referenced in some of the appendices of this Opinion, they are not proposed for the current batch of projects, and will not be discussed further in this Opinion.

Table 2. Mitigation options and offset multipliers (as outlined in the 2011 Assessment) for edge habitat impacts in the lower Skagit River mainstem as proposed by stakeholder working group. (Source: Corps' January 2011 Assessment.)

Primary Function	Mitigation Options	Offset multiplier	Source document for fish density improvement[1]
Rearing	Layback (3:1 or shallower) up to 10 feet wide	3.04	Technical Working Group
Rearing	Layback (3:1 or shallower) 11 feet and wider	4.05	Technical Working Group
Rearing	Single logs in line	1.2	Beamer and Henderson 1998
Rearing	Woody debris piles	6.4	Beamer and Henderson 1998
Rearing	Anchored rootwads	8.7	Beamer and Henderson 1998
Rearing	Anchored single logs with rootwads	8.7 to 1.2	Technical Working Group
Rearing	Setback Levee*	10	Hayman et al. 1996, p. 33-34
Rearing	Slough (or large backwater) habitat creation*	case-by-case	
Rearing	Remove bank armoring*	5.4	Beamer and Henderson 1998
Refuge	Layback transition zone	2.03	Technical Working Group
Refuge	Fish Bench that slow velocity and depth up to 30 "	1.3	Beechie, Lierman, Beamer, and Henderson 2005
Refuge	Habitat Weirs / groins creating backwater (rock outcropping)	4	Friesen et al – 2003
Refuge	Willow Lift – double, starting at or below OHW	1.4	Beamer and Henderson1998, Peters,Missildine, and Low 1998 and Technical Working Group input
Refuge	Willow Lift – triple, spanning wide range of flows	1.8	Beamer and Henderson1998, Peters,Missildine, and Low 1998 and Technical Working Group input
Forage	Willow Lift – single, at or below OHW	0.7	Beamer and Henderson1998, Peters,Missildine, and Low 1998 and Technical Working Group input
Forage	Single lift + bank plantings:	1.4	Beamer and Henderson1998, Peters,Missildine, and Low 1998 and Technical Working Group input

Primary Function	Mitigation Options	Offset multiplier	Source document for fish density improvement[1]
Forage	Single row of riverward bench plantings	0.4	Technical Working Group
Forage	Double row of riverward bench plantings	0.6	Technical Working Group
Forage	Triple row of riverward bench plantings	0.7	Technical Working Group
Forage	Spread dirt over riprap and hydroseed (top portion of riverward slope)	0.35	Technical Working Group
Riparian Corridor Improvements	Landward plantings of overstory trees	0.2	Technical Working Group
Riparian Corridor Improvements	Invasive plants replaced with native plants	0.7	Technical Working Group
Case-by-case	Mitigation Banks* (only where fish credits available)	case-by-case	
Case-by-case	Conservation Easements*	case-by-case	
Case-by-case	Cottonwood Slough, other habitat projects*	case-by-case	

[1] The citations listed in Table 2 are found in the main Literature Cited section at the end of this Opinion.
*Not proposed for the batched actions covered in this Opinion.

The group worked to reach agreement on a number of assumptions regarding the mitigation options, ranging from feasibility and minimum acceptable construction specifications for fish benches, habitat weirs, plantings, and other features to performance standards and post-construction monitoring. The group acknowledged that it would be difficult and costly to test all of the assumptions needed to draw quantitative conclusions on benefits to listed species and fish habitat upon installation of the various options, but recognized that some measure of effectiveness was needed.

Monitoring of Mitigation Options

After coordinating with the other members of the group on a variety of potential qualitative performance measures, the Corps proposed a subset of measures (Appendix B, Part 2) under the categories of implementation monitoring and effectiveness monitoring that would address some of the assumptions regarding the habitat enhancement value associated with the various mitigation features. Implementation monitoring would consist of reviewing post-construction, as-built drawings to document that the various mitigation features were properly installed during construction, and would be used to determine whether any corrective actions need to be taken to avoid issues encountered in 2007, such as where willow lifts were installed too high above the OHWM. Effectiveness monitoring would be performed to determine whether the habitat features are functioning as planned. No qualitative or quantitative fish surveys would be conducted, but the Corps would monitor several physical and biological parameters at multiple flow stages as indicators of habitat function. Stream velocities at different features (e.g., willow lifts, the fish bench, habitat weir, etc.) would be measured annually for five years under low flow conditions (10 to 12 thousand cubic feet per second [kcfs]), medium flows (15 to 20 kcfs), high

flows (~ 25 kcfs), and during flood conditions (30+ kcfs) to analyze conditions (as safety permits) at the range of flows during which juvenile salmonids would be outmigrating.

Construction Methods

Construction at each site varied/will vary slightly, depending on the suite of activities that was/ will be completed at each site. For the most part, the repair process for all the Actions is similar and is comprised of several activities at each site, most of which occurred/would occur above the OHWM. The general implementation of construction for all sites includes the following activities:

- Clear and grub site to remove vegetation and other materials
- Excavate and reshape slope
- Add spall rock to the slope
- Install armor rock
- Install willow lifts or other mitigation features as indicated in site project designs, where applicable
- Top disturbed level ground with soil and hydroseed

Heavy equipment was/will be used for placement of riprap, large woody debris (LWD), anchors for LWD, and other materials. The installation of riprap consisted/will consist of individual placement of clean rock. At some sites, excavation below the OHWM was/will be necessary for placement of materials. For example, excavation may be required if the Corps determines toe work will be necessary at a given site. The installation of more substantial mitigation features below the OHWM, such as construction of the habitat weir, fish bench, and placement of logs, rootwads, other LWD, and their anchors (as applicable) during the 2011 construction, will be scheduled at lower flows where possible to reduce in-water effects to salmonids, their prey, and their habitat. The timing of installation of these individual mitigation features within the sequence of the levee repair construction schedule may vary at a given site based on access and other considerations.

<u>Work Windows</u>

Completed work occurred during flood fighting efforts outside of the work window in early 2007 or during follow-up construction later that year. The initiation of the summer/fall 2007 follow-up work was delayed until the final days of the recommended work window and beyond due to scheduling challenges and other constraints.

Alternatively, all proposed in-water work would occur during the recommended work window for salmonids for this reach of the river (June 15 to August 31). Proposed upland activities, such as plantings and invasive species removal may be implemented outside of the recommended work window.

Conservation Measures

The Corps implemented or plans to implement a number of Best Management Practices (BMPs) and other conservation measures to avoid or reduce the potential for the adverse impacts from project construction on listed species, their prey species, water quality, and habitat. Such measures include but are not limited to the following:

Completed Actions

- Turbidity was monitored visually and work was to be halted if turbidity exceeded required thresholds (per Washington State Department of Ecology (Ecology) water quality standards *(RCW 940.48 and WAC 173-201A)*).

Proposed Actions

- All in-water work for the 2011 sites will be completed between June 15 and August 31, to avoid or reduce effects to listed species and other salmonids during sensitive life history periods such as juvenile outmigration and spawning.
- Site-specific measures will be implemented at most of the sites per the mitigation plan, and will include the installation of one or more of the following features to reduce edge habitat impacts to salmonids, their prey, and/or their habitat: willow lifts, native shrub plantings, rootwads and/or LWD, slope laybacks, installation of a fish bench, habitat weir and/or other habitat enhancement structures or features.
- A turbidity monitoring and response plan will be implemented during sediment-generating activities to minimize elevated suspended sediment levels in the stream (Appendix D and summarized below).
    - The plan will include monitoring measures for sediment-generating activities (e.g., excavation below the OHWM, installation of LWD, laybacks, fish bench, habitat weir, etc.), with the following caveats:
        - For each type of sediment-generating activity, monitoring would follow the protocol described in Appendix D for the first few sites (or in some cases several sites) implementing this activity.
        - If monitoring results indicate that a given type of activity is not causing exceedences as described below, or if effective contingencies can be included that can be repeated at the other project sites, no further monitoring would occur for subsequent project activities of this type under most circumstances. If other sites have notably different site conditions that may result in exceedences or if there are other influences such as rain events that are expected to produce different results, monitoring would be performed at these sites.
    - The Corps would measure 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 15 minute intervals, then once every 3 hours if no exceedences are noted.

- Maximum turbidity levels will be the lower of:
  - Washington State Code 173-201A-200, which allows a maximum of 10 percent above background if background levels are less than 50 Nephelometric Turbidity Units (NTU)
  - As determined by Muck (in litt. 2010, pp.1-22) guidance to minimize salmon impacts, the following values are seen:
    - Between 0-1 hours, NTU levels must not exceed 21 NTUs above background turbidity levels.
    - After 1 hour, NTU levels must not exceed 7 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 remains consistent with the above values, turbidity monitoring may be reduced or discontinued. Monitoring will be resumed during sediment-generating activities if precipitation events or other hydrologic changes result in higher or lower background levels of turbidity. Monitoring would also be resumed if noticeable changes in the plume are observed due to project activities.
- If sediment-generating activities exceed the above values, such activities will cease. The Corps will then take actions to avoid or reduce further exceedences before construction activities resume.
- The Corps will provide a monitoring report upon completion of the construction.

<u>All Actions</u>

- Equipment used near the water at each site was/will be cleaned prior to construction.
- Construction equipment was/will be regularly checked for drips or leaks.
- Work was/will be conducted during the summer period of low flow.
- Biodegradable hydraulic fluids were/will be used for machinery at the sites.
- Refueling occurred/will occur on the landward side of the levee at each site.
- A minimum of one fuel spill kit with absorbent pads was/will be onsite at all times.
- Drive trains of equipment did/will not operate in the water.

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 area for each of the projects, we evaluated the farthest reaching physical, chemical, and biotic effects of each of the actions on the environment.

The action area for each of the batched projects extends from just upstream of each project site to Skagit Bay. Due to the large number of projects considered in this Opinion, and the overlapping nature of individual action area for many of the projects, we have chosen to delineate the action area for the batched projects as a whole (hereafter, "action area"). The upstream extent of effects of the batched projects is anticipated to be the next upstream meander-bend for the most upstream of the actions (Site DD12-14), near river mile (RM) 19 (see Figure 1). 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 this project site. Additively, the actions would affect the entire mainstem reach from Site DD12-14 through the two forks and Tom Moore Slough into Skagit Bay. Skagit Bay is considered the lower boundary of the farthest reaching effects of these actions, and includes the long-term effects of precluding the establishment of mature riparian vegetation due to levee maintenance and requirements of the local levee sponsors (Diking Districts) to meet Corps performance standards. As the continued existence and maintenance of the levees would preclude recruitment of large riparian vegetation, they also preclude LWD source development and 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, with some eventually reaching the mouth of the river. Consequently, we have determined that the lower boundary of the action area for the Actions will be Skagit Bay, the terminus of the forks of the lower Skagit River.

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 Federal Actions in the context of the bull trout's current status, taking into account any cumulative effects, to determine if implementation of the 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 range-wide status of bull trout is provided in Appendix E.

STATUS OF THE SPECIES IN THE CORE AREAS

Core areas represent the closest approximation of a biologically functioning unit for bull trout and consist of habitat that could supply all of 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 (IRU).

The projects are located in the Lower Skagit core area of the Puget Sound Management Unit, which supports nineteen local populations of bull trout. We anticipate that fluvial and/or anadromous bull trout[4] from one or more of these local populations as well as anadromous individuals from other nearby systems (e.g., Snohomish/Skykomish, Stillaguamish, and Nooksack Rivers) may have been/will be present in the action area of these projects during and after construction. While occasional bull trout may pass downstream and through the Diablo and Ross dams separating the Upper Skagit core area from the Lower Skagit core area, we anticipate that this passage is extremely rare. Thus, the Upper Skagit core area is not included in this section of the Opinion. Each of the four core areas relevant to this Opinion are discussed below.

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 (Kraemer 2003; WDFW et al. 1997).

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.

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

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 (R2 Resource Consultants and Puget Sound Energy 2005; Shannon, in litt. 2004). 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 Washington State Department of Fish and Wildlife 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.

Stillaguamish Core Area

The Stillaguamish core area comprises the Stillaguamish River basin, including the North Fork and South Fork Stillaguamish Rivers and their tributaries. Major tributaries to the North Fork Stillaguamish River include the Boulder River and Deer, Little Deer, and Higgins Creeks. Canyon Creek, the only major tributary to the South Fork Stillaguamish River, has minor tributaries including Millardy, Deer, Coal, Palmer, Perry, and Beaver Creeks.

Bull trout occur throughout the Stillaguamish River basin and, in the Stillaguamish core area, primarily include anadromous and fluvial life-history forms (USFWS 2004). There are no known populations in the North Fork Stillaguamish River above the barrier to migration at river mile 37.5 (Kraemer, in litt. 1999). No resident populations have been found above any of the natural migratory barriers on Deer or Higgins Creeks. No exclusively resident populations have been identified in this core area, but the South Fork Stillaguamish River population has a strong resident component coexisting with migratory forms.

The South Fork Stillaguamish River upstream of Granite Falls has supported anadromous bull trout since the construction of a fishway in the 1950s. Previously the falls were impassable to anadromous fish. Anecdotal information from fish surveys in the 1920s and 1930s, however, suggest that native char likely were present above Granite Falls prior to construction of the fishway (WDFW 1998).

Spawning habitat is generally limited in the Stillaguamish core area, and apparently, only the upper reaches provide adequate spawning conditions. Bull trout spawn in the upper reaches of the accessible portions of the upper North Fork Stillaguamish River and its tributaries, including Deer and Higgins Creeks. There has been no extensive juvenile sampling or evaluation of spawning success in the North Fork Stillaguamish River. Bull trout in the Upper Deer Creek local population spawn in Higgins Creek, and spawning also may occur in upper Little Deer Creek. Bull trout spawn in the Boulder River below the impassible falls at RM 3. Although unconfirmed, spawning and rearing probably occur in the Squire Creek system, which is similar

in size to Boulder River and also influenced by snowmelt. Boulder River may be identified as an additional local population when more distribution information is available.

Spawning areas in the South Fork Stillaguamish River and its tributaries include Canyon Creek and upper South Fork Stillaguamish. Bull trout are known to spawn and rear in Palmer, Perry, and Buck Creeks and the upper South Fork mainstem above Palmer Creek. Recent spawning surveys identified a major spawning area above the Palmer Creek confluence. Between 50 and 100 bull trout spawn in this reach. Electrofishing surveys also documented high densities of juveniles (Downen, in litt. 2003a). Spawning and early rearing habitat in the South Fork Stillaguamish River is considered to be in fair condition. Although bull trout spawn in the upper South Fork Stillaguamish River and other tributaries, available habitat is partially limited by gradient and competition with coho salmon. Upstream movement of bull trout from the lower river depends on proper functioning of the fish ladder at Granite Falls. Migratory and resident fish coexist on the spawning grounds.

Bull trout in the Canyon Creek local population use the upper South Fork Stillaguamish River for spawning and rearing. Although there have been isolated and incidental observations of spawning by migratory-size bull trout, electrofishing surveys have been unable to locate any juvenile or resident bull trout from this population. Despite repeated survey efforts, very few bull trout have been located in this population because of the difficulty in locating individuals.

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

Four local populations have been identified in the Stillaguamish core area: 1) Upper Deer Creek, 2) North Fork Stillaguamish River, 3) South Fork Stillaguamish, and 4) Canyon Creek. The scarcity and spatial isolation of available spawning habitat limits the number of local populations in the Stillaguamish core area. With only four local populations, bull trout in this core area are considered to be at increased risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

The bull trout population in the Stillaguamish River basin is estimated at fewer than 1,000 adults. In the North Fork Stillaguamish River, as many as 100 adult bull trout have been observed holding near the mouth of the Boulder River. Surveys documented nearly 300 adult char between river miles 21 and 25 during fall 2001; fewer than 100 adults were counted in the remaining sample years between 1996 and 2003 (Pess 2003). Other limited snorkel surveys had similar results (Downen, in litt. 2003b). These staging adult bull trout are assumed to spawn somewhere in the North Fork Stillaguamish River. Adult abundance in the Upper Deer Creek

and Canyon Creek local populations is considered low. The Boulder River population probably has fewer than 100 adults. Approximately 50 to 100 adults are present in the South Fork Stillaguamish River, based on conservative estimates from spawning and electrofishing surveys (Downen, in litt. 2003a). Although accurate counts are unavailable, current estimates of adult abundance suggest that Upper Deer Creek and Canyon Creek local populations have fewer than 100 adults and are considered at risk of inbreeding depression.

Connectivity

Primary foraging, migration, and overwintering areas in the Stillaguamish River basin include the mainstems of the North Fork and South Fork Stillaguamish Rivers and the Stillaguamish River to the estuary. Foraging sub-adults and adults may be found in nearly all reaches of the basin below migratory barriers to the basin. Rearing individuals may use nearly all accessible reaches in higher elevation and coldwater portions of the basin. Anadromous forms in the Stillaguamish core area are presumed to use nearshore marine areas in Skagit Bay, Port Susan, and Possession Sound, but may also use areas even farther from their natal basin.

All native char habitat within the Stillaguamish River Basin generally has good connectivity. However, because the local populations are somewhat isolated from one another, maintaining connectivity among them will be critical to support life-history diversity, refounding, and genetic exchange.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Stillaguamish core area have caused harm to or harassment of bull trout. These actions include statewide Federal restoration programs that include riparian restoration, restoration of fish passage at barriers, and habitat-improvement projects. In addition, federally funded transportation projects involving repair and protection of roads and bridges have been completed. Finally, section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans that address bull trout in this core area.

The number of non-Federal actions occurring in the Stillaguamish 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 Stillaguamish core area include:

- Channel widening and a significant reduction in primary pool abundance have seriously degraded habitat conditions in the North Fork and lower South Fork Stillaguamish Rivers.
- Spawning habitats in Deer and Canyon Creeks have been extremely degraded.

- Past logging and logging-related activities, such as roads, have degraded habitat in the Stillaguamish River basin. The loss of riparian cover, slope failures, stream sedimentation, increased stream temperatures, flooding, and loss of large woody debris have adversely affected bull trout in Deer Creek and in the South Fork Stillaguamish River (USFWS 2004; WDFW 1997). Deer and Higgins Creeks currently violate State water-quality standards for temperature.
- Agricultural and residential development has contributed to poor water quality in the lower Stillaguamish River basin. Excessive siltation caused by mud and clay slides on the North Fork Stillaguamish River near Hazel, Washington, and on the South Fork above Robe, contributes to poor water quality (Williams et al. 1975).
- Other limiting factors in the North Fork Stillaguamish River include loss of deep holding pools for adults and low summer flows (USFWS 2004).
- Low flows and high temperatures during the summer affect holding habitat for anadromous migrants in the mainstem Stillaguamish River, especially in the lower river sloughs that have slow-moving water without significant riparian cover (WDFW 1997).

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, Vol. 1, p. 215).

<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" in Bull Trout Status of the Species, in Appendices, p. 5).

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, Vol. 1, p. 103), but have recently declined to just over 240 in 2005 and 2006 (WDFW 2007, p. 17). 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 (Jackson, 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:

- Loss of habitat that can provide thermal and high-flow refuge. Armoring the riparian areas results in the loss of natural river functions.
    - Bank armoring to protect homes, towns, and roads built in the rivers natural channel migration zones results in the river's inability to develop side- and off-channel habitat that bull trout need for survival.
    - Bank armoring is also associated with reduced riparian vegetation and shading, which eliminates prey sources and thermal refuge for bull trout.
- Degraded habitat conditions from timber harvests and associated activities, including roads, sedimentation, and fertilization, especially in the upper watershed, where spawning occurs.
- Blocked fish passage, altered stream morphology, and degraded water quality in the lower watershed resulting from agricultural and livestock practices.
- Injury and/or mortality from illegal harvest or incidental hooking/netting, which may occur where recreational fishing is allowed by the Washington Department of Fish and Wildlife.
- Degraded water quality from municipal and industrial effluent discharges and development.
- Loss of nearshore foraging habitat and prey from continual development along riparian areas, especially from residential, commercial, and transportation construction, which usually substantiate the need for bank armoring to protect the river's natural migratory process.

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).

Number and Distribution of Local Populations

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").

Adult Abundance

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.

STATUS OF BULL TROUT CRITICAL HABITAT

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

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 the projects. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Setting

The Actions are located in the lower Skagit River basin, at and downstream of the cities of Burlington and Mount Vernon in Skagit County, Washington. The Skagit River is the largest watershed in Puget Sound. It is located within the Cascades (upper watershed) and Puget Lowlands (lower watershed) ecoregions and drains a total of 8,011 square kilometers (km^2) (3,093 square miles [mi^2]) of land, including 1,036 km^2 (400 mi^2) in British Columbia (USGS 1969 *in* USFWS 2004; p.31). The Skagit Basin is composed of two geographic regions: the lower Skagit River and the upper Skagit River (USGS 2001 *in* USFWS 2004; p.31). The river has an extensive delta in Skagit Bay.

The Skagit River basin is located within Skagit, Whatcom, and Snohomish Counties. The majority of the watershed is under Federal ownership, followed by private, State, and Tribal, respectively (USFWS 2004; p. 31). Ownership in the lower Skagit basin is predominately private, while the majority of the upper watershed is Federal. Forestry is the major land use (in the Skagit Basin, followed by range, water, agriculture, and urban, and other land uses. The lower Skagit River watershed has more agricultural lands, and less forested lands than the upper watershed.

The Lower Skagit core area includes all of the Skagit basin downstream of the Diablo Dam located at river mile (RM) 101 and encompasses approximately 5,260 km^2 (2,030 mi^2). This area includes the mainstem Skagit River downstream of Diablo Dam (including Gorge Lake), Cascade, Sauk, Suiattle, White Chuck, and Baker Rivers (including the lake systems upstream from Lower and Upper Baker Dams) and the estuary and nearshore marine areas (*e.g.*, Skagit Bay, Port Susan). Two large reservoirs, Lake Shannon (RM 1.2) and Baker Lake (RM 9.3), were created by hydroelectric dams, the Lower and Upper Baker Dams, on the Baker River. Gorge Lake, created by Gorge Dam (RM 96.6), is located on the mainstem Skagit River. The geology of the lower Skagit River includes rolling moraines and foothills, and floodplains with the surface material of silt loam and gravel/sand loam (WDOE 2000; p.21). The geology of the upper Skagit River is glaciated ridges and plateaus, and U-shaped valleys with the surface material of deep sandy-gravelly loams and bare rock and rubble. Natural vegetation includes western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), and Douglas-fir (*Pseudotsuga menziesii*) in the lower watershed and Pacific silver fir (*Abies amabilis*), subalpine fir (*Abies lasiocarpa*), Douglas-fir and other mixed conifers in the

upper watershed. Mean annual precipitation in the lower Skagit River basin is 94 centimeters (cm) (37 inches [in]) with mean temperatures of 2.2 to 7.8 degrees Celsius (36.0 to 46.0 degrees Fahrenheit) in the winter and 11.1 to 16.7 degrees Celsius (52.0 to 62.0 degrees Fahrenheit) in the summer (WDOE 2000; p.21). Low flows in the system typically occur in September. Stream flows are also greatly influenced by the operations of the five upstream dams, three on the upper Skagit River and two on the Baker River. The Skagit River system supports all five species of Pacific salmon, bull trout, the rare Salish sucker (*Catostomus* sp.), and other fish species.

In the lower portion of the action area, the Skagit River passes around Fir Island, finally discharging into Skagit Bay through the North and South Forks with several historic or existing distributaries. Padilla Bay is a National Estuarine Research Reserve located to the north of Skagit Bay, connected to the southern delta by the Swinomish Channel. There are nearly 32 km^2 (12.5 mi^2) of eelgrass (*Zostera* spp.) in Padilla Bay. Although Padilla Bay is not currently connected to the Skagit River system, historically it was connected periodically through flood flows.

Condition of the Action Area

Land use activities in the Skagit River basin have affected bull trout, their prey base, and habitat, with the most significant land use changes occurring since the mid-1800s. These activities include construction of dams, forest management practices, agriculture, and residential/urban development among others (USFWS 2004, pp. 140-191). Each of these activity types and their associated effects are briefly described in the following paragraphs.

Dams

Barriers caused by human activities limit population interactions and may eliminate life history forms of bull trout. Bull trout that migrate downstream of dams without fish passage are unable to contribute to the bull trout population upstream. In many systems controlled by dams, this loss can be significant. Additionally, dams and diversions significantly affect downstream habitats by altering sediment transport, woody debris distribution, and natural flow and temperature regimes.

Several dams exist within the Skagit River watershed, some of which have affected bull trout passage and habitat. The City of Seattle hydroelectric complex on the upper Skagit River (Gorge, Diablo, and Ross Dams) is thought to have been placed at the approximate site of a historical migration barrier(s). Genetic exchange between the upper river populations and the lower river may have been primarily one-way (downstream). Prior to construction of the dams, it is possible that on rare occasions fish in the Lower Skagit core area gained access beyond the barriers to the Upper Skagit core area, but this is not known for certain. The presence of char and rainbow trout in the upper Skagit drainage supports the supposition that these fish did gain access at some point in time. It is believed that historically bull trout could migrate upstream to at least the area near Diablo Dam. The three upper Skagit River dams have prevented the transport of large wood to the Lower Skagit core area. This, in conjunction with past wood

removal efforts, has significantly contributed to the reduction of historical habitat complexity in the lower Skagit River mainstem and estuary.

On the Baker River, the Lower and Upper Baker dams have altered the historical connectivity with the rest of the lower Skagit River system. However, available information seems to indicate that there is currently a reluctance for bull trout to migrate from the Baker Lake complex. This may be the result of the abundant forage base that exists in the lake (juvenile sockeye and kokanee) reducing or negating the need to migrate to marine forage areas. Small numbers of bull trout are collected at the adult trap and- haul facility at the Lower Baker Dam and transported upstream of the dams to Baker Lake each year. Connectivity is dependent on this trap-and-haul facility and the Baker and Shannon Lakes smolt traps. It is unknown to what extent bull trout migrated in and out of this system prior to the damming of the Baker River and the enlargement of Baker Lake.

Forest Management Practices

Forestry activities that adversely affect bull trout and their habitat are primarily timber extraction and road construction, especially where these activities involve riparian areas. Such practices can impact stream habitat by altering recruitment of large woody debris, erosion and sedimentation rates, decreased slope stability, snowmelt timing, runoff patterns, the magnitude of peak and low flows, alterations in channel morphology, water temperature, and annual water yield (Furniss *et al.* 1991, pp.297-301; Murphy 1995, pp. 31-54; Spence *et al.* 1996 in USFWS 2004, p. 154; Spencer and Schelske 1998 in USFWS 2004, p. 154; Swanson *et al.* 1998 in USFWS 2004, p. 154). Other impacts of timber harvesting may include decreased slope stability (Chamberlin *et al.* 1991, pp. 193-194; Murphy 1995, p. 18).

Timber harvest and associated road building has had impacts to habitat in a number of watersheds in the Lower Skagit core area, including the Lower White Chuck (northside tributaries), Tenas Creek, Straight Creek, Lime Creek, Illabot Creek, Upper North Fork Sauk River, and South Fork Sauk River. Tributaries to the Skagit River that have been seriously impacted by forest and County roads include Finney Creek and Grandy Creek. Both streams have high sediment loads and warm water temperatures caused by landslides triggered by roads and logging, and by warm water temperatures resulting from impacts to the riparian corridor and widening of the stream channels due to high sediment loads. Both of these streams are currently on the Ecology's 303(d) list of water quality impaired streams due to excessive warming and high sediment loads.

Agriculture

Agriculture, urbanization, and channel modifications have significantly changed the lower Skagit Valley. Much of the river below Sedro-Woolley has been extensively channelized, leveed, and armored with riprap. The Skagit River delta was one of the first in Puget Sound to be converted from tidal wetlands to agriculture (Beechie *et al*. 1994 in USFWS 2004, p. 32), resulting in the loss of approximately 96 $km^2$of estuarine habitat (37 mi^2), or 93 percent of its historical coverage (Dean *et al.* 2000 in USFWS 2004, p. 32). Agricultural practices over the past 100 years more have significantly altered the natural functions of the lower river and estuary (USFWS 2004; p.

169). The lower Skagit River delta and estuary was historically a huge saltmarsh and freshwater wetland complex that extended from the community of Mount Vernon to Padilla and Skagit Bays. Tide gates, pump stations, and a network of drainage canals and levees effectively drained the wetlands and created the largest subtidal agricultural area in the State. This once productive salmon rearing area is now drained and virtually completely blocked off to anadromous fish.

Other impacts from land use activities in the lower Skagit River have also been reported (USFWS 2004; p. 170). Water quality impacts from V-ditching and dredging of the drainage canals contributes to elevated sediment levels in the waterways and decreases the levels of dissolved oxygen during the low flow season. Extensive use of pesticides, fertilizers, and herbicides also impacts water quality within several sloughs. Agricultural practices upstream from the city of Mount Vernon are dominated by livestock grazing and hay production. These practices impact riparian vegetation, long-term recruitment of large woody debris, and contribute to bank erosion and water quality impacts where livestock have direct access to the streams.

In addition to the loss of estuary habitat and access, agricultural practices have had significant impacts to the hydrology and water quality in the action area and have degraded bull trout habitat. The drainage network increases peak flows and velocities, and flushes sediments that would historically have been deposited in the wetlands out into Skagit Bay. The result is a build-up of the tidal flats beyond the levees. The hydrologic conveyance system has reached capacity and solutions continue to be evaluated. Past flood control proposals that were considered included constructing a bypass canal that would divert Skagit River floodwaters into Padilla Bay during high flow events. If such a project were to be implemented, it could result in the re-designation of the floodplain and open agricultural areas to development.

Residential Development and Urbanization

Although significant development and urbanization has occurred within portions of most core areas, this trend is less pronounced in the Skagit River basin. There is relatively small-scale development, mostly of small communities within the lower Skagit River watershed, with the largest population centers in Burlington and Mount Vernon near the upper end of the action area. The estuarine and marine portions of the action area are primarily farmland or other rural environments.

Impacts to bull trout, their prey, and other aquatic species from urbanization include stormwater runoff, discharges of municipal and industrial waste water, leaching contaminants from shoreline structures, construction of dikes and revetments for flood control and bank protection. Many historical floodplain areas in the Puget Sound lowlands that were originally diked and drained for agricultural use have been or are now being converted to residential and industrial developments. These developments can reduce or preclude options for restoration of floodplain areas important for reestablishing off-channel habitats and maintaining groundwater recharge.

Impervious surface associated with residential development and urbanization creates one of the most lasting impacts to stream systems. Changes to hydrology (increased peak flows, increased flow duration, reduced base flows) as a result of loss of forest cover and increases in impervious surfaces and degradation or loss of riparian areas are typically the most common outcomes of

intensive development in watersheds (May et al. 1997 in USFWS 2004, p. 181; Booth et al. 2002 in USFWS 2004, p. 181). Increased peak flows and flow duration often lead to the need to engineer channels to address flooding, erosion, and sediment transport concerns. Although recent changes have been made to most regional and local development regulations to provide protection (*i.e.*, buffer zones) for riparian areas, the integrity of these areas is frequently compromised by encroachment (May et al. 1997 in USFWS 2004, p. 181).

Fisheries

In their 1992 Draft Bull Trout/Dolly Varden Management and Recovery Plan, the Washington Department of Wildlife identified fishing pressure impacts on char (WDW 1992, p. 9). By 1994, marine waters in Western Washington and all but two river systems in the Puget Sound Region, the Skagit and Snohomish-Skykomish Rivers, were closed to recreational fishing for bull trout by the Washington Department of Fish and Wildlife (WDFW 2004, p. 74, 91). Limited recreational fisheries are allowed in the Skagit River system in the mainstem Skagit, Cascade, Suiattle, Whitechuck, and Sauk Rivers (WDFW 2004, p. 74). The Bull Trout Recovery Plan indicates that bull trout from the Lower Skagit core area have rebounded to or near recovered levels since fisheries impacts were reduced (USFWS 2004, p. 191). This information should be interpreted with caution, as bull trout from other core areas besides the Lower Skagit core area use the action area as well, and recent bull trout observations in this core area (Brennan-Dubbs, in litt. May 16, 2011) suggests lower numbers than were observed immediately prior to the release of the Bull Trout Recovery Plan in 2004. Additionally, habitat quality in much of the spawning reaches higher in the core area may offset or mask the habitat impacts in the lower reaches of the core area.

Although primarily localized in impact, illegal harvest of bull trout persists in some core areas and may have significant impacts to certain local populations. According to the Bull Trout Recovery Plan (USFWS 2004, p. 183), areas within the Lower Skagit core area identified as having high incidences or potential for illegal bull trout harvest include Downey Creek (tributary to Suiattle River) and upper Bacon Creek and Illabot Creek (tributary to Skagit River).

Recreational, commercial, and Tribal salmon and steelhead harvest and associated incidental mortality of bull trout may have significantly influenced the abundance of bull trout in Puget Sound rivers. For recreational fisheries it is likely that incidental catch of native char occurs during general “trout” and salmon fisheries, and in particular during the early portion of winter steelhead fisheries (WDW 1992, p. 9). Bull trout are an aggressive apex predator, and they are highly vulnerable to incidental hooking from these and other targeted fisheries. We anticipate similar instances to occur in the action area.

Previous Activities in the Vicinity of the Project Sites

Prior to the 2006-2007 flood seasons, emergency flood-fight actions were conducted in 2004 and to a lesser degree in previous years at several 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 or soon after flood events occurred. Many of the previous repairs are near or adjacent to the sites covered by

this Opinion, as shown by Figure 8 (in part). In 2004, the Corps repaired over 4 linear mi of levee damaged in recent flood events (N. Gleason, in litt. April 27, 2011).

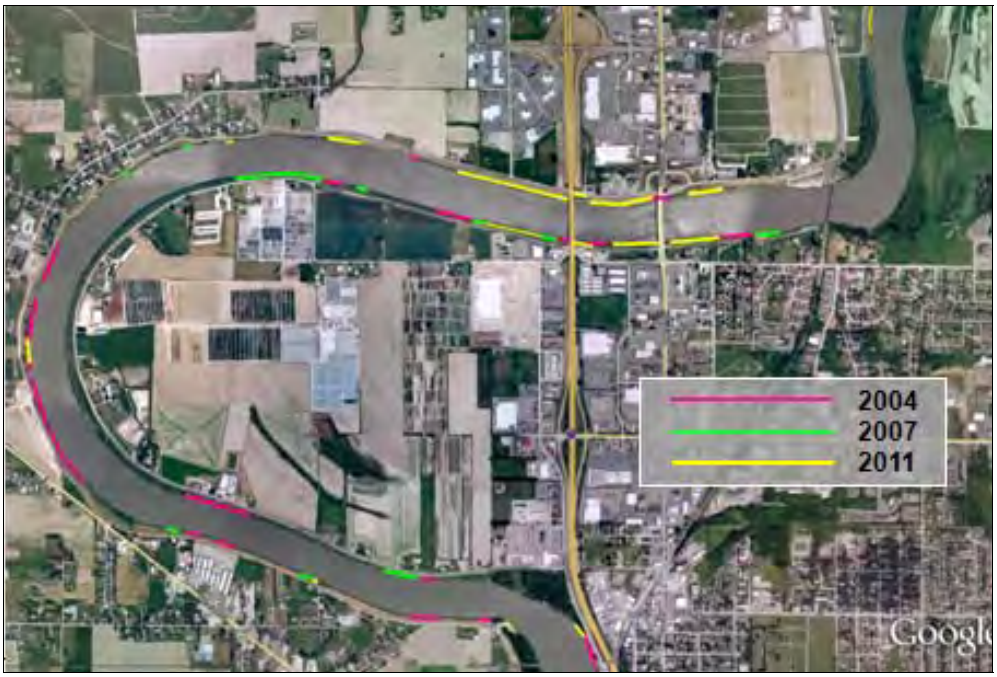

Figure 8. A subset of emergency repair actions completed in 2004, showing proximity to 2007 and 2011 actions in the lower Skagit River basin, within Diking Districts 1, 12, and 17. (Photograph provided by Corps.)

It is reasonable to assume that numerous small- and large-scale repair activities have been periodically conducted by the local sponsors and other entities at these sites and other sites in the lower Skagit River in response to localized damage from flooding. Some repairs, such as the 2004 repairs by the Corps, have been constructed subsequent to consultation under the Act. We anticipate that other work that did not have a Federal nexus has also been performed as needed to maintain and/or prevent failure of the levee system in the lower Skagit River mainstem and tributaries. The net effect of these actions has helped to maintain the integrity of the extensive levee system in the lower river system, and contributed to maintaining degraded habitat conditions for listed species and their prey resources.

Recovery Actions in the Mainstem Lower Skagit River

The Bull Trout Draft Recovery Plan has described a number of recovery actions that are needed in the Skagit River watershed (USFWS 2004; p. 237) and other basins in Puget Sound. A number of these actions are applicable to the lower mainstem Skagit River, and include (but are not limited to) the following:

- Identify and eliminate or modify tide gates, pump stations, and flood gates blocking access to bull trout habitat (Measure 1.2.4)
- Restore and protect riparian areas (Measure 1.3.1.)

- Identify, evaluate, and restore overwintering habitat in the mainstem rivers and tributaries (Measure 1.3.2)
- Identify and restore foraging waters with high restoration benefit (Measure 1.3.3)
- Reduce stream channel degradation and increase channel complexity (Measure 1.3.4)
- Practice non-intrusive flood control and flood repair activities (Measure 1.3.5)
- Enhance and restore instream habitat (Measure 1.3.10)

Recent projects in the watershed have been considered or implemented that would address some of the recovery actions outlined in the Bull Trout Draft Recovery Plan (e.g., Beamer et al. 2000, p. 56; WDFW 2009, pp. 1-10). Projects range from reestablishing tidal connection in estuarine reaches (e.g., Milltown Island, Wiley Slough) to removals or replacement of failing tide gates. While some projects have been implemented or initiated in recent years, the timeline for implementing many of the remaining proposed actions is dependent on funding availability, land acquisition, opportunities, and other factors. The combined result of many of these restoration and enhancement actions, if implemented, will result in significant improvements in bull trout foraging, migrating, and overwintering habitat. However, the highly altered nature of the lower Skagit River basin and associated land use will continue to maintain the overall existing degraded condition of the lower watershed and continue to preclude use of the majority of the extensive pre-development floodplain habitat currently isolated from access by bull trout and other salmonids for the foreseeable future.

Cumulative Effects of Past Activities

The accumulative effects of the activities discussed above have affected bull trout and their prey base. The Gorge Dam and Baker Dams restrict connectivity some of the local populations and the rest of the core area. Operations of the Lower Baker Dam have at times significantly impacted water quantity in the lower Baker and Skagit Rivers. 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. Nearshore foraging habitats have and continue to be impacted by agricultural practices and development activities. On a more positive note, bull trout within this system were overharvested in the past, but the implementation of more restrictive regulations in the early 1990's have helped allow the population to increase in abundance from the low levels of the late 1980's. Additionally, large portions of this core area fall within areas under National Park and Wilderness designation, so these areas have generally avoided many of the impacts from more intensive land management that has occurred more commonly downstream.

Overall, habitat quality and complexity in the lower Skagit River mainstem and its forks have been dramatically altered. Collins (2000, pp. 4-21) and Collins and Sheikh (2002, pp. 2-18) reviewed historical surveys, documents, and other data in an effort to recreate historical conditions in the lower Skagit River and estuary prior to the development described earlier in this section. Their maps indicate past presence of a variety of wetland and riparian habitat types

(all of which contained varying proportions of trees), and suggest that much of the riparian area immediately adjacent to the lower mainstem Skagit River and a portion of its major forks was forested floodplain and forested fan habitat (Collins 2000, p. 45; Collins and Sheikh 2002, p. 45). Collins (2000, p. 44) noted that alder was a major component of the riparian and floodplain forests along the lower Skagit River, with conifers less abundant than deciduous trees in most cases, though some large-growing conifers were present in freshwater forests and tended to be larger in this habitat type.

Log jams were also reported in pre-development historical observations (Collins, 1998, p. 6; Collins 2000, p. 37), with LWD sources in both the upper and lower Skagit River watershed riparian areas. The Skagit River, like many rivers in the Puget Sound lowlands, had much of its LWD removed during snagging efforts in the 1800s and early1900s (Collins 1998, p. 20-26). Collins (1998, p. 18) describes reports of numerous logjams in the mainstem, the forks, and distributary channels, including one near Mount Vernon that was almost a mile long and is believed to have existed for a at least a century and even supported large living trees (2 to 3 ft in diameter). The vast logjams created pool habitats, spread flood waters onto the Skagit floodplain, and delivered sediment downstream to the lower river and mudflats (Collins 1998, p. 18-19), conditions that are much removed from the heavily armored and confined levee system of the lower Skagit River delta that exists today.

The quality of available foraging, migration, and overwintering habitat for bull trout has been severely altered over historic conditions. The lack of complex cover is a consequence of many different past and present land use activities that will continue in perpetuity and are supported by the levee system in the lower Skagit River basin. The levee system, as it exists prior to implementation of the Actions, will largely preclude the formation of undercut banks. The levee system also reduces or precludes the establishment of mature riparian area with large-growing trees that supply cover- and pool-forming LWD sources along a large portion of its footprint where a functioning riparian zone is currently absent or compromised. The Skagit Chinook Recovery Plan (Beamer et al. 2005, p.33) reports that much of the lower Skagit River and its tributaries have impaired riparian function.

Bull trout have more specific habitat requirements than most other salmonids. Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, and migratory corridors, among others. Cold water temperatures play an important role in determining bull trout habitat, as these fish are primarily found in colder streams (below 15 degrees Celsius or 59 degrees Fahrenheit). All life history stages of bull trout are associated with complex forms of cover, including LWD, undercut banks, boulders, and pools. Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns. Additionally, since bull trout are iteroparous (they survive to spawn year after year) and many populations are migratory, these fish therefore require two-way passage upstream and downstream not only for repeat spawning, but also for foraging. Bull trout that use the action area are likely to be exposed to the pre-project conditions multiple times in their life spans. Existing conditions do not preclude bull trout migration through the action area between their spawning and foraging areas, although the overall lack of complex cover is likely to affect individual bull trout use of the action area for foraging, migration, and overwintering purposes.

Existing conditions also affect bull trout through some of their prey species. According to the Bull Trout Recovery Plan, the loss of productive anadromous salmonid rearing habitat for juvenile salmon in the lower Skagit River, such as sloughs and brackish water, slow-water overwintering areas, and habitat connectivity, impacts the Skagit River bull trout because of the reduced duration that these prey species spend in the nearshore environment (USFWS 2004, p. 169). Beamer and Larson (2004, p. 3) found that, overall, wild sub-yearling Chinook outmigrants spending more time in the Skagit River delta before reaching Skagit Bay estuarine and marine waters had a higher growth rate than outmigrants that spent less time in the delta. While they noted a few difference across life history types (e.g., fry migrants), they suggested a longer rearing period in the delta resulting in a larger size upon reaching the bay may result in faster growth in the bay and better survival than would occur with smaller individuals (p. 4). Under current conditions, the amount of suitable juvenile salmonid rearing habitat is limited and affects the current rearing capacity for juvenile salmonids that rear in streams. Other bull trout prey would be expected to depend less on rearing habitat in lower rivers, particularly if their life history strategies including primarily rapid outmigration, such as with pink salmon (*Oncorhynchus gorbuscha*) and Chinook fry migrants.

In summary, we anticipate that the present use of the action area by bull trout in its degraded condition likely functions primarily as a migratory corridor between foraging, overwintering, and spawning areas in the absence of more complex habitat features in much of the action area. While Goetz et al. (2004, p. 2-3) and Beamer and Henderson (2004, Appendix E in Goetz et al 2004) have documented bull trout use of estuarine and marine habitats in the lower Skagit River and other nearby watersheds, little is known about how bull trout use the lower Skagit River in terms of foraging or overwintering. Stream temperatures in the action area are conducive to bull trout foraging, migration, and overwintering, but other habitat features in the lower Skagit River and its forks have been significantly degraded. Prior to the snagging and diking activities discussed previously, the existence of large and complex LWD structures, pools, off-channel habitats, and other features likely supported a much wider range of foraging and overwintering opportunities for bull trout and their prey base than is present today.

All bull trout using the lower Skagit River mainstem and forks as foraging, migration, and overwintering habitat would be exposed to the degraded conditions present in much of the action area. Some individuals may show site fidelity to foraging areas, returning over multiple years to the same sites or sites either seasonally or annually (Goetz et al. 2004, p. 57), and may thus experience these degraded conditions several times during their life cycle. We anticipate that chronic, long-term exposure to these conditions result in appreciable impacts to bull trout individuals.

Status of the Species in the Action Area

We anticipate that bull trout from four core areas are likely to use the action area of the batched projects for foraging, migration, and overwintering. While the improved status of the Lower Skagit River core area populations of bull trout is encouraging, their status does not discount the threats to their survival and recovery in the lower Skagit River system or the importance of the action area for bull trout and their prey base. Population trends of bull trout from the other core

areas that access the action area are less stable. The status of the Nooksack and Stillaguamish core area populations is unknown, with less than 1,000 individuals each. The Snohomish-Skykomish core area populations, while increasing, have a lower estimated abundance, with an estimated 500 to 1,000 adults (USFWS 2004, p. 138-139). Anadromous bull trout from other core areas may experience habitat impacts in the lower Skagit River mainstem and its forks that are similar to degraded conditions in the lower mainstem rivers of their core areas, such as bank armoring, reduced or absent complex habitat, and degraded riparian zones.

While habitat complexity has been significantly reduced in the lower Skagit River mainstem and its forks, it is not completely lacking in the action area. Some portions of the action area have narrow bands or larger stands of riparian vegetation near or in the vicinity of the stream (see Figures 1 and 2). This is particularly true of the more rural reaches of the action area, where upland riparian habitat is more intact than the more developed shorelines in Burlington and Mount Vernon (Figure 9). Past and future planned restoration projects are anticipated to address some of these impacts but are not expected to fully address the large-scale degradation in the basin. Overall, the habitat is highly degraded, but continues to provide foraging, migratory, and overwintering habitat for bull trout, and as rearing, migratory, and foraging habitat for other salmonids, though to a much reduced degree over historic conditions (pre-1860s).

Life Stages of Bull Trout in the Action Area

We anticipate that two life history stages of fluvial or anadromous bull trout were/will be present in the action area during construction and over the life of the Actions: adults and subadults. Subadults include larger out-migrating juveniles that have moved downstream into the lower Skagit River from their natal streams as well as larger fish that have not yet matured sexually. Based on observations of bull trout in the Skagit River and 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 (Goetz 2004, p. 97; Zimmerman and Kinsel 2010, p. 9), although individuals as small as 90 mm may also be present (Zimmerman and Kinsel 2010; p. 16).

Surveys by Goetz (et al. 2004, p. 58-60) have documented bull trout from the Skagit River and other nearby watersheds moving through the lower Skagit River, estuary, and marine areas. The surveys have indicated movement of bull trout into the estuary and marine waters in spring and early summer, with most tagged individuals leaving marine waters by late July (Goetz et al. 2004, p. 54). We presume that spawning adult Skagit River bull trout leaving marine waters in the summer would travel quickly upstream of the action area to their spawning areas, with spawners from other systems returning to their natal streams. Nonspawning adults and subadults from the Skagit River or other systems may also migrate upstream or may remain in the lower river to forage or overwinter.

Figure 9. Examples of rural areas in Lower Skagit River basin with little to no vegetation near or adjacent to the stream. (Photographs courtesy of the Corps.)

No spawning has been documented or is anticipated to occur in the action area. Therefore, we do not anticipate eggs, early-rearing juveniles, or spawning adults in the action area. We do anticipate pre-spawning fluvial or anadromous adults to migrate through the action area as they travel upstream to their spawning areas. Suitable foraging, migration, and overwintering habitat exists within the action area, and bull trout outmigrants ranging from 90 mm to 290 mm (fork length) have been reported in the lower Skagit River in late spring and summer, from approximately early April to late July (Zimmerman and Kinsel 2010; pp. 12, 16).

Thus, for the purposes of this Opinion, we assume the following: 1) most of the subadults in the action area range from approximately 100 to 350 mm in length, although some may be smaller, and 2) adults are generally 350 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.

Conservation Role of the Action Area for Bull Trout

The action area provide foraging, migration, and overwintering habitat for bull trout. The lower Skagit River and its forks are essential corridors for migration between spawning areas in the upstream portion of the core area to foraging and overwintering habitats in the estuary and marine waters. According to the Bull Trout Recovery Plan (USFWS 2004, p. 77), the diverse and connected habitats found in Lower Skagit core area as a whole have allowed for the continued expression of the diverse life forms and behaviors that would have been typically found in robust coastal bull trout populations. Connectivity among most local populations and foraging areas in the core area is good to excellent, although some habitat diversity has been lost in the mainstem Skagit River due to channel simplification, impassable culverts, and diking and leveeing of the mainstem and estuary areas. For much of the basin, the migration corridors connecting the spawning and early rearing areas to essential downstream foraging and overwintering areas remain intact. The quality of the action area for foraging and overwintering is less certain.

STATUS OF BULL TROUT CRITICAL HABITAT IN THE ACTION AREA

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 Area for Bull Trout Critical Habitat

The USFWS has designated the lower Skagit River as critical habitat for bull trout. The action area is within the Coastal-Puget Sound IRU and includes the Skagit River Basin (Unit 3). 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 IRUs, and the coterminous listing. 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

Eight of the designated PCEs are present within the action area, and the baseline is described below in terms of each applicable PCE. The omitted PCE (#2) 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 area.

PCE #1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

The action area may contain springs, seeps, groundwater sources, and/or subsurface water in the hyporheic zone that provide cold water to the river, although springs and seeps are probably more likely to be found in reaches of the Skagit upstream of the historic delta or in its tributaries. The existing levee system in the lower Skagit River basin has likely interrupted hyporheic inputs of subsurface flows by disconnecting flows in the mainstem from groundwater sources and existing and former wetlands in the historic floodplain. A number of source streams that eventually flow into the Skagit River mainstem are glacial fed and are likely to contribute cold water inputs downstream. Bull trout are expected to use areas of localized groundwater input as refugia during periods of high temperatures in the lower Skagit River. Cold water refugia in the foraging, migration, and overwintering habitats of the action area are also expected to provide critical "stepping stones" to upstream spawning grounds.

PCE #3: Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

The mainstem Skagit River is an essential migratory corridor for bull trout. No physical or biological impediments to the migratory corridors of the mainstem Skagit River, such as blocking culverts, occur within the action area of the projects. However, due to the construction and ongoing maintenance of the levee system in the lower Skagit River basin and other man-made blockages, much of the historic channel habitat in the lower basin has been lost or isolated from salmonids access. Beamer et al. (2000, p. 42) report that only 44 percent (146 km) of the historical channels in the Skagit and Samish River deltas (which are adjacent to each other) are currently accessible to salmonids. In this same area, they note that 229 man-made barriers and 164 km of blocked channel have been documented by the date of the study, although they also anticipate finding more than 100 additional blockages in future studies based on preliminary findings (Beamer et al. 2000, p. 42). Water temperatures at the water quality station at Mount Vernon have been documented above 15º C (and as high as 19º C) during the summer months in the period of record (WDOE, in litt. 2011), and may result in occasional seasonal thermal impediments to bull trout movement through the action area.

PCE # 4: 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 area and their maintenance and retention has decreased the contribution of terrestrially based and aquatic prey organisms to the river by reducing the amount of mature riparian vegetation, large wood, and through other impacts to stream habitat such as reduced wetlands and floodplain connectivity. As described above, the loss of off-channel habitat in the lower watershed over time has also appreciably reduced the amount of rearing and foraging habitat for juvenile salmonids, which serve as prey resources for bull trout.

PCE #5: Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

The channelization, levees, and other armoring have reduced river processes that form pools, side channels, and other habitat features that add habitat complexity. Channelization has straightened, confined, and simplified the river channel to such an extent in the lower Skagit River that stream and tributary complexity has been significantly compromised, according to the Skagit Chinook Recovery Plan (Beamer et al. 2005, p. 87-88).

PCE #6: Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range.

The lower Skagit River is currently listed as Class A surface water by Ecology. Water bodies in this class must meet or exceed the requirements for all or substantially all uses. These requirements include that temperatures not exceed 18 degrees Celsius (64.4 degrees Fahrenheit) in freshwater and 16 degrees Celsius (60.8 degrees Fahrenheit) in marine waters due to human activities. Stream flow, temperature, turbidity, and other data have been collected annually at several water quality monitoring stations in the lower Skagit, with monitoring occurring at some stations since the early 1970s. Water temperatures in the lower Skagit River are generally good, but there have been documented temperatures above 15º C (and as high as 19º C) during the summer months in the period of record (WDOE in litt. 2011).

Elevated water temperatures created by the loss of mature, large-growing vegetation along many areas of the mainstem river due to maintenance of the levee system, as well as the interruptions in subsurface hydrology as described above, may result in occasional seasonal water quality impediments that impede or delay bull trout attempting to move through the action area during certain times of the year. The dams further upstream of the action area may also influence stream temperatures. Although there is little available information on pre-dam stream temperatures, the Skagit Chinook Recovery Plan noted that there is evidence to suggest that the mainstem Skagit River is currently warmer in the fall and early winter, colder in late winter to early spring, and colder in the summer than pre-dam conditions (Beamer et al. 2005, pp. 51-52). We anticipate that while temperatures in the mainstem may sometimes rise above 15 degrees Celsius, associated migratory delays to bull trout are probably rare under current conditions.

PCE # 7: A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

Several dams are present in the Skagit River system, as described above. Operation of these facilities affects the flow regime downstream in the action area. For example, according to the Skagit Chinook Recovery Plan (Beamer et al 2005, p. 35), the down-ramping rate for the mainstem Skagit River dams was restricted to less than 2 in/hour, but the Baker River dam is currently unable to meet this standard based on its current single-turbine configuration. If additional turbines are added (Beamer et al. 2005, p. 36), down-ramping rates would likely be met downstream of the Baker River.

In addition to the dams, the combined effect of the levee system on the lower Skagit River contributes to maintaining the altered hydrologic conditions that currently exist in the lower basin. The river has been 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 and throughout the extent of the levee system. At present, the effects associated with continued maintenance of levees likely result in alteration of the peak flows of the lower Skagit River from their historic ranges.

PCE # 8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

As noted before, the lower Skagit River is currently listed as Class A surface water by Ecology. Various tributaries and/or reaches of the lower Skagit River are on the Ecology's 303(d) list[5] as not meeting water quality standards for several substances, including fecal coliform, temperature, Ammonia-N, pH, copper, dissolved oxygen, lead, mercury, nickel, and zinc. Waters that have at least one 303(d) designation are considered by the USFWS to be functioning at risk for bull trout.

Temperature water quality impacts in the lower Skagit River were described previously and have not precluded bull trout use of the stream. Runoff from farms and impervious surfaces in urban areas are examples of non-point pollution sources that likely affect the water quality in the action area. Typical sources of metals include industry, urban and highway runoff, and landfills. Nutrients such as nitrogen and phosphorus, which can also runoff or be discharged at point sources (e.g., stormwater outfalls) can cause increased aquatic plant growth. Decomposition of

[5] Source: http://apps.ecy.wa.gov/wats/QueryListings.asp and http://www.ecy.wa.gov/programs/wq/303d/1998/1998_by_wrias.html)

algae and plants can decrease dissolved oxygen levels. In addition, the biochemical oxygen demand of organic waste depletes dissolved oxygen in water. Low dissolved oxygen levels in streams can cause fish kills in surface waters.

PCE #9: Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

Two species of nonnative species introduced by fisheries managers in the Puget Sound region may occur in the lower Skagit River that have the potential to affect bull trout critical habitat. Westslope cutthroat trout populations in Western Washington have become common in headwater streams below the alpine lakes where they were originally stocked, many overlapping with native char populations. This species has been documented in the Lower Skagit core area in the South Fork Sauk River, Illabot Creek, and White Chuck River. Introduced populations of cutthroat in the Puget Sound region are resident and develop piscivorous life histories in habitats where bull trout emerge from the gravel. While introduced cutthroat populations may constitute a competitive and predatory risk to depressed populations (USFWS 2004, p. 185), we anticipate that this is less likely for the Lower Skagit core area populations.

Naturalized populations of brook trout are present within the Upper Skagit core area, and, though extremely unlikely, may enter the Lower Skagit core area through one-way travel through the dams and reservoirs. In the Upper Skagit core area, brook trout have been detected in Hozemeen, Silver, Lightning, and Canyon Creeks. Brook trout are also present in Ross Lake (Johnston 1989, p. 24) and so are presumed to have access to all adfluvial bull trout spawning and rearing tributaries within the Upper Skagit core area. In the upper Skagit River tributary, Nepopekum Creek (British Columbia), mature brook trout have been observed in the same spawning area as Dolly Varden (McPhail and Taylor 1995, p. 14), which is also accessible to Upper Skagit core area migratory bull trout. However, aside from the very rare downstream migrant, we do not anticipate that brook trout are generally present within the lower reaches of the Skagit River.

Summary

Adult and subadult bull trout use the action area for foraging, migration, and overwintering. The action area of the projects has been channelized and simplified 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 much of the action area reduces habitat for aquatic and terrestrial macro-invertebrates and prevents the accumulation of LWD and the habitat complexity it provides. Rural and urban development in the action area, as well as agricultural and other activities, continue 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 area 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. 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. The Bull Trout Draft Recovery Plan (USFWS 2004; p. 237) identifies and recommends a number of recovery actions for bull trout in the Skagit 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 Actions are expected to have affected/affect fluvial and anadromous adult and subadult bull trout that use the action area for foraging, migration, and overwintering. While there is a substantial amount of information on bull trout presence in the Skagit River compared to other systems in Puget Sound, there is still much to be learned about bull trout use of the lower river systems in Puget Sound. 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 Skagit River and adjacent river systems, 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 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. 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). We anticipate that the Actions resulted/would result in both short-term and long-term effects to bull trout. Most of the construction-related effects to bull trout are anticipated to be short-term, while operation and maintenance of the structures would result in both short-term and long-term effects. The effects of the Actions are separated below into construction and operation/maintenance categories.

Effects from Construction

The primary construction-related effects of the Actions on bull trout were/would be: 1) disturbance from generation of suspended sediment, 2) disturbance associated with placement of rock and other materials below or adjacent to the OHWM, 3) exposure to contaminants (e.g.

herbicides during removal of nonnative species, spills from use of heavy equipment in or adjacent to the stream channel), 4) crushing from placement of materials in the wetted width of the stream, and 5) short-term habitat impacts. These effects may result in disturbance, injury, and/or mortality of adult and subadult 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. 1987, 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. 2001, 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 3, and a more detailed discussion of effects is included in Appendix D (Part 2).

Table 3. Summary of adverse effects to fish resulting from elevated sediment levels.

Sediment Impacts to Fish	**Summary of Adverse Effects 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 a number of the tributaries in the Skagit 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. The USFWS assumes that construction activities associated with the Actions did/will comply with water quality standards (RCW 940.48 and WAC 173-201A) set forth by the Ecology. These regulations set criteria for mixing zones that allow temporary increases in turbidity.

Based on the research and considerations described above, we anticipate that excavation or other sediment-generating activities have the potential to may result in bull trout avoidance of high concentrations of suspended sediments. Such activities can also result in potential reductions in feeding, feeding efficiency, and/or growth rates, resulting in disruptions in bull trout foraging behaviors. Under normal circumstances, bull trout would generally be expected to move away from areas of increased levels of turbidity. In situations where bull trout are physically exposed to high levels of turbidity resulting in gill trauma or physiological stress, bull trout may be significantly impaired, resulting in injury or mortality. With assistance from the USFWS during consultation, the Corps analyzed effects to bull trout from elevated levels of suspended sediment using the protocol described in Muck (in litt. 2010). The following paragraphs are based on our review of the Corps analysis and the research and considerations described above.

Completed Actions

The Corps monitored turbidity during each of the completed actions per the water quality standards mentioned above. In the Addendum, the Corps reported that elevated levels of suspended sediment above background monitored during the 2007 construction projects did not reach levels that would have resulted in appreciable effects to bull trout, based on the subsequent analysis done according to Muck (in litt. 2010). Consequently, we anticipate that no significant disruptions of normal foraging, migration, or overwintering behavior occurred during construction of the completed actions.

Proposed Actions

For the proposed actions, 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. The protocol would address both the Ecology water quality standards and the potential effects to individual bull trout as outlined by the USFWS (Muck, in litt. 2010), and would ensure elevated turbidity levels above background would not exceed the lesser of the two values generated by these protocols at the sites so that both standards would be met. However, monitoring would not necessarily occur for every sediment-generating activity at every site.

The Corps has proposed to monitor turbidity levels during construction of the first few instances of each activity type that would potentially generate sediment (e.g., rock placement, willow plantings, etc.). Sediment-reducing BMPs and other contingencies would be employed as needed to keep suspended sediment levels below potentially injurious levels, as described in the Corps' monitoring plan. Once the Corps has successfully implemented construction of these

features with the applicable BMPs or other contingencies and has established their ability at several sites not to exceed injurious levels of suspended sediment for a given action type, future monitoring at subsequent sites for the same type of activity would not be performed in most circumstances. However, the Corps has recognized that specific site conditions, precipitation events, and other factors may result in different outcomes at subsequent sites, and will resume monitoring at any site as deemed necessary. Additionally, the Corps has noted that they may monitor at more sites for certain activity types, such as installation of LWD. We assume that implementation of the proposed monitoring protocol is likely to avoid most instances of potentially injurious levels of suspended sediment, although certain activities or instances may not be adequately addressed using this method due to differences in construction methods, site conditions and/or unpredictable circumstances, particularly where activity types are not monitored due to assumptions about previous monitoring activities at similar sites.

Consequently, while we anticipate that most of the potential releases of sediment from the proposed construction are not expected to result in significant disruptions of normal bull trout foraging, migration, or overwintering behaviors, there may be situations where elevated levels of turbidity will occur that will not be monitored and could result in significant disruptions of these behaviors. We anticipate that these significant disruptions of these behaviors will occur during activities involving excavation and other in-stream work within the wetted channel such as installation of LWD, slope laybacks, construction of the fish bench, and installation of the habitat weir. However, the Corps has indicated they will monitor at least the first instance (or in some cases several instances) of each type of potential sediment-generating activity (Appendix D). Since the proposed Actions include two laybacks and a single instance each of a fish bench and habitat weir, we anticipate that all of these will be monitored for elevated levels of turbidity. Additionally, since the Corps has determined that they will not need to excavate to place the LWD and associated anchors, this activity is now less likely to result in elevated levels of suspended sediment.

The most likely sediment-generating activities that may result in unmonitored exceedances of turbidity will occur where excavation in the wetted width of the stream, such as if the Corps determines that that toe work is necessary at a given site. The Corps has indicated that a maximum of 20 proposed sites may include bank excavation with or without toe work (N. Gleason, pers. comm. May 25, 2001). However, we do not yet know which of these project sites would not be monitored during construction activities and therefore which would result in elevated suspended sediments downstream of the project site. At this time, we are unable to specify the downstream extent of the plume at a site-specific level at any of unmonitored project sites since the unmonitored sites have not yet been identified or evaluated as such. However, we anticipate that, in a reasonable worst case scenario, elevated levels of suspended sediment may travel a significant distance downstream of a given project site, with settling rates dependent on flow velocities, the number and orientation of stream bends that can aid in settling out suspended sediments, and other site conditions. While the extent of the plumes are difficult to predict, we anticipate that is unlikely that the plumes of sediment would reach Skagit Bay, due to configuration of the channels and anticipated ranges of velocities.

We anticipate that for each unmonitored site that would result in that the sediment plume may extend to the next stream bend, or potentially further, depending on flow velocities. It is

reasonable to assume that any of these distances would range from 0.5 mi to 1.0 mi based on stream bends locations in relation to project sites, although other factors may influence the area of extent. We assume that for most if not all project sites, while elevated levels of suspended sediments would be expected to extend to approximately 0.5 mi, we anticipate that levels that would result in significant disruption of normal foraging, migration, and overwintering behaviors of bull trout would be limited to a maximum of 300 ft downstream of the project site.

Placement of Rock and Other Materials

Construction activities at each of the sites may have resulted/may result in disturbance to bull trout in the stream reaches adjacent to each site. While we anticipate that much of the disturbance would be related to activities that occur directly within the wetted width of the stream, such as placement of rock and other materials, the accompanying vibrations created by the heavy equipment used to place the materials may also contribute to the disturbance. Disturbance of bull trout would be expected to result in a range of behavioral effects, the most significant of which would be temporary displacement from the project sites and avoidance of the area during these activities. In such cases, most bull trout would be expected to leave the area in which the disturbance occurred/would occur until the disturbance subsided, although some individuals may remain in the vicinity of the work and be exposed to disturbance stressors. The potential area for behavioral effects during the Actions extends for a short distance (e.g., likely ranging from a few meters (m) to approximately 100 m) upstream and downstream from each of the project sites as well as some short, but undetermined distance into the channel, but not exceeding the width of the channel.

Completed Actions

We anticipate that all of the completed activities that included in-water work and/or work below the OHWM may have resulted in significant disruptions to normal foraging, migrating, or overwintering behaviors. Of the completed sites, all but one included such work. Furthermore, multiple projects were completed in 2007, most of which were conducted at the latter part of the in-water work window or immediately following the closure of the in-water work window. Some work also occurred at some of the sites during the flood-fight efforts. Thus, individual bull trout were likely exposed to these stressors multiple times, and the timing of the construction at some sites may have affected larger numbers of bull trout than would have been present during the recommended work window.

Proposed Actions

We anticipate similar pathways for effects and bull trout response for the proposed repairs during installation of the riprap and mitigation features, several of which were or will be placed in the wetted width of the stream. Of the proposed, deferred, and rework sites, all but four are expected to have in-water work or work below the OHWM. Increased turbidity, vibration, and in-water activities may result in delayed movement of individual bull trout in the vicinity of the project site, and these behavior alterations, including displacement and avoidance, are likely to occur during at least some of the actions. All of the proposed projects will be completed in the upcoming construction window, and in-water work will occur during recommended work window for the action area.

Based on the rationale described above, we anticipate that the construction activities will result in significant disruptions to normal foraging, migrating, or overwintering behaviors, particularly with recurring activities being conducted at multiple sites in the lower Skagit River during the work windows. We anticipate that these effects would be short term and temporary, although we anticipate that bull trout in the action area will be affected for the entire construction period and/or at different sites within the action area of the projects, as multiple activities will be constructed concurrently or subsequently. Bull trout would likely resume their normal behavior when installation of these structures 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). The proposed actions include(d) spill plans and other BMPs to avoid or reduce the risk of bull trout exposure to construction-related contaminants.

Several conservation measures and BMPs will also be used to avoid exposure of bull trout to herbicides (Agridex and Imazapyr) during Japanese knotweed control efforts. In the unlikely event that bull trout would be exposed to herbicides, the duration of exposure and amount of herbicide entering the water column and the resulting exposure concentrations are expected to be low. The herbicide Imazapyr is proposed for use along with the adjuvant Agridex® at a rate of 4 pints per acre.

Imazapyr impedes production of a specific enzyme required in the synthesis of particular amino acids in plants. This interferes with cell growth and kills the new plant tissue. Patten (2004, p.4) confirms the rapid dilution of imazapyr and demonstrated that the concentration of Imazypyr was reduced by 99 percent minutes after application just 5.4 m (approximately 18 ft) outside the spray zone. According to monitoring data for Washington, herbicides were detected up to 50 ft from the treatment zone (K. Murphy, in litt. April 24, 2006 in USFWS 2006, p. 20); therefore, Imazapyr does not appear to be detectable at great distances from the application site.

Spray adjuvants such as Agridex® are used to improve performance and efficacy of the herbicide or formula. These additives can affect the toxicity of the formulation and the mixture, and are sometimes primarily responsible for the mixtures toxicity (Smith et al. 2004, p. 653). Agridex® is a crop oil concentrate consisting of a blend of heavy range[6], paraffin-based petroleum oil and nonionic surfactants. It is used to improve the herbicide application's wetting and deposition characteristics resulting in a more uniform distribution of the herbicide on the plant. It is the least toxic of the surfactants registered for aquatic use in Washington State (Smith et al. 2004, p.653), and is considered practically nontoxic according to the classification established by the Environmental Protection Agency and lethality toxicity data[7].

Agridex® has not been measured during any previous monitoring programs. Therefore, we have no surface water concentration data from which to predict bull trout exposure. Fate and transport information is lacking from which to predict the amount that would wash off vegetation, remain in the water column, adsorb to sediments, and degrade over time. However, according to discussions with individuals from the Helena Chemical Company (makers of Agridex®), adjuvant is designed to enhance wetting[8] and penetration of herbicides into the plant (Greg Volgas, and Scott Pace, Helena Chemical Company, pers. comm. April 27, 2006). In an aquatic application to control *Spartina*, they estimated that 75 percent to 85 percent of the product would be absorbed into the plant, with only 15 percent to 25 percent of the Agridex® expected to wash off into surface water. While the proposed activities would not include an aquatic application, it is reasonable to assume that where this chemical accidentally entered the water, the majority of the product would likely be broken down quickly by microbial degradation. Based on the inclusion of BMPs and other conservation measures, we anticipate that an accidental spill is extremely unlikely to occur, but if a spill did occur, that bull trout would be extremely unlikely to be appreciably exposed to its effects.

Completed Actions

No fuel leaks were observed during the emergency work for the completed actions. Several BMPs and conservation measures were in place to ensure that equipment would not operate in the water. Precautions were taken to avoid accidental leaks at or adjacent to the shoreline. Additionally, no herbicides were used during construction of the completed actions. Therefore, we anticipate that the completed actions did not result in significant disruption to normal foraging, migrating, or overwintering behaviors of bull trout due to exposure to contaminants.

Proposed Actions

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[6] The weight of oil is an indication of its viscosity.

[7] To our knowledge sublethal data are not available for Agridex® which we believe constitutes a significant data gap.

[8] A wetting agent is designed to reduce surface tension, so that an herbicide spreads evenly over a plant surface.

The proposed 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, 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.

Herbicides will be used during control of Japanese knotweed, but the risk of exposure to bull trout is anticipated to be extremely low due to conservation measures and BMPs during application. In the event that bull trout are exposed to herbicides, the duration of exposure and amount of herbicide entering the water column and the resulting exposure concentrations are expected to be low. We conclude the effects to bull trout from applying imazapyr and Agridex® are insignificant due to the following, 1) there is a low likelihood of exposure because the largest quantity of herbicides will be applied during the bull trout work window, 2) there is limited transport of detectable concentrations of the herbicides from the application site, 3) Imazapyr and Agridex® do not appear to be persistent in the aquatic environment, 4) none of the chemicals used are expected to bioaccumulate in the aquatic food web due to their characteristics, and 5) the herbicide concentrations that have been measured in surface water and sediment in the past are below toxic levels for fish, plants and aquatic invertebrates. There will be an overall beneficial effect for bull trout from improved habitat conditions due to the removal of Japanese knotweed.

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 of bull trout.

Crushing

Bull trout may be crushed or injured during the placement of large rock, LWD, anchors, or other features in the water. Subadults and adults migrating upstream to their spawning areas have been documented in the lower Skagit River during the summer months. Because these larger life history stages are mobile and can easily detect and avoid activities that are conducted below the OHWM, it is extremely unlikely that adult or subadult bull trout would have been or will be injured during the placement of rock, wood or other material in the river. However, it is possible that smaller subadult bull trout may have been in the project area during the completed actions or may enter the area during construction of the remaining projects. We anticipate that the number of small (e.g., <100 mm) out-migrant subadult bull trout is likely to be low, based on observations in Goetz et al.'s (2005, p. 46-47, 67) and Zimmerman and Kinsel's (2010, p. 16-20) reports.

Completed Actions

Smaller subadult bull trout may have been injured or killed during placement of large armor rock or excavation in the water because smaller bull trout may be more likely than larger bull trout 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 turbidity, sudden movements and vibration associated with the activities,

and because few small subadult bull trout are expected to have been present in the lower Skagit River during construction. We anticipate that most subadult bull trout in the action area would be extremely unlikely to seek refuge along the shoreline or in the substrate at the life history stage anticipated to be present in the lower mainstem river and distributaries. Zimmerman and Kinsel (2010, p. 28) found little to no downstream migration of smaller bull trout during their January/February and September/October surveys. Consequently, it is reasonable to assume an extremely low number of small bull trout subadults may have been present and crushed during placement of rock at some of the completed project sites. However, we anticipate that no more than one bull trout was crushed during the completed actions.

Proposed Actions

Similar effects may occur to a few smaller subadult bull trout for the remaining proposed actions that include placement of rock, LWD, or structural anchors in the wetted channel. We expect that the likelihood of crushing is low, due to the anticipated size and behavior of bull trout using the action area of the proposed projects. However, we anticipate that more small subadult bull trout may be present during the recommended work window for the action area during the proposed actions compared to the completed actions. According to Zimmerman and Kinsel (2010, p. 15), bull trout were observed migrating through the lower Skagit River most commonly from April through August, with peak migration in May. Additionally, more in-water work will occur during the proposed actions (as compared to the completed actions), particularly through placement of large woody debris and associated anchors, the habitat weir, and other instream features, in addition to placement of riprap. Consequently, we assume that a slightly larger number of smaller subadult bull trout may be crushed during construction of the proposed actions. However, we assume that the number of bull trout crushed would be limited to one bull trout per site for a maximum of 10 percent of the proposed sites during construction, or about 3 bull trout.

Effects from Operation and Maintenance

Due to the degraded nature of the existing habitat conditions, the indirect effects of maintaining the levee system into the future will include the impacts described in the Environmental Baseline section of this Opinion such as hydrological and geomorphological effects, edge habitat effects, as well as interruption of complex habitat-forming processes necessary to support bull trout, their prey, and their habitat.

Hydrological and Geomorphological Effects

Bank stabilization, as its primary purpose, interrupts natural processes that are necessary for forming and maintaining functional habitat for salmonids along stream corridors. The rock armoring and other site conditions associated with the repair of the levees 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 at and adjacent to each site 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 stream reaches at all of the project sites. 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 that bull trout would use for refugia and to seek prey.

Additionally, the repair at Site 3-8 (along Tom Moore Slough) includes the installation of new rock along a section of the levee that is not currently armored. The Assessment indicated that the proposed repair is adjacent to work that was constructed at an adjacent site (Site 3-5) in 2007, and which is currently armored. Although the site is located on an existing levee, the proposed activities at this site will degrade the existing unarmored habitat that is present at the site. Such degradation includes, but is not limited, to eliminating the potential for existence and development of undercut banks and development of localized shoreline habitat complexity that provide cover and refuge for bull trout and their prey (Johnson and Stypula 1993, Chapter 2, pp.12-13; WDFW 2002, Chapter 4, pp. 8-9). The Corps' Assessment for Site 3-8 does not include any analysis of whether armoring this section of the levee face will result in these or other impacts to other unrocked areas of the levee. There are also other sections of shoreline in this slough that have not yet been armored. In the absence of any reach analysis provided by the Corps to the contrary, it is reasonable to assume that the 2007 repairs may have resulted in displacement of effects to this section of the levee, and placement of new rock at this site may further displace impacts to adjacent reaches or shorelines across the slough, resulting in a cascading effect of similar impacts to reaches adjacent to this site and/or on the opposite bank.

Edge-Habitat Effects

Most of the Actions have incorporated mitigation options that are intended to address some of the edge habitat impacts associated with the continuing presence and maintenance of the levee. The mitigation features are anticipated to provide improvements to juvenile salmonid rearing habitat, and we appreciate the Corps' and local sponsors' efforts to try to address these issues at the sites.

The mitigation features are intended to reduce the edge habitat effects at these sites and increase the shoreline capacities to support juvenile salmonid rearing, foraging, and refugia, although the banks will still be comprised of large rock, and will not be structurally analogous to a natural shoreline. Although large rock can provide some habitat features used by bull trout, fish densities at rocked banks are low compared to natural banks (e.g., 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 working group endeavored to reach consensus on offset ratios that met the goals of the mitigation strategy, as described previously. While we do not anticipate that the enhanced shorelines will be as functional for bull trout and their prey as a natural bank with overhangs (e.g., for refugia), large native trees for LWD recruitment, and other shoreline features, the carrying capacity of the action area for bull trout is anticipated to be significantly improved over existing conditions.

Planting willows along the riverbank will restore some of the function of the area for foraging, migrating, and overwintering bull trout. Installation of the planned willows and short, shrubby native vegetation, while providing important benefits that would otherwise be completely lacking, will not offer the range of beneficial effects that the larger trees and the natural riparian

buffer provide at the project sites. Over time, we expect that the willows will become established on the reconstructed bank, and that the habitat conditions, while still of lower quality than mature, larger-growing trees, will be improved over time relative to the existing rock revetment. There will still be a temporal loss of habitat value at some of the sites where existing mature, native vegetation is removed until the willows fully mature.

In the short-term, shade and cover will increase and provide habitat for invertebrate forage items (e.g., fall-out insects). Under the current levee vegetation maintenance restrictions, the willows may be thinned or cut (although they would resprout) once they mature and/or become too dense to allow inspection of levee. However, the Corps has endeavored to plant species that will remain at the desired size to reduce the amount of pruning needed to maintain the plantings. While providing benefits to bull trout, willows do not offer the same substantial multi-functional benefits to the stream as mature, larger-growing trees do. At a few sites, the Corps will plant larger-growing trees landward of the levee. While the long-term fate of these trees and their full contribution to the system is uncertain, they are anticipated to provide some level of allochthonous inputs to the stream.

Removal of larger trees at some of the sites and preventing large hardwoods and mature conifer from becoming established along the shoreline throughout the action area of the projects indefinitely precludes the potential over the long term for the riparian areas to function fully to provide shade (e.g., for cooler temperatures), fallout insects for prey contribution and food web support, and nutrient contributions. Where project sites are located on the north side of the stream, the riparian vegetation on these levees provides less shading potential than vegetation along east or westerly oriented riverbanks would provide. Nonetheless, the remaining functions of the riparian areas will continue to be limited by precluding establishment of mature vegetation.

At some sites, the inclusion of LWD (logs and rootwads) will provide some structure and complexity that may be used by bull trout for refugia or other purposes in the absence of a long-term source for LWD (e.g., via development of a mature riparian vegetation buffer). We anticipate that these functions are likely to occur to some degree if the structures remain intact over the long-term and function as expected. We are uncertain how long the anchored structures will remain intact or the level of benefits they would provide over the long-term. Because the structures include anchors designed to withstand the forces for the associated reach conditions, they are not anticipated to rapidly be displaced from the site.

There will also be placement of woody debris piles comprised of smaller wood at some of the sites. Some piles of woody debris will be placed on the shoreline, with others intertwined into existing structures such as derelict pilings. Based on past construction, the piles may remain at the site for multiple years, with the intertwined features perhaps lasting somewhat longer, but at some point the smaller wood piles likely will be dislodged and distributed downstream during high flows. Although their residence time at the original sites may be relatively short, the woody debris piles are intended to mimic natural wood inputs into the system, and are expected to provide habitat features and benefits beyond the site as they are distributed further downstream.

As in any populated area, there is always the risk of individuals removing or destroying the woody debris structures for a variety of purposes, including but not limited to, aesthetics, perceived hazards, or for use in other pursuits. As such, and due to natural decay and stream processes, it is impossible to ensure that the placement of these structures will be permanent. Nonetheless, the installation of these mitigation features, and particularly the anchored structures, have been designed to remain in place for a relatively long period of time barring unauthorized removal activities, and will provide improved foraging and rearing opportunities for juvenile salmonids in the lower Skagit River, which is anticipated to improve the forage base for bull trout.

Habitat-Forming Processes

Riprap precludes 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), which provide refugia and allochthonous inputs, and support important habitat-forming processes. The lack of habitat complexity in areas with riprap is expected to directly reduce abundance of bull trout in those areas, limiting opportunities for refugia, natural sediment sloughing (to maintain habitat forming processes), and backwater or side channel formation (e.g., for foraging and refugia), among others.

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 at best delay and likely preclude the natural establishment of larger riparian vegetation in the action area. The sustained loss of LWD inputs from reduced recruitment reduces the structural component of instream habitat that creates pools, refugia, and cover from predators.

In summary, 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 through sustained impacts to stream hydrology, geomorphology, and habitat forming processes through operation and maintenance of the levee sections and the larger levee system that they maintain. These impacts will persist for the foreseeable future in the action area, though admittedly in degrees that are difficult, if not impossible, to describe or calculate based on the complex nature of such ecological relationships. As each of the individual repairs are designed to maintain the integrity of the levee section of which they are a part, and all of the sections combined help to maintain the integrity of the larger levee system, the accumulative effect of continued operation and maintenance of the levee system is anticipated to result in additive effects to bull trout. However, we are unable to establish that these impacts would result in significant disruptions of normal foraging, migration, or overwintering behaviors of individual bull trout in the lower Skagit River basin. Furthermore, the edge habitat improvements that will result from implementation of the mitigation options is expected to substantially improve the foraging and rearing capacity of the action area for juvenile salmonids, which in turn will enhance the prey base for bull trout, and may also provide moderate improvements in cover habitat for bull trout.

Effects to Bull Trout Critical Habitat

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

PCE#1 - Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

As indicated previously in the Environmental Baseline section of this Opinion, the aquatic action area of these projects is assumed to contain subsurface flows adjacent to the channel, which may provide cold water to the river if unconstrained by the levees. Cold water refugia are critical for bull trout, especially during the summer in the action area when adults are migrating to upstream spawning grounds. Because the action area is currently a leveed system, the Actions are not anticipated to further reduce the cold water sources to the stream beyond what has already occurred due to the prior existence of the levees. However, the continual repair and maintenance of these levees contributes to the currently degraded condition at the project sites by continuing to limit connectivity to subsurface waters landward of the levees. The long-term indirect effects of maintaining the levees will 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 Actions are likely to be measurable.

PCE#2 - Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

The action area is 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 completed actions may have resulted in disturbance 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, 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 construction-related 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 completed actions and the proposed actions will largely maintain the degraded condition of the migratory corridors in the vicinity of the project sites by maintaining

the integrity of the overall levee system in the lower Skagit River. As described in previous sections of this Opinion, the levees will continue to contribute to the degraded water quality conditions in the lower Skagit River, which affects the migratory corridor for bull trout. Alternatively, the edge habitat mitigation alternatives, such as overhanging vegetation, LWD, fish bench, and the habitat weir, is expected to provide varying levels of cover and refugia for bull trout and their prey base over existing conditions, which may provide limited and/or site-specific enhancement of migratory habitat.

Overall, impacts from operation and maintenance of the Actions are not expected to prevent migration of bull trout through the action area, and some features may provide limited improvements to migration, foraging, and/or overwintering habitat. However, accumulatively, the Actions will measurably affect this PCE through the combined short- and long-term impacts associated with vegetation maintenance that precludes development of mature riparian habitat along the migratory corridor.

PCE#3 - An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Repair of the Actions is expected to result in short-term impacts to the food base of bull trout through a variety of pathways. Construction is 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. Additionally, riparian vegetation provides a source of terrestrial prey items (e.g., insects), as described previously. The removal of riparian vegetation during clearing of many of the sites would affect the prey base of bull trout over the short-term through the reduction in terrestrial food base, and may result in a lag time of several years to restore allochthonous inputs while the planted willows and other vegetation matures (e.g., refer in Figures 10 and 11). As numerous sites along more than 5 miles of shoreline were constructed in 2007 and will be constructed in 2011, and several years will likely be needed to restore appreciable levels of allochthonous inputs, we anticipate that the bull trout prey base will be temporarily reduced until the vegetation matures.

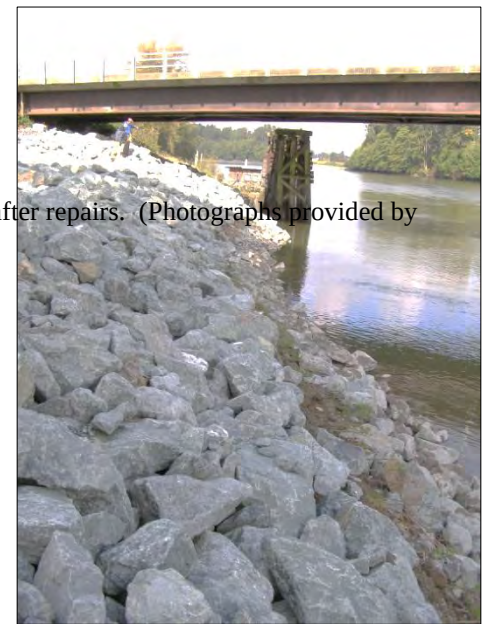

Figure 10. Example of project site conditions at DD 22-3 before and after repairs. (Photographs provided by Corps.)

Figure 11. Example of willow growth in foreground at Site 12-6, approximately 2 years after planting.

The levees will also 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 other salmonids in the Skagit River. The inclusion of willows may provide some level of inputs for these resources, although they will not reach the size or dimensions of mature riparian buffers. There is some potential that the plantings would not reach their full potential due to maintenance for other purposes[9] (e.g., access) by other entities, further limiting their full potential to contribute these resources to the stream. However, for the most part, we anticipate that the willows will be thinned and pruned only as necessary during maintenance to meet Corps standards for eligible levees. Even so, the operation and maintenance of the levees over the long term is expected to largely maintain the overall degraded conditions of this PCE. Therefore, effects to this PCE from the Actions, accumulatively, are likely to be measurable.

[9] While the USACE and Diking Districts have indicated that they will work together in an attempt to maintain the plantings to function as designed, there is some uncertainty as to the site-specific maintenance conditions that will be employed based on landowner preferences and ongoing/future maintenance practices.

Once established and fully functioning, however, the installation of the mitigation alternatives are anticipated to improve the bull trout food base by creating additional rearing and foraging habitat for juvenile salmonids, on which bull trout forage. Consequently, we anticipate that the overall impacts to this PCE will be at least partially mitigated by the proposed edge habitat enhancements for the life of the mitigation features.

PCE#4 - Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and 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 or isolated from the main channel in areas with extensive levee sections or systems, and the continued operation and maintenance of the levees precludes the river from accessing the floodplain and developing these features in the project areas. The combined length of the 57 individual levee repair sections is approximately 5.2 miles. As described previously, 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. Several of the sites will incorporate LWD or other habitat enhancement structures through implementation of the mitigation options, which may enable some level of instream structure development for as long as the LWD remains in the system. If the LWD does not remain onsite and/or intact, we anticipate some limited, but unquantifiable, benefits to downstream reaches where the wood may be recruited into the system, but onsite benefits would be lost.

Although some of the levees or stream reaches in the lower Skagit River, such as Cottonwood Island and several more rural stretches in the lower delta, have mature vegetation present, most lower Skagit River leveed reaches do not have large trees growing on them. Overall, impacts to this PCE from the Actions are considered to be appreciable because maintenance of the levee system where it currently exists will continue to preclude the development of mature riparian vegetation. Installation of LWD and smaller wood at several of the sites as proposed will provide some benefit to habitat structure over the short-term (i.e., for as long as the features remain intact and/or in the system). However, the mitigation features cannot replace the function of mature riparian vegetation and natural recruitment, as substantial riparian buffers that include large trees are not currently allowed to develop along much of the lower shoreline due to the current vegetation restrictions. 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 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 Actions are expected to be measurable.

PCE#5 - Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range.

As described previously, the existing levees in the lower Skagit River contribute to degraded water temperatures through impacts to floodplain connectivity and reduction instream pools and habitat-forming processes. The Actions are anticipated to contribute to the degraded condition of this PCE in the lower Skagit River into the future. 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 and the levee system that they sustain. The Actions accumulatively are expected to measurably degrade water temperatures periodically during the summer.

PCE#7 - A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

The continued operation and maintenance of these levees will, accumulatively, help to maintain the altered hydrologic conditions that currently existing the lower mainstem and forks. The combined Actions will result in over 5 miles of levee repairs in the lower Skagit River. 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 maintenance of levees will continue to appreciably alter the peak flows of the lower Skagit River from their historic ranges. Therefore, effects to this PCE from the Actions are expected to be measurable.

PCE#8 - Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

The 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 area by bull trout. As described above, however, the levees will continue to contribute to the degraded water temperature conditions in the lower Skagit River, which impacts the normal reproduction, growth, and survival of bull trout. We anticipate that precluding the development of mature vegetation at each of the project sites and continued isolation of the stream from its floodplain will contribute to periodic elevated summer water temperatures in perpetuity. Therefore, effects to this PCE from the Actions, accumulatively, are likely to be measurable.

PCE#9 - Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The Actions are not anticipated to result in the introduction of nonnative predatory, inbreeding, or competitive species into the action area 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 of Effects to Bull Trout and Bull Trout Critical Habitat

The projects are anticipated to result in adverse effects to bull trout during construction, and to both the species and its critical habitat over the life of the projects. During construction, disturbance is expected to occur from placement of rock, LWD, anchors, and other materials adjacent to or below the OHWM, and a few small bull trout may be crushed during placement of these materials. 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 actions will include the installation of mitigation features such as willow lifts, LWD, and fish bench, that are anticipated to improve edge habitat conditions to varying degrees over the existing riprap banks present all of the sites (except Tom Moore Slough, which currently contains no rock on the waterward face of the levee). Some of the features, such as the LWD structures, are anticipated to provide refugia for salmonids and add complexity to the mainstem Skagit River in its lower reaches. These features are expected to provide localized habitat improvements, and some may function in place for a considerable period of time, especially the fish bench, habitat weir, and anchored LWD that were designed to withstand most anticipated high flows and storm events. The mitigation features are expected to be locally beneficial over the long-term in the vicinity of their proposed locations.

Overall, the long-term effects of the repaired levee system are expected to result in adverse effects to bull trout and bull trout critical habitat, although the effects to individual bull trout may be difficult to measure. The Actions, in combination with other armoring in the basin, will maintain the degraded habitat conditions of the action area in perpetuity, limiting the ability of the river to move freely in the floodplain and reach equilibrium in the absence of the structures. The levee system maintained by these repairs will continue to preclude the establishment of mature riparian vegetation along the shoreline of the lower mainstem Skagit River and its main forks. A mature riparian buffer would provide a source of multiple LWD inputs into the lower Skagit River basin, which supports the development of complex instream habitat features, such as pools and instream complex cover, over a long period of time as the wood made its way to the mouth of the river and estuary. Taken together, we anticipate that the long-term accumulative effects of the Actions are expected to appreciably affect bull trout and bull trout critical habitat, but we are unable to relate these impacts to the level of a significant disruption of normal foraging behaviors for individual bull trout.

In summary, most of the projects include features that provide some level of localized improvements to edge habitat enhancement features, and this is anticipated to improve the bull trout prey base by increasing the available rearing and foraging areas for juvenile salmonids, consistent with the goals of the mitigation strategy. The installation of the mitigation options, particularly the willows and other vegetation, LWD, the fish bench, and the habitat weir, is expected to provide improved (though limited and/or localized) refugia or cover for migrating, foraging, or overwintering habitat bull trout. Consequently, edge habitat will be much improved over the existing conditions. There are, however, still significant long-term effects from the continued maintenance and operation of the levees that cannot be remedied through these improvements. The levees and other armoring present in the basin will effectively maintain the

degraded hydrological and geomorphological conditions found in the watershed in perpetuity, all of which influence a suite of habitat types that are relatively limited in the basin. Furthermore, all anadromous bull trout individuals in the Skagit populations must travel through the lower Skagit River, and would therefore be impacted by these degraded habitat conditions during foraging, migration, and overwintering in the lower river.

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/completed action and depends on the proposed/completed action for its justification. An interdependent action is an action that has no independent utility apart from the proposed/completed action. We anticipate no interrelated or interdependent actions[10] would be associated with the Actions.

[10] While maintenance and other repairs not requiring a Federal nexus are likely to occur upon completion of construction at the sites, these activities would likely occur to some degree even in the absence of the Actions considered in this Opinion. In this instance such activities do not depend on the Actions for their justification and also have independent utility apart from the Actions and are thus discussed in the following section.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the 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 multiple years of flood events on the Skagit 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 overtopping, breaching, or other damage to 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 rest of the action area in the lower Skagit River and its forks and distributaries during or after storms and other high flow conditions where levees, revetments, or other armoring are present and protect existing infrastructure such as agricultural lands and residential/commercial development.

The cumulative effects of non-Federal maintenance of the largely contiguous, system of bank hardening prevalent in the lower Skagit River Basin are expected to maintain the existing degraded shoreline and habitat conditions prevalent in the basin. Other impacts such as climate change and residential and urban development in the watershed are also anticipated to add to the extent of future effects to bull trout, their prey, and habitat. While there is some uncertainty related to the level of effects that will occur as a result of each of these stressors, they will nonetheless contribute to the existing suite of effects previously described in the Environmental Baseline and Effects of the Actions sections above.

Climate Change

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing and that effects from climate change will continue for at least the next several decades (Intergovernmental Panel on Climate Change 2007, p 2, 7-9). 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, p. 8) 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, p. 6721-6722) 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, p. 6724). 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 other North Puget Sound basins (e.g., Pelto 2008, pp. 73-74).

Battin et al. (2007, p. 6722) 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 Skagit 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. Additionally, Beamer and Larson (2004, p. 5) reported that juvenile salmonids that reared longer in the Skagit River delta (which include much of the riverine action area of the Actions) experienced increased growth than individuals that migrated sooner to the bay (e.g., estuarine/marine waters). They also suggested that faster growth and larger size may lead to improved survival. While longer rearing in streams may promote faster growth, the effects of higher stream temperatures on growth and survival of juvenile salmonids, as prey species for bull trout, is uncertain.

With the impacts of climate change, connectivity, thermal refugia, and other critical habitat features between lower and upper reaches of the Skagit River basin 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 Skagit 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

To maintain or restore the likelihood of long-term persistence of self-sustaining, complex, interacting groups of bull trout within the action area, the USFWS (USFWS 2004, p.15) has identified the following recovery objectives: 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.

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 Skagit River watershed would maintain the existing degraded habitat conditions that are prevalent in the action area. The Bull Trout Draft Recovery Plan (USFWS 2004; pp. 190-191) lists several reasons for the decline of bull trout in the Skagit River watershed and describes impacts that affect different life stages of bull trout. Foraging, migration, and overwintering habitats in this basin have been impacted by dams, agricultural practices, residential development, the transportation network, and stream channel/bank modifications. Additionally, marine foraging areas have been impacted by agricultural activities (including diking) along the marine shoreline, which is expected to directly affect anadromous bull trout and their prey species in the nearshore.

While some of activities listed above occur outside of the action area for the projects, their additive impacts influence the ability of the bull trout using the action area to be resilient to sustained or increased habitat degradation. The Bull Trout Recovery Plan does note that recent spawning index area counts indicate that the population (in 2004) in the Lower Skagit core area was assumed to be rebounding to near or to recovered levels (USFWS 2004, p. 191), which s is likely based on more restrictive harvest regulations in the early 1990s. While this optimistic note is certainly important to consider in our analysis, more recent bull trout observations suggest that bull trout populations may be declining in the Lower Skagit core area (N. Brennan-Dubbs, *in litt* May 16, 2011). It should also be noted that others stressors to bull trout, their prey, and their habitat continue to maintain the degraded aquatic habitat conditions in the lower basin, while habitat (including some spawning areas) higher in the basin is more protected and less impacted. Additionally, individuals from other core areas that are not faring as well are expected to use the action area for foraging, migration, and overwintering, and may encounter similar conditions (e.g., levees, residential/urban development, etc.) in their streams of origin. For these reasons, the highly degraded condition of the lower Skagit River basin cannot be discounted in terms of level of impact to bull trout, their prey, and their habitat.

The action area is used by individuals from local bull trout populations in the lower Skagit River Basin and other watersheds and is essential to individuals that use the lower Skagit River to forage, overwinter, or migrate between habitats. As noted previously, bull trout in the Lower Skagit core area may be at an diminished risk of local extirpation and adverse effects from random, naturally occurring events and anthropogenic activities, although recent bull trout

counts may need further evaluation. In any case, the USFWS 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 the establishment of large mature riparian vegetation, and preclusion of natural LWD recruitment are expected to maintain and likely exacerbate the degraded conditions in the lower Skagit 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 Actions will, at minimum, contribute to maintaining the existing highly degraded riparian and floodplain habitat conditions in the lower Skagit River. We recognize that the levee sections addressed by the individual repair 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/levee system in the lower Skagit River that does result in a highly degraded system.

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 (or all of the above). 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 or are in danger of failing. Such repairs will likely consist of repetitive or similar actions at the same sites or at nearby sites, resulting in the perpetual addition of new rock to replace lost armor rock. In some cases, such as the Tom Moore Slough site, 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.

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 to150 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 Skagit River may be susceptible to more erosion, and the amount of large rock and riprap being washed into the river channel would increase, requiring additional rock for replacement. We assume this will occur in the action area of the projects, as well as throughout the lower Skagit River basin.

The Lower Skagit core area, along with the Nooksack, 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 IRU (USFWS 2004; p. 137). When comparing all core areas within the IRU, the Lower Skagit core area is unique in its geographic size and population abundance. This core area is believed to be central to maintaining anadromous bull trout within the Puget Sound Management Unit.

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, p.7) noted that fecundity is a function of body size,; larger female bull trout are expected to be 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 Lower Skagit core area's local populations. A small number of small subadult bull trout may have been crushed in the completed actions, and additional small subadults may be crushed during construction of the proposed actions. However, the loss of this small number of individual subadult bull trout is not anticipated to measurably affect numbers of bull trout at the scale of the Lower Skagit 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, while the net extent of repairs covers approximately 5 mi, or about one tenth of the amount of shoreline in the action area of the projects, the Corps has proposed a number of edge habitat mitigation options that are intended to improve the rearing capacity of the mainstem for juvenile salmonids, prey species of bull trout. While the proposed enhancement features are not anticipated to fully mitigate for the impacts of the levee repairs, they are anticipated to result in significant improvements to the bull trout prey base over the existing conditions by increasing the rearing capacity for juvenile salmonids. Therefore, we do not anticipate that appreciable declines in the numbers of bull trout in the Lower Skagit core area will result directly from long-term habitat impacts from the actions addressed in this Opinion, due to the relatively small extent of each of the repairs and the mitigation features proposed. Thus, the impacts from these actions are not expected to appreciably reduce the survival and recovery of the Lower Skagit core area

population, the Coastal-Puget Sound IRU, 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 Lower Skagit core area.
- Implementation of mitigation options are expected to result in improvements to the forage base of bull trout and may also provide additional cover and refugia opportunity for bull trout, supporting productivity at the scale of the Lower Skagit 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 Lower Skagit 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 IRU, or the coterminous U.S. population.

Bull trout critical habitat in the lower Skagit 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 effects to 6 of the 8 PCEs present in the action area through a variety of pathways, including sustained elevated stream temperatures and 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 area and the project sites. On the other hand, the proposed mitigation will help to offset much of the edge habitat degradation present at the project sites, and will provide localized opportunities for cover and refugia. While the Actions will overall maintain the current degraded baseline, with some level of improvements provided by implementation of the mitigation options, the Actions 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:

- Construction and operation will not appreciably increase the overall degradation already present in the lower Skagit River mainstem and forks. A number of the completed projects and most of the proposed projects will implement mitigation options that will enhance edge habitat, which is anticipated to improve PCEs #2, 3, and 4. Consequently, the action area will continue to serve the intended conservation role for the species at the scale of the core area, IRU, and coterminous range.

CONCLUSION

After reviewing the current status of the Coastal-Puget Sound bull trout, the environmental baseline for the action area, the effects of the completed and proposed levee repair and rehabilitation projects, and the cumulative effects, it is the USFWS's Biological Opinion that these actions, as proposed and completed 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 USFWS 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 USFWS 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 USFWS 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 USFWS anticipates the following extent of incidental take occurred and/or is likely to occur:

The USFWS 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:

Completed Actions

- Incidental take of bull trout in the form of ***harassment*** in the vicinity of each of the 31 completed actions is anticipated to have occurred over the short-term during construction due to significant disruption of bull trout foraging, migrating, and overwintering behaviors resulting from avoidance of construction areas due to disturbance associated with in-water work or work below the OHWM. We anticipate that all bull trout that were present in the action area during the time when these activities were conducted were harassed during the construction window for the project during flood fight activities in early 2007 and follow-up construction in late summer 2007s. The extent of construction-related disturbance and habitat modification for each action is defined as the stream reach adjacent to each project site for approximately 31 of the sites and extending no more than 100 m upstream and downstream of the project site, and waterward of the shoreline, not to exceed the channel width for a total of approximately 22,500 linear ft.
- 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 in-water construction activities. Given the location of the project and the time of year that work was conducted, the USFWS anticipates that a maximum of 2 bull trout may have been injured or killed during the combined repair activities for these completed projects.

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:
    - We anticipate that all bull trout that are present in the action area during the time when these activities are conducted (June 15 to August 31, 2011) would be harassed for the 28 project sites that will may include in-water work or work below the OHWM for levee repair and/or installation of mitigation features. The extent of disturbance would extend no more than 100 m upstream and downstream of the project site for up to 28 of the proposed, deferred, or rework sites, and waterward of the shoreline, not to exceed the channel width, for a total of approximately 18,000 linear ft.

- Elevated levels of sediment during excavation and other significant sediment-generating activities during excavation associated with toe work or other slope work at the proposed sites where in-water work or work below the OHWM would occur, not to exceed 20 sites. We anticipate that harassment would occur along the shoreline at the project site downstream to approximately 300 ft below each site, for a total of approximately 15,000 linear ft.

- Incidental take of bull trout in the form of **harm** is anticipated to occur during proposed construction resulting from placement of rock, LWD, and associated anchors due to significant impairment of foraging, migrating, and overwintering behaviors resulting from crushing of small subadult bull trout during construction activities from June 15 to August 31, 2011. The extent of take is expected to be 1 bull trout at approximately 10 percent of the sites for a total of 3 bull trout.

EFFECT OF THE TAKE

In the accompanying Opinion, the USFWS 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 USFWS 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. Reduce impacts from suspended sediment to bull trout in each of the project areas that would include excavation and/or other appreciable releases of sediment during construction.

3. Reduce future impacts to constructed mitigation features to ensure that they provide the anticipated function and resource benefits for which they were designed and implemented.

4. Monitor the implementation and effectiveness of all conservation measures and mitigation 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 USACE must comply with the following terms and conditions, which implement the reasonable and prudent measures

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 USACE shall replace any native conifers and other native riparian trees removed from the proposed action project sites with like or similar species (i.e., conifers and other large-growing species) on the landward side of the levee at a minimum 2:1 ratio (2 replacement trees for each 1 removed). The plantings should be located 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 or planted in the riparian zone or landward of the levee at the project sites the USACE shall coordinate with the local sponsor and/or landowner to create a site-specific management plan for retention of suitable fallen trees in the vicinity of the riparian zone levee to ensure that these trees will be actively recruited to the stream and would not be 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), incorporated into mitigation options for this batched group of projects, or otherwise create habitat-forming structures (e.g., logjams). The USACE 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. 100 percent survival annually for all shrubs and trees during the first 3 years, with replacements as needed to achieve this value;
    b. 100 percent survival of trees and at least 80 percent survival of shrubs at the end of 5 years, with replacements as needed to achieve this value.

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

1. The monitoring protocol for suspended sediments shall be implemented for all proposed, rework, or deferred projects that would include any excavation activities that would occur within the wetted width of the stream. As currently proposed by the monitoring plan, we understand that even this activity would include monitoring for at least the first one or more projects, if it occurs in the wetted width.

The following Terms and Conditions are required for the implementation of RPM #3:

1. The USACE will work with the Diking Districts to promote the long-term function of the proposed mitigation features, so that they are not intentionally removed or destroyed by other entities. Such coordination may include, but is not limited to:

    a. Ensuring future flood-fight activities at the sites would not bury or otherwise reduce or eliminate the function of the LWD and other mitigation features.

    b. Providing outreach to landowners and other community members, particularly where such outreach can most effectively facilitate retention of LWD, plantings, and other features.

The following Terms and Conditions are required for the implementation of RPM #4:

1. The USACE 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.

2. For each year of long-term monitoring of mitigation features, the USACE shall submit a monitoring report by no later than January 31 of the following year. The report shall include, at minimum, the following: (a) dates and types of monitoring activities undertaken, (b) status and observations of mitigation features implemented at each site per the monitoring plan, and (c) summary of any corrective actions taken.

The USFWS 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.

We are making the following recommendations to the Corps for the lower Skagit River Basin as well as for other watersheds in which the Corps conducts levee and other armoring repairs. We offer these recommendations to assist you in meeting your obligations and 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 also make this recommendation under 7(a)(1) and 2(c) of the Act to assist you in your responsibilities to conserve listed species. We recommend that the Corps:

1. Engage in a programmatic consultation with the USFWS (and NMFS, if amenable) for all of the levees and other armoring in this and other watersheds (e.g., by WRIA) that are likely to be damaged by floods and for which structural repairs would be proposed. While the batching of 57 projects in the lower Skagit River mainstem does more appropriately characterize effects from maintaining the levee system than piece-mealing of individual projects, the proposed mitigation addresses only edge habitat effects of the levee repairs and maintenance. There are many other long-term habitat effects to listed species, their prey, and their habitat from the maintenance of the levee system. A programmatic approach to address the landscape-level degradation of many of these watersheds from shoreline armoring and levees with associated activities that also focus on reducing the other effects from maintaining the levee system would better able to address recovery of bull trout and other listed species.

2. With stakeholder cooperation, identify suitable areas for levee removal, restoration, and enhancement activities, particularly those that are generally difficult to implement on a project-by-project basis. Where other potential enhancement or restoration activities are planned or are being investigated for a basin (e.g., Cockreham levee), ensure that Corps levee repair actions do not preclude the future success or implementation of the restorative actions.

3. Once these areas are identified, work with stakeholders (including the USFWS and NMFS) to implement these projects. An in-lieu fee system, conservation bank, or other similar tool may be potential methods for funding the acquisition and restorative actions. Other Corps programs besides the PL-84-99 program may be identified to address or support implementation of these projects.

4. Coordinate with the USFWS, NMFS, and other stakeholders on a watershed approach for addressing the long-term impacts of the levee system and shoreline armoring in each watershed. For example, levees and other hard shorelines within the Skagit 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.
- For the Tom Moore Slough site and other levee sections that have an unarmored face that is likely to erode or otherwise be damaged, investigate alternatives to armoring well in advance and plan for implementation prior to the need for emergency action. Other authorities or programs besides PL-84-99 may be more relevant for these sites.
- Create more stream complexity in project designs, using information gathered from the site- and reach-based analyses and results of the proposed mitigation alternatives (e.g., installation of LWD, fish benches, etc.).
- 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 USFWS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the USFWS 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: INDIVIDUAL SKAGIT RIVER LEVEE REPAIR PROJECT DESCRIPTIONS

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Note: The following revised and updated project description sections were provided[1] by the U.S. Army Corps of Engineers (USACE) to the U.S. Fish and Wildlife Service via email dated March 18, 2011. Several of the site descriptions were slightly revised from the USACE Biological Assessment (Assessment) and the March 2011 Addendum.

From the USACE's revised project description section:

The majority of the work at each site occurred or will occur above the ordinary high water elevation (OHW). Excavation, clearing, and grubbing generally did not occur below the water line at the time of construction but it did occur on portions of the bank that were lower than OHW; material was placed to rebuild the pre-flood toe. Work above OHW consisted of excavation of failed slope material and unsuitable deposits of sand and silt. The general construction process was and will be as follows: Clear and grub, reshape the slope, spall the slope, and install the armor rock. Willow lifts were installed at 27 of the 2007 repair locations during the construction process and all disturbed level ground was or will be topped with soil and hydroseeded. For the 2011 repairs, a variety of designs will be implemented, most of which will include willow lifts. All 2011 repairs will be completed during the fish window; however, many of the repairs in 2007 were completed outside the approved in-water work window so that the damage could be repaired prior to the winter flood season. All repairs that are or were not backslope work only, or specifically defined as being behind a wide riverward bench, are considered to have included in- water work. Descriptions of the repairs performed in 2007 and those scheduled to be constructed in 2011 within DD1, DD3, DD12, DD17, and DD22 are as follows (see Appendix B for a summary table of construction at all sites; Appendix D for as-built drawings of sites reconstructed in 2007 and Appendix E for design drawings of the 2011 sites).

1.1. Diking District 1 Levee

- General Characteristics of DD1 Levees: Levees within this district are typically well maintained with a grassy surface that is mowed regularly. There are several vegetated benches where the levee is set back from the river, but the majority of the levee follows along the river channel. Typically, this rural district does not maintain its revetments as extensively as other urban Skagit diking districts, such that vegetation along the revetment grows in wider tracts with larger trees. At the repair sites, the levee crown, backslope, and riverward slope are maintained as grassy surfaces. Any shrubby vegetation, detailed below by site, is found in a narrow band along the revetment face.

- Site 1-1: 207.5 linear feet (LF) of levee was repaired in 2007. The riverward slope was reshaped and armored with a three-foot blanket of class IV riprap at a 2H:1V slope. No buried toe was constructed. One willow lift 196 LF long (400 willows) was installed 3.5 LF below the levee top, approximately 4 ft above ordinary high water (OHW). The levee crown was topped with crushed

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[1] U.S. Fish and Wildlife Service note: The USACE provided their changes in track changes for expedited review of revisions. The final version (with track changes "accepted"), minus the USACE's project area and action area description and document footer, is shown in this appendix.

gravel providing a driving surface upon completion of construction. Disturbed vegetation along the revetment face consisted of 160 LF of grass, five very low brushy alders and willows, 47 LF of four- to six-inch diameter at breast height (dbh) alders (10 to 12 trees), and a blackberry understory.

- Site 1-2: 200 LF of levee was repaired in 2007. The riverward slope was reshaped and armored with a three-foot blanket of class IV riprap at 2H:1V. One willow lift 163 LF long (330 willows) was installed 6.5 LF below the levee top on the levee face, approximately 3 ft above OHW. The levee crown was topped with crushed gravel providing a driving surface. Disturbed vegetation along the revetment face consisted of approximately 30 percent shrubby alders and willows four to ten feet tall with an understory composed of various species.

- Site 1-3: This site was deferred from the 2007 construction season and is scheduled to be repaired in 2011. The damaged section of levee is 75 LF long. This section of levee is on an inside bend of the river, adjacent to an armored section. The downstream end of the armored area is experiencing erosion that could continue behind the armor and unravel the levee. Continued erosion will lead to levee failure and loss of access to Young's Bar. Engineers recommended that the repair include re-grading and armoring the slope to tie in the armored revetment to high ground. Disturbed vegetation along the revetment face consists of a few alders four to eight inches dbh, with willows, blackberry, and dogwoods in the understory. The designs for repair include a double willow lift starting at OWH, inclusion of anchored rootwads and placement of soil and hydroseed over the top of the riverward face and the bench.

- Site 1-4: 108 LF of levee was repaired in 2007. The riverward slope was reshaped and armored with a three-foot blanket of class IV riprap at a 1.5H:1V slope. No buried toe was constructed. A large scour hole approximately 20 feet into the riverward revetment was filled with riprap. A double willow lift spanning 105 LF (~210 willows) was installed at 4.3 and 8.7 LF below the levee top, with the lowest lift at approximately 0.5 ft above OHW. Access to the riverward side of the levee was via an existing ramp; a spall road 147 feet long by 12 feet wide was constructed to provide access to the site. Disturbed vegetation on the revetment face consisted of blackberries on the levee and a single row of small shrubby willows and alders along the levee face at OHW, and roughly eight trees that were four to six inches dbh.

- Site 1-7: 257 LF of levee was repaired in 2007. The riverward slope of 2H:1V was reshaped and armored with a three-foot blanket of class IV riprap. No buried toe was constructed. One willow lift (400 willows) spanning 153 LF was installed 8.6 LF below the levee top, approximately 6 ft above OHW. Disturbed vegetation along the revetment face consisted of one locust tree less than four inches dbh, four to five small brushy alders, and a dense blackberry understory. In 2011, woody debris will be placed along the toe at this site, intertwined in the piles for 100 LF.

All repair sites within the DD1 levee project were and will be accessed by existing levee access ramps and the levee crown, which are accessible from public rights-of-way at several locations throughout the length of the project. Excavated materials were/will be staged within the levee footprint.

1.2. Diking District 3 Levee

- General Characteristics of DD3 Levees: Levees within this district are typically well maintained with a grassy surface that is mowed regularly along the crown and side slopes. Along the Skagit mainstem, most of the levee in this district is setback from the river; however, along the South Fork of the Skagit River and along Tom Moore Slough, the levee generally follows the river's edge with only a few riverward vegetated benches. Typically, this rural district does not maintain its revetments as extensively as other urban Skagit districts, such that vegetation along the revetment grows in wider tracts with larger trees. At the repair sites, the levee crown, back slope, and riverward slope are maintained as grassy surfaces. Any vegetation, to be detailed below by site, is found in a narrow band along the revetment face.

- Site 3-1: 382 LF of levee was repaired in 2007 on the South Fork Skagit River. The riverward slope was reshaped and a spall blanket was placed on the bench and slopes. The riverward face was armored with a three-foot blanket of class IV riprap. No buried toe was constructed. One willow lift (~600 willows) was installed 5.8 LF below the levee top, approximately 2.5 ft above OHW. The levee crown was topped with crushed gravel to provide a driving surface. Disturbed vegetation consisted of approximately half the revetment face including low brushy alders less than 15 feet tall, the rest of the revetment was dominated by grass with some blackberries. In 2011, soil and hydroseed will be placed as mitigation over the riprap above the 2007 willow lifts and three rows of shrubs will be planted along the top of the riverward bank.

- Site 3-2: 436 LF of levee was repaired in 2007 on the South Fork Skagit River. The riverward slope was reshaped, spall rock was placed, and the levee riverward face was armored with a three-foot blanket of class IV riprap. No buried toe was constructed. One willow lift (~238 willows) was installed throughout the project area. The willow lift elevation changes through the repair area with 391 LF at 3.6 ft below the levee crown (3 ft above OHW) and 45 ft at 6.6 LF below the levee crown (at OHW). The levee crown was topped with crushed gravel, providing a driving surface. Disturbed vegetation was grass, blackberries, and six to seven alders smaller than four inches dbh that were growing along the river.

- Site 3-3: 139 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V, spall rock was placed, and the riverward levee slope was armored with a three-foot blanket of class IV riprap. No buried toe was constructed. One willow lift spanning 106 LF was constructed (~121 willows. The height of the lift changes within the repair area, with 34 LF at 3.2 ft below the levee crown (4.5 ft above OHW) and 72 LF at 7.7 LF below the levee top (at OHW). The levee crown was topped with crushed gravel to provide a driving surface. Disturbed vegetation consisted of six alders ranging from 12 to 15 feet tall and less than four inches dbh, which were present along the riverbank. Various grasses dominated the rest of the repair area.

- Site 3-4: 287 LF of levee was repaired in 2007 on the South Fork of the Skagit River. The riverward slope was reshaped to 2.5H:1V, spall rock was placed, and the levee riverward face was armored with a three-foot blanket of class IV riprap. No buried toe was constructed. One willow lift (~678 willows) was installed 5.2 ft below the levee top (1 ft above OHW). Disturbed vegetation consisted of seven alders less than 15 feet tall and brushy vegetation along the revetment. As-built drawings show several logs and woody debris at the riverward toe.

- Site 3-5: 460 LF of levee was repaired in 2007 on the South Fork of the Skagit River. The riverward slope was reshaped to 2H:1V, spall rock was placed, and the levee riverward face was armored with a three-foot blanket of class IV riprap. No buried toe was constructed. One willow

lift (~700 willows) was installed along 350 LF of the repair at 1.4 LF below the levee top (6.6 ft above OHW). The levee crown was topped with crushed gravel. Disturbed vegetation consisted of various shrubby plants on the revetment and bench, ranging from two to ten feet tall and groundcover dominated by grass. In 2011, anchored rootwads will be added as further mitigation throughout this site.

- Site 3-6: This is a 2007 levee rehabilitation site that is scheduled to be reworked in 2011. The 2007 repair was 375 LF. The riverward slope was reshaped to 3.5H:1V and armored with a three-foot blanket of class IV riprap, extending from OHW to the top of the levee. No buried toe was constructed. One willow lift (~800 willows) was installed 10.2 LF below the levee top, at approximately 0.5 ft above OHW. The section to be constructed in 2011 is 150 LF. Excess riprap was placed on the upper slope during the 2007 construction season to prevent erosion during a possible flood, but the weight increased the load on the slope. This can cause rotational failure of the levee. The excess rock will be excavated and will be reused on the downstream end of the site to tie the levee into the bank. A spall layer will be placed below the riprap, and the riprap will be replaced at the toe. Disturbed vegetation in 2007 consisted of species such as Nootka rose, thimbleberry, salmonberry, shrubby willows, and blackberry on the riverward face that ranged from two to ten feet tall. Vegetation to be disturbed by the 2011 repair is similar. The rootballs removed from within the levee during 2007 construction were placed onto the riverward face of the levee post-construction, shading the rock, increasing organic inputs to the river, and diversifying the bank line. These rootballs may need to be moved to remove the excess rock during the 2011 construction, but will be placed back on the levee face post-construction. Any small rootballs removed for the 2011 repair will similarly be staged during construction and placed on the levee face post-construction. The 2011 repair will include a double willow lift and placement of anchored logs with rootwads throughout the full 3-6 repair site (525 LF). The riverward face above the willow lifts will be covered with soil and seeded with native grasses.

- Site 3-7: This is a 2007 repair site that included no in-water work. The repair was 6,110 LF long on the grassy backside of the levee. It involved removing a layer of clay along the backslope and replacing it with soil and spalls. The disturbed area was hydroseeded after construction.

- Site 3-8: This site is to be constructed in 2011. The site includes 225 LF of repair due to an over-steepened bank. This site is along Tom Moore Slough and has not been armored in the past. It is adjacent to the 2007 repair at site 3-5. The landward side of the levee appears to be a forested wetland. The riverward revetment and narrow bench is vegetated with grasses, blackberry, Nootka rose, red osier dogwood, multiple willow clumps, and alders. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A double willow lift will be installed with the lowest lift at OHW. Anchored logs with attached rootwads will be placed along the toe of the repair. The levee crown will be topped with crushed gravel to create a driving surface for inspections. The riverward face above the willow lifts will be covered with soil and seeded with native grasses. The landward wetland and slope will not be disturbed.

- Site 3-11: This site is to be constructed in 2011. The site includes 200 LF of repair due to an over-steepened bank and loss of face rock. Several large sinkholes are present. This site is within the City of Mount Vernon. The riverward face includes blackberry, alders and several young dogwood plantings at the top of the levee. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried

toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction.

Ingress and egress to the repair sites within the DD3 Levee Project was/will be gained through use of existing DD3 levee access ramps and the levee-top road. These are accessible from public rights-of-way at four locations along the length of the DD3 Levee Project.

1.3. Diking District 12 Levee

- General Characteristics of DD12 Levees: Levees within this district are well maintained with a grassy surface that is mowed regularly along the crown and side slopes. Levees within this district typically follow the river's edge with narrow grassy benches (less than 75 feet wide). At the repair sites, the levee crown, backslope, and riverward slope are maintained as grassy surfaces. Any shrubby vegetation, detailed below by site, is in a narrow band along the revetment face.

- Site 12-1: 109 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap, extending 22 LF from OHW to the top of the bank. No buried toe was constructed. After construction, spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Willow lifts were not installed. Disturbed vegetation consisted of willow and alder brush ranging from ten to 15 feet tall along the revetment face and grass across the levee bench.

- Site 12-2: 261 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap, extending from OHW to the top of the bank. A spall blanket was extended approximately 33 LF landward from the top of bank. No buried toe was constructed. Two willow lifts were installed; one at 11 LF below the levee top and the other 14 LF below the levee top (at OHW). A total of 275 willows were planted. After construction, spalls and gravel were placed on the levee crown and access ramps to provide a driving surface for maintenance and inspection. Lost vegetation consisted of one row of short scrubby willows mixed with grass along the river. Four large cottonwoods stand near the repair. These trees were retained during the repair, though the roots may have sustained some damage.

- Site 12-3: 511.5 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. A spall blanket was extended 29 LF landward from the top of bank. No buried toe was constructed. Two willow lifts were installed, beginning at OHW, specifically 8.5 and 6.5 LF below the levee top. A total of 1,845 willows were planted. Disturbed vegetation consisted of mostly grass with several small native willows less than three feet tall. One corkscrew willow was maintained through construction. In 2011, soil and hydroseed will be added to the top of the bank above the willow lifts. This will be planted with three rows of native shrubs.

- Site 12-4A: This site was deferred from the 2007 construction season. The repair spans a 250 LF section of levee along Whitmarsh Road. The landward side of the levee is experiencing sloughing and material movement below Whitmarsh Road, which appears to be the effects of seepage. Ground penetrating radar has shown an anomaly below the levee that may be causing or exacerbating the issue. If left unrepaired, the levee could fail, potentially resulting in the flooding of Burlington. The site is within the three-bridge corridor (a confined river section containing bridges for I-5, Riverside Drive, and Burlington Northern Railroad). The levee will be excavated

to below the level of the adjacent road to explore the anomaly. The levee will be rebuilt in compacted lifts. The repair will not include any in-water work but will include work on the riverward side of the levee behind the bench. The site is a mowed grassy area. The disturbed area will be hydroseeded after construction and will quickly return to pre-repair habitat condition.

- Site 12-4B: This site is to be constructed in 2011. The site includes 970 LF of riverward repair due to loss of face rock. The toe rock appears to be intact, so in-water work should be minimal. The proposed project area is dominated with grass and blackberry with some bushy willows. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction.

- Site 12-5: 236 LF of riverward levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three foot blanket of class IV riprap. A spall blanket was extended approximately 44 LF landward from the top of the bank. No buried toe was constructed. Spalls and gravel were placed on the levee crown and access ramps were created to provide a driving surface. Willows were not installed. Cleared vegetation consisted of short blackberry bushes, grasses, and one alder.

- Site 12-6: Initial repairs were completed in 2007 with a rework expected in 2011. In 2007, 651 LF of levee was repaired in two separate sections, with a 160 LF span between the two constructed areas. This 160 LF area will be constructed in 2011. The riverward slope was reshaped to 1.5H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket extended approximately 21.5 LF landward from the top of the bank. No buried toe was constructed. Two willow lifts were installed beginning at OHW; 7.6 and 11.6 LF below the levee top; a total of 220 willows were planted. Disturbed vegetation consisted of brushy alders and willows ranging from eight to 15 feet tall that covered 50-70% of the shoreline. Blackberries dominated the groundcover. The 2011 construction will include a double willow lift beginning at OHW or lower, similar to those installed in 2007. In 2011 the riverward bank above the willow lifts will be covered in dirt and hydroseeded throughout the 12-6 repair site (651 ft in 2007 and 160 ft in 2011, so that 811 ft will be covered in dirt and hydroseeded). Also in 2011 a double row of shrub plantings will be added along 250 LF of the upper riverward bank.

- Site 12-7: This site was repaired in 2007 and received 170 LF of levee repair to the riverward side of the levee. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket extended approximately 37 LF landward from the top of bank. No buried toe was constructed. A double willow lift was installed at OHW and 4 ft above OHW. The disturbed area included very little vegetation, mostly grasses, with extensive woody debris deposited on the riverbank.

- Site 12-8: 124 LF of the riverward side of the levee was repaired in 2007. The riverward slope was reshaped to 2.5H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket extended 18.5 LF landward from the top of bank. No buried toe was constructed. Two willow lifts were instialled at 7 and 11 LF below the levee top (the lowest lift was at OHW); approximately 375 willows were planted. Cleared vegetation consisted of mostly short blackberry bushes with a few short, scrubby alders and willows less than four feet tall.

- Site 12-9: This site is to be constructed in 2011. The site includes 1850 LF of riverward repair due to seepage, toe scour and loss of face rock. The proposed project area is dominated by blackberry and grass with some horsetail and rose. Woody species are scattered along the length of the repair including red osier dogwood, alder, and small willows. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A double row of native shrubs will be planted at the top of the revetment, three feet on center. Anchored rootwads will be installed along 1,575 LF of the toe of this site.

- Site 12-11: This site is to be constructed in 2011. The site includes 600 LF of riverward repair due to toe scour and loss of face rock. This site is adjacent to a 2007 repair (12-6).The proposed project area is dominated by grass and blackberry. Young willows grow at OHW and approximately 10 alders, 2 mature willows, and some red-osier dogwood stand along the revetment. Several pilings stand at the toe and an outfall flows 20 to 30 feet downstream of the project site. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A single row of native shrubs will be planted at the top of the revetment three feet on center.

- Site 12-12: This site is to be constructed in 2011. The site includes 50 LF of riverward repair due to toe scour and loss of face rock. The proposed project area is dominated with blackberry. A small dock is in front of the levee. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. The top two-thirds of the riverward bank and the bench will be covered in dirt and hydroseeded following construction.

- Site 12-13: This site is to be constructed in 2011. The site includes 350 LF of riverward repair due to toe scour and loss of face rock. The revetment includes two large alders, some young willows, and blackberry. Six very large cedars stand along the riverward bench behind the repair area. A fish bench will be installed at this site that will be 9 ft wide and will slope from 2 ft above OHW at the upstream to 2 ft below OHW at the downstream end and will slope riverward at a 2% grade to avoid fish stranding. The riverward levee slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A double willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A single row of native shrubs will be planted along the top of the riverward bank. With the installation of the fish bench it is likely that some of the bench trees will have to be removed. They will be reused as anchored woody debris at nearby repair sites.

- Site 12-14: This site is to be constructed in 2011. The repair site includes 250 LF of riverward repair due to loss of face rock. This site is a gap between 2 project areas constructed in 2007. In-water work will be minimized as the toe rock appears to be mostly intact, though it may need to be supplemented in some areas. The proposed project area is dominated by grass with some bushy willows. The riverward slope will be reshaped to 3H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A double

willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and seeded with native grasses following construction. A single row of native shrubs will be planted at the top of the revetment three feet on center. To layback the slope throughout the repair area, a transition zone will be built to connect the layback to the upstream and downstream slopes. The transitions at each end of the layback section will be gradual to avoid scour and will be approximately 40 ft at each end.

- Site 12-15: This site is to be constructed in 2011. The site includes 180 LF of riverward repair due to toe scour and loss of face rock. This site has a wide grassy bench with one very large cedar, and six large big leaf maple trees. These bench trees will not be removed for this repair. The revetment has 18 alders, 3 large snags, 5 mature willows and many immature willows. The understory is mostly blackberry. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A double row of native shrubs will be planted at the top of the revetment, three feet on center. A layback was considered at this site, but a layback will require the removal of the large trees on the bench. As there are very few trees on the right bank in this reach of the river, the layback option was not chosen so that these trees could be preserved.

- Site 12-16: This site is to be constructed in 2011. The site includes 670 LF of riverward repair due to an over-steepened bank. This site has a grassy bench with the revetment including scattered alder, grass, blackberry, and horsetail. The riverward slope will be reshaped to 2H:1V, spall rock and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at or below OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded.

- Site 12-17: This site is to be constructed in 2011. The site includes 450 LF of riverward repair due to an over-steepened bank. This site has a grassy bench with the revetment including alder, grass, and blackberry. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at or below OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded.

1.4. Diking District 17 Levee

- General Characteristics of DD17 Levees: Levees within this district are well maintained with a grassy surface that is mowed regularly along the crown, side slopes, and short grassy bench. The levee follows the river channel with no setback beyond a short maintained bench. At the repair sites, the levee crown, backslope, and riverward slope are maintained as grassy surfaces. Any shrubby vegetation, detailed below by site, is in a narrow band along the revetment face.

- Site 17-1: 400 LF was repaired in 2007 on the riverward side of the levee. The riverward slope was reshaped to 1.5H:1V and armored with a three-foot blanket of class IV riprap with a spall blanket extending landward of the top of the bank. No buried toe was constructed. Two willow lifts were installed. The willow lifts vary in height across the repair site with 167 LF of willow lift starting at 4.5 ft above OHW and 233 LF of willow lift starting 6.3 ft above OHW. Cleared

vegetation consisted of nine cottonwoods less than 20 feet high, interspersed with extensive blackberries.

- Site 17-2: 275 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. A spall blanket was extended landward from the top of the levee bank. No buried toe was constructed. Two willow lifts were installed 5.9 and 9.2 LF below the levee top with the lowest lift at 6 ft above OHW. Cleared vegetation consisted of blackberries and one or two short willows and/or alders less than four feet tall. In 2011, 100 LF of woody debris will be placed along the toe at this site, intertwined in pilings that stand just off the toe.

- Site 17-3: 159 LF of levee was repaired in 2007. The riverward slope was reshaped to 1.5H:1V and armored with a three-foot blanket of class IV riprap. A spall blanket was extended landward from of the top of bank. No buried toe was constructed. Two willow lifts were installed 10.7 and 13.3 LF below the levee top (first lift at 3.6 ft above OHW); a total of 276 willows were planted. Cleared vegetation consisted of five brushy alders less than eight feet tall, one alder ten inches dbh, and grasses and blackberry that were distributed throughout the site.

- Site 17-4: 170 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. A spall blanket was extended landward of the top of the bank. No buried toe was constructed. Three willow lifts were installed 3.6, 7.4, and 10.4 LF below the levee top (first lift at 2.4 ft above OHW); 326 willows were planted. After construction, spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Cleared vegetation consisted of seven scrubby willows and/or alders less than six feet high, grasses, and some blackberries.

- Site 17-5: 1,350 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket extended landward from the top of the bank. No buried toe was constructed. A single willow lift was installed through a portion of the repair. Approximately 494 willows were planted along 425 LF of repair at 10.3 LF below the levee top (4 ft above OHW). After construction, spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Cleared vegetation consisted of a row of willows and alders ranging from four to ten feet high along the river's edge, and grasses and blackberries on the levee face.

- Site 17-6: 522 LF of levee was repaired in 2007. In 2007, the riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket was extended landward from the top of the bank. No buried toe was constructed. Two willow lifts spanning 305 LF were installed 4.3 and 8.0 ft below the levee top (the first lift was at one ft above OHW); 740 willows were planted. After construction, spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Cleared vegetation consisted of one clump of willows, approximately four feet tall. Blackberries dominated approximately 45% of the revetment, with grasses dominating the remainder. In 2011, further mitigation work will be completed at this site. The mitigation effort will include placement of soil and hydroseed on the bench and top of the riverward face and placement of anchored rootwads at the toe for 400 LF.

- Site 17-7: This site is to be constructed in 2011. The site includes 800 LF of riverward repair due to loss of toe protection and face rock. This site has sink holes along the entire length and is adjacent to the Riverside Drive Bridge within the three-bridge corridor. The revetment within the

project area is dominated by blackberry with some snowberry and immature willows. Trees are scattered along the revetment including alders, willow saplings, holly, and rose. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A single row of native shrubs will be planted at the top of the revetment three feet on center.

- Site 17-9: This site is to be constructed in 2011. The repair site includes 700 LF of riverward repair. This site has sink holes and multiple stress cracks along the top of the revetment. The revetment within the project area is dominated by blackberry and reed canary grass. Trees are scattered along the revetment including mature willows, alder, and willow saplings. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A single row of native shrubs will be planted at the top of the revetment three feet on center.

- Site 17-10: This site is to be constructed in 2011. The repair site includes 200 LF of riverward repair between a small rock groin and the I-5 bridge. Sinkholes and sloughing are at the site, with loss of toe rock and face rock. The revetment within the project area includes snowberry and reed canary grass, willow saplings, blackberry, cluster rose, and maple saplings. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. A single row of native shrubs will be planted at the top of the revetment three feet on center.

- Site 17-12: This site is to be constructed in 2011. The repair site includes 925 LF of repair due to toe scour and loss of face rock. The revetment is dominated by blackberry and reed canary grass with scattered snowberry, willow, holly, red osier dogwood, alders, and big leaf maple saplings. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction.

- Site 17-15: This site is to be constructed in 2011. The site has an over-steepened bank that requires toe and face rock repair along 125 LF of the revetment. The site is near an old Public Water Supply well that will not be modified by the repair. Blackberry and grasses dominate the revetment along with two mature alders. The riverward slope will be reshaped to 2H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction.

- Site 17-16: This site is to be constructed in 2011. The over-steepened bank requires toe and face rock repair along 250 LF of the revetment. DD17 reported a very deep scour hole at the toe. The

site is near Freeway Drive and I-5 and is adjacent to a 2004 levee repair site. This site is forested with large trees and an understory of snowberry and blackberry. There are nine large big leaf maples and a few saplings of the same species, two mature alders, two *Prunus* species, and five very large cottonwoods, three of which are dying presumably from being undercut by the bank scour. The riverward slope will be reshaped to 2H:1V, a one-foot blanket of spall rock will be laid, and a three-foot blanket of class IV riprap will be placed. No buried toe will be constructed. A triple willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. Two rows of native shrubs will be planted at the top of the revetment three feet on center and a row of tree plantings (15 ft on center) will be completed between the repair area and Freeway Drive. A habitat weir will be added to the upstream end of this site. The weir will be a pyramidal rock structure with a 2H:1V face slope, which will extend 10 feet from the face of the levee. It will extend above OHW to provide hydraulic complexity at many river stages. In section view of the groin, the side slopes that are roughly angled toward upstream and downstream will have a 1H:1V profile. The weir will not change the thalweg of the river or change river dynamics within the reach, but will create localized changes that include velocity slowing upstream of the structure and pool creation downstream. Both of these effects improve rearing habitat.

1.5. Diking District 22 Levee

- General Characteristics of DD22 Levees: Levees within this district typically are well maintained with a grassy surface that is mowed regularly along the crown and side slopes. There are several large vegetated benches where the levee is set back from the river. Typically, this rural district does not maintain its revetments as extensively as other Skagit districts, such that vegetation along the revetment grows in wider parcels with larger trees. At the repair sites, the levee crown, backslope, and riverward slope are maintained as grassy surfaces. Any shrubby vegetation, detailed below by site, is along the revetment face.

- Site 22-1: 395 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap, with the spall blanket extending landward from the top of the bank. No buried toe was constructed. One willow lift was installed 5.4 LF below the levee top (1.5 ft above OHW); 678 willows were planted. Spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Cleared vegetation consisted of approximately 30 cottonwoods, alders, and willows less than 40 feet tall that were located along the river. Half of these trees were between four and six inches dbh and half had diameters less than two inches dbh. Grasses and blackberry dominated the understory.

- Site 22-2: 118 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket was extended landward from the top of the bank. No buried toe was constructed. One willow lift was installed one ft above OHW, five LF below the levee top; 226 willows were planted. After construction, spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Cleared vegetation consisted of approximately 50 LF of grass intermixed with blackberries. The remaining area (~68 LF) had mature riparian forest; including four to five moderate to large cottonwoods and alders with a dense understory.

- Site 22-3: This is a 2007 levee rehabilitation site that is scheduled to be reworked in 2011. The 2007 repair spanned approximately 273 LF of levee. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket was extended landward from the top of the bank. No buried toe was constructed. One willow lift was installed

at 0.5 ft above OHW; 500 willows were planted. Spalls and gravel were placed to provide a driving surface on the levee crown and access ramps. The length of the section scheduled to be reworked in 2011 is 110 LF. Excess rock was placed at this site during the 2007 repair, staged for this construction effort. The overburden will be removed and used to tie in the downstream end of the 2007 work. The 2011 construction area as well as the 2007 repair will be covered with soil, and hydroseeded. Cleared vegetation in 2007 consisted of 75 LF of predominantly blackberry and approximately 200 LF of mature riparian vegetation (cottonwoods and alders) with a dense understory. The 2011 work will remove 110 LF of mature riparian vegetation (cottonwoods and alders) and will include a double willow lift. A row of native shrubs will be planted at the top of the riverward bank throughout the entire project reach (383 ft).

- Site 22-4: 246 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket was extended landward from the top of the bank. No buried toe was constructed. A single willow lift spanning 239 LF was installed three ft above OHW; 482 willows were planted. After construction, spalls and gravel were placed on the levee crown and access ramps for a driving surface. Cleared vegetation consisted of four or five small brushy alders, a dense stand of Japanese knotweed, and grasses. As-built designs also show a single log at the toe.

- Site 22-5: 70 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall bench was extended landward from the top of the bank. No buried toe was constructed. Spalls and gravel were placed on the levee crown and access ramps to provide driving surfaces. Cleared vegetation consisted of approximately 30 LF of mixed yarrow and purple loosestrife, 40 LF of mixed-age riparian vegetation dominated by four larger cottonwoods and alders up to 45 feet tall. As-built designs also show unanchored logs at the toe.

- Site 22-6: 359 LF of levee was repaired in 2007. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket was extended landward from the top of the bank. No buried toe was constructed. Two willow lifts were installed, the first at 1.5 ft above OHW; 704 willows were planted. Spalls and gravel were placed on the levee crown and access ramps for a driving surface. Cleared vegetation consisted of nine cottonwoods, alders, and willows ranging from 30 to 50 feet tall. Grasses dominated the understory. As-built designs also show unanchored woody debris at the toe.

- Site 22-7: This site was deferred from the 2007 construction season, and is planned to be repaired in 2011. The damaged section is 350 LF at the point of Fir Island where the Skagit River splits into the North and South Forks. The site has scour at the toe and into the revetment face. Continued bank erosion will lead to levee failure. The levee will be repaired by re-grading the slope to 3H:1V, placing a spall blanket filter layer and riprap armor to create a toe and provide erosion protection. A double willow lift and anchored rootwads will be installed throughout the project site, with the lowest willow lift at OHW. Overstory trees will be planted along the riverward bench. The Corps will clear seven large cottonwoods and five mature alders greater than 12 inches dbh on the bench, ten to twelve smaller alders, and willows less than four inches dbh with a brushy understory along the revetment. Trees removed for the repair will be salvaged and used as anchored woody debris. To layback the slope throughout the repair area, a transition zone will be built to connect the layback to the upstream and downstream slopes. The transitions will be gradual to avoid scour and are expected to be approximately 40 ft on each side.

- Site 22-8: This 2007 repair consisted of 554 LF of levee restoration. The riverward slope was reshaped to 2H:1V and armored with a three-foot blanket of class IV riprap and extended to the top of the levee. No buried toe was constructed. Two willow lifts spanning 429 LF were installed at 2.5 ft above OHW; 838 willows were planted. As built drawings also show unanchored logs and debris at the toe. Spalls and gravel were placed on the levee crown and access ramps to provide a driving surface. Cleared vegetation consisted of a row of ten to twelve willows less than twenty-five feet tall, brush on river edge to a width of 25 LF from the river, and grasses located upstream of the willows. In 2011, excess rock placed on the bench during the 2007 repair will be removed as the additional weight of this rock could cause rotational failure. This excess rock will be reused at other repair sites.

- Site 22-9: 338 LF of levee was repaired in 2007. The riverward slope was reshaped to 1.5H:1V and armored with a three-foot blanket of class IV riprap. The spall blanket was extended landward from the top of the slope. No buried toe was constructed. Two willow lifts were installed spanning 208 LF in length and beginning at 1.5 ft above OHW; 408 willows were planted. As built drawings also show unanchored debris at the toe. Disturbed vegetation consisted of three small brushy willows and/or alders approximately four feet tall, a variety of small shrubs, and grasses.

- 22-10: This site is to be constructed in 2011. The site includes 300 LF of repair due to seepage through the levee and an over-steepened bank with missing toe rock. The revetment has approximately 40 clumps of willows and alders that have been cut and regrown many times so they have large trunks but small stems (1/2 to 1" DBH). The riverward slope will be reshaped to 1.5H:1V, spall rock will be placed, and a three-foot blanket of class IV riprap will be placed. Additionally an impermeable core will be excavated and built along the centerline of the levee to reduce seepage. No buried toe will be constructed. A double willow lift will be installed with the lowest lift at OHW. The riverward bank above the willow lifts will be covered in dirt and hydroseeded following construction. . . Two houses are in front of or on top of the levee near the end of the site.

- 22-11: This site is to be constructed in 2011. The site includes 800 LF of backslope repair due to seepage through the levee. No work along the riverward bank will be done; this site is behind a vegetated bench. The repair will be completed through installation of a keyway along the center of the levee by excavation and placement of a clay layer through the center of the levee. The bench will not need to be cleared or grubbed. Disturbance will occur to the levee crown, which is maintained as a grassy area. Following construction, the disturbed areas will be hydroseeded. No work will be completed on the riverward side so not mitigation is proposed.

- 22-12: This site will be repaired in 2011 and is behind a wide forested bench. No in-water work is needed. There is sloughing along the riverward face. The riverward face is soil, except for a length (124 ft) that was patched with rock. The levee face is dominated by blackberry and grass with no woody species. Many woody species are growing in the bench near the toe of the levee, some of which will be removed during construction. These include many willow saplings, 3 large cottonwoods (15" DBH), and 6 alders (2-12" DBH). Total length of repair area is 360 LF (including a 120 LF section that was repaired during the 2008/9 high water event). The riverward face will be re-sloped and covered in spall rock. Following construction the spall rock will be covered with topsoil and hydroseeded.

In the lower Skagit River, the designated window for in-stream construction to avoid and/or minimize impacts to salmonids is June 15 to August 31. Construction in 2007 was planned to occur within the work window; however, construction could not commence early enough to complete work within that period. In fact, construction did not start until only a few days before the closure of the fish window. Completion dates for in-water repairs at the sites in DD1 ranged from September 15 to October 7, 2007. Construction in DD3 ended between September 7 and September 25, 2007. Construction at sites in DD12 extended from September 4 through October 16. Construction at sites in DD17 extended from September 4 through October 19, 2007. At sites in DD22, construction extended from August 20 through November 15, 2007. All in-water work for the 2011 repairs is scheduled to be completed by August 31, 2011.

Most of the repairs were or will be completed within the original levee footprint as it existed before the November 2006 flood event. After completion of construction, the levee owners have been advised that willows growing at the OHW should not be cut, so that habitat benefits can be maintained. The willow species planted (namely Hooker and Sitka) tend to remain shrubs and do not grow over four inches dbh. Although, if the trees grow beyond four inches dbh, selective removal will be required in order to remain eligible for the Seattle District USACE PL 84-99 Levee Repair Program. These standards are set to maintain levee safety and allow for periodic inspection of the levee. The diking districts perform shrub maintenance and tree removal as part of their maintenance responsibilities.

In total, 27 of the 32 sites constructed in 2007 included willow lifts. The Corps completed 10,143 LF of construction along the riverward face of levees in 2007, of which approximately 6699 LF (66% of the total length) of willow lifts were installed. All but eight of these sites were revisited in 2008 or 2009 to check on the success of the lifts. Thirteen of the willow lifts are growing well, though some show slower growth than others. Five of the sites show sparse distribution indicating some loss of willows, though the surviving plants are generally growing well. One of these sparse sites shows evidence of beaver damage.

APPENDIX B: MITIGATION OPTIONS, RATIOS, AND OUTPUTS

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Note: The following pages were provided by the U.S. Army Corps of Engineers (USACE) during consultation and describe mitigation option, ratios, and outputs from working group discussions as follows:

Part 1: Habitat Capacity Mitigation Tool, reproduced from USACE Biological Assessment Appendix A (in part), dated November 2008, provided to the U.S Fish and Wildlife Service in December 2010.

> *(Note: While the Assessment was completed in 2008, its Appendix A was not provided in its final form until December 2010. The date at the bottom of these pages is apparently a template error, as this process was not undertaken for these projects until 2010.)*

Part 2: Habitat Capacity Mitigation Tool Outputs and Monitoring Details, reproduced from USACE Final Addendum to Biological Assessment (in part), dated March 2011.

- Habitat Capacity Mitigation Tool: Updated Outputs
- Monitoring Details by Mitigation Type

APPENDIX C: INVASIVE SPECIES REMOVAL PROTOCOLS

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Note: The following protocol was taken from the U.S. Army Corps of Engineers' March 2011 Addendum for the batched actions.

4.0 INVASIVE SPECIES REMOVAL PROTOCOLS

Five invasive species occur on the Skagit River Levees that this mitigation effort will target. They are Himalayan blackberry (*Rubus armeniacus*), reed canarygrass (*Phalaris arundinacea*), Canada thistle (*Cirsium arvense*), bittersweet nightshade (*Solanum dulcamara*), and Japanese knotweed (*Polygonum cuspidatum*).

Himalayan blackberry is a Class C noxious weed on the Washington State Noxious Weed List (Washington State Noxious Weed Control Board 2011) and is the most common invasive species on the Skagit levee repair sites. Class C weeds are considered common throughout the state and have no requirement for their control. Himalayan blackberry is abundant along rivers and wetland edges, often creating monocultures that prevent establishment of native species. Blackberry lacks the deep, bank stabilizing roots of native wetland shrubs and trees and may mask eroding banks (King County 2011a). Blackberry can be controlled by digging, mowing, herbicide, plowing, and/or livestock grazing. According to King County (2011a) the removal of top growth will eventually kill blackberry if done regularly and over several years. The protocol for blackberry removal at the Skagit levee repairs is to pull out new growth each spring and fall for approximately 5 years. Pulled vegetation will be removed from the site and disposed of properly. If the native plantings have become well-established before the 5 year mark and are shading the soil enough that blackberry would be unlikely to recolonize, weeding may be reduced. No chemicals (herbicides) will be applied for the removal of blackberry.

Reed canarygrass is a Class C noxious weed on the Washington State Noxious Weed List (Washington State Noxious Weed Control Board 2011). As with blackberry, class C weeds are considered common throughout the state and have no requirement for their control. Reed canarygrass will be removed from the sites during the clearing of each site for construction. Reed canarygrass is a wetland plant that grows in soils that are saturated or nearly saturated for much of the growing season (Ecology 2011). Shading is an effective method for controlling reed canarygrass (USDA-NRCS 2001). Willow lifts are expected to create dense shade that will control the growth of this species along the water line. No chemicals (herbicides) will be applied for the removal of this species.

Canada thistle is a Class C noxious weed on the Washington State Noxious Weed List (Washington State Noxious Weed Control Board 2011). Skagit County lists this as a Class C weed but designates it as being selected for control (Skagit County Noxious Weed Control Board 2011). Canada thistle grows poorly in shade. The protocol for removal of Canada thistle at the Skagit levee repairs is to pull out new growth each spring and fall for approximately 5 years. Pulled vegetation will be removed from the site and disposed of properly. If the native plantings have become well-established before the 5 year mark and are shading the soil enough that Canada thistle would be unlikely to recolonize, weeding may be reduced. No chemicals

(herbicides) will be applied for the removal of this species.

Bittersweet nightshade is originally from Europe and is now widespread throughout North America (King County 2011c). Due to its prevalence, the species is not listed on the Washington State Noxious Weed List (King County 2011c), nor is it listed on the Noxious Weed List for Skagit County (Skagit County Noxious Weed Control Board 2011). This plant will be removed during the clearing of each site for construction and sites will be monitored for its presence. No chemicals (herbicides) will be applied for the removal of this species.

Japanese knotweed is a Class B noxious weed on the Washington State Noxious Weed List (Washington State Noxious Weed Control Board 2011). Class B weeds are designated for control in the regions where they are not yet wide-spread. Skagit County Noxious Weed Board (2011) places knotweed in Class B, which is defined as weeds of "limited distribution whose populations within a region or area are such that all seed production can be prevented within a year. Control is required in Skagit County." As with blackberry, knotweed creates monocultures that provide poor erosion control and displace native vegetation due to aggressive growth (King County 2011b). The Diking Districts have been controlling knotweed for a several years with a variety of methods. Current treatments, as provided by the Skagit Fisheries Enhancement Group (SFEG), include the following:

1. manual bending of stems taller than 1 meter during surveys in spring and early summer,
2. treat knotweed with a foliar spray using a mix of 1% Imazapyr (Polaris AQ) and 1% Agridex surfactant with 50 oz hand sprayers or 4-gallon backpack sprayers. Herbicide treatments begin in July and continue until the first freeze in mid/early October. SFEG suggests using a calibrated volume and product rate of 50/gal per acre, which equates to 4 pints of Imazapyr per acre, less than the label limit of 6 pints per acre, and
3. Maps of knotweed locations with treatment type noted. These areas will be monitored each year with continued notes on the patch status.

As Japanese knotweed is a regulated weed and control is required, treatments are expected to continue for a minimum of five years but may continue longer as required. It is expected that the efforts will allow the establishment of native vegetation such that the mitigation areas will no longer be suitable for knotweed colonization.
Imazapyr is a broad-spectrum herbicide that is most effective when the vegetation is actively growing (Ecology 2009). It is relatively non-toxic to conifers, but is toxic to many other nontarget
plants. Imazapyr is an enzyme inhibitor in plants, disrupting the synthesis of a certain type of protein. Imazapyr does not bioconcentrate (EPA 2006). Photodegradation of Imazapyr is the primary form of degradation in water where it has a half life of 2.5 to 5.3 days (EPA 2006). Ecology (2009) performed a risk assessment study that showed that no adverse effects to humans, as well as terrestrial and aquatic animals, are plausible from typical to worst-case scenario exposure.
AgriDex is a derivative of a paraffin-based petroleum oil (Ecology 2006). Crop-oils promote penetration of an herbicide spray (Ecology 2006). According to a USFWS (2011) review of

herbicides in a training document, “Agri-Dex is the surfactant [within their test group, that is] least acutely toxic to aquatic invertebrates and fish when tested by itself.” The training document goes on to say that this chemical does not contain the suspected endocrine disruptors that are found in other herbicides, which have been shown to affect testicular growth and plasma vitellogenin induction in adult male rainbow trout. The USFWS paper cautions that population level effects are unstudied.

APPENDIX D: SUSPENDED SEDIMENT MONITORING PLAN (PART 1) AND DISCUSSION OF EFFECTS (PART 2)

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PART 1: SUSPENDED SEDIMENT MONITORING PLAN

Note: The following monitoring plan was taken from the U.S. Army Corps of Engineers' March 2011 Addendum, with minor clarifications added in [brackets].

SEDIMENT MONITORING PROTOCOLS

As requested by USFWS, the Corps has reviewed and applied [a suspended sediment analysis based on Newcombe and Jensen 1996 and Anderson et al. 1996] regarding the impacts of suspended solids on bull trout. Muck (USFWS 2010) reviewed literature to determine bull trout tolerance thresholds of suspended solids so as to limit impacts to individual bull trout and their habitat. Because field measurement of suspended solids is difficult, the report details a regression analysis that predicts the levels of suspended solids with easily obtained turbidity measurements. This allows the establishment of thresholds that can be easily quantified in the field during construction. See Attachment E for the analysis.

Monitoring will occur during sediment-generating activities. Each new type of sediment generating activity will be monitored. If monitoring shows that a particular type of activity is not causing exceedances, then that type of activity will not be monitored at each new site unless the existing conditions at the sites are notably different. For example, in-water bank resloping will occur at multiple sites to create stable riverward slopes. This activity will be monitored at the first three sites where it occurs. If no exceedances occur, or if an exceedance is shown to be remedied by a modified construction method that can be repeated at all future sites, then this sediment-generating activity will not be further monitored. However, if anchored rootwad placement is monitored at sites in Diking Districts 12 and 17, that sediment-generating activity would need to be monitored when constructed in Diking District 3 because the river bottom and velocities are significantly different.

Sediment-generating activities expected to occur during construction include, but are not limited to the following:

- In-water resloping of the banks, which includes general resloping to a stable 2H:1V as well as fish bench and layback installation,
- Boulder placement for toe rock and for construction of the habitat weir, and
- Rootwad placement due to soil in the roots and placement of the boulder.

Monitoring will consist of the following procedures:

- Establish background turbidity levels each day during sediment-generating activities. Levels will be rechecked if river clarity changes.
- Monitor turbidity immediately downstream of sediment-generating activity, as safety permits, at approximately 1/3 and 2/3 depth twice in the first hour at 15 minute intervals and then once every 3 hours if no exceedance is noted.
- Maximum turbidity levels will be the lower of either,
    - Washington State Code 173-201A-200 which allows up to 10 % above background or 5 NTU above background if background levels are less than 50 NTU, or
    - As determined by [USFWS 2010] to minimize salmon impacts
        - Between 0-1 hours, NTU levels must not exceed 21 NTUs above background turbidity levels, and
        - After one hour, NTU levels must not exceed 7 NTUs above background turbidity levels.
- If, after a minimum of one to two full days, the monitoring results verify that turbidity levels from sediment-generating activities are remaining consistent with the above values, turbidity monitoring may be reduced or stopped. Monitoring would be resumed during sediment-generating activities if precipitation events or any other changes would result in higher or lower project-related turbidity.
- If turbidity levels exceed the above values, activities will cease and actions will be taken to avoid or reduce turbidity levels. Monitoring would then continue every fifteen minutes, through construction until measures show three consecutive measurements below the thresholds. Then the Corps will continue monitoring as normal.
- The Corps will complete a final monitoring report after construction.

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APPENDIX D, PART 2: 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. 2001, 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 (Ahearn 2002, p .2; Uehlinger et al. 2002, p. 1).

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 et al. 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 (Berry et al. 2003, pp. 4, 7; Judy et al. 1985 as cited in Henley et al. 2000, p. 126). 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 (Birtwell 1999, p. 7; FAO 1976, pp. 13, 15). 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 (Berry et al. 2003, p. 7; Rhodes et al. 1994, pp. 16-21). 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 (Barrett et al. 1992, p. 437; Bash et al. 2001, p. 9; Berry et al. 2003, p. 33; Lake and Hinch 1999, p. 865; McLeay et al. 1987, p. 671; Newcombe and MacDonald 1991, pp. 72, 76, 77; Vondracek et al. 2003, p.

1005; Watts et al. 2003, p. 551). 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 1995, 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 et al. 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. 2001, 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 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.

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 (Bash et al. 2001, pp. 3-4; Waters 1995, pp. 13-14). 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 nephelometric turbidity units (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. 2001, 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 1995, p. 2). Particle diameters less than 6.4 mm are generally defined as “fines” (Bjornn et al. 1977, p. 1; Bjornn and Reiser 1991, p. 103; Castro and Reckendorf 1995, p. 2; Chapman 1988, p. 14; Hillman et al. 1987, p. 185; MBTSG 1998, p. 8; Rieman and McIntyre 1993, p. 6; Shepard et al. 1984, p. 148).

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 (Bash et al. 2001, p. 10; Newcombe and MacDonald 1991, pp. 72-73; Waters 1995, pp. 81-82)

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. 2001, 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. 2001, 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 1991, 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. 2001, 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 (Anderson et al. 1996, p. 13; Cederholm and Reid 1987, p. 384). 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 (Bash et al. 2001, pp. 17-18; Cederholm and Reid 1987, p. 384; Chapman 1988, pp. 12-16), delay development of alevins (Everest et al. 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 et al. 1987, p. 113). Sedimentation fills the interstitial spaces and can prevent alevins from emerging from the gravel (Anderson et al. 1996, p. 13; Suttle et al. 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 et al. 1991, p. 99). A decrease of 30 percent in mean egg-to-fry survival can be expected to reduce salmonid fry production to extremely low levels (Slaney et al. 1977, p. 33).

<u>Indirect Effects</u>

Macroinvertebrates

Sedimentation can have an effect on bull trout and fish populations through impacts or alterations to the macroinvertebrate communities or populations (Anderson et al. 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 et al. 1996, p. 14; Henley et al. 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 (Anderson et al. 1996, pp. 14-15; Reid and Anderson 1999, pp. 10-12; Shaw and Richardson 2001, p. 2220; Waters 1995, pp. 61-78). 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 et al. 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) (Henley et al. 2000, pp. 126, 130; Reid and Anderson 1999, p. 10; Shaw and Richardson 2001, p. 2219; Suren and Jowett 2001, p. 726; Suttle et al. 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 (Berry et al. 2003, pp. 8, 11; Cederholm and Reid 1987, p. 384; Shaw and Richardson 2001, p. 2218). The effect of turbidity on light transmission has been well documented and results in increased invertebrate drift (Birtwell 1999, pp. 21, 22; Waters 1995, p. 58). 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 et al. 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 et al. 1996, p. 14; Berry et al. 2003, p. 11; Birtwell 1999, p. 21; Shaw and Richardson 2001, p. 2213; Suren and Jowett 2001, pp. 725-726). 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. 2001, 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 et al. 1992, pp. 437, 440; Bash et al. 2001, p. 21; Henley et al. 2000, p. 133). 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 et al. 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 (Bash et al. 2001, pp. 21-23; Klein 2003, pp. 1, 21; Sweka and Hartman 2001, p. 141). 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. 2001, 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 characteristics 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 et al. 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 habitats (Anderson et al. 1996, pp. 11-15; Bash et al. 2001, 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 1995, 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. 2001, 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 et al. 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. 1977, 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. 1977, 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 et al. 1987, p. 194). Deposition of sediment on substrate may lower winter carrying capacity for bull trout (Shepard et al. 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 (MBTSG 1998, p. 9; Rieman and McIntyre 1993, p. 6; Shepard et al. 1984, p. 153). 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 et al. 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 1998, p. 9). The reduction of rearing habitat will ultimately reduce the potential number of recruited juveniles and therefore reducing population numbers (Shepard et al. 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 et al. 1996, p. 12). This can reduce available fish habitat, decrease fish holding capacity, and decrease fish populations (Anderson et al. 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, pp. 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 et al. 1996, pp. 5-6; Jacobson et al. 2003, p. 2; USEPA 2001, pp. 1-2). At the individual level, stress may affect physiological systems, reduce growth, increase disease, and reduce the individual's ability to tolerate additional stress (Anderson et al. 1996, p. 7; Bash et al. 2001, p. 17). At the population level, the effects of stress may include reduced spawning success, increased larval mortality, and reduced recruitment to succeeding life stages and, therefore, overall population declines (Bash et al. 2001, 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 (Barton 2002, p. 517; Davis 2006, p. 116; Gregory and Wood 1999, p. 286; Schreck et al. 2001, p. 5). 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 (Barton 2002, p. 517; Haukenes and Buck 2006, p. 385; Mazeaud et al. 1977, p. 201). 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 (Barton 2002, p. 517; Pickering et al. 1982, p. 229; 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 et al. 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 et al. 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 et al. 1996, p. 5). In a natural system, fish are exposed to multiple chemical and physical stressors which can combine to cause adverse effects (Berry et al. 2003, p. 4). The chemical releases from each stressor results in a cumulative or additive response (Barton et al. 1986, pp. 245, 247; Cobleigh 2003, pp. 16, 39, 55; Milston et al. 2006, p. 1172; USEPA 2001, pp. 3-25).

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 et al. 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 1991, 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 1991, p. 497).

Once exposed to a stressor, the primary chemical releases can take one-half to twenty-four hours to peak (Barton 2002, p. 520; Quigley and Hinch 2006, p. 437; Schreck 1981, p. 298). Recovery or return of the primary chemical release to normal or resting levels can take two hours to two weeks (Mazeaud et al. 1977, pp. 205-206; Schreck et al. 2001, 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 et al. 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. 2001, 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 et al. 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 et al. 1996, p. 6; Bash et al. 2001, pp. 19-25; Suttle et al. 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. 2001, 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 (Bash et al. 2001, pp. 12, 20; McLeay et al. 1987, pp. 670-671; Suttle et al. 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 (Bash et al. 2001, p. 20; Berg and Northcote 1985, p. 1416).

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 1998, 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. 2001, p. 29).

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APPENDIX E: STATUS OF THE SPECIES – BULL TROUT

APPENDIX E: 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. 165-166; Leary and Allendorf 1997, pp. 716-719).

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. 6672-6673; 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. vi-viii; 2004a, Vol. 2 p. 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. 210-218, 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 2004b). 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 2004b).

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 (IDFG, 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, 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. 135-137; 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. 135-137; 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. 293-294; Sedell and Everest 1991, p. 1; Watson and Hillman 1997, pp. 246-250). 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 (Gilpin, in litt. 1997, pp. 4-5; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1114). 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. 118-120). 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. 426-427; Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1117). 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, pp. 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. 121-122; Fraley and Shepard 1989, pp. 135-137; Rieman and McIntyre 1993, p. 2; Rieman and McIntyre 1995, p. 288; Rieman et al. 1997, p. 1114). 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 (Gamett, pers. comm. 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. 135-137; 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. 367-369; Thomas 1992, pp. 4-5; Watson and Hillman 1997, pp. 247-249). 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. 135-137; 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 (Ratliff and Howell 1992 in Howell and Buchanan 1992, pp. 10, 15; Pratt 1992, pp. 5-6).

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, 1079-1080; Frissell 1993, p. 350; Goetz et al. 2004, pp. 45, 55, 60, 68, 77, 113-114, 123, 125-126). 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, pp. 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. 239-243; 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 F: STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

APPENDIX F: STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

Legal Status

Current Designation

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (70 FR 63898); the rule becomes effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species' coterminous range, which includes the Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units)[1]. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table 1. Stream/shoreline distance and reservoir/lake area designated as bull trout critical habitat by state.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir /Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total	19,729.0	31,750.8	488,251.7	197,589.2

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

This rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning

[1] The Service's 5 year review (USFWS 2008, pg. 9) identifies six draft recovery units. Until the bull trout draft recovery plan is finalized, the current five interim recovery units are in affect for purposes of section 7 jeopardy analysis and recovery. The adverse modification analysis does not rely on recovery units.

migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. See Tables 2 and 3 for the list of excluded areas. 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. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

Table 2.—Stream/shoreline distance excluded from bull trout critical habitat based on tribal ownership or other plan.

Ownership and/or Plan	Kilometers	Miles
Lewis River Hydro Conservation Easements	7.0	4.3
DOD – Dabob Bay Naval	23.9	14.8
HCP – Cedar River (City of Seattle)	25.8	16.0
HCP – Washington Forest Practices Lands	1,608.30	999.4
HCP – Green Diamond (Simpson)	104.2	64.7
HCP – Plum Creek Central Cascades (WA)	15.8	9.8
HCP – Plum Creek Native Fish (MT)	181.6	112.8
HCP–Stimson	7.7	4.8
HCP – WDNR Lands	230.9	149.5
Tribal – Blackfeet	82.1	51.0
Tribal – Hoh	4.0	2.5
Tribal – Jamestown S’Klallam	2.0	1.2
Tribal – Lower Elwha	4.6	2.8
Tribal – Lummi	56.7	35.3
Tribal – Muckleshoot	9.3	5.8
Tribal – Nooksack	8.3	5.1
Tribal – Puyallup	33.0	20.5
Tribal – Quileute	4.0	2.5
Tribal – Quinault	153.7	95.5
Tribal – Skokomish	26.2	16.3
Tribal – Stillaguamish	1.8	1.1

Tribal – Swinomish	45.2	28.1
Tribal – Tulalip	27.8	17.3
Tribal – Umatilla	62.6	38.9
Tribal – Warm Springs	260.5	161.9
Tribal – Yakama	107.9	67.1
Total	3,094.9	1,923.1

Table 3. Lake/Reservoir area excluded from bull trout critical habitat based on tribal ownership or other plan.

Ownership and/or Plan	Hectares	Acres
HCP – Cedar River (City of Seattle)	796.5	1,968.2
HCP – Washington Forest Practices Lands	5,689.1	14,058.1
HCP – Plum Creek Native Fish	32.2	79.7
Tribal – Blackfeet	886.1	2,189.5
Tribal – Warm Springs	445.3	1,100.4
Total	7,849.3	19,395.8

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898:63943 [October 18, 2010]). 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. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with Primary Constituent Elements (PCEs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs 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. 314-315; 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. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

The Olympic Peninsula and Puget Sound CHUs are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound population segment.

These CHUs contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult foraging, overwintering, and migration.

Primary Constituent Elements for Bull Trout

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. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the following PCEs are essential for the conservation of bull trout.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

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

4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

5. Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

6. In spawning and rearing areas, substrate 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. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The revised PCE's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PCE to address the presence of nonnative predatory or competitive fish species. Although this 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.

Note that only PCEs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PCEs 1 and 6. Additionally, all except PCE 6 apply to FMO habitat designated as critical habitat.

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. 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. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent 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 no longer serving the intended

conservation role for the species or retaining those PCEs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898:63943; 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). Thus, 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, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (75 FR 63898:63943).

Current Critical Habitat 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. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

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.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may

directly threaten the integrity of the essential physical or biological features described in PCEs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Consulted on Effects for Critical Habitat

The Service has formally consulted on the effects to bull trout critical habitat throughout its range. Section 7 consultations include actions that continue to degrade the environmental baseline in many cases. However, long-term restoration efforts have also been implemented that provide some improvement in the existing functions within some of the critical habitat units.

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