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United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

JUN - 7 2010

In Reply Refer To:
13410-2008-F-0384

Michelle Walker
Department of the Army
Seattle District, Corps of Engineers
ATTN: Rebecca McAndrew
P.O. Box 3755
Seattle, Washington 98124-3755

Dear Ms. Walker:

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) based on our review of the proposed State Route 410 White River CED (MP 41.4 - 42.0) project in Pierce and King Counties, Washington, and its effects on the bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), and bull trout critical habitat, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Your request for initiation of formal consultation, dated May 28, 2008, was received in our office on May 29, 2008. The U.S. Army Corps of Engineers (Corps) provided information in support of "may affect, likely to adversely affect" determinations for the bull trout, marbled murrelet, and northern spotted owl (*Strix occidentalis caurina*), and a "may affect, not likely to adversely affect" determination for bull trout critical habitat. On December 8, 2008, we received additional information from the Washington State Department of Transportation (WSDOT) and Corps, and initiated formal consultation on the project.

The enclosed Opinion addresses the proposed action's adverse effects on the bull trout and marbled murrelet, and includes mandatory terms and conditions intended to minimize certain adverse effects. In addition, the Opinion finds that the action's foreseeable effects on northern spotted owl behaviors, its habitat, and prey base are insignificant. No measurable adverse effects to the northern spotted owl or its habitat are anticipated.

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These portions of the White River are currently excluded from the bull trout critical habitat designation. Recently, however, the Service proposed revisions to designated bull trout critical habitat (75 FR 2270 [January 14, 2010]), and it is uncertain at this time whether the Service will continue to exclude these waters from the final designation. The Opinion addresses the proposed action's adverse effects on bull trout critical habitat, and concludes that the proposed action "will not destroy or adversely modify" bull trout critical habitat. The WSDOT and Corps should notify the Service if this portion of the White River is included in the final bull trout critical habitat re-designation prior to completion of the proposed project. Assuming there have been no changes to the project with significance for bull trout critical habitat, and the basis for this conference remains unchanged, no additional information should be needed to concur with a "may affect, likely to adversely affect" determination.

If you have any questions regarding the Opinion or your responsibilities under the Endangered Species Act, please contact Ryan McReynolds at (360) 753-6047 or Emily Teachout at (360) 753-9583 of this office.

Sincerely,

Martha L. Jensen

for Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc:
WSDOT – NW Region, Seattle, Washington (B. Bigler)
WSDOT – Environmental Services Office, Olympia, Washington (P. Wagner)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference: 13410-2008-F-0384

State Route 410, White River CED (MP 41.4 - 42.0)

Pierce and King County, Washington

Agency:

U.S. Army Corps of Engineers, Seattle District
Seattle, Washington

Consultation Conducted By:

U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

for Martha L. Jensen

Ken S. Berg, Manager
Washington Fish and Wildlife Office

6/7/10
Date

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LIST of ABBREVIATIONS and ACROYNMS

Act	Endangered Species Act
Addendum	Biological Assessment Addendum
BA	Biological Assessment
BMP	Best Management Practices
CED	Chronic Environmental Deficiency
CMZ	Channel Migration Zone
Corps	U.S. Army Corps of Engineers
cy	Cubic Yard
dbh	Diameter Breast High
ELJ	engineered log jams
FFSP	Federation Forest State Park
FMO	Foraging Migration and Overwintering
FWS	U.S. Fish and Wildlife Service
Hz	Hertz
LWM	Large Woody Material
m	Meter
mi	Mile
mm	Millimeter
MP	Milepost
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity units
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
PCE	Primary Constituent Element
project	State Route 410 White River Chronic Environmental Deficiency (MP 41.4 - 42.0) Project
RPM	Reasonable and Prudent Measures
SEL	Sound Exposure Level
SEV	Severity-of-Effect
SPCC	Spill Prevention, Control, and Countermeasures
SPL	Sound Pressure Level
SR	State Route
TL	Transmission Loss
TTS	Temporary Threshold Shift
WDFW	Washington State Fish and Wildlife Service
WSDOT	Washington State Department of Transportation

CONSULTATION HISTORY

The Washington State Department of Transportation (WSDOT) and U.S. Army Corps of Engineers (Corps), Seattle District, propose to raise a 0.5 mile (mi) segment of State Route (SR) 410 and construct a series of six engineered log jams (ELJs) and groins along approximately 1,000 linear ft of the White River in Pierce and King Counties, Washington. The State Route 410 White River Chronic Environmental Deficiency (CED) (MP 41.4 - 42.0) project (project) will stabilize the roadway embankment and prevent overtopping of SR 410 at a location where chronic right-bank erosion has frequently required road closures, placement of bank armoring (often under emergency conditions), and other related maintenance activities.

The proposed project is funded under the WSDOT's CED program. The CED program aims, in part, to reduce the potential for environmental damage at sites that have required (or may require) repetitive roadway maintenance repairs. The project will require a Clean Water Act section 404 permit. Issuance of a section 404 permit establishes a nexus requiring consultation under section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. l53I et seq.) (Act).

The U.S. Fish and Wildlife Service (FWS) based this Biological Opinion (Opinion) on the following sources of information: the Biological Assessment (BA), dated February 2008 and received on May 29, 2008; the BA Addendum (Addendum), dated April 28, 2008, and received on May 29, 2008; WSDOT responses to our questions and comments (including attachments), received electronically on December 8, 2008; a field review of the project site (August 13, 2008 and January 13, 2009); and various scientific literature and personal communications cited herein. A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Lacey, Washington.

The following timeline summarizes the history of this consultation:

May 29, 2008 – The Corps submits a BA, Addendum, and request for formal consultation with the effect determination of "may affect, likely to adversely affect" for bull trout (*Salvelinus confluentus*) and designated bull trout critical habitat, marbled murrelet (*Brachyramphus marmoratus*), and northern spotted owl (*Strix occidentalis caurina*).

July 31, 2008 – We send a request for additional information to the Corps and WSDOT regarding potential effects to bull trout, marbled murrelet, northern spotted owl, and their habitat.

August 13, 2008 – We conduct a site visit and meet to discuss the project with WSDOT design and environmental staff, the National Marine Fisheries Service (NMFS), and fisheries staff from the Puyallup Tribe of Indians.

December 8, 2008 – WSDOT and the Corps provide responses to our request for additional information; we initiate formal consultation.

February 15, 2009 – The WSDOT notifies us that funds for the project have been withdrawn; we agree to complete consultation as time and workload allows.

CONCURRENCE FOR NORTHERN SPOTTED OWL

The proposed project is approximately 18 mi east of Enumclaw, Washington, at an elevation of 1,700 ft above mean sea level. Land use throughout the action area consists of mixed-use Federal and State forestland, private commercial timberland, and small rural residential development. The Federation Forest State Park (FFSP) is an approximately 620-acre State park and forest preserve supporting large, intact stands of mature, late-seral coniferous and mixed deciduous-coniferous forest. The terrestrial component of the action area includes all of FFSP and a surrounding mosaic of second and third-growth, private, commercial, and State forests.

Available data indicate that the action area includes a portion of two historic northern spotted owl territories, both with site centers located between 1.5 and 2.0 mi northeast of the project. Activity at the "Slippery Creek" site (reproductive pair) and "Slippery Creek Upper" site (resident single) was last documented during the 1990s. Available data also identified a single northern spotted owl detection (dated 1992) within FFSP, approximately 0.9 mi west of the project. Outside of the action area, larger concentrations of historic and active northern spotted owl nest territories are located to the south and east at a distance of 4.0 to 5.0 mi.

The Corps and WSDOT have provided information in support of a "may affect, likely to adversely affect" determination for the northern spotted owl. Temporary increases in sound associated with impact pile driving and proofing are expected to have the farthest reaching effects in the terrestrial environment. While stands within the action area provide suitable dispersal and foraging habitats, FFSP is small relative to the median northern spotted owl home range (i.e., 1.8 mi radius or approximately 6,500 acres), and outside FFSP the action area includes only small, fragmented, discontinuous patches of potentially suitable nesting habitat.

We conducted an independent analysis of in-air sound transmission and attenuation using conservative assumptions. Our assessment finds that increased sound levels are likely to exceed ambient in-air sound levels to a distance of approximately 2 mi, but also that the sound-only injury effects threshold (92 dBA) should not be exceeded to a distance of more than 220 ft from the locations of impact pile driving activities.

We conducted a field reconnaissance survey of the SR 410 right-of-way within FFSP, and visually inspected the project's clearing-and-grubbing limits and surrounding upland habitats to a distance of approximately 500 ft north of SR 410 (R. McReynolds pers. comm. 2009). While walking the area where we expect 92 dBA would extend, we observed no large snags, broken-topped trees, or large cavities suitable for northern spotted owl nest sites. This, combined with the small size and linear dimensions of FFSP, and in light of the larger landscape context, suggests that the presence of nesting northern spotted owls within 220 ft of pile driving activities is extremely unlikely.

The Corps and WSDOT do not propose, because of other environmental constraints (i.e., approved in-water work windows), to avoid construction during the early or late northern spotted owl nesting seasons (i.e., March 1 to July 15 and July 16 to September 30, respectively). However, from March 1 through September 30 of each year of construction, the project will observe a "daylight-only" work timing restriction. All work, including onsite staging, will be

completed between 2 hours after sunrise and 2 hours before sunset.

Construction of the proposed project will result in temporary increases in sound and human activity. Northern spotted owls that nest, forage, or disperse in the vicinity of the project may experience temporarily elevated levels of sound and human activity. However, increases in sound and human activity will be of short duration and will occur only during daylight hours, when northern spotted owls are less active. The sound-only injury effects threshold should not be exceeded to a distance of more than 220 ft, and therefore disturbance sufficient to cause missed feedings or a flushing response will not extend to any suitable and potentially occupied nesting habitats. Given the nature, timing, and duration of the proposed project, and with implementation of the proposed conservation measures, effects to normal northern spotted owl behaviors (including crepuscular movements, nesting, foraging, and dispersal) will be insignificant. No measurable adverse effects to northern spotted owl behaviors are anticipated.

The project will clear and grub approximately 2.4 acres, including mature coniferous and deciduous trees to the south and north of SR 410. Approximately 170 trees will be cleared as a narrow (but more or less continuous) strip directly adjacent and to the north of SR 410, and from smaller pockets of trees that lie to the south of SR 410 between the roadway and river. These trees range in size from 4 to 50 inches diameter-at-breast-height (dbh), and include approximately three dozen trees greater than 21 inches dbh.

The proposed project will have no measurable adverse effects on northern spotted owl habitat, the northern spotted owl prey base, or availability of food resources. The project will not diminish the function or productivity of adjoining forested stands as northern spotted owl habitat in either the short or long term. The project will not result in changes in the function of the highway infrastructure and there are no foreseeable indirect effects to northern spotted owls or northern spotted owl habitat that might occur later in time. Foreseeable direct and indirect effects to the northern spotted owl, its habitat, and prey base are insignificant.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The WSDOT and Corps propose to raise a 0.5 mi segment of SR 410 and construct a series of six ELJs and groins along approximately 1,000 linear ft of the White River. The project is intended to stabilize the roadway embankment and prevent overtopping of SR 410 at a location where flood events and chronic right-bank erosion have frequently required road closures, placement of bank armoring, and other related maintenance activities.

The project is in Section 9 of Township 19 North, Range 9 East, along a portion of the White River which serves as the border between Pierce and King Counties (Figure 1). The project is located within FFSP, approximately 18 mi east of Enumclaw, Washington, and approximately 1

mi downstream of the confluence of the White River and Greenwater River [Water Resources Inventory Area 10 – Puyallup-White; hydraulic unit code 17110014 (Puyallup)].

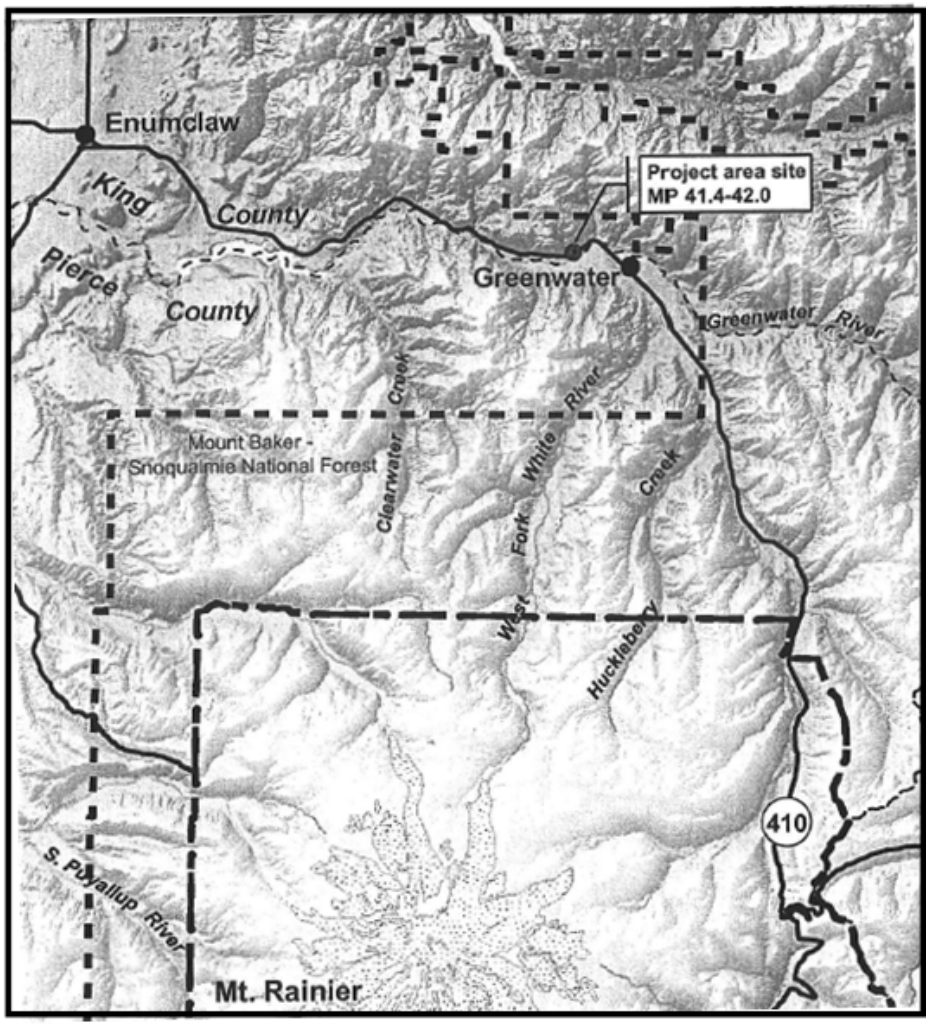

Figure 1 Vicinity map.

From milepost (MP) 38 through MP 62, SR 410 is constructed on alluvial sediments in the floodplain and channel migration zone (CMZ) of the middle and upper White River (Herrera Environmental 2007). The WSDOT has identified more than a dozen locations along these portions of SR 410 where bank erosion and flooding have damaged, or pose a high risk of damaging, the roadway embankment, shoulders, and travel lanes. At many of these locations bank armoring has been used to repair damage (at some locations repeatedly) and to mitigate the risk of damage (Herrera Environmental 2007).

The White River originates in steep headwaters, which are prone to landslides and debris flows. It transports large quantities of coarse and fine glacial sediment, and experiences frequent overbank flows and flooding in response to seasonal rain-on-snow precipitation and glacial melting (Herrera Environmental 2007). These conditions, which contribute to the White River's natural tendency for stream bed and bank instability, are today exaggerated as a result of past

and present land use practices, including the systematic removal of large woody material (LWM) during the 1970s and the loss or reduction of riparian/floodplain forested buffers. Throughout much of its length, the middle and upper White River exhibits a highly dynamic braided channel form, with a propensity for stream bed and bank instability, side channel development (or reactivation), and channel migration or avulsion (Herrera Environmental 2007).

The WSDOT and Corps have identified site- and reach-scale mechanisms (or causes) for failure, including the following (WSDOT 2008a): excessive coarse sediment supply, channel aggradation, lack of channel roughness, entrainment of the channel thalweg and heightened shear forces along the roadway embankment, hydraulic erosion of the embankment toe and armor under high-flow conditions, and, periodic overtopping leading to prolonged flooding and road closure. The WSDOT and Corps have acknowledged this portion of SR 410 acts as an artificial constraint on the White River's CMZ and floodplain (Figure 2).

The WSDOT and Corps evaluated a variety of design alternatives (WSDOT 2008b). These included vegetated or bioengineered bank stabilization, augmented riprap bank armor protection, dikes, retaining walls, and log or wood crib walls. In each case, it was determined there is insufficient room to implement the alternative and/or the alternative is likely to exacerbate (rather than reduce) shear velocities and forces. The WSDOT and Corps also considered elevating this portion of SR 410 on a constructed viaduct, or relocating the roadway further to the north and outside of the CMZ and floodplain. Funding constraints, unavoidable impacts to valued aesthetic and natural resources (including mature forest), and public opposition are the reasons cited for not pursing these final two alternatives (WSDOT 2008b).

The proposed project would raise the roadway and build stream bed and stream bank stabilization measures that are intended to serve as a permanent solution to the frequent flooding and bank erosion that occurs along this segment of SR 410. Subject to the constraints imposed by available right-of-way and proximity to sensitive resources, the project includes design elements that address causes for failure within the project reach and, to the extent practicable, avoid and minimize (or offset) impacts to instream habitat structure and function.

Figure 2 View of the existing right bank riprap revetment within the project limits.

The project would apply techniques endorsed by the Integrated Streambank Protection Guidelines (ISPG) (WDFW/WSDOT/ WDOE 2003). A series of approximately five ELJs, three bio-engineered "lenticular bars", and one buried groin (Figures 3 through 5) would function to redirect flow, increase channel roughness, and reduce or dissipate flow velocities and forces. The design would further increase bank and floodplain roughness along the reach, and compensate for unavoidable impacts to riparian and stream buffers by planting woody and herbaceous vegetation throughout the reconstructed roadway embankment (inter-planted rock slope protection) and along a portion of the upstream, right bank, floodplain bench.

The WSDOT and Corps expect the project will eliminate, or greatly reduce, the frequency of overtopping and flooding at the site, dissipate shear forces, and encourage movement of the channel thalweg away from the right bank. The project will reinforce an existing artificial constraint on the CMZ and floodplain, but would also improve instream habitat function compared to the existing smooth riprap revetment. The WSDOT and Corps expect the project will permanently stabilize the roadway embankment in a manner that creates and maintains functioning, diverse instream habitat, and avoids the damage resulting from repeat emergency repairs.

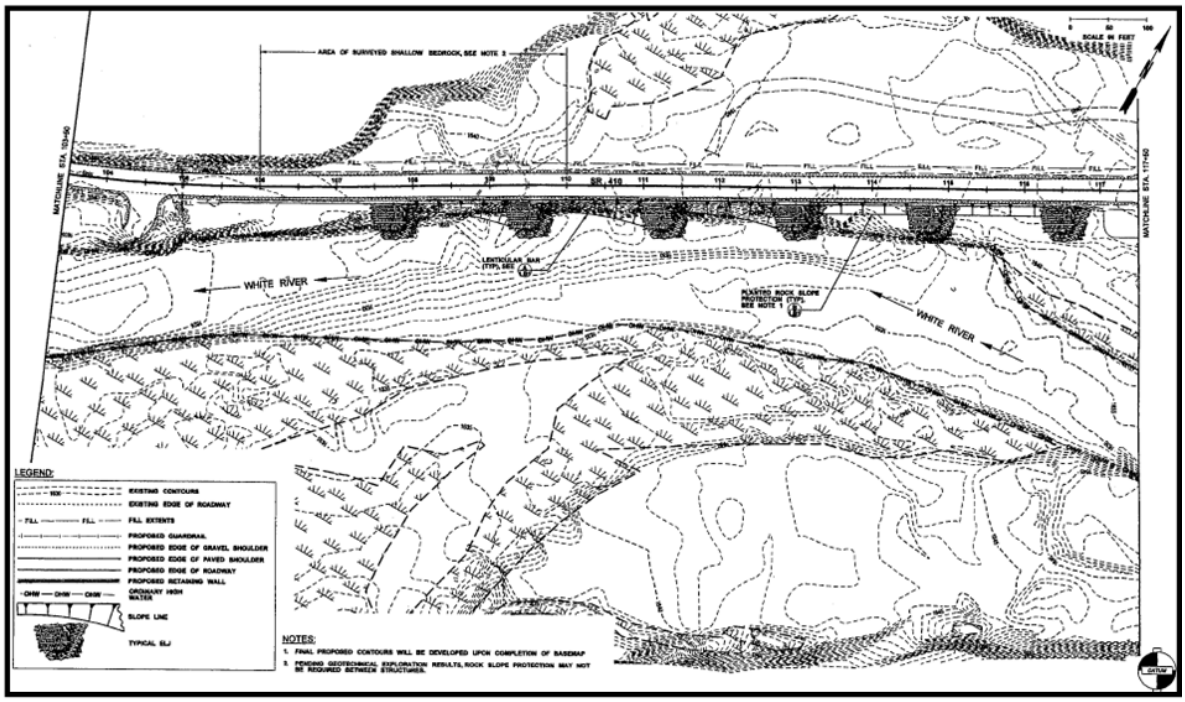

Figure 3 Roadway alignment, channel morphology, ELJs and groins in plan view.

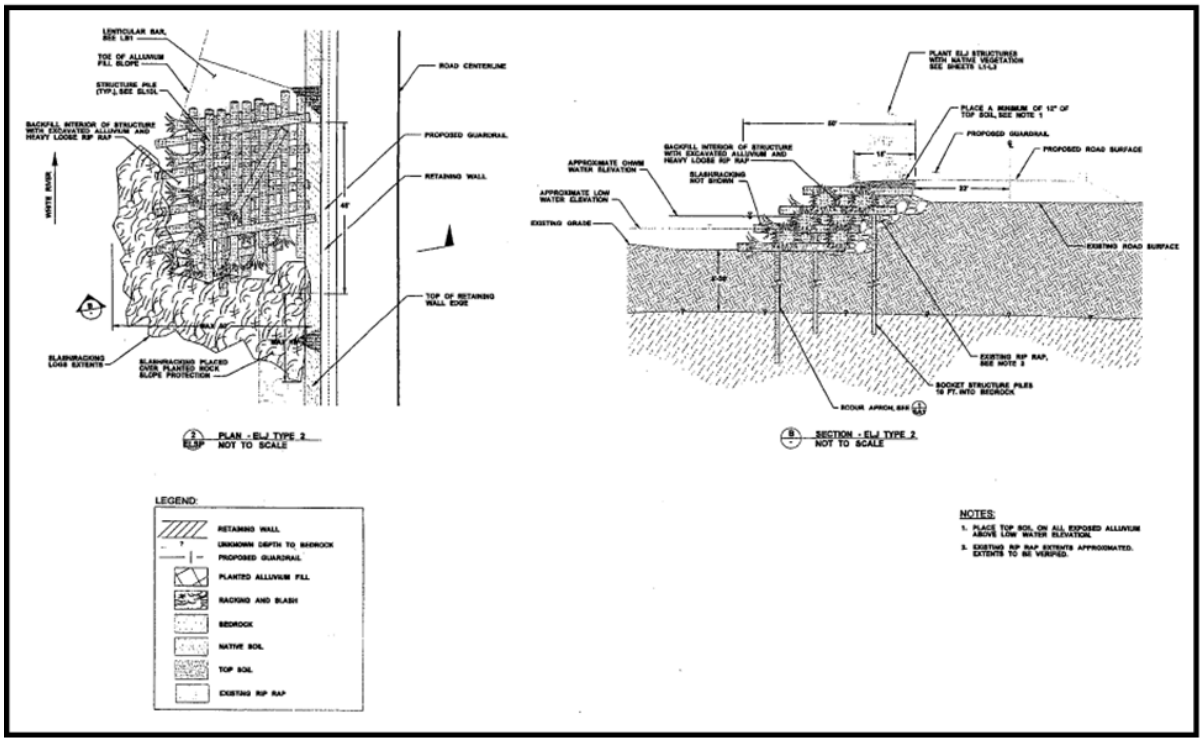

Figure 4 Type 2 ELJ in plan and cross-section view.

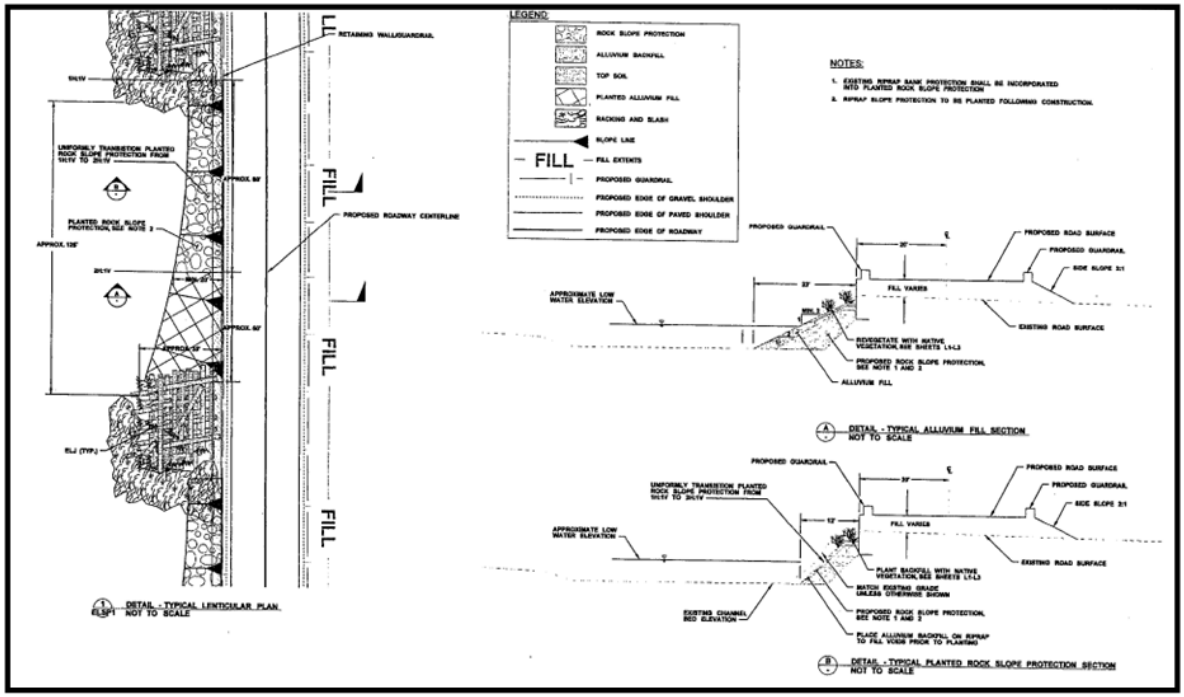

Figure 5 Lenticular bar and rock slope protection in plan and cross-section view.

Design Elements and Items of Work

The proposed action includes several design elements and items of work. The following are discussed in the sub-sections that follow: site preparation, temporary access, and staging; construction of the raised road prism, including placement of fill, rock, and retaining walls; preparation of a temporary diversion channel; work area isolation, fish capture and handling, and staged dewatering; implementation of in-water construction best management practices (BMPs); construction of the ELJs, buried groin, lenticular bars, and inter-planted rock slope protection; and site restoration and onsite compensatory mitigation. These design elements and items of work are described more completely in the BA and Addendum submitted by the Corps (WSDOT 2008a,b). Those descriptions are incorporated here by reference, except where they have been revised or amended as agreed to during the course of consultation and documented in correspondence between the Corps and the FWS.

Site Preparation, Access, and Staging

Preparing the site for construction will require clearing and grubbing an area of approximately 2.4 acres, including mature coniferous and deciduous trees to the south and north of SR 410. The project will permanently remove approximately 0.7 acre, and temporarily remove and then restore approximately 0.3 acre of functioning riparian vegetation. These totals include work necessary to stage, and gain access to the south side (left bank) of the White River.

The WSDOT and Corps have identified five suitable locations for onsite staging of equipment and materials during construction. These locations, which include existing gravel pull-outs and

access roads along SR 410 within FFSP (Stations 104+50, 108+50, 118+00, etc.), will not require clearing to be used for these purposes.

The project will have no temporary or permanent effects to wetlands. The project will gain access the south side of the White River by way of an existing gravel road owned by the Hancock Timber Resource Group. The project will use temporary bridge spans to avoid filling or compacting floodplain wetlands located between the existing access and left bank location of the temporary diversion channel.

The project will clear approximately 170 trees, primarily as a narrow, continuous strip adjacent and to the north of SR 410's westbound lane, and also from smaller pockets of trees that lie to the south of SR 410 between the roadway and river. These trees range in size from 4 to 50 inches dbh, and include approximately three dozen trees greater than 21 inches dbh (Figure 6). Except for a few large trees located immediately adjacent to SR 410, between the roadway and White River in the vicinity of the easternmost ELJ (ELJ 5) and buried groin, the project will postpone removal of mature trees until after September 30 of the first year of construction.

Figure 6 View of trees and vegetation adjacent to SR 410.

Construction of the Raised Road Prism

The project will place fill, construct a rock retaining wall (to the north), and a welded-wire gabion wall (to the south) in order to raise an approximately 0.5 mile segment of SR 410 above flood-flow elevations. The proposed roadway dimensions will match existing dimensions (i.e., two paved 11-foot lanes; two paved 4-foot shoulders), except that additional 2-foot unpaved shoulders will be constructed in order to support guardrail runs to both the north and south. All or nearly all of the work necessary to raise the road prism will be completed outside of the Ordinary High-Water Mark (OHWM).

Preparation of a Temporary Diversion Channel

Some of the proposed ELJs will extend as far as 50 ft horizontally, beyond the existing roadway embankment and into the White River's active channel. Constructing the stream bed and stream bank stabilization measures will require diverting all or nearly all of the White River's flow to a temporary channel constructed on the left bank bar opposite the eroding right bank (Figure 7).

Figure 7 View of left bank bar, location of temporary diversion channel.

The temporary left bank diversion channel will have approximate dimensions of 1,000 ft (length), by 30 ft (width), by 6 ft. The project will use stacked ecology blocks and/or durable 1 cubic yard (cy) bulk bags filled with clean rock to form the sides of the diversion channel and diversion dam. The project will remove and stockpile onsite any large, obtrusive cobbles or boulders, before placing layers of geotextile and seam-sealed reinforced polyethylene to prevent erosion of the native substrate. The layers of geotextile and polyethylene will be fixed upstream and downstream with anchor trenches and a small energy dissipater, and will be interlocked to the periphery with the ecology blocks and bulk bags, so as to form a continuously lined, water-tight channel.

Preparing the left bank diversion channel, and placement of the diversion dam, will require operation of heavy equipment below the OHWM and on the White River's channel bed. Much of the work necessary to prepare the diversion channel will be conducted outside the wetted perimeter (i.e., along exposed portions of the left bank bar), and may be completed during June leading up to the approved in-water work window (July 1 to September 30 in the second year). The temporary diversion channel will remain in place for approximately three months and will be decommissioned at or near the close of the in-water work window.

Work Area Isolation, Fish Capture and Handling, and Staged Dewatering

The project will isolate and divert flow from approximately 1,000 linear ft of the White River's low-flow channel. Stacked and lined ecology blocks, 1 cy bulk bags, and/or an approved, proprietary dam/device will be used at both the upstream and downstream extent of the diversion channel. When placing the upstream dam, the project will take steps to ensure that flows are introduced to the diversion channel gradually and in a controlled manner. The project will inspect and monitor conditions along the diversion channel, so as to prevent and adaptively manage any channel bed or bank instability, scour, or excessive turbidity and sedimentation. The WSDOT and Corps expect that seepage through the channel bed, around or through the diversion dam and diversion channel will prevent a complete dewatering of the isolated work area.

The project will implement WSDOT's recently revised *Fish Exclusion Protocols and Standards* (Appendix A). These protocols require that the fish capture operations be conducted by or under the supervision of an experienced biologist, and that all staff participating in the operation must have the necessary knowledge, skills, and abilities to ensure safe handling of fish. The project will divert flows gradually, for the reasons mentioned above and to allow and encourage fish to move downstream by their own choosing.

Successful removal of fish from the isolated work area will require a variety of methods, including perhaps electrofishing. However, electrofishing shall be performed only when other methods of fish capture and removal have proven impracticable or ineffective. The WSDOT and Corps shall ensure that attempts to seine and/or net fish precede the use of electrofishing equipment, and shall confirm that other methods have been effective in removing most or all of the adult and subadult fish before resorting to the use of electrofishing. Electrofishing attempts shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish.

Fish capture and removal operations shall be planned and conducted so as to minimize the amount and duration of handling. The operations shall maintain captured fish in water to the maximum extent possible during seining/netting, handling, and transfer for release. In the event fish are observed dying or in distress, the project will cease any and all activities that may exacerbate conditions and take remedial actions as necessary.

If pumps are used to temporarily bypass water or to dewater residual pools or cofferdams, pump intakes shall be screened to prevent aquatic life from entering the intake. Fish screens or guards shall comply with Washington State law (RCW 77.57.010 and 77.57.070), with guidelines prescribed by the NMFS (NMFS 1997), and any more stringent requirements contained in the Hydraulic Project Approval issued for the project by the Washington State Department of Fish and Wildlife (WDFW). If pumps are used on a more permanent basis, as a secondary method for diverting flow around the isolated work area, plans for dewatering shall address contingencies (i.e., extremes of flow or weather). These plans shall include ready access to a larger or additional back-up pump with screened intake. If the WSDOT and Corps have confirmed that all fish have been successfully excluded from the area, if there is no risk of entraining fish, and adequate plans are in-place to address contingencies (including a routine schedule for inspection), then pumps may be operated without a screened intake.

Upon completion of the in-water work, the project will reintroduce flow to the isolated work area gradually and will fully decommission the temporary diversion channel and dam(s). Any cobbles or boulders removed and stockpiled when preparing the temporary diversion channel will be returned. The WSDOT and Corps will identify any obvious signs of channel instability resulting from the work (e.g. headcutting), and will document any additional actions taken to correct channel instability, and the final condition of the work area.

Implementation of In-Water Construction BMPs

The project will implement a number of in-water construction BMPs to prevent or reduce excessive turbidity and sedimentation, release of harmful or deleterious materials, and other adverse exposures and effects to fish and their habitat. The project will implement an Engineer-approved Temporary Erosion and Sediment Control plan and Spill Prevention, Control, and Countermeasures (SPCC) plan. The WSDOT and Corps expect the project will use silt curtains to encircle the entirety of the isolated work area, and perhaps within the isolated work area (i.e. concentrically) when work is focused at one or another of the ELJ or groin locations. Turbid dewater will be routed to an upland settling basin or grassy swale(s). All equipment operating below the OHWM shall use vegetable-based hydraulic fluid, and no oils, fuels, cleaning agents or solvents, concrete or equipment wash water, slurry, waste, or construction debris shall be discharged to surface waters or onto land with a potential to reenter surface waters.

In light of the White River's tendency for extremes of flow (even during the summer months), and considering the nature of the proposed in-water work, the WSDOT and Corps have stated that the project will apply for a temporary exceedance of the State of Washington's aquatic life turbidity criteria (5 nephelometric turbidity units (NTU) over background when less than 50 NTU; 10 percent increase over background when more than 50 NTU). The project will seek to

obtain a section 401 water quality modification that would permit temporary turbidity exceedances to a distance of approximately 2,000 ft from sediment generating activities.

The project will monitor in-water sound when installing steel H- or sheet piles below the OHWM with an impact hammer. The WSDOT and Corps propose to monitor sound levels with a hydrophone positioned 10 meters (m) from the pile driving activities, and with a second hydrophone positioned just outside of the isolated work area.

Construction of the ELJs, Buried Groin, and Related Bank Protection

The project will construct five bank-anchored ELJs, three bio-engineered lenticular bars, and one buried groin along approximately 1,000 linear ft of channel. The ELJs and buried groin will be spaced at approximately 170 ft on-center, with lenticular bars constructed upstream of ELJs 1, 2, and 3 (Figures 3 and 5).

Each ELJ will be composed of approximately 12 vertical support steel H-piles, a steel sheet pile scour apron, 25 horizontal structural logs, 60 racking logs, and 270 cy of ballast rock, alluvium, and topsoil. Each structural log shall have a minimum 24-inch diameter, most or all with root wads left intact. Racking logs will vary in both length (15 to 30 ft) and diameter. The scour aprons, which are designed to resist hydraulic erosion and undermining, will be installed to a depth of approximately 15 ft below the channel bottom, or until reaching bedrock (+/– 5 ft). Scallop-shaped lenticular bars, composed of inter-planted rock and alluvium, will be constructed in the lee of ELJs 2, 3, and 4. The project will place, in total, approximately 2,000 cy of regulated fill (rock and alluvium) and 600 cy of LWM below the OHWM. Much or all of the angular rock from the existing revetment will be incorporated into the new stream bed and bank treatments.

The project will install steel H- and sheet piles below the OHWM with a vibratory hammer where site conditions allow, and with an impact hammer where necessary to reach required depths. Because all piles installed below the OHWM will be located outside the wetted perimeter or at shallow depths within an isolated work area from which fish have been captured and relocated, the WSDOT and Corps do not propose to use a noise attenuation device (i.e., bubble curtain, temporary noise attenuation pile, or functional equivalent) (WSDOT 2008a,b).

Site Restoration and Onsite Compensatory Mitigation

The project will provide compensatory mitigation at approved ratios for temporary and permanent effects to functioning riparian vegetation. This mitigation will consist of woody and herbaceous plantings throughout the reconstructed roadway embankment and along a portion of the upstream right bank floodplain bench. The proposed stream bank stabilization measures include inter-planted rock slope protection with live stakes and live poles, live brush mattresses, and native woody shrubs and trees planted along benches formed by the lenticular bars and groin. Along the upstream right bank floodplain bench the project proposes to restore and enhance riparian function and floodplain roughness with plantings throughout an area of approximately 1.4 acres.

Work Schedule, Timing, Miscellaneous

The proposed project will require approximately 200 working days. All in-water work is scheduled for work windows specified by the WDFW during two consecutive years (August 1 to September 30 in the first year; July 1 to September 30 in the second year) (WSDOT 2008a,b).

The first year of construction will begin in mid- or late-summer and will include placement of rock and fill for the raised roadway prism, wall construction, a shifting of traffic to the westbound lane and widened shoulder, construction of the easternmost ELJ (ELJ 5) and buried groin, and clearing and grubbing for construction access and along the roadway clear-zone. Both ELJ 5 and the buried groin are outside the wetted perimeter of the channel (except during high flows), and therefore diversion of the White River's flow to the temporary channel will not be necessary during the first year of construction. Except for a few large trees located immediately adjacent to SR 410, between the roadway and White River in the vicinity of ELJ 5 and the buried groin, the project will postpone removal of mature trees until after September 30 of the first year of construction.

The second year of construction will begin in mid- or late-spring and extend through fall. During the second year of construction the project will complete all remaining work necessary to raise the road prism and construct ELJs 1-4, the lenticular bars, related bank protection, and onsite compensatory mitigation. Diversion of the White River's flow to the temporary channel, and related fish capture operations and staged dewatering, will commence on July 1, or soon after. The project will not commence with the installation of piles or placement of rock, alluvium, and LWM within the White River's low-flow channel until the WSDOT and Corps have confirmed that fish capture operations have successfully removed all or nearly all fish from the isolated work area. If, during the course of this work, river conditions or other factors (e.g., breaching of the temporary diversion dam or channel) allow fish to re-enter the isolated work area, the project will cease in-water work and again attempt to capture and remove fish. The installation of piles and placement of rock, alluvium, and LWM within the low-flow channel will not again commence until the WSDOT and Corps have confirmed that fish allowed to re-enter have been successfully removed from the isolated work area. These same procedures shall apply if, at any time during pile installation operations, fish are observed dying or in distress. When installing steel H- or sheet piles below the OHWM with an impact hammer, the WSDOT and Corps will monitor sound levels with a hydrophone positioned 10 m from the pile driving activities, and with a second hydrophone positioned just outside of the isolated work area. The temporary diversion channel will remain in place for approximately three months and will be decommissioned at or near the close of the second year in-water work window (September 30).

At the close of each year of construction the project will install woody and herbaceous plantings consistent with the plans for permanent stabilization, site restoration, and onsite compensatory mitigation. At the close of the first year of construction this will include the vicinity of ELJ 5 and the buried groin. Any areas disturbed during the first year of construction that may again be disturbed during the second year of construction will be stabilized according to WSDOT Standard Specifications (WSDOT 2007). The project will complete all site restoration and onsite compensatory mitigation by the close of the second year of construction.

Conservation Measures

The proposed project will implement conservation measures, including but not limited to the following, to avoid and minimize impacts associated with construction:

- The project will install high-visibility construction fencing to avoid unintended impacts to sensitive areas.

- The project will implement an Engineer-approved SPCC plan. A current copy of the SPCC plan will be maintained onsite for the duration of the project and no work or staging in advance of work will commence prior to implementing the plan. The approved SPCC plan will provide site- and project-specific details identifying potential sources of pollutants, exposure pathways, spill response protocols, protocols for routine inspection fueling and maintenance of equipment, preventative and protective equipment and materials, and emergency notification and reporting protocols.

- When refueling or servicing equipment located within 150 ft of any sensitive area, the project will use diapers or another suitable structural BMP.

- All equipment operating below the OHWM will use vegetable-based hydraulic fluid, and no oils, fuels, cleaning agents or solvents, concrete or equipment wash water, slurry, waste, or construction debris will be discharged to surface waters or onto land with a potential to reenter surface waters.

- The project will use suitable, Engineer-approved locations for onsite staging of equipment and materials during construction. The project will use approximately five onsite locations, none requiring clearing for these purposes. The project will containerize and remove garbage and debris (including food waste) at the close of each day of construction so as to prevent attracting corvids or other nuisance species.

- From March 1 through September 30 of each year of construction, the project will observe a daylight-only work timing restriction. All work, including onsite staging, will be completed between 2 hours after sunrise and 2 hours before sunset.

- All in-water work will be completed during work windows specified by the WDFW (August 1 to September 30 in the first year; July 1 to September 30 in the second year).

- The project will construct a stable temporary diversion dam and channel composed of clean, inert materials (e.g., ecology blocks, 1 cy bulk bags filled with clean rock, polyethylene sheeting, geotextile, etc.). The project will introduce flows to the diversion channel gradually and will inspect and monitor conditions so as to prevent and adaptively manage any resulting channel bed or bank instability, scour, or excessive turbidity and sedimentation. Upon completion of the in-water work, the project will reintroduce flow to the isolated work area gradually and will fully decommission the temporary diversion channel. Any cobbles or boulders removed and stockpiled when preparing the channel

will be returned. The project will identify and document any obvious signs of channel instability resulting from the work (e.g. headcutting), and will document any additional actions taken to correct channel instability, and the final condition of the work area.

- The project will implement WSDOT's *Fish Exclusion Protocols and Standards* (Appendix A). The project will ensure that attempts to seine and/or net fish precede the use of electrofishing equipment, and shall confirm that other methods have been effective in removing most or all of the adult and subadult fish before resorting to the use of electrofishing. Electrofishing attempts will use the minimum voltage, pulse width, and rate settings necessary to immobilize fish.

- Any pumps used to temporarily bypass water or to dewater residual pools or cofferdams will be screened at the intake. Fish screens or guards will comply with Washington State law (RCW 77.57.010 and 77.57.070), with guidelines prescribed by the NMFS (NMFS 1997), and any more stringent requirements contained in the Hydraulic Project Approval issued for the project by the WDFW. Pumps will not be operated without a screened intake unless the project has confirmed that all fish have been successfully excluded from the area, if there is no risk of entraining fish, and there are adequate plans in place to address contingencies (including a routine schedule for inspection).

- The project will monitor in-water sound transmission and attenuation when installing steel H- or sheet piles below the OHWM with an impact hammer.

- Except for a few large trees located immediately adjacent to SR 410, between the roadway and White River in the vicinity of the easternmost ELJ (ELJ 5) and buried groin, the project will postpone removal of mature trees until after September 30 of the first year of construction. Subject to the minor exemption identified above, the project will remove all trees in excess of 4 inches dbh between October 1 and February 28.

Many of the proposed conservation measures are described more completely in the BA and Addendum submitted by the Corps (WSDOT 2008a,b). Those descriptions are incorporated here by reference, except where they have been revised or amended as agreed to during the course of consultation and documented in correspondence between the Corps and the FWS.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analyses in this Opinion rely on four components: (1) the *Status of the Species*, which evaluates the species' 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 species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (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 species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

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

The jeopardy analyses in this Opinion place an emphasis on consideration of the range-wide survival and recovery needs of the species and the role of the action area in the survival and recovery of the species as the context for evaluating the significance of the effects of the proposed Federal action, 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 analyses in this Opinion rely on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the species 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 determinations, the effects of the proposed Federal action on 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 species.

The analyses in this Opinion place an emphasis on using the intended range-wide recovery function of 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 action, taken together with cumulative effects, for purposes of making the adverse modification determination.

ENVIRONMENTAL BASELINE

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

Description of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR section 402.02). As such, the action area includes the extent of the physical, biotic, and chemical effects of the action on the environment.

The terrestrial boundaries of the action area were defined based on the extent of temporary sound and visual disturbance that will result during construction. Temporary increases in sound associated with impact pile driving and proofing are expected to have the farthest reaching effects in the terrestrial environment. Our assessment of in-air sound generation and attenuation finds that increased sound levels are likely to exceed ambient in-air sound levels to a distance of approximately 2 mi from the locations of impact pile driving, and approximately 0.5 mi from all other locations where work activities will be conducted (Figure 8).

The aquatic boundaries of the action area were defined with consideration for the following:

- Where, and how far, are suspended sediments expected to extend upstream and downstream of work activities during construction?

- Where, and how far, are bedload movements, LWM transport and accumulation, and channel formation processes likely to be influenced (directly or indirectly) by construction of the project?

We expect that sediment resulting from in-water work will have the farthest reaching effects in the aquatic environment during the period of construction. We also expect the project will have indirect effects associated with channel response to the constructed stream bed and stream bank stabilization measures. The proposed project is expected to influence bedload movements, LWM transport and accumulation, and channel formation on a localized scale.

The data needed to determine the actual distance that suspended sediments will travel downstream were not provided, nor are they readily available. To predict the extent of downstream effects, we made the following assumptions:

- Concentrations of suspended sediment resulting from construction activities will be diluted by flow in the White River.

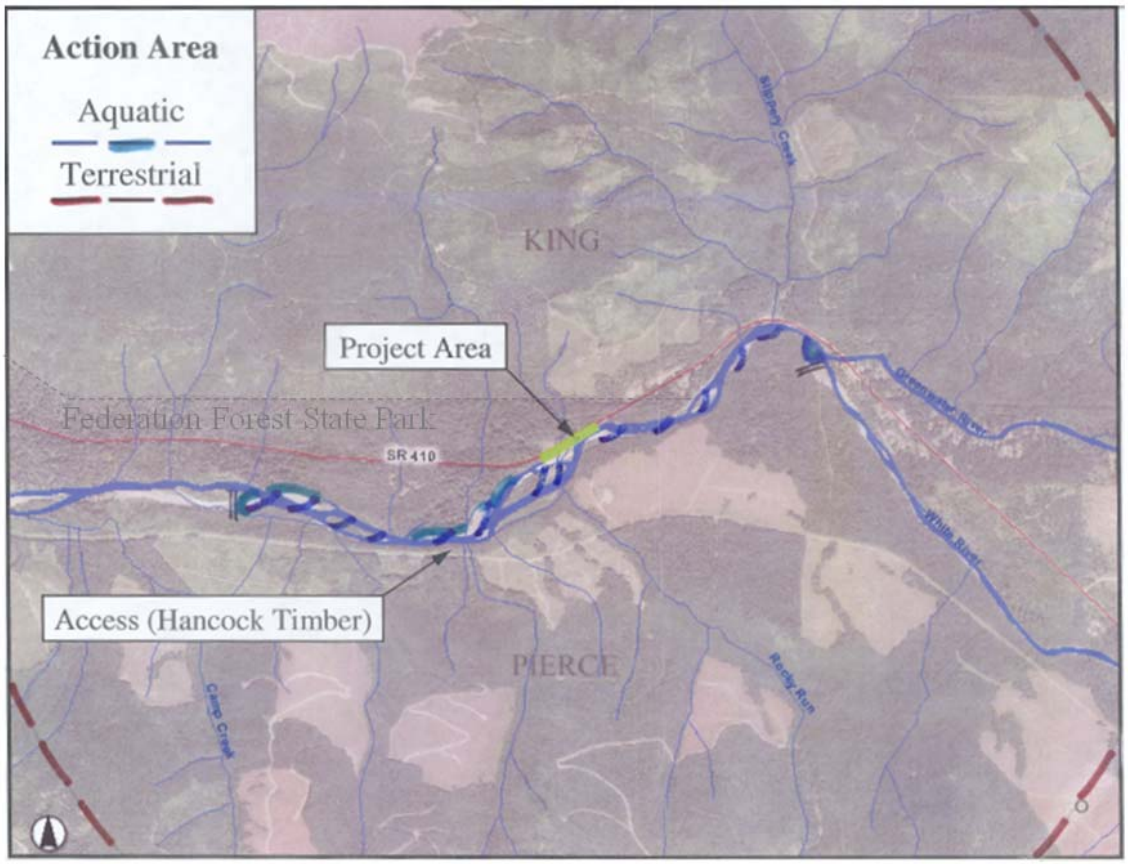

Figure 8 Aerial photo depicting extent of the action area.

- As suspended sediments and bedload move downstream, heavier components will fall out of suspension sooner, while lighter components (e.g., silt and clay particles) will be carried farther downstream.

- Sediments and bedload will fall out sooner in a slow moving, low gradient, reach and later in a high gradient, fast moving, reach.

- Morphological features such as meanders and bends generally slow flows. The inside bends of such features are characteristically depositional, while the outside of the bends are erosive.

We also considered the White River's tendency for extremes of flow and discharge, and the WSDOT and Corps' stated intention to obtain a section 401 water quality modification that would permit temporary turbidity exceedances to a distance of approximately 2,000 ft. Based upon the nature of the proposed work, the size, volume, and morphology of the White River within the action area, and the conditions likely to prevail during construction of the project we expect that project-induced sediment will travel as far as 2,000 ft downstream before

concentrations are diminished by dilution and deposition to levels that are difficult to distinguish from background/ ambient concentrations.

However, bedload movements, LWM transport and accumulation, and channel formation processes are likely to be influenced on a larger scale. Based upon the relative position of "response" and "transport" reaches, and proximity to several moderate-radius meander bends, bedload movements, LWM transport and accumulation, and channel formation processes are likely to be influenced to a distance of approximately 1.25 mi downstream and 0.75 mi upstream. Later sections discuss in greater detail the anticipated effects to LWM and bedload transport, channel formation processes, and instream habitat quantity and quality.

The aquatic boundaries of the action area include the active channel migration zone, side-channels, and floodplain of the White River, including the alluvial fans located at the confluence with two small tributaries (i.e., Rocky Run and Slippery Creek). In total, the aquatic boundaries of the action area extend over approximately 2.2 linear mi of channel and floodplain (Figure 8). In the upstream direction, the action area extends to the vicinity of the confluence with the Greenwater River.

Environmental Baseline in the Action Area

The proposed project is located approximately 18 mi east of Enumclaw, Washington, along a portion of the mainstem White River which serves as the administrative border between neighboring Pierce and King Counties. The project is located approximately 35 mi inland from the nearest marine waters (Puget Sound, Commencement Bay), at an elevation of approximately 1,700 ft above mean sea level.

Land use throughout the action area consists of mixed-use Federal and State forestland, private commercial timberland, and small rural residential development. The FFSP is an approximately 620-acre State park and forest preserve supporting large, intact stands of mature, late-seral coniferous and mixed deciduous-coniferous forest. The terrestrial component of the action area includes all of FFSP and a surrounding mosaic of second-and third-growth private commercial and State forests.

Mixed-use Federal lands (i.e., Mt. Baker-Snoqualmie National Forest, Mount Rainier National Park) and commercial timberlands are the dominant land uses throughout the upper White River and upper Puyallup River basins (Kerwin 1999, p.9). In the upper White River basin these land uses account for nearly 99 percent of the total watershed area (Kerwin 1999, p.73). A U.S. Forest Service study from the early 1990s found that forest communities of the upper White River basin are predominantly mid- (62 percent) and early-successional (20 percent); the study found that less than 5 percent of the upper White River basin may be categorized as late-seral forest (USFS 1995 *In* Kerwin 1999, p.73).

The White River drains an approximately 500 square mi watershed on the north and east flanks of Mt. Rainier. The river's headwaters are of glacial origin and upper portions of the watershed have been characterized as "inherently unstable" (Kerwin 1999, p.66). Sediment transport rates of 0.5 million to 1.5 million tons per year have been estimated for the upper White River basin,

an indication of the system's dynamism and erosive potential.

A common set of factors limit habitat function and productivity along the middle and upper White River, and its major tributaries (including the Clearwater River, Greenwater River, and West Fork White River). These limiting factors include reduced floodplain connectivity and side-channel habitat, bank instability, impaired riparian function, and dramatically reduced sources and inputs of LWM (Kerwin 1999, p.13). These conditions have led to reduced instream habitat diversity and function, and a corresponding loss of natural productivity. Several of the White River's tributaries fail to meet, or are suspected of failing to meet, the State of Washington's surface water quality criteria for temperature, including portions of the Clearwater River (downstream of the project area) and Huckleberry Creek (upstream of the project area) (Kerwin 1999, pp.46, 68-9; WDOE 2009a). The White River has a long history of impaired habitat connectivity and fish passage, principally associated with operation of the Mud Mountain and Buckley Diversion Dams. Downstream of these dams the lower third of the White River is extensively modified, and natural stream processes are severely impaired. These dams and their operations continue to this day as a source of stress and/or mortality for all native fluvial and anadromous fish that migrate through these portions of the watershed.

Baseline instream habitat and watershed conditions may be assessed with the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1998). The matrix provides a framework for considering the effects of individual or grouped actions on habitat elements and processes important to the complete life cycle of bull trout. The BA applied the matrix in describing baseline environmental conditions at the scale of the action area (WSDOT 2008a). Those descriptions are incorporated here by reference, and what follows is only a very brief summary: the waters within the action area are rated as *properly functioning* for four indicators, including chemical contamination, physical barriers, width/depth ratio, and peak/base flows; the waters within the action area are rated as *functioning at risk* or *not properly functioning* for all remaining indicators, including temperature, large woody debris, pool frequency/quality, off-channel habitat, refugia, floodplain connectivity, and riparian reserves.

Status of the Species in the Action Area – Bull Trout

The action area contains foraging, migration, and overwintering (FMO) habitat for fluvial and anadromous bull trout of the Puyallup River core area, and lies in close proximity to productive bull trout spawning and rearing habitats. A complete description of the Puyallup River core area is included as an appendix to this Opinion (Appendix C).

In total, the aquatic boundaries of the action area extend over approximately 2.2 linear mi of the mainstem White River's active channel migration zone, side-channels, and floodplain, including the alluvial fans located at the confluence with two small tributaries (Rocky Run and Slippery Creek) (Figure 8). In the upstream direction, the action area extends to the vicinity of the confluence with the Greenwater River.

The action area provides core FMO habitat and, based on proximity, is presumed to support adult and subadult bull trout originating from three of the core area's five local bull trout populations (Upper White River, West Fork White River, and Greenwater River) (USFWS

2004). The nearest known bull trout spawning and rearing habitats are located upstream of the action area, within the Greenwater River sub-basin. The Clearwater River, which enters the White River downstream of the action area, provides suitable bull trout spawning and rearing habitats and may support an as yet undocumented local bull trout population (USFWS 2004). Adult and subadult bull trout may occur within the action area at any time of year and, based on proximity to suitable spawning and rearing habitats, there is some potential for rearing juvenile bull trout to occur in the action area.

The Puyallup River core area supports anadromous, fluvial, and resident life history forms. The core area is believed to support the Puget Sound Management Unit's southernmost anadromous bull trout populations (USFWS 2004). Long term viability of the Puyallup River bull trout population is critically important to maintaining the overall distribution of migratory life history forms throughout the management unit.

Data available for the Puyallup River core area, including the three local bull trout populations identified above, are incomplete and do not allow for an accurate estimation of adult abundance or productivity. However, trap counts at the Buckley Diversion Dam suggest that the middle and upper White River and its tributaries support only very low numbers of migratory bull trout. Information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area.

Status of Critical Habitat in the Action Area – Bull Trout

Adjacent lands are managed for commercial timber production under the Washington State Forest Practices Habitat Conservation Plan, and therefore these portions of the White River are currently excluded from the bull trout critical habitat designation. Recently, however, the Service proposed revisions to designated bull trout critical habitat (75 FR 2270 [January 14, 2010]), and it is uncertain at this time whether the FWS will continue to exclude these waters from the final designation.

At least eight of the PCEs of proposed bull trout critical habitat are present in the action area. The baseline conditions of each PCE in the action area are described below. For a fuller definition of bull trout critical habitat, and for a description of its current rangewide condition, please refer to Appendix D. [Note: Appendix D uses the PCE nomenclature included in the 2005 designation (70 FR 56212 [September 26, 2005]); the 2010 proposed designation includes a

slightly modified nomenclature, and a single new or additional PCE; the discussion that follows below uses the 2010 PCE nomenclature.]

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

The White River headwaters are of glacial origin. The river's hydrological and temperature regimes are strongly influenced by seasonal glacial melt, snow-on-snow, and rain-on-snow precipitation events. Presumably, within the action area, springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) all contribute to water quality and quantity, and provide thermal refugia. These portions of the White River currently meet the State of Washington's surface water quality criteria for temperature (WDOE 2009a). Water temperature is not a limiting factor within the action area.

(2) *Migratory 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.*

There are no significant barriers or impediments to migration within the action area. However, at the scale of the larger watershed, operation of the Mud Mountain and Buckley Diversion Dams impairs both habitat connectivity and fish passage. These dams and their operations are a source of stress and/or mortality for all native fluvial and anadromous fish that migrate through those lower portions of the White River watershed.

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

These portions of the White River provide an abundant food base for adult, subadult, and juvenile bull trout. The upper White River supports populations of Chinook, steelhead, pink, and coho salmon, cutthroat trout, and other native fishes, which together provide a sizable prey base for adult bull trout. There are no indications that either terrestrial organisms or aquatic macroinvertebrates are lacking. The food base is not a limiting factor within the action area.

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

The action area extends over approximately 2.2 linear mi of the mainstem White River's active channel migration zone, side-channels, and floodplain, including the alluvial fans located at the confluence with two small tributaries (Rocky Run and Slippery Creek). While past and present land use practices, including the systematic removal of LWM, have caused simplification or loss of habitat features within the action area, the action area does still provide a diversity of habitat types. Some portions of the action area do exhibit an excess of aggraded bedload, and reduced pool frequency and quality. All portions of the action area lack sufficient amounts of LWM and channel roughness (i.e., diversity of instream structure and velocities).

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

The White River headwaters are of glacial origin. The river's hydrological and temperature regimes are strongly influenced by seasonal glacial melt, snow-on-snow, and rain-on-snow precipitation events. These portions of the White River currently meet the State of Washington's surface water quality criteria for temperature (WDOE 2009a). Water temperature is not a limiting factor within the action area.

(6) *Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 millimeter (mm) (0.03 in) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.*

The action area may or may not provide pockets of suitable spawning substrates. However, the nearest documented bull trout spawning and rearing habitats are located in the Greenwater River, outside of the action area and at higher elevations. Within the action area, the White River transports large quantities of coarse and fine glacial sediment, and is prone to frequent scouring flows and channel bed and bank instability. Channel instability may limit salmonid spawning success and productivity within the action area (R. Ladley pers. comm. 2008).

(7) *A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.*

The White River headwaters are of glacial origin. The river's hydrological regime is strongly influenced by seasonal glacial melt, snow-on-snow, and rain-on-snow precipitation events. Within the action area, peak, high, low, and base flows are not controlled and do not depart significantly from the natural hydrograph. However, channel confinement, bank armoring, and lack of channel/ floodplain roughness do contribute to heightened velocities and shear forces within the action area.

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

Water quality and quantity conditions are properly functioning. These portions of the White River currently meet the State of Washington's surface water quality criteria for temperature (WDOE 2009a). There are no apparent sources of chemical contamination or excess nutrient loading. The White River does transport large quantities of coarse and fine glacial sediment, resulting in high baseline turbidities. Within the action area, water quality and quantity conditions do not limit normal bull trout reproduction, growth, and survival.

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

The upper White River supports relatively few nonnative species of concern for native bull trout. Inbreeding species (e.g., brook trout) are known to occur in other portions of the larger Puyallup River watershed and core area (i.e., the Carbon River sub-basin), but are not known to occur in the upper White River (J. Chan pers. comm. 2010). Nonnative predatory or competitive species do not limit normal bull trout reproduction, growth, and survival within the action area, or within the upper White River sub-basin as a whole.

Status of the Species in the Action Area – Marbled Murrelet

The proposed project is located 35 mi inland from the nearest marine waters (Puget Sound, Commencement Bay), at an elevation of approximately 1,700 ft above mean sea level. The terrestrial component of the action area includes all of FFSP, an approximately 620-acre State park and forest preserve, and a surrounding mosaic of second-and third-growth private commercial and State forests (Figure 8).

The action area encompasses stands or portions of stands that provide suitable nesting habitat for the marbled murrelet. Much of this habitat has not been surveyed to protocol in years and the nearest documented below-canopy murrelet observations are located at distance of approximately 6.5 mi to the southwest and 5.7 mi to the east. This portion of the White River serves as a flight corridor for marbled murrelets transiting between nesting and foraging habitats.

We use two models to predict landscape-scale patterns of marbled murrelet habitat suitability and distribution, the Expert Judgment Model and the Ecological Niche Factor Analysis Model (Raphael *et al*. 2006). Outputs from these models indicate that nearly all of FFSP is moderately to highly suitable. Model outputs also suggest that FFSP is the single largest, contiguous tract of moderately to highly suitable marbled murrelet nesting habitat located within 2 mi of the project. Smaller, fragmented patches of moderately to highly suitable habitat are present outside of FFSP, but these patches are discontinuous and occur within a landscape that includes large swaths of unsuitable or low-suitability habitat.

We refined our assessment of marbled murrelet habitat suitability with a field reconnaissance survey of the SR 410 right-of-way within FFSP:

- The stand is mostly contiguous to the north of SR 410, exhibits high canopy closure (>70 percent), mature Douglas-fir, hemlock, and Sitka spruce trees (>60 inches dbh), and a multi-storied canopy with overstory heights exceeding 200 ft.

- Less dead and downed wood was observed than might be expected in an undisturbed old-growth stand, but the occasional large snag or large broken-topped tree was observed.

- Suitable lateral limbs providing a 4 inch-diameter (minimum) platform, located 33 or more ft off the forest floor, and with good vertical and horizontal canopy cover, were observed with a density well in excess of 2 per acre. Suitable lateral limbs in excess of 5

inches diameter were less common, but some platforms as large as 6 or 7 inches diameter were observed.

- In general, however, many of the dominant mature Douglas-fir trees do not provide lateral limbs of adequate diameter, and most limbs exhibited less epiphytic moss and/or duff than would be ideal for supporting a marbled murrelet nest. Dwarf mistletoe infestation and deformities were not observed with great frequency.

Our assessment of in-air sound generation and attenuation finds that the sound-only injury effects threshold (92 dBA) should not be exceeded to a distance of more than 220 ft from the locations of impact pile driving activities. With this approximate distance serving as a guide to focus our field effort, we visually inspected the clearing and grubbing limits and surrounding upland habitats to a distance of approximately 500 ft north of the SR 410 right-of-way (Figure 9). We observed fewer lateral limbs providing a 4 inch-diameter (minimum) platform than were observed elsewhere in FFSP. However, we did observe trees providing suitable platforms located between 150 and 500 ft from where pile driving would be conducted, with a platform density in excess of 2 per acre.

The stand and trees located within 220 ft of pile driving activities do provide suitable marbled murrelet nesting habitat. This habitat is of marginal quality, due to the close proximity of SR 410, close proximity of other established human uses (i.e., park pull-out, picnic, and day-use areas), and the low density of suitable nest platforms. However, the stand does contain several trees that provide potential nest platforms, and since the site is located less than 40 mi from marine waters, marbled murrelet occupancy cannot be discounted without protocol surveys.

Figure 9 Aerial photo depicting FFSP and upland habitats in the project vicinity.

Effects of Past and Contemporaneous Actions

Mixed-use Federal lands (Mt. Baker-Snoqualmie National Forest, Mount Rainier National Park) and commercial timberlands are the dominant land uses throughout the upper White River and upper Puyallup River basins (Kerwin 1999, p.9). In the upper basin these land uses account for nearly 99 percent of the total watershed area (Kerwin 1999, p.73). A U.S. Forest Service study from the early 1990s found that forest communities of the upper basin are predominantly mid- (62 percent) and early-successional (20 percent); the study found that less than 5 percent of the upper basin may be categorized as late-seral forest (USFS 1995 *In* Kerwin 1999, p.73).

The terrestrial component of the action area includes all of FFSP, an approximately 620-acre State park and forest preserve, and a surrounding mosaic of second-and third-growth private commercial and State forests (Figure 8). Throughout the action area, habitats which may historically have supported marbled murrelet and/or northern spotted owl populations are today fragmented and degraded. As a result of past and present land use practices, especially timber harvest and related activities (e.g., building of forest roads), the nearest large, contiguous stands providing suitable marbled murrelet and northern spotted owl habitat are located at a distance in excess of 4.0 mi.

The White River originates in steep headwaters which are prone to landslides and debris flows, transports large quantities of coarse and fine glacial sediment, and experiences frequent overbank flows and flooding in response to seasonal rain-on-snow precipitation and glacial melting (Herrera Environmental 2007). These conditions, which contribute to the White River's

natural tendency for stream bed and bank instability, are exaggerated as a result of past and present land use practices, including the systematic removal of LWM during the 1970s and the loss or reduction of riparian/floodplain forested buffers. Throughout much of its length, the middle and upper White River exhibits a highly dynamic braided channel form, with a propensity for stream bed and bank instability, side channel development, and channel migration or avulsion (Herrera Environmental 2007).

Throughout the middle and upper White River watershed current and historical land use practices, including gravel mining/removal and bank armoring in the name of flood control, continue to have a lasting impact on floodplain and riparian functions, instream habitat diversity, and the availability of off-channel habitats and refugia. Since 1948 operations at the Mud Mountain and Buckley Diversion Dams have presented a barrier to free movement for migratory fluvial and anadromous fish (Kerwin 1999, p.71). Modifications made to these facilities and their operations, during the 1990s and more recently, have lessened concern for direct effects to migrating fish (e.g., stress and/or mortality), but downstream of the dams natural stream processes remain severely impaired (USFWS 2004).

Managed public and private forest is the dominant land use throughout the middle and upper White River watershed. Conditions that limit or reduce instream habitat function and productivity may improve over the long term as a result of modern forest practices and implementation of the Forest Practices Act.

We have previously issued Opinions and granted incidental take for actions adversely affecting bull trout of the Puyallup River core area. In each case we determined that these actions are not likely to jeopardize the continued existence of the bull trout and will not destroy or adversely modify designated bull trout critical habitat. Nevertheless, the combined effects of these past and contemporaneous Federal actions have resulted in short and long term adverse effects to bull trout and, in some instances, an incremental degradation of the environmental baseline.

EFFECTS OF THE ACTION

This section addresses the direct and indirect effects of the proposed action and its interrelated and interdependent activities. The regulations implementing the Act define "effects of the action" as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline" (50 CFR section 402.02).

We expect that the proposed action will result in both direct and indirect effects to bull trout and their habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. Our analysis specifically addresses the following potential adverse exposures and effects, as well as any effects associated with interrelated and interdependent actions:

- Exposures and effects (i.e., stress and/or injury) resulting from fish capture and handling

operations.

- Exposure to construction activities and resulting direct effects. Construction activities will directly affect instream habitat that supports bull trout, and exposure of adult, subadult, and juvenile bull trout to construction activities is not discountable. Bull trout will or may be temporarily exposed to elevated underwater sound pressure levels (SPLs) resulting from impact pile driving, and to elevated levels of turbidity and sedimentation.

- Permanent and temporary effects to instream habitat structure, function, and diversity. The project will reinforce an existing artificial constraint on the CMZ and floodplain, but would also improve instream habitat function over the long term compared to the existing smooth riprap revetment. Temporary effects to instream habitat, including those associated with work area isolation and flow diversion, will present a barrier to free movement and migration.

Construction activities have the potential to kill or injure a limited number of adult, subadult, and juvenile bull trout. Temporary exposures may also significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). These exposures may temporarily cause bull trout to avoid the action area, may impede or discourage free movement through the action area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. Suitable bull trout spawning habitats are not present in the action area, and therefore the proposed action will have no effect on bull trout spawning habitat or essential spawning behaviors.

Some of the proposed action's potential effects to bull trout and their habitat are/will be insignificant or discountable. With implementation of the proposed conservation measures and permanent design elements, we have concluded that the following potential effects are extremely unlikely to occur (discountable) or are not measurable or detectable (insignificant): direct effects (i.e., disturbance) to bull trout spawning behaviors and redds/eggs/alevins, exposure to chemical contamination during construction, temporal losses of wetland/buffer and riparian function, and, long term effects to the bull trout prey base.

We also expect that the proposed action will result in direct and indirect effects to the marbled murrelet and its habitat. This portion of the White River serves as a flight corridor and marbled murrelet nest occupancy cannot be ruled out in the immediate vicinity of the project. Even with implementation of the proposed conservation measures, including daylight-only work timing restrictions, temporary exposures associated with construction (i.e., sound and visual disturbance) are likely to significantly disrupt normal marbled murrelet behaviors. Furthermore, the proposed action would remove mature trees providing potential nest platforms from within suitable marbled murrelet nesting habitat. Removal of potential marbled murrelet nest trees, removal of adjacent vertical and horizontal canopy cover, and attending edge effects (e.g., resulting increased exposure to predation) will permanently degrade suitable marbled murrelet nesting habitat adjacent to SR 410 in the vicinity of the project.

Some of the proposed action's potential effects to the marbled murrelet and its habitat are/will be insignificant or discountable. With implementation of the proposed conservation measures,

including seasonal timing restrictions on the removal of mature trees, the direct physical disturbance or destruction of any occupied marbled murrelet nest is considered extremely unlikely and therefore discountable. We also conclude that despite partial or complete loss of function throughout a portion of the suitable marbled murrelet nesting habitat in the vicinity of the project, the proposed action is unlikely to have any long term, measurable or detectable effect on function or productivity at the scale of the larger stand. Furthermore, the project will not result in changes in the use or function of the highway infrastructure and there are no foreseeable indirect effects to the marbled murrelet or its habitat that might occur later in time. Considered at the scales of the larger stand and surrounding landscape, the project's long term effects to marbled murrelet habitat function and productivity will not be measurable and are therefore considered insignificant.

Insignificant and Discountable Effects

Some of the proposed action's potential effects to bull trout, the marbled murrelet, and their habitats are/will be insignificant or discountable. With implementation of the proposed conservation measures and permanent design elements, we conclude that the following potential effects are extremely unlikely to occur (discountable) or are not measurable or detectable (insignificant).

Bull Trout

Construction of the proposed project will require diverting flow from a large area below the OHWM (approximately 1,000 linear ft or 2.3 acres), will involve intensive construction throughout much of this area, and will or may also cause temporary effects to water quality (turbidity and sedimentation) extending 2,000 ft downstream over as much as 4.6 acres of additional instream habitat. While all in-water work will be completed during work windows specified by the WDFW (August 1 to September 30 in the first year; July 1 to September 30 in the second year), these windows do partially overlap with the timing of documented early bull trout spawning. Some bull trout of the Puyallup River core area spawn during the month of September, which is considered "early" by comparison with most other Puget Sound core areas (Marks *et al*. 2002).

Despite the large area affected by construction activities, and the partial overlap with the timing of documented early bull trout spawning, direct effects (i.e., disturbance) to bull trout spawning behaviors and redds/eggs/alevins is considered extremely unlikely and therefore discountable. The nearest known bull trout spawning and rearing habitats are located upstream of the action area, within the Greenwater River sub-basin, and will not be affected (directly or indirectly). Furthermore, construction activities will be focused along high energy portions of the reach, which do not provide suitable spawning substrates or conditions. The aquatic component of the action area does encompass spawning habitats used annually by some salmonids (e.g., Chinook and steelhead), but local, expert knowledge of the area indicates no history of bull trout spawning (R. Ladley pers. comm. 2008).

Constructing the proposed stream bed and stream bank stabilization measures will require that one or more pieces of heavy equipment enter and operate below the OHWM of the White River.

A release of harmful materials (e.g., fuel, lubricants, hydraulic fluid, etc.) is possible, but unlikely. The project will implement an Engineer-approved SPCC plan to guard against the release of any harmful pollutant or product. All equipment operating below the OHWM will use vegetable-based hydraulic fluid, and no oils, fuels, cleaning agents or solvents, concrete or equipment wash water, slurry, waste, or construction debris will be discharged to surface waters or onto land with a potential to reenter surface waters. With full implementation of the proposed conservation measures, effects to bull trout or their habitat resulting from exposure to chemical contamination during construction are extremely unlikely to occur and are therefore discountable.

Temporal losses of wetland/buffer and riparian function are not expected to have a measurable or detectable effect on bull trout or their habitat. The project will provide compensatory mitigation at approved ratios, including woody and herbaceous plantings throughout the reconstructed roadway embankment and along an approximately 1.4 acre right bank floodplain bench located at the upstream limits of the project. The project will also fully decommission the temporary diversion channel, and identify and correct any obvious signs of channel bed or bank instability resulting from the work (e.g. headcutting). With full implementation of the proposed conservation measures and permanent design elements, including site restoration and onsite compensatory mitigation, any related temporary effects to bull trout or their habitat will be insignificant.

Construction of the proposed project will require fish capture and handling operations and will result in temporary increases in underwater SPLs, turbidity, and sedimentation (see sections that follow). Bull trout prey may be exposed to these stressors, and we assume that construction activities may have a direct, short term effect on the bull trout prey base. However, within the limits of the constructed stream bed and stream bank stabilization measures, we expect the project will create a more diverse and complex assemblage of instream habitats to replace the existing smooth riprap revetment and entrained channel thalweg that exists today. Furthermore, the project will replace wetland/buffer and riparian functions, increase channel and floodplain roughness, and lessen hydraulic forces and resulting bed and bank erosion along the downstream reach. Taken as a whole, and with consideration for both the direct and indirect effects of the action, we expect that the proposed project will not have an adverse, long term effect on the bull trout prey base. With implementation of the proposed conservation measures and permanent design elements, we expect long term effects to the bull trout prey base will be insignificant.

Marbled Murrelet

The project will clear and grub approximately 2.4 acres, including mature coniferous and deciduous trees to the south and north of SR 410. Approximately 170 trees will be cleared as a narrow (but more or less continuous) strip directly adjacent and to the north of SR 410, and from smaller pockets of trees that lie to the south of SR 410 between the roadway and river. These trees range in size from 4 to 50 inches dbh, and include approximately three dozen trees greater than 21 inches dbh.

The proposed action includes conservation measures which the Corps, WSDOT, and their contractor will implement to avoid direct physical disturbance or destruction of any occupied

marbled murrelet nest:

> Except for a few large trees located immediately adjacent to SR 410, between the roadway and White River in the vicinity of the easternmost ELJ (ELJ 5) and buried groin, the project will postpone removal of mature trees until after September 30 of the first year of construction. Subject to the minor exemption identified above, the project will remove all trees in excess of 4 inches dbh between October 1 and February 28.

We conducted a field reconnaissance survey of the SR 410 right-of-way within FFSP, and walked and visually inspected the project's clearing and grubbing limits and surrounding upland habitats to a distance of approximately 500 ft north of SR 410 (R. McReynolds pers. comm. 2009). The field reconnaissance survey identified approximately three mature Douglas-fir trees located in the immediate vicinity of the easternmost in-water structures. The proposed action requires removal of these trees during June, July, or August of the first year of construction. Removal of any other trees in excess of 4 inches dbh can and will be postponed until after September 30 of the first year of construction.

With implementation of the proposed conservation measures, including seasonal timing restrictions on the removal of mature trees, we conclude that the direct physical disturbance or destruction of any occupied marbled murrelet nest is extremely unlikely and therefore discountable. None of the trees planned for removal during the marbled murrelet nesting season (i.e., during June, July, or August of the first year of construction) represent suitable and potential marbled murrelet nest trees. These trees are located between the river and the road, are exposed on all sides, and isolated from the adjacent stand. Due to their location and exposure, it is extremely unlikely (and therefore discountable) that an active marbled murrelet nest might be encountered or damaged when removing these trees.

Temporary exposures sufficient to cause missed feedings or a flushing response are not entirely discountable, but will be limited in spatial extent (see a sub-section that follows; *Adverse Effects of the Action – Marbled Murrelet*). The trees and stands located within 220 ft of pile driving activities provide nesting habitat of only marginal quality, due to the close proximity of SR 410, close proximity of other established human uses (i.e., park pull-out, picnic, and day-use areas), and the low density of suitable nest platforms. Construction-related sound and visual disturbance will be of short duration and will occur only during daylight hours, when marbled murrelets are generally less active. Based on the intensity and duration of these potential exposures, we conclude that nest abandonment and/or nest failure (physical injury and/or mortality of eggs or chicks) is extremely unlikely and therefore discountable.

We also conclude that despite partial or complete loss of function throughout a portion of the suitable marbled murrelet nesting habitat in the vicinity of the project, the proposed action is unlikely to have any measurable or detectable effect on function or productivity at the scale of the larger stand (see a sub-section that follows; *Adverse Effects of the Action – Marbled Murrelet*). Effects to suitable and potentially occupied habitat would be focused along the periphery of FFSP and are unlikely to cause or contribute to significant crowding, displacement of breeding pairs, or long term increase in predation risk. The action will have little or no effect on the core-to-interior ratio of available nesting acreage, nest patch size, and the average density

of available marbled murrelet nest trees and platforms. We expect that the direct and indirect effects of the proposed action will not cause a measurable decline in juvenile recruitment or productivity at the scale of the stand, action area, or larger landscape. When considered at the scales of the stand and surrounding landscape, we expect that the action's direct effects and long term, indirect effects to marbled murrelet habitat function and productivity will not be measurable and are therefore insignificant. For a fuller discussion of this topic see a sub-section that follows (*Adverse Effects of the Action – Marbled Murrelet*).

Adverse Effects of the Action – Bull Trout

We expect that the proposed action will result in measurable adverse effects to bull trout and their habitat, including: exposures and effects (i.e., stress and/or injury) resulting from fish capture and handling operations; temporary exposures to elevated underwater SPLs resulting from impact pile driving, and to elevated levels of turbidity and sedimentation; and, adverse permanent and temporary effects to instream habitat structure, function, and diversity. The sub-sections that follow address these potential adverse effects.

Construction activities have the potential to kill or injure a limited number of adult, subadult, and juvenile bull trout. Temporary exposures may also significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). These exposures may temporarily cause bull trout to avoid the action area, may impede or discourage free movement through the action area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. Suitable bull trout spawning habitats are not present in the action area, and therefore the proposed action will have no effect on bull trout spawning habitat or essential spawning behaviors.

Exposures Resulting from Fish Capture and Handling

The proposed project will require temporarily diverting flow from a large area below the OHWM (approximately 1,000 linear ft or 2.3 acres) and will involve intensive construction throughout much of this area for the duration of the approved in-water work window during the second year of construction (July 1 to September 30). The Corps and WSDOT propose a number of related measures to avoid and minimize effects to the environment. These measures include planning and constructing a stable temporary diversion channel, implementation of other in-water construction BMPs (e.g., turbidity curtains, cofferdams, screened pumps, etc.), and implementation of the WSDOT's recently revised *Fish Exclusion Protocols and Standards* (Appendix A). Any pumps used to temporarily bypass water or to dewater residual pools or cofferdams will be screened at the intake. Pumps will not be operated without a screened intake unless the project has confirmed that all fish have been successfully excluded from the area, if there is no risk of entraining fish, and there are adequate plans in-place to address contingencies (including a routine schedule for inspection).

The project will not commence with the installation of piles or placement of rock, alluvium, and LWM within the White River's low-flow channel until the WSDOT and Corps have confirmed that fish capture operations have successfully removed all or nearly all fish from the isolated work area. If, during the course of this work, river conditions or other factors (e.g., breaching of

the temporary diversion dam or channel) allow fish to re-enter the isolated work area, the project will cease in-water work and again attempt to capture and remove fish. The installation of piles and placement of rock, alluvium, and LWM within the low-flow channel will not again commence until the WSDOT and Corps have confirmed that fish allowed to re-enter have been successfully removed from the isolated work area. These same procedures shall apply if, at any time during pile installation operations, fish are observed dying or in distress. In the event (at any time) fish are observed dying or in distress, the project will cease any and all activities that may exacerbate conditions and take remedial actions as necessary.

Work area isolation and partial dewatering are conservation measures intended to reduce exposure and the risk of potential injury associated with elevated underwater SPLs (resulting from impact pile driving), increased turbidity and sedimentation, operation of heavy equipment, and extensive placement of rock and large wood. While a small number of individual bull trout may be exposed to stresses resulting from fish capture, handling, and exclusion, these practices are being implemented to avoid the more severe effects that bull trout would experience from remaining in the isolated work area.

It is possible that a limited number of bull trout may be killed or injured when capturing and removing fish from the isolated work area, from within deployed turbidity curtains and/or cofferdams, or otherwise excluding fish from the in-water work area. However, it is more likely that adverse effects to juvenile, subadult, or adult bull trout resulting from fish capture and handling will occur in the form of increased stress and a temporary disruption to their normal bull trout behaviors.

The Corps and WSDOT will ensure implementation of the WSDOT's recently revised *Fish Exclusion Protocols and Standards* (Appendix A). These protocols require that the fish capture operation be conducted by or under the supervision of an experienced biologist, and that all staff participating in the operation must have the necessary knowledge, skills, and abilities to ensure safe handling of fish. WSDOT protocols require that the fish capture operation must have proper equipment on-hand (e.g., buckets, aerators, etc.) and take appropriate steps to minimize the amount and duration of handling. The protocols require that captured fish be released to flowing waters in close proximity, in areas that offer adequate cover and suitable temperature and water quality conditions, as quickly as is practicable. Where the in-water work area is large and will or may contain a large number of fish, these protocols suggest staging of dewatering or diversion, fish capture, temporary holding, and release, to minimize the risks associated with prolonged holding.

Electrofishing will be employed only as a last resort, after all other means of fish capture and removal have been exhausted (e.g. herding with block nets, seining, dip nets in conjunction with dewatering, etc.), and only after a qualified biologist determines that all or nearly all of the adult and subadult-sized fish have been effectively removed. Only biologists trained by qualified personnel and familiar with equipment handling, settings, maintenance, and safety may operate electrofishing equipment. Capture operations that utilize electrofishing equipment shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, and shall measure water conductivity in the field before electrofishing in order to determine appropriate settings.

Electrofishing is typically used as a last resort to remove fish. The process involves passing an electrical current through water to immobilize fish and facilitate their capture and removal from the in-water work area. The process of running an electrical current through the water can cause a range of effects, including: annoyance, startle, or avoidance behavior; temporary immobility; physical injury; and, mortality. The amount of unintentional (or incidental) injury or mortality attributable to electrofishing can vary widely, depending upon the equipment used, settings used, site conditions (e.g., clarity of water and visibility), and the expertise of the operator. Accidental contact with the electrodes is a frequent cause for physical injury or mortality. When fish capture operations use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, shocked fish normally revive quickly.

Electrofishing can more severely affect adult salmonids because of their larger size and surface area. Injuries, which may cause or contribute to delayed mortality, can include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns (Hollender and Carline 1994; Dalbey *et al*. 1996; Thompson *et al*. 1997). Sharber and Carothers (1988) report that electrofishing killed 50 percent of the adult rainbow trout in their study. The long term effects of electrofishing on juvenile and adult salmonids are not well understood, but long experience with electrofishing indicates that most measurable effects occur at the time of fish capture operations and are of relatively short duration.

Most studies on the effects of electrofishing have been conducted on adult fish greater than 300 millimeters in length (Dalbey *et al*. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988), and may therefore experience lower injury rates (Dalbey *et al*. 1996; Thompson *et al*. 1997; Thompson *et al*. 2008). McMichael *et al*. (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River. The incidence and severity of electrofishing injury is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988; Dalbey *et al*. 1996; Dwyer and White 1997).

Continuous direct current or low-frequency pulsed direct current (equal or less than 30 Hz) have been recommended for electrofishing (Fredenberg 1992; Dalbey *et al*. 1996) because lower spinal injury rates, particularly in salmonids, have resulted from these waveforms (Fredenberg 1992; Dalbey *et al*. 1996). Only a few studies have examined the long term effects of electrofishing on salmonid survival and growth (Dalbey *et al*. 1996; Ainslie *et al*. 1998). These studies indicate that although some fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes exhibit no growth at all (Dalbey *et al*. 1996).

Adult and subadult salmonids, because of their larger size (i.e., older than one year and larger than 150 mm; with variation dependent on species), cannot seek refuge in gravels and are generally easier to detect, herd, seine, and/or net. Therefore, fish capture operations that exhaust other means of capture (e.g. herding with block nets, seining, dip nets in conjunction with dewatering, etc.) should not generally expose many adult or subadult salmonids to the added risks associated with electrofishing. However, some adults and subadults may hide under vegetation or other cover (e.g., cut banks, rootwads, etc.). While herding, seining, and netting are much safer means by which to capture and remove fish (i.e., they present lower risks of injury and/or incidental mortality), all forms of capture and handling contribute some degree of stress and otherwise disrupt normal behaviors (i.e., ability to successfully feed, move and/or shelter).

We expect that with careful, full implementation of the proposed conservation measures, and considering the large size of the area(s) where fish capture operations will or may be conducted, a modest number of juvenile, subadult, and adult bull trout may be affected by fish capture and handling. All, or nearly all, of the subadult and adult bull trout should be effectively removed prior to electrofishing, and the rate of injury and/or accidental (incidental) mortality should be low for juvenile, subadult, and adult bull trout. It is more likely that adverse effects to juvenile, subadult, or adult bull trout resulting from fish capture and handling will take the form of increased stress and a temporary disruption to their normal bull trout behaviors. While this added stress and disruption to their normal behaviors will have measurable short term effects (including interruption to feeding and increased energetic demands), we expect that all, or nearly all, of the exposed individuals will experience no long term effects.

Applying best professional judgment, and with consideration for the timing and location of construction activities, the amount and quality of affected habitat, methods for work area isolation and dewatering, and WSDOT's *Fish Exclusion Protocols and Standards* (Appendix A), we expect that no more than one adult or subadult bull trout, and two juvenile bull trout will suffer physical injury or mortality, and that no more than three adult or subadult bull trout, and eight juvenile bull trout will suffer significant disruption of their normal behaviors (including stress not reaching the level of physical injury) as a result of fish capture and handling.

Exposure to Elevated Underwater Sound Pressure Levels

During the second year of construction, the proposed project will construct ELJs 1-4, the lenticular bars, and related bank protection. This work includes installation of steel H- and sheet piles below the OHWM by a combination of methods, with a vibratory hammer where site conditions allow, and with an impact hammer where necessary to reach required depths. Diversion of the White River's flow to the temporary channel will commence on July 1 (or soon after), and all subsequent in-water work will be complete by September 30.

The project will place approximately 50 steel H-piles and 300 linear ft of steel sheet pile below the OHWM. Pile driving and proofing with an impact hammer(s) will be an intermittent activity. The WSDOT and Corps have provided a "worst-case" estimate for the duration of proposed impact pile driving and proofing (up to 500 hours) (WSDOT 2008b), which equates to approximately 5 to 6 hours per workday over the course of the allowable in-water work window.

The project will not commence with the installation of piles or placement of rock, alluvium, and LWM within the White River's low-flow channel until the WSDOT and Corps have confirmed that fish capture operations have successfully removed all or nearly all fish from the isolated work area. If, during the course of this work, river conditions or other factors (e.g., breaching of the temporary diversion dam or channel) allow fish to re-enter the isolated work area, the project will cease in-water work and again attempt to capture and remove fish. The installation of piles and placement of rock, alluvium, and LWM within the low-flow channel will not again commence until the WSDOT and Corps have confirmed that fish allowed to re-enter have been successfully removed from the isolated work area. These same procedures shall apply if, at any time during pile installation operations, fish are observed dying or in distress.

Because all steel H- and sheet piles installed below the OHWM will be located outside the wetted perimeter, or at shallow depths within an isolated work area from which fish have been captured and relocated, the WSDOT and Corps do not propose to use a noise attenuation device (i.e., bubble curtain, temporary noise attenuation pile, or functional equivalent) (WSDOT 2008a,b). However, the project will monitor in-water sound generation and attenuation when installing steel H- or sheet piles below the OHWM with an impact hammer. The WSDOT and Corps propose to monitor sound levels with a hydrophone(s) positioned 10 m from the pile driving activities and with a second hydrophone positioned just outside of the isolated work area.

Pile driving and proofing with an impact hammer(s) has the potential to kill or injure a limited number of adult, subadult, and juvenile bull trout. The WSDOT and Corps have stated that because the project will divert flow from and partially dewater the area surrounding this work, they expect that underwater SPLs resulting in potential injury or mortality will be confined to the isolated work area (approximately 1,000 linear ft or 2.3 acres below the OHWM) (WSDOT 2008a). Because the isolated work area is large, and some fish may repeatedly evade capture and remain in the area, it is possible that pile driving and proofing with an impact hammer may kill or injure a very few adult, subadult, and/or juvenile bull trout.

Elevated underwater SPLs resulting from pile driving and proofing with an impact hammer may also transmit beyond the isolated work area and thereby significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). Pile driving and proofing with an impact hammer may cause bull trout to temporarily avoid the area, may impede or discourage free movement through the area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions.

Effects of Elevated Underwater SPLs - General

High underwater SPLs are known to have negative physiological and neurological effects on a wide variety of vertebrate species (Yelverton *et al*. 1973; Yelverton and Richmond 1981; Turnpenny and Nedwell 1994; Hastings and Popper 2005). High underwater SPLs are known to injure and/or kill fishes, as well as cause temporary stunning and alterations in behavior (Turnpenny and Nedwell 1994; Turnpenny *et al*. 1994; Popper 2003; Hastings and Popper 2005). Risk of injury appears related to the effect of rapid pressure changes, especially on gas-filled spaces in the bodies of exposed organisms (Turnpenny *et al*. 1994). Fish-kills have been among the most noticeable and well-documented adverse effects of in-water impact pile driving. With

few exceptions, however, fish-kills are generally reported only when dead or injured fish are observed at the surface and therefore the frequency and magnitude of such kills are likely underestimated. High underwater SPLs can also cause a variety of behavioral responses, many of which have not been thoroughly studied.

The effects of elevated underwater SPLs on exposed organisms can vary substantially, ranging broadly from no noticeable effect to instantaneous mortality. Over this continuum of effect, there is no easily identifiable point at which behavioral responses transition to physical effects. We evaluated two types of exposure to elevated SPLs, those causing injury and/or mortality, and those causing significant behavioral responses or disruption.

Effects of Elevated Underwater SPLs - Injury and Mortality

Injury and mortality in fishes has been attributed to impact pile driving (Stotz and Colby 2001; Stadler 2002; Abbott *et al*. 2005; Hastings and Popper 2005). The injuries associated with exposure to high SPLs are referred to as barotraumas, and include hemorrhage and rupture of internal organs, hemorrhaged eyes, and temporary stunning (Yelverton *et al*. 1973; Yelverton *et al*. 1975; Yelverton and Richmond 1981; Turnpenny and Nedwell 1994; Hastings and Popper 2005). Death as a result of barotrauma can be instantaneous, occurring within minutes after exposure, or can occur several days later (Abbott *et al*. 2002). Necropsy results from Sacramento blackfish (*Othodon microlepidotus*) exposed to high SPLs showed fish with extensive internal bleeding and a ruptured heart chamber were still capable of swimming for several hours before death (Abbott *et al*. 2002). Sub-lethal injuries can interfere with the ability to carry out essential life functions such as feeding and predator avoidance (Popper 2003).

The potential for injury and/or mortality depends on several factors, including the type of sound and intensity of sound produced. These, in turn, are strongly influenced by the type of hammer, characteristics of the substrate and subsurface conditions, depth of water, and the presence or absence of channel (bed and bank) formations that might serve to naturally intercept and attenuate SPLs. Firmer substrates are more resistant to penetration, generally require more force and energy when pile driving, and therefore usually produce more intense sound pressures. In addition to the type of sound and intensity of sound produced, other factors that influence the potential for injury and/or mortality include the size of the exposed organism(s), anatomical variation, and location in the water column (Gisiner *et al*. 1998). Sound energy from an underwater source readily enters the bodies of exposed organisms because the acoustic impedance of animal tissue nearly matches that of water (Hastings 2002).

Gas-filled structures are particularly susceptible to the adverse effects of elevated underwater sound (Gisiner *et al*. 1998). Examples of gas-filled structures found in vertebrate species include swimbladders, bowels, sinuses, and lungs. As sound travels from a fluid medium into a gas-filled structure there is a dramatic drop in pressure, which can cause rupture of the hollow organs (Gisiner *et al*. 1998). This has been demonstrated in fishes with swimbladders (including salmonids). As a sound pressure wave passes through a fish, the swimbladder is rapidly compressed due to the high pressure and then rapidly expanded by the underpressure. Exposure to this type of "pneumatic pounding" can cause rupture of capillaries in the internal organs, as observed in fishes with blood in the abdominal cavity, and maceration of kidney tissues (Abbott

et al. 2002; Stadler 2002).

Yelverton and Richmond (1981) and Yelverton *et al*. (1973) exposed a variety of fish species, various birds, and terrestrial mammals to underwater explosions. Common to all the species were injuries to air- and gas-filled organs, as well as eardrums. These studies identified injury thresholds in relation to the size of the charge, the distance at which the charge was detonated, and the mass of the exposed animal. Yelverton *et al*. (1973) and Yelverton and Richmond (1981) found that the greater the fish's mass, the greater impulse level needed to cause an injury. Conversely, a fish with smaller mass would sustain injury from a smaller impulse.

At Bremerton, Washington, approximately 100 surfperch (*Cymatogaster aggregata, Brachyistius frenatus* and *Embiotoca lateralis*) were killed during impact driving of 30-inch diameter steel pilings (Stadler 2002). The size of these fish ranged from 70 mm to 175 mm fork length. Dissections revealed that the swimbladders of the smallest of the fishes (80 mm fork length) were completely destroyed, while those of the largest individual (170 mm fork length) were nearly intact. Damage to the swimbladder of *C. aggregata* was more severe than to similar-sized *B. frenatus*. These results are suggestive of size and species-specific differences and are consistent with those of Yelverton *et al*. (1975) who found size and/or species differences in injury from underwater explosions.

Another mechanism of injury and mortality resulting from high SPLs is "rectified diffusion", or the formation and growth of bubbles in tissue. Rectified diffusion can cause inflammation and cellular damage because of increased stress and strain (Vlahakis and Hubmayr 2000; Stroetz *et al*. 2001) and blockage or rupture of capillaries, arteries, and veins (Crum and Mao 1996). Crum and Mao (1996) analyzed bubble growth caused by sound signals at low frequencies (less than 5,000 Hz), long pulse widths, and atmospheric pressure. Their analysis indicates that underwater SPLs exceeding 190 dB_{peak} can cause bubble growth.

Due to differences between species and from variation in exposure type and duration, uncertainty remains as to the degree of potential adverse effect from SPLs between 180 and 190 dB_{peak}. Turnpenny *et al*. (1994) exposed brown trout (*Salmo trutta*) to SPLs greater than 170 dB using pure tone bursts for a duration of 90 seconds. This resulted in a mortality rate of 57 percent (after 24 hours) in brown trout; 50 percent mortality (after 24 hours) was observed in bass (*Dicentrarchus labrax*) and whiting (*Merlangius merlangus*) exposed to SPLs greater than 176 dB. The authors suggest that the threshold for continuous sounds is, or ought to be, lower than for pulsed sounds, such as seismic airgun blasts. Sound pressures produced by impact pile driving are more similar to those produced by airgun blasts. As such, we conclude that the 170 dB threshold for injury to brown trout identified by Turnpenny *et al*. is likely lower than the injury threshold associated with underwater SPLs produced by impact pile driving.

Until recently, we used SPLs measured as peak pressure to estimate the onset of injury. However, effective June 2008, the FWS, WSDOT, and other signatory agencies have formally endorsed application of new interim criteria recommended by the Fisheries Hydroacoustic Working Group (June 12, 2008 MOA). These new interim criteria apply a Sound Exposure Level (SEL) framework for assessing fish injury. For further details, see a sub-section that follows (Estimate of the Extent of Effect).

Effects of Elevated Underwater SPLs - Behavioral Responses

Elevated underwater SPLs can elicit a variety of behavioral responses. In general, there is much uncertainty regarding the response of organisms to sources of underwater sound, and there are no experimental data specific to bull trout exposed to underwater sound from impact pile driving. Further confounding the issue, most of the information on behavioral effects of underwater sound is obtained from studies examining pure tone sounds. Sounds generated by impact pile driving are impulsive and are made up of multiple frequencies/tones, making comparisons with existing data difficult.

Knudsen *et al*. (1992) studied spontaneous awareness reactions (consisting of reduced heart beat frequency and opercular movements), and avoidance responses to sound in juvenile Atlantic salmon. This study evaluated responses to frequencies ranging from 5 to 150 Hz. With increasing frequency, the difference between the threshold for spontaneous awareness reaction and the estimated hearing threshold also increased. At 5, 60 and 150 Hz, the signal had to exceed the hearing thresholds by 25, 43 and 73 dB, respectively, to elicit reactions. Most of the sound energy produced by impact pile hammers is concentrated at frequencies between 100 and 800 Hz. Salmonids can detect sounds at frequencies between 10 Hz (Knudsen *et al*. 1997) and 600 Hz (Mueller *et al*. 1998). Optimal salmonid hearing is thought to be at frequencies of 150 Hz (Hawkins and Johnstone 1978). Therefore, impact pile installation produces sounds within the range of salmonid hearing.

Exposure to elevated SPLs can result in temporary hearing damage referred to as Temporary Threshold Shift (TTS). Most bioacoustic specialists consider TTS to be physiological fatigue and not injury (Popper *et al*. 2006). However, an organism experiencing TTS may be unable to detect biologically relevant sounds such as approaching predators or prey, and/or mates attempting to communicate. Mesa (1994) examined predator avoidance ability and physiological response of Chinook salmon subjected to various stressors. Test subjects were agitated to cause disorientation. When equal numbers of stressed and unstressed fish were exposed to predators, there was significantly more predation of stressed fish. Shin (1995) reports that impact pile driving may result in agitation of fish, manifested as a change of swimming behavior.

Turnpenny *et al*. (1994) attempted to determine a level of underwater sound that would elicit behavioral responses in brown trout, bass, sole, and whiting. In brown trout an avoidance reaction was observed above 150 dB_{rms}, and other reactions (e.g., a momentary startle) were observed at 170-175 dB_{rms}. The report references Hastings' "safe limit" recommendation of 150 dB_{rms} and concludes that the Hastings' "safe limit" provides a reasonable margin below the lowest levels where fish injury was observed. In an associated literature review, Turnpenny and Nedwell (1994) also state that the Hastings' 150 dB_{rms} limit did not appear overly stringent and that its application seemed justifiable.

More recently, Fewtrell (2003) held fish in cages in marine waters and exposed them to seismic airgun impulses. The study detected significant increases in behavioral response when sound pressure levels exceeded 158-163 dB_{rms}. Responses included alarm, faster swimming, tighter grouping, and movement toward the lower portion of the cage. It is difficult to discern the

significance of these behavioral responses. The study also evaluated physiological stress response by measuring plasma cortisol and glucose levels and found no statistically significant changes. Conversely, Santulli *et al*. (1999) found evidence of increased stress hormones after exposing caged European bass to seismic survey noise.

Popper (2003) suggests that the behavioral responses of fishes may include swimming away from the sound source, thereby decreasing potential exposure to the sound, or "freezing" (staying in place), thereby becoming vulnerable to possible injury. Feist *et al*. (1992) found that impact pile driving affected juvenile pink and chum salmon distribution, school size, and schooling behavior. In general, on days when impact pile driving was not conducted, fish exhibited a more polarized schooling behavior (i.e., movements in a more definite pattern). On days when impact pile driving was conducted, fish exhibited an active "milling" behavior (i.e., movement in an eddying mass); fish did appear to change their distributions about the site, more commonly orienting and moving towards an acoustically-isolated cove, on days when impact pile driving was conducted. Observations by Feist *et al*. (1992) suggest that SPLs in excess of 150 dB_{rms} may disrupt normal migratory behavior in juvenile salmon.

Clearly, there is a substantial gap in scientific knowledge on the topic of significant behavioral responses to elevated underwater SPLs. The most recent study by Fewtrell (2003) presents some experimental data on behavioral responses of fishes to impulsive sounds above 158 dB_{rms}. However, given the large amount of uncertainty that lies not only in extrapolating from experimental data to the field, but also between sound sources (airguns vs. pile driving), and from one species to another, we believe it is appropriate to utilize the most conservative known threshold. As such, for the purposes of this analysis, we expect that SPLs in excess of 150 dB_{rms} will cause significant behavioral changes in bull trout and will or may disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter).

Estimate of the Extent of Effect

Until recently, we used SPLs measured as peak pressure to estimate the onset of injury. However, effective June 2008, the FWS, WSDOT, and other signatory agencies have formally endorsed application of new interim criteria recommended by the Fisheries Hydroacoustic Working Group (2008). These new interim criteria apply a SEL framework for assessing fish injury.

In 2004, the California Department of Transportation and Federal Highway Administration convened a group of experts in the field of underwater acoustics (referred to as the Fisheries Hydroacoustic Working Group) with the intent of evaluating and refining criteria. This effort included an extensive literature review as the basis for a report on the topic (Hastings and Popper 2005) and a white paper proposing interim criteria (Popper *et al*. 2006). The Hastings and Popper report (2005) suggested a metric of SEL may be more appropriate for assessing potential injury to fishes from impact pile driving; in part, because the use of SEL allows for the summing of energy over multiple pile driving pulses, which cannot be accomplished when using peak pressure.

The new interim criteria for fish injury identify a single-strike SPL of 206 dB_{peak} and 183 dB

accumulated SEL for fish less than 2 grams. The interim criteria identify a single-strike SPL of 206 dB_{peak} and 187 dB accumulated SEL for fish greater than 2 grams (FHWG 2008).

We use the practical spreading model (Davidson 2004) to estimate the distance from piling installation operations (R; range) at which transmission loss (TL) can be expected to attenuate SPLs and SELs to below thresholds for injury and significant behavioral interference. The calculation [TL = 15*Log(R)] assumes that sound levels decrease at a rate of 4.5 dB per doubling distance. This method also assumes that single-strike SELs less than 150 dB do not accumulate to cause injury ("effective quiet") (J. Stadler pers. comm. 2009).

We used what we consider, for this project, a "worst-case" set of assumptions when applying the practical spreading model. We used single-strike SPLs of 190 dB_{peak} and 175 dB_{rms}, a single-strike SEL of 165 dB, and assumed as many as 6,000 strikes/day during a single 10- or 12-hour workday without the use of an underwater noise attenuation device. These assumptions regarding unattenuated pressures are within the range reported in the literature for similar operations (i.e., operations involving impact pile driving of steel H-piles) (CALTRANS 2007).

Based on the studies and findings presented here and in previous sub-sections, we expect that adult and subadult bull trout exposed to an accumulated SEL of 187 dB will be injured or killed. Based on the studies and findings presented here and in previous sub-sections, we also expect that juvenile bull trout exposed to an accumulated SEL of 183 dB will be injured or killed. Finally, we expect that bull trout of any life history stage (i.e., adult, subadult, or juvenile), when exposed to single-strike SPLs of 150 dB_{rms} or above, will or may experience a significant disruption of their normal behaviors (i.e., ability to successfully feed, move, and/or shelter). Pile driving and proofing with an impact hammer may cause bull trout to temporarily avoid the area, impede or discourage free movement through the area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions.

Applying the methods of analysis summarized here, impact driving and proofing of steel H- and sheet piles may kill or injure adult, subadult, and/or juvenile bull trout to a distance of approximately 325 ft from piling installation operations. Impact driving and proofing of steel H- and sheet piles may also significantly disrupt normal bull trout behaviors to a distance of approximately 1,520 ft. It should be noted, these estimates of potential effect do not and cannot account for the natural attenuation that is likely to result when piling installation operations are conducted in shallow waters. Similarly, these estimates of potential effect do not and cannot account for further attenuation which is likely to result when sound pressures are interrupted and/or refracted by exposed bars, channel bends or discontinuities, or structures associated with the temporary diversion dam.

It is impossible to know with certainty whether accumulated SELs sufficient to cause injury or mortality will propagate beyond the isolated work area, through the temporary diversion dam and/or through exposed or partially dewatered natural streambed substrates (i.e., exposed bars, shallow riffles, etc.). The WSDOT and Corps have argued that underwater sound levels with the potential to cause injury should be confined to the isolated work area, and have committed to in-water sound monitoring which should be sufficient to detect injurious SELs if in fact they do propagate beyond the isolated work area (WSDOT 2008a,b). Accordingly, and assuming full implementation of all agreed upon conservation measures, we assume that underwater sound levels with the potential to cause injury will in fact be confined to the isolated work area (approximately 1,000 linear ft or 2.3 acres below the OHWM).

We are not, however, confident that underwater SPLs with the potential to cause significant behavioral changes will also be confined to the isolated work area. To the contrary, we expect that SPLs in excess of 150 dB_{rms} will propagate beyond the isolated work area and thereby significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). We expect these SPLs may extend as far as 1,520 ft upstream and downstream of piling installation operations, including the length of the temporary diversion channel. Pile driving and proofing with an impact hammer may cause bull trout to avoid this portion of the action area, may impede or discourage free movement through the area (including the upstream migration of adult bull trout), prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions.

We expect that a limited number of adult, subadult, and juvenile bull trout may evade capture and relocation from the isolated work area, may be subsequently exposed to accumulated SELs sufficient to cause injury, and may therefore suffer injury or mortality as result of exposure to impact pile driving operations. With full implementation of the agreed upon conservation measures, we expect the number of injured or killed bull trout will be very low (i.e., a few individuals at most). We do not expect that any adult, subadult, or juvenile bull trout will be injured or killed outside of the isolated work area.

In addition, we expect that impact pile driving operations will significantly disrupt the normal behaviors of a larger number of adult, subadult, and juvenile bull trout. Perhaps most significant, we expect that impact pile driving operations will produce sound levels which may impede or discourage free movement through the action area, and, combined with other aspects of construction in and around the White River's low-flow channel (including flow diversion), may delay or discourage adult bull trout from migrating up through and around the project area. However, because the proposed project will observe a daylight-only work timing restriction, bull trout will not be exposed to elevated underwater SPLs outside daylight hours, and therefore nocturnal movements and migration through and around the project area should be relatively unimpeded. Impact pile driving and proofing may prevent individuals from exploiting preferred habitats and/or expose individuals to less favorable conditions, but because suitable bull trout spawning habitats are not present in the action area these operations will have no effect on bull trout spawning habitat or essential spawning behaviors.

Exposure to Elevated Turbidity and Sedimentation During Construction

The proposed action includes in-water work to be completed during two consecutive construction seasons. Construction will require temporarily diverting flow from a large area below the OHWM (approximately 1,000 linear ft or 2.3 acres) and will involve intensive construction throughout much of this area for the duration of the approved in-water work window during the second year of construction (July 1 to September 30).

The Corps and WSDOT propose measures to avoid and minimize effects to the environment, including a number of in-water construction BMPs (e.g., turbidity curtains, cofferdams, screened pumps, etc.). However, the Corps and WSDOT also intend to obtain a section 401 water quality modification that would permit temporary turbidity exceedances to a distance of approximately 2,000 ft. With consideration for the nature and extent of the proposed in-water work, and for the extremes of flow and discharge typical of the White River during even the low-flow summer months, we expect that sediment generating activities will degrade surface water quality as far as 2,000 ft downstream and thereby result in a significant temporary disruption of normal bull trout behaviors.

Although few studies have specifically examined the issue as it relates to bull trout, increases in suspended sediment affect salmonids in several recognizable ways. The variety of effects of suspended sediment may be characterized as lethal, sublethal or behavioral (Bash *et al*. 2001; Newcombe and MacDonald 1991; Waters 1995). Lethal effects include gill trauma (physical damage to the respiratory structures), severely reduced respiratory function and performance, and smothering and other effects that can reduce egg-to-fry survival (Bash *et al*. 2001). Sublethal effects include physiological stress reducing the ability of fish to perform vital functions (Cederholm and Reid 1987), increased metabolic oxygen demand and susceptibility to disease and other stressors (Bash *et al*. 2001), and reduced feeding efficiency (Bash *et al*. 2001; Berg and Northcote 1985; Waters 1995). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash *et al*. 2001). Fish may be forced to abandon preferred habitats and refugia, and may enter less favorable conditions and/or be exposed to additional hazards (including predators) when seeking to avoid elevated concentrations of suspended sediment.

In order to assess the suspended sediment concentrations at which adverse effects will occur and to determine the downstream extent to which these effects may extend as a result of the proposed project, we used the analytical framework attached as Appendix F (USFWS 2006). This framework uses the findings of Newcombe and Jensen (1996) to evaluate the "severity-of-effect" (SEV) based on suspended sediment concentration, exposure, and duration. Factors influencing suspended sediment concentration, exposure, and duration include waterbody size, volume of flow, the nature of the construction activity, construction methods, erosion controls, and substrate and sediment particle size. Factors influencing the SEV include duration and frequency of exposure, concentration, and life stage. Availability and access to refugia are other important considerations.

The framework in Appendix F requires an estimate of suspended sediment concentration (mg/L) and exposure duration. In the absence of any reliable, large datasets with which to determine the ratio of turbidity to suspended solids for this portion of the White River, we instead relied on a large dataset available for another, comparable glacially-fed headwater system of the Washington Cascade Mountains (Sauk River). Monitoring data collected at the Washington State Department of Ecology station on the Sauk River (WDOE 2009b) were used to determine the ratio of turbidity to suspended solids (1 NTU : 4.20 mg/L). To determine exposure duration, we assumed that work below the OHWM would occur 10 hours a day, for as many as 30 working days during the first season of construction (August 1 to September 30), and as many as 90 days during the second season of construction (July 1 to September 30). It is important to note we expect that any measurable increases in turbidity will be short term and episodic.

Using this approach, we expect that adverse effects to adult, subadult, and juvenile bull trout are likely to occur under the following circumstances:

1. When background NTU levels are exceeded by 96 NTUs at any point in time.

2. When background NTU levels are exceeded by 35 NTUs for more than 1 hour, cumulatively, over a 10-hour workday.

3. When background NTU levels are exceeded by 13 NTUs for more than 3 hours, cumulatively, over a 10-hour workday.

4. When background NTU levels are exceeded by 5 NTUs for more than 7 hours, cumulatively, over a 10-hour workday.

To assess the potential extent of these effects we relied on a limited set of monitoring data collected to determine the effectiveness of BMPs and compliance with State surface water quality standards (Appendix F; Table 5). We also considered the nature and extent of the proposed in-water work, and the White River's tendency for extremes of flow and discharge (including during the low-flow summer months). Based on this information we expect that suspended sediment concentrations resulting in adverse effects to bull trout are reasonably certain to occur as far as 2,000 ft downstream of construction activities.

We expect that a potentially large number of adult, subadult, and juvenile bull trout will be in the action area at the time of construction and may be exposed to elevated turbidity and sedimentation. We expect that some bull trout will avoid the area when elevated suspended sediment concentrations result from construction activities. Resulting turbidities may also impede or discourage free movement through the action area, and combined with other aspects of construction in and around the White River's low-flow channel (including flow diversion), may delay or discourage adult bull trout from migrating up through and around the project area. However, because the proposed project will observe a daylight-only work timing restriction, bull trout will not be exposed to elevated turbidities outside daylight hours, and therefore nocturnal movements and migration through and around the project area should be relatively unimpeded.

Temporary increases in turbidity may prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. We expect that elevated turbidity and sedimentation will result in a significant temporary disruption of normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). Suitable bull trout spawning and rearing habitats do not occur within the action area and therefore these essential bull trout behaviors will not be exposed to in-water work or resulting temporary effects to surface water quality.

Permanent and Temporary Effects to Instream Habitat

We expect that the proposed action will result in both direct and indirect effects to bull trout FMO habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be permanent or long term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. Suitable bull trout spawning and rearing habitats do not occur within the action area and therefore will not be affected by the action.

Temporary Effects to Instream Habitat

Construction of the project will require diverting flow from a large area below the OHWM (approximately 1,000 linear ft or 2.3 acres) and will involve intensive construction throughout much of this area. Temporary, construction-related increases in turbidity may extend as far as 2,000 ft downstream of sediment generating activities. The WSDOT and Corps also expect a "first-flush" pulse of additional turbidity soon after construction, as the channel adjusts to the new stream bed and stream bank stabilization measures under seasonal flows (WSDOT 2008a).

We expect that these construction-related and "first-flush" pulses of turbidity will cause a measurable increase in sedimentation along the downstream reach, extending as far as 2,000 ft. Sediments deposited along the downstream reach may accumulate in pools or tailouts, and may for a time bury some of the native substrates. However, we expect these effects will be limited in both physical extent and duration. We expect that within the action area the channel will adjust and resume natural patterns of bedload and sediment transport within one year of construction.

Increased sedimentation along the downstream reach will temporarily degrade bull trout FMO habitat. We expect that measurable increases in sedimentation will significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move and/or shelter) for a distance of 2,000 ft and a duration of up to one year.

Permanent Effects to Instream Habitat

The proposed action will reinforce an existing artificial constraint on the CMZ and floodplain along approximately 1,000 linear ft of the White River. Bank hardening will reduce opportunities for interaction between the active channel and floodplain, will permanently (or indefinitely) reduce the potential for development of off-channel habitat complexity, and impair natural processes that contribute to the formation and maintenance of diverse instream habitats. However, the project does incorporate design elements (e.g., ELJs with substantial amounts of

LWM, inter-planted rock slope protection, and lenticular bars) which we expect will partially offset these adverse effects. Within the limits of the constructed stream bed and stream bank stabilization measures, the project will or may improve instream habitat function compared to the existing smooth riprap revetment that exists today. Furthermore, because the project includes site restoration and onsite compensatory mitigation to replace wetland/buffer and riparian functions, we do not expect that temporal losses of these functions will have any significant effect on bull trout or their habitat.

Bank hardening impairs the natural processes that contribute to the formation and maintenance of diverse instream habitats. The adverse effects of bank hardening are well documented in the scientific literature, and the extensive bank hardening that has occurred along the lower Sacramento River provides one good, thoroughly investigated example (USFWS 2000). The adverse effects of bank hardening can include: (a) Interruption of the dynamic equilibrium, which through patterns of erosion and sedimentation contributes, sorts, and distributes substrates of varying size within the active CMZ; (b) Uncoupling of the active channel and riparian zones, reducing the frequency of overbank flows and recruitment of LWM; (c) Confinement of the CMZ, reducing or eliminating opportunities for meander migration and development of off-channel habitat; and, (d) Straightening of the active channel and reduction in bank roughness, leading to intensification of water velocities and forces which cause channel incision and accelerated rates of bank erosion upstream and downstream of the hardened bank (Schmetterling *et al*. 2001; USFWS 2000). These effects impair the natural processes that contribute to the formation and maintenance of diverse instream physical habitat.

Bank hardening most acutely affects the diversity of near-shore and off-channel habitats. Microhabitats in the form of point bars, backwaters and eddies, undercut banks, debris jams, side channels, oxbows, and overhanging bank vegetation are generally all substantially reduced as a result of bank hardening and channel confinement (Schmetterling *et al*. 2001; USFWS 2000). Furthermore, with decoupling of the natural processes and interactions within the floodplain, systems lose their ability to replace and repair degraded habitats.

The proposed action will further harden approximately 1,000 linear ft of the White River's right bank and will raise an approximately 0.5 mi segment of SR 410 above flood-flow elevations. In doing so, the project will eliminate the opportunity for meander migration and further development of near-shore and off-channel habitats, and will further decouple the active channel and floodplain. The project will have significant indirect effects, occurring later in time but persisting for the functional life of the stream bed and stream bank stabilization measures. These indirect effects include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of LWM. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect greatly simplified and homogenized instream structure to result in time along the affected bank.

The proposed stream bed and stream bank stabilization measures include a series of approximately five ELJs, three bio-engineered lenticular bars, and one buried groin. These bank treatments will function to deflect or redirect flow away from the eroding roadway embankment, increase channel roughness, and thereby reduce or dissipate flow velocities and forces. The project will further increase bank and floodplain roughness along the reach by planting woody

and herbaceous vegetation throughout the reconstructed roadway embankment and along a portion of an upstream right bank floodplain bench.

We expect that the proposed action will create a more diverse and complex assemblage of instream habitats to replace the existing smooth riprap revetment and entrained channel thalweg. With reestablishment of adjacent and overhanging vegetation, the proposed ELJs, lenticular bars, and groin should function to provide a range of channel depths, thermal and visual cover, and resting and refuge habitat from stream velocities and forces. Resulting conditions may provide improved foraging and overwintering opportunities for bull trout.

Outside the limits of the constructed stream bed and stream bank stabilization measures, we do not expect that the action will have adverse indirect effects to bull trout habitat. The project should substantially increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion along the downstream reach. The proposed action will redirect water velocities and forces locally, but we do not expect this will result in significant indirect effects along the downstream reach.

Because the project will further impair natural processes that contribute to the formation and maintenance of diverse instream physical habitat, and because we don't expect engineered bank treatments to function exactly as intended (or indefinitely), the proposed action does present some potential risk for adverse effects to bull trout. Therefore, we anticipate that the project will have measurable, adverse effects to bull trout from degradation of habitat along 1,000 linear ft of the White River.

Summary of Effects (Matrix of Pathways and Indicators)

An earlier section applied the *Matrix of Diagnostics / Pathways and Indicators* (USFWS 1998) as a tool for describing whether aquatic habitat is functioning adequately, functioning at risk, or functioning at unacceptable levels of risk at the scale of the action area (see Environmental Baseline in the Action Area). Table 1 summarizes the effects of the action using this same matrix. For a fuller description of the anticipated effects of the action see the preceding sub-sections.

Table 1 Effects of the action ("Matrix of Pathways & Indicators").

Pathway	Indicator	Baseline Conditions	Effect of the Action
Water Quality	Temperature	At Risk	Maintain
	Sediment	At Risk	**Degrade** (Temporary)
	Chemical Contamination & Nutrients	Functioning Adequately	Maintain
Habitat Access	Physical Barriers	Functioning Adequately	**Degrade** (Temporary)
Habitat Elements	Substrate	At Risk	**Degrade** (Temporary)
	Large Woody Debris	Unacceptable Risk	**Restore**
	Pool Frequency / Quality	At Risk	**Restore**
	Large Pools	At Risk	Maintain
	Off-Channel Habitat	At Risk	**Degrade**
	Refugia	At Risk	Maintain
Channel Conditions & Dynamics	Width/Depth Ratio	Functioning Adequately	Maintain
	Streambank Condition	Unacceptable Risk	**Degrade**
	Floodplain Connectivity	Unacceptable Risk	**Degrade**
Flow / Hydrology	Peak / Base Flows	Functioning Adequately	Maintain
	Drainage Network	At Risk	Maintain
Watershed Conditions	Road Density / Location	Unacceptable Risk	Maintain
	Disturbance History	At Risk	Maintain
	Riparian Reserve	At Risk	Maintain

Adverse Effects of the Action – Bull Trout Critical Habitat

An earlier section identified the PCEs that define bull trout critical habitat and described their baseline condition in the action area (Environmental Baseline, Status of Critical Habitat in the Action Area – Bull Trout). The following section discusses the effects of the action with reference to the nine PCEs.

The proposed action will have both direct and indirect effects to critical habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be permanent or long term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. Suitable bull trout spawning and rearing habitats do not occur within the action area and therefore will not be affected by the action.

Construction of the project will require diverting flow from a large area below the OHWM (approximately 1,000 linear ft or 2.3 acres) and will involve intensive construction throughout much of this area. Temporary, construction-related increases in turbidity may extend as far as 2,000 ft downstream of sediment generating activities. Sediments deposited along the downstream reach may accumulate in pools or tailouts, and may for a time bury some of the native substrates. However, we expect these effects will be limited in both physical extent and duration. We expect that within the action area the channel will adjust and resume natural patterns of bedload and sediment transport within one year of construction.

Construction activities may temporarily impair function of the migratory corridor. We expect that the left bank temporary diversion channel, elevated sound levels resulting from impact pile driving, and temporary increases in turbidity, may impede or discourage free movement through the action area during the course of in-water work (August 1 to September 30 during the first season of construction; July 1 to September 30 during the second season of construction). In particular, adult bull trout may be delayed or discouraged from migrating up through and around the project area. However, because the proposed project will observe a daylight-only work timing restriction, nocturnal movements and migration through and around the project area should be relatively unimpeded.

The proposed action will reinforce an existing artificial constraint on the CMZ and floodplain along approximately 1,000 linear ft of the White River. Bank hardening will reduce opportunities for interaction between the active channel and floodplain, will permanently (or indefinitely) reduce the potential for development of off-channel habitat complexity, and impair natural processes that contribute to the formation and maintenance of diverse instream habitats. However, the project does incorporate design elements (e.g., ELJs with substantial amounts of LWM, inter-planted rock slope protection, and lenticular bars) which we expect will partially offset these adverse effects to critical habitat. Within the limits of the constructed stream bed and stream bank stabilization measures, the project will or may improve instream habitat function compared to the existing smooth riprap revetment that exists today. Furthermore, because the project includes site restoration and onsite compensatory mitigation to replace wetland/buffer and riparian functions, we do not expect that temporal losses of these functions will have any significant effect on bull trout critical habitat.

The project will have significant indirect effects, occurring later in time but persisting for the functional life of the stream bed and stream bank stabilization measures. These indirect effects include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of LWM. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect greatly simplified and homogenized instream structure to result in time along the affected bank.

We expect that the proposed action will create a more diverse and complex assemblage of instream habitats to replace the existing smooth riprap revetment and entrained channel thalweg. With reestablishment of adjacent and overhanging vegetation, the proposed ELJs, lenticular bars, and groin should function to provide a range of channel depths, thermal and visual cover, and resting and refuge habitat from stream velocities and forces. Resulting conditions may provide improved foraging and overwintering opportunities for bull trout.

Outside the limits of the constructed stream bed and stream bank stabilization measures, we do not expect that the action will have adverse indirect effects to bull trout habitat. The project should substantially increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion along the downstream reach. The proposed action will redirect water velocities and forces locally, but we do not expect this will result in significant indirect effects along the downstream reach.

Because the project will further impair natural processes that contribute to the formation and maintenance of diverse instream physical habitat, and because we don't expect engineered bank treatments to function exactly as intended (or indefinitely), the proposed action does present some potential risk for adverse effects to bull trout. Therefore, we anticipate that the project will have measurable, adverse effects to bull trout from degradation of habitat along 1,000 linear ft of the White River.

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

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant.

2. *Migratory 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 proposed action will have measurable adverse effects on this PCE. Construction activities may temporarily impair function of the migratory corridor during the course of in-water work (August 1 to September 30 during the first season of construction; July 1 to September 30 during the second season of construction). However, because the proposed project will observe a daylight-only work timing restriction, nocturnal movements and migration through and around the project area should be relatively unimpeded.

The proposed action will have no measurable, permanent or long term effect on this PCE. The

proposed action will not create or contribute to any existing impediments to migration.

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

The proposed action may have measurable adverse effects on this PCE. Temporary, construction-related increases in turbidity may extend as far as 2,000 ft downstream of sediment generating activities, accumulate in pools or tailouts, and may for a time bury some of the native substrates. However, we expect these effects will be limited in both physical extent and duration, not exceeding a period of one year after construction.

The proposed action will have no permanent or long term adverse effect on this PCE. We expect that the proposed action will create a diverse and complex assemblage of instream habitats, including a range of channel depths, thermal and visual cover, and resting and refuge habitat from stream velocities and forces. Resulting conditions may provide improved foraging and overwintering opportunities for bull trout.

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

The proposed action will reinforce an existing artificial constraint on the CMZ and floodplain along approximately 1,000 linear ft of the White River. Bank hardening will reduce opportunities for interaction between the active channel and floodplain, will permanently (or indefinitely) reduce the potential for development of off-channel habitat complexity, and impair natural processes that contribute to the formation and maintenance of diverse instream physical habitats. Because the project will further impair natural processes that contribute to the formation and maintenance of diverse instream physical habitat, we expect that the proposed action will have permanent or long term adverse effects on this PCE (including interrupted patterns of erosion, sedimentation, and recruitment of LWM).

However, we also expect, that within the limits of the constructed stream bed and stream bank stabilization measures, the proposed action will create a more diverse and complex assemblage of instream habitats to replace the existing smooth riprap revetment and entrained channel thalweg. With reestablishment of adjacent and overhanging vegetation, the proposed project should function over time to provide a range of channel depths, thermal and visual cover, and resting and refuge habitat from stream velocities and forces. The action should substantially increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion along the downstream reach. Resulting conditions may provide improved foraging and overwintering opportunities for bull trout.

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

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant.

6. *Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 in.) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.*

Suitable bull trout spawning habitats are not present in the action area, and therefore the proposed action will have no effect on bull trout spawning habitats. The nearest documented bull trout spawning habitats are located in the Greenwater River, outside of the action area and at higher elevations. The proposed action will have no measurable temporary or permanent effect on this PCE.

7. *A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.*

The proposed action will have no adverse effect on this PCE. We expect that the action should substantially increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion along the downstream reach. Any permanent or long term effect to this PCE will be insignificant and/or beneficial.

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

The proposed action will have measurable adverse effects on this PCE. Temporary, construction-related increases in turbidity may extend as far as 2,000 ft downstream of sediment generating activities. We expect that measurable increases in turbidity will be short term and episodic, but may occur at any time during the course of in-water work (August 1 to September 30 during the first season of construction; July 1 to September 30 during the second season of construction).

The proposed action will have no measurable, permanent or long term effect on this PCE. The proposed action will not permanently degrade or impair water quality or quantity within the action area.

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

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant.

<u>Adverse Effects of the Action – Marbled Murrelet</u>

We expect that the proposed action will result in measurable adverse effects to the marbled murrelet and its habitat. In addition to those temporary exposures and effects that are likely to occur during construction, the proposed action will also permanently degrade suitable marbled murrelet nesting habitat adjacent to SR 410 in the vicinity of the project.

This portion of the White River serves as a flight corridor, and marbled murrelet nest occupancy cannot be ruled out in the immediate vicinity of the project. Construction of the project will result in temporary increases in sound and visual disturbance, and may significantly disrupt normal marbled murrelet behaviors.

The proposed action would permanently remove mature trees, nest platforms, and vertical and horizontal canopy cover from approximately 2 acres of suitable and potentially occupied marbled murrelet nesting habitat. Partial or complete loss of function (i.e., as marbled murrelet nesting habitat) would extend beyond the clearing and grubbing limits to include or account for loss or reduction of adjacent cover, increased exposure to predation, and related edge effects. However, despite this partial or complete loss of function, the proposed action is unlikely to have any measurable or detectable effect on function or productivity at the scale of the larger stand. For a fuller description of these potential effects, see a sub-section that follows (*Permanent Effects to Suitable Nesting Habitat*).

Temporary Exposures and Effects Associated with Construction

The proposed project will be constructed over two consecutive construction seasons and will require approximately 200 working days. Because of other environmental constraints (i.e., the approved in-water work windows), the Corps and WSDOT do not propose to avoid construction during the murrelet nesting season (i.e., April 1 through September 15). However, from March 1 through September 30 of each year of construction, the project will observe a daylight-only work timing restriction. All work, including onsite staging, will be completed between 2 hours after sunrise and 2 hours before sunset.

Temporary increases in in-air sound associated with impact pile driving and proofing are expected to have the farthest reaching effects in the terrestrial environment and may significantly disrupt normal marbled murrelet behaviors. Our assessment of in-air sound generation and attenuation finds that increased sound levels are likely to exceed ambient sound levels to a distance of approximately 2 mi from the locations of impact pile driving. Our assessment also finds that the sound-only injury effects threshold (92 dB) should not be exceeded to a distance of more than 220 ft, and that the sound-only disturbance effects threshold (70 dB) should not be exceeded to a distance of more than 1,700 ft, from the locations of impact pile driving.

Even with implementation of the proposed conservation measures, including daylight-only work timing restrictions, temporary exposures associated with construction (i.e., sound and visual disturbance) are likely to significantly disrupt normal marbled murrelet behaviors. Construction activities will impede free movement through the action area and may cause some individuals to temporarily avoid the trees and stands that lie in closest proximity, especially when work activities are most intense.

Temporary exposures sufficient to cause missed feedings or a flushing response are not entirely discountable, but will be limited in spatial extent. Described spatially as temporary sound extending approximately 220 ft from pile driving activities (landward along approximately 1,000 linear ft of the White River), we estimate that approximately 6 acres of suitable and potentially occupied marbled murrelet nesting habitat will be temporarily exposed to sound levels exceeding the injury effects threshold. For marbled murrelet chicks throughout these 6 acres, temporary exposures present a likelihood of injury. However, because the trees and stands located within 220 ft of pile driving activities provide nesting habitat of only marginal quality, and based on the intensity and duration of these potential exposures, we conclude that nest abandonment and/or nest failure (physical injury and/or mortality of eggs or chicks) is extremely unlikely and therefore discountable.

Construction-related sound and visual disturbance will be of short duration and will occur only during daylight hours, when marbled murrelets are generally less active. We expect that these temporary exposures could result in missed feedings, and are likely to cause stress and/or place larger energetic demands on affected, adult individuals. However, we do not expect that these temporary exposures will kill or injure any individuals, nor have a lasting, measurable effect on the long term survival or reproductive fitness of any adult marbled murrelet. Temporary exposures resulting from construction will have no measurable, short or long term effect on juvenile recruitment, marbled murrelet numbers, or productivity at the scale the stand, action area, larger landscape, or in Conservation Zones 1 and 2.

Permanent Effects to Suitable Nesting Habitat

The proposed action would permanently remove mature trees, nest platforms, and vertical and horizontal canopy cover from approximately 2 acres of suitable and potentially occupied marbled murrelet nesting habitat. Based upon our field reconnaissance survey of the SR 410 right-of-way and proposed clearing and grubbing limits, we estimate these 2 acres include approximately 10 individual trees meeting the FWS's definition of a suitable/potential marbled murrelet nest tree. However, partial or complete loss of function (i.e., as marbled murrelet nesting habitat) would also extend beyond the clearing and grubbing limits to include or account for loss or reduction of adjacent cover and related edge effects.

Nesting marbled murrelets frequently exhibit strong nest site fidelity, returning to sites where stands have been altered but still retain suitable nesting structure (Divoky and Horton 1995, pp. 83-84). Divoky and Horton (1995, p. 86) report that nesting alcids have returned to recently damaged or destroyed nest sites for up to two years. Marbled Murrelet occupancy has been

documented in remnant habitat patches ranging from 24 acres (Zharikov *et al*. 2006, p. 113), down to 5 acres in size (Miller and Ralph 1995, p. 211).

By far the greatest threat to marbled murrelets from habitat loss and fragmentation is the increased level of predation risk associated with forest edges (McShane *et al*. 2004, p. 4-109). Multiple studies point to prevailing high rates of nest predation and poor overall nesting success along edges (Nelson and Hamer 1995, p.96; Raphael *et al*. 2002, p. 231; McShane *et al*. 2004, p. 4-91). Raphael *et al*. (2002, p. 231) report that nest failure and predation was highest within 50 m (164 ft) of a forest edge, especially in areas closest to human activity. As nest patch size decreases, the amount of edge to interior habitat increases, resulting in both short term and long term increases in predation risk, which ultimately could result in reduced juvenile recruitment into the breeding population (Raphael *et al*. 2002, p. 232).

Actions that degrade occupied nesting habitat can also result in short term displacement and crowding of marbled murrelets into remaining patches (Raphael *et al*. 2002, p. 232). Nest relocation (i.e., the establishment of a "new" nest site) can lead to delays in the onset of breeding, nest site abandonment, or failed breeding due to increased predation risk at a marginal nesting location (Divoky and Horton 1995, p. 83; Raphael *et al*. 2002, p. 232). If nesting success is reduced for the affected breeding pairs, this can lead to reduced juvenile recruitment at the scale of the local population (Raphael *et al*. 2002, pp. 231-233).

The project's direct, permanent effects to suitable marbled murrelet nesting habitat will be focused as a narrow (but more or less continuous) strip directly adjacent and to the north of SR 410's westbound lane. The affected habitat lies within FFSP, which offers the single largest, contiguous tract of moderately to highly suitable marbled murrelet nesting habitat within 2 mi. The White River represents the southern boundary of FFSP, and this portion of the park is narrow, not exceeding 0.25 mi in a northerly direction from any point within the project limits. We conclude, therefore, the proposed action will have little or no effect on the core-to-interior ratio of available nesting acreage. While the proposed action would degrade suitable nesting habitat, it would do so along an existing stand edge, in close proximity to other established human uses (i.e., park pull-out, picnic, and day-use areas), and would therefore have less pronounced, long term effects on habitat function and productivity at the scale of the stand.

Applying conservative methods, i.e., methods likely to overstate rather than understate the potential effect, we used one-half of the average tree height (100 ft) and the linear dimension of the proposed clearing and grubbing limits to estimate the quantity of suitable marbled murrelet nesting habitat that may be affected indirectly by the proposed project. We expect that partial or complete loss of function (i.e., as marbled murrelet nesting habitat) would extend beyond the clearing and grubbing limits to include approximately 3 acres of additional habitat. Therefore, in total, we expect the proposed action will degrade or diminish function throughout 5 acres of suitable and potentially occupied marbled murrelet nesting habitat.

Despite this partial or complete loss of function, the proposed action is unlikely to have any measurable or detectable effect on marbled murrelet habitat function or productivity at the scale of the larger stand. The project will degrade or diminish function throughout 5 acres of habitat, which is less than 1 percent of the existing total available within FFSP. FFSP is managed with

the long term goal of maintaining habitat structure and function over time, and therefore there are few (if any) foreseeable actions that would or might lead to a further loss of marbled murrelet habitat function or productivity.

The proposed action is unlikely to cause or contribute to significant crowding or displacement of breeding pairs. Effects to suitable and potentially occupied habitat are focused along the periphery of FFSP, in close proximity to other established human uses (i.e., park pull-out, picnic, and day-use areas), and will have little or no effect on the core-to-interior ratio of available nesting acreage, nest patch size, or the average density of available marbled murrelet nest trees and platforms. We expect that any long term increases in predation risk, and any long term decreases in productivity, will not be measurable at the scale of the stand and will not have significance for breeding pairs that may use the stand.

There is little or no information available to describe how productivity within the affected habitat, or how habitats found within FFSP in general, contribute to local marbled murrelet numbers and productivity at the scale of the surrounding landscape. Multiple studies point to prevailing high rates of nest predation and poor overall nesting success along edges (Nelson and Hamer 1995, p.96; Raphael *et al*. 2002, p. 231; McShane *et al*. 2004, p. 4-91), and therefore, the most productive nesting habitat within FFSP may be that which is located furthest from existing stand edges (including SR 410). However, because of the park's linear dimensions, and because SR 410 bisects the park along its entire length, no location within FFSP is more than approximately 0.5 mi from a prominent edge or source of human disturbance.

The nearest documented, occupied habitat is located at a distance of more than 5 mi, and throughout much of the action area suitable marbled murrelet habitat is present only as small, discontinuous patches surrounded by large swaths of unsuitable or low-suitability habitat. However, with mixed-use Federal lands (i.e., Mt. Baker-Snoqualmie National Forest, Mount Rainier National Park) and commercial timberlands comprising nearly 99 percent of the total watershed area in the upper White River basin (Kerwin 1999, p.73), and with a considerable amount of designated critical habitat and late-successional reserves managed on Federal lands for late-seral characteristics, it is safe to assume that habitats found within FFSP contribute only very modestly to the surrounding landscape-scale patterns of marbled murrelet productivity.

Based on the amount and quality of affected habitat, and with consideration for baseline levels of disturbance (i.e., the close proximity of SR 410 and other established human uses), we do not expect that the proposed action will cause any measurable, short term reduction in nesting success or productivity. Nearly every habitat indicator measurable at the scale of the stand will remain unchanged (i.e., core-to-interior ratio, patch size, density of available nest trees and platforms, etc.) and we do not expect that the proposed action will cause or contribute to an increase in murrelet predator densities or penetration into surrounding productive habitat.

We expect that the direct and indirect effects of the proposed action will not cause a measurable decline in juvenile recruitment at the scale of the stand, action area, or larger landscape. When considered at the scales of the stand and surrounding landscape, we expect that the action's direct effects and long term, indirect effects to marbled murrelet habitat function and productivity will not be measurable. Accordingly, we expect that any related effect on marbled

murrelet numbers or productivity in Conservation Zones 1 or 2 will not be measurable.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action (USFWS and NMFS 1998).

The proposed action may have significant indirect effects to the bull trout, marbled murrelet, and their habitats. These indirect effects include: a "first-flush" pulse of additional turbidity soon after construction; potential long term effects to LWM transport, bedload transport, and channel formation processes along the reaches upstream and downstream of the project; and, partial or complete loss of marbled murrelet habitat function adjacent to the proposed clearing and grubbing limits as a result of loss or reduction of adjacent cover and related edge effects. Some of these potential indirect effects were addressed in previous sub-sections. For a fuller discussion of turbidity during and after construction, and for a fuller discussion of indirect effects to marbled murrelet habitat function, see the related preceding sub-sections (*Adverse Effects of the Action*).

The proposed action would construct a series of approximately five ELJs, three bio-engineered "lenticular bars", and one buried groin, some of which may extend as far as 50 ft horizontally, beyond the existing roadway embankment and into the White River's active channel. The project would reinforce an existing artificial constraint on the CMZ and floodplain and raise an approximately 0.5 mi segment of SR 410 further above flood-flow elevations. The project would also function to deflect or redirect flow away from the eroding roadway embankment, increase channel and floodplain roughness, and thereby reduce or dissipate flow velocities and forces.

The proposed stream bed and stream bank stabilization measures will, once constructed, have indirect effects to LWM transport, bedload transport, and channel and habitat formation processes which extend beyond the area directly effected, to include the "transport" and "response" reaches located upstream and downstream. Based upon the relative position of, and proximity to several moderate-radius meander bends, we expect that the project will influence these processes to a distance of approximately 1.25 mi downstream and 0.75 mi upstream (Figure 8).

Because the proposed action would further harden and raise approximately 1,000 linear ft of the White River's right bank, we expect the project will eliminate the opportunity for meander migration and development of off-channel habitats, and will further decouple the active channel and floodplain (see a preceding sub-section; *Adverse Effects of the Action*). Persistent indirect effects would include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of LWM. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect greatly simplified and homogenized instream structure to result in time along the affected bank.

However, with full implementation of the proposed conservation measures and permanent design elements, including site restoration and onsite compensatory mitigation, we do not expect that the project will have adverse indirect effects to bull trout habitat along the reaches upstream and downstream of the project. Outside the limits of the constructed stream bed and stream bank stabilization measures, the project should in fact substantially increase channel and floodplain roughness, lessen hydraulic forces, and result in reduced bed and bank erosion along the downstream reach. The proposed action will redirect water velocities and forces locally, but we do not expect this will result in significant indirect effects along the downstream reach.

The project will not result in changes in the use or function of the highway infrastructure and there are no other foreseeable indirect effects to the bull trout, marbled murrelet, or their habitats that might occur later in time. Over the long term, the Corps, WSDOT, and the FWS expect that the proposed action will permanently stabilize the roadway embankment in a manner that creates and maintains functioning, diverse instream habitat, and avoids the damage resulting from repeat emergency repairs.

Effects of Interrelated & Interdependent Actions

Interrelated actions are defined as actions "that are part of a larger action and depend on the larger action for their justification"; interdependent actions are defined as actions "that have no independent utility apart from the action under consideration" (50 CFR section 402.02).

The following may be considered interrelated or interdependent actions related to the proposed action under consideration:

- Onsite staging of equipment and materials during construction.

- Access to the left bank location for the temporary diversion channel by way of an existing gravel road owned by the Hancock Timber Resource Group and a temporary bridge span over floodplain wetlands.

- Post-construction monitoring and maintenance activities that do not alter the function or as-built physical footprint of the constructed stream bed and stream bank stabilization measures.

Previous sub-sections have addressed all of the anticipated direct and indirect effects that may result from these interrelated and interdependent actions. No additional effects to bull trout, the marbled murrelet, or their habitat are expected to result from interrelated or interdependent actions.

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. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Managed public and private forest is the dominant land use throughout the middle and upper White River watershed, including those lands that lie directly adjacent to the White River within the action area. Conditions that limit or reduce instream habitat function and productivity may improve over the long term as a result of modern forest practices and implementation of the Forest Practices Act.

FFSP is managed with the long term goal of maintaining the forest's late-seral structure and function over time, and there are few (if any) foreseeable actions that would result in impacts to marbled murrelet habitat function or productivity. We are not aware of any pending or future actions that would substantially change established management practices or uses at FFSP.

Like much of the middle and upper White River watershed, the White River within the action area is prone to flooding and related bed and bank instability. Future actions, either in response to flooding or in anticipation of flooding, are likely, and could include additional bank armoring and/or removal of aggraded bedload and LWM. These actions could have adverse effects to instream habitat.

Climate change and its potential effects cannot be ignored when describing possible future actions and conditions within the action area. In particular, potential effects to seasonal patterns of precipitation, surface water temperatures, and stream hydrology could present dramatically altered conditions for bull trout and other cold-water fisheries of the Pacific Northwest. A recent, wide-ranging assessment of these potential effects has identified the following trends (Littell *et al*. 2009 *in* USFWS 2010):

- Wetter autumns and winters; drier summers; reductions in snowpack.
- Higher winter stream flows; earlier spring snowmelt and peak spring stream flow; lower summer stream flows in rivers that depend on snowmelt.
- Rising stream temperatures and a corresponding reduction in the quality and extent of cold-water habitats.

Littell *et al*. (2009) have concluded that the combined effects of warming stream temperatures and altered stream flows will very likely reduce the reproductive success of many salmon populations. As much as one-third of the current habitat in the Pacific Northwest may no longer be suitable by the end of the century. Rising stream temperatures and temporal shifts in stream hydrology will have more pronounced effects on the systems, populations, and life-history types that are most sensitive.

As a glacially-fed system which originates in steep headwaters prone to landslides and debris flows, and which already experiences pronounced bed and bank instability in response to seasonal rain-on-snow precipitation and glacial melting (Herrera Environmental 2007), the middle and upper White River watershed represents a "sensitive" system where climate change's effects to instream habitat function and productivity could be very pronounced. We expect that bull trout and salmon of the middle and upper White River watershed could be at greater future risk for the kinds of natural, chronic and/or stochastic events which can degrade and fragment habitats, suppress productivity, and increase the physical or genetic isolation of local populations.

Climate change and its potential effects may also have consequences for marbled murrelets and their habitat where they are found within the action area. Some forests and plant communities could undergo significant changes in composition, structure, and/or distribution in response to disease and pestilence, thermal or drought stress, wildfire, and other factors (USFWS 2010). These changes could, over time, include a reduction in the availability of forests and stands providing the structure necessary to support successful marbled murrelet reproduction. A reduction of suitable habitat could in turn lead to crowding and/or selection and use of marginal nesting habitat (Divoky and Horton 1995, p. 83; Raphael *et al*. 2002, p. 232), and increase the relative importance of remaining highly suitable habitat. Because climate change would act on a massive scale to influence forest health, composition, and structure, its potential consequences for murrelet populations, while uncertain, could be both strong and pervasive.

Taken as a whole, the foreseeable future State, tribal, local, and private actions may have both beneficial effects and adverse effects to bull trout, the marbled murrelet, and their habitats. At the scale of the action area, we expect that foreseeable future actions may be less important than the consequences of climate change and its potential effects to watershed functions and forest health.

CONCLUSION

We have reviewed the current status of the bull trout in its coterminous range, the current status of the marbled murrelet in its coterminous range, the environmental baseline for the action area, the direct and indirect effects of the proposed project, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area.

Bull Trout

It is our Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout in its coterminous range. This determination is based on the following:

- The action area contains FMO habitat for fluvial and anadromous bull trout of the Puyallup River core area, and lies in close proximity to productive bull trout spawning and rearing habitats. The action area is presumed to support adult, subadult, and juvenile bull trout originating from three of the core area's five local populations (Upper White

River, West Fork White River, and Greenwater River). The Clearwater River, which enters the White River downstream of the action area, provides suitable bull trout spawning and rearing habitats and may support an as yet undocumented local bull trout population. The action area does not contain suitable bull trout spawning habitat.

- The proposed action incorporates both permanent design elements and conservation measures which will reduce effects to habitat and avoid and minimize impacts during construction. The action's temporary adverse effects are limited in both physical extent and duration. The incorporated design elements, including site restoration and onsite compensatory mitigation, will partially offset the action's permanent adverse effects, create and maintain functioning habitat, and avoid the damage resulting from repeat emergency repairs within the project area.

- With full implementation of the proposed conservation measures, we expect low numbers of adult, subadult, and juvenile bull trout will be adversely affected by construction activities. Exposure to construction activities may kill or injure a limited number of bull trout and will significantly disrupt normal bull trout behaviors (feeding, moving, and sheltering). Construction activities may temporarily delay or discourage adult migration up through the action area, but will have no effect on bull trout spawning habitat or essential spawning behaviors.

- The proposed action would permanently reinforce an existing artificial constraint on the CMZ and floodplain, and thereby impair natural processes that contribute to the formation and maintenance of diverse instream physical habitat. However, these adverse effects would be limited in physical extent, partially offset by the incorporated permanent design elements, and would not extend beyond the limits of the constructed stream bed and stream bank stabilization measures.

- While the proposed action may kill or injure a limited number of bull trout and will significantly disrupt normal bull trout behaviors (feeding, moving, and sheltering), we expect that any temporary effects to bull trout numbers (abundance) or reproduction (productivity) will not be measurable at the scale of the local populations or core area. The action's temporary and permanent effects will not preclude bull trout from rearing, foraging, and migrating within the action area.

- The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not appreciably reduce the likelihood of survival and recovery of the species. The anticipated direct and indirect effects of the action (permanent and temporary) will not measurably reduce bull trout reproduction, numbers, or distribution at the scale of the core area or Puget Sound interim recovery unit. The anticipated direct and indirect effects of the action will not alter the status of bull trout at the scale of the Puget Sound interim recovery unit or coterminous range.

Bull Trout Critical Habitat

It is our Opinion that the action, as proposed, will not destroy or adversely modify bull trout critical habitat. This determination is based on the following:

- The action area extends over approximately 2.2 linear mi of the mainstem White River's active channel migration zone, side-channels, and floodplain. At least eight of the PCEs of bull trout critical habitat are present in the action area.

- The action area provides core FMO habitat and, based on proximity, is presumed to support bull trout originating from three of the Puyallup River core area's five local bull trout populations (Upper White River, West Fork White River, and Greenwater River). The Puyallup River core area is believed to support the Puget Sound Management Unit's southernmost anadromous bull trout populations. Long term viability of the Puyallup River bull trout population is critically important to maintaining the overall distribution of migratory life history forms throughout the management unit.

- The proposed action will have both direct and indirect effects to bull trout critical habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be permanent or long term, lasting for the functional life of the proposed stream bed and stream bank stabilization measures. The proposed action incorporates permanent design elements and conservation measures which will partially offset effects to critical habitat, and avoid and minimize impacts during construction.

- Construction activities will present a temporary, partial barrier to free movement, for approximately 5 months (over two construction seasons). None of the proposed action's temporary adverse effects to the PCEs of bull trout critical habitat, including effects to water quality and the bull trout food base, are expected to persist for more than one year after construction.

- The proposed action will reinforce an existing artificial constraint on the CMZ and floodplain along approximately 1,000 linear ft of the White River. Because the project will further impair natural processes that contribute to the formation and maintenance of diverse instream physical habitat, we do expect permanent or long term adverse effects to PCE #4 (complex aquatic environments and processes). Bank hardening will reduce opportunities for interaction between the active channel and floodplain, and permanently (or indefinitely) reduce the potential for development of off-channel habitat complexity. However, we also expect the proposed action will create a more diverse and complex assemblage of instream habitats to replace the existing smooth riprap revetment and entrained channel thalweg. The incorporated permanent design elements should function over time to provide a range of channel depths, thermal and visual cover, and resting and refuge habitat from stream velocities and forces. The action should substantially increase channel and floodplain roughness, lessen hydraulic forces, and result in reduced bed and bank erosion along the downstream reach. Resulting conditions may provide improved foraging and overwintering opportunities for bull trout.

- The direct and indirect effects of the proposed action (permanent and temporary) will not preclude bull trout from foraging, migrating, or overwintering within the action area.

- Within the action area, bull trout critical habitat will retain its current ability to establish functioning PCEs. The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not prevent the PCEs of critical habitat from being maintained, and will not degrade the current ability to establish functioning PCEs at the scale of the action area. Critical habitat within the action area will continue to serve the intended conservation role for the species at the scale of the core area, Puget Sound interim recovery unit, and coterminous range.

Marbled Murrelet

It is our Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet in its coterminous range. This determination is based on the following:

- The action area provides suitable nesting habitat for the marbled murrelet, although occupancy is uncertain. This portion of the White River serves as a flight corridor for marbled murrelets transiting between nesting and foraging habitats. The terrestrial component of the action area includes all of FFSP, which is the single largest, contiguous tract of moderately to highly suitable marbled murrelet nesting habitat within 2 mi of the project.

- With full implementation of the proposed conservation measures, we expect that only a limited number of individuals and/or breeding pairs may be exposed to construction activities, and the direct physical disturbance or destruction of any occupied marbled murrelet nest is considered extremely unlikely and therefore discountable. The action's temporary and permanent effects will not preclude marbled murrelets from nesting and transiting within the action area.

- Temporary exposures sufficient to cause missed feedings or a flushing response are not entirely discountable, but will be limited in spatial extent. Furthermore, because the trees and stands located within 220 ft of pile driving activities provide nesting habitat of only marginal quality, and based on the intensity and duration of these potential exposures, we conclude that nest abandonment and/or nest failure (physical injury and/or mortality of eggs or chicks) is extremely unlikely and therefore discountable.

- Construction-related sound and visual disturbance will be of short duration and will occur only during daylight hours, when marbled murrelets are generally less active. We expect that these temporary exposures could result in missed feedings, presenting a likelihood of injury for chicks within 220 ft of pile driving activities. However, based on the intensity and duration of these potential exposures, we do not expect that the action will kill or injure any individuals, nor have a lasting, measurable effect on the long term survival or reproductive fitness of any adult marbled murrelet. Temporary exposures resulting from construction will have no measurable, short or long term effect on juvenile recruitment,

marbled murrelet numbers, or productivity at the scale the stand, action area, larger landscape, or in Conservation Zones 1 and 2.

- The proposed action will permanently remove mature trees, nest platforms, and vertical and horizontal canopy cover from approximately 2 acres of suitable and potentially occupied marbled murrelet nesting habitat. We expect that partial or complete loss of function will extend beyond the clearing and grubbing limits to include approximately 3 acres of additional habitat. Therefore, in total, we expect the proposed action will degrade or diminish function throughout 5 acres of suitable and potentially occupied marbled murrelet nesting habitat.

- Despite partial or complete loss of function throughout a portion of the suitable marbled murrelet nesting habitat in the vicinity of the project, the proposed action is unlikely to have any measurable or detectable effect on function or productivity at the scale of the larger stand or surrounding landscape. Only lower quality habitat along an existing stand edge would be removed or modified, with little or no effect to the core-to-interior ratio of available nesting acreage, nest patch size, and the average density of available marbled murrelet nest trees and platforms. The proposed action is unlikely to cause or contribute to significant crowding or displacement of breeding pairs, and we expect that any increases in predation risk, and any decreases in productivity will not be measurable at the scale of the stand.

- The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not appreciably reduce the likelihood of survival and recovery of the species. The anticipated direct and indirect effects of the action (permanent and temporary) will not measurably reduce marbled murrelet reproduction, numbers, or distribution at the scale of the surrounding landscape (i.e., middle and upper White River basin) or in Conservations Zones 1 and 2. The anticipated direct and indirect effects of the action will not alter the status or distribution of the marbled murrelet in Conservations Zones 1 and 2, or at the scale of the coterminous range.

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 FWS 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 FWS 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, 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 the contractor or applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR section 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

We anticipate that take in the form of harm and harassment of adult, subadult, and juvenile bull trout from the Puyallup River core area will result from the proposed action.

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 adults, subadults, or juveniles; 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.

1. Incidental take of bull trout in the form of ***harm*** (physical injury or mortality) resulting from handling related to fish capture and removal operations.

- One adult or subadult bull trout, and two juvenile bull trout will be harmed as a result of fish capture and removal operations conducted between July 1, 2012, and September 30, 2012, or the second year of construction.

2. Incidental take of bull trout in the form of ***harassment*** (significant disruption or interference with normal behaviors) resulting from handling related to fish capture and removal operations.

- Three adult or subadult bull trout, and eight juvenile bull trout will be harassed as a result of fish capture and removal operations conducted between July 1, 2012, and September 30, 2012, or the second year of construction.

3. Incidental take of bull trout in the form of ***harm*** as a direct effect of exposure to elevated underwater SPLs resulting from impact pile driving and proofing. Approximately 50

steel H-piles and 300 linear ft of steel sheet pile, between July 1, 2012, and September 30, 2012, or the second year of construction.

- Any adult, subadult, and/or juvenile bull trout that evade capture and remain in the isolated work area, extending to a distance of approximately 325 ft from piling installation operations, will be harmed.

4. Incidental take of bull trout in the form of ***harassment*** as a direct effect of exposure to elevated underwater SPLs resulting from impact pile driving and proofing. Approximately 50 steel H-piles and 300 linear ft of steel sheet pile, between July 1, 2012, and September 30, 2012, or the second year of construction.

- All adult, subadult, and juvenile bull trout within the wetted perimeter of the White River (including the temporary diversion channel) to a distance of approximately 1,520 ft upstream and downstream from piling installation operations will be harassed.

5. Incidental take of bull trout in the form of ***harassment*** resulting from degraded surface water quality and exposure to elevated turbidity and sedimentation during construction. Water quality will be degraded intermittently during the approximately 120-day period when construction activities are being completed below the OHWM of the White River. Take will result when levels of turbidity reach or exceed the following:

    i) 96 NTUs above background at any time; or

    ii) 35 NTUs above background for more than 1 hour, cumulatively, over a 10-hour workday; or

    iii) 13 NTUs above background for more than 3 hours, cumulatively, over a 10-hour workday; or

    iv) 5 NTUs above background for more than 7 hours, cumulatively, over a 10-hour workday.

- All adult, subadult, and juvenile bull trout within the wetted perimeter of the White River, from a point approximately 100 ft upstream to a point approximately 2,000 ft downstream of construction activities, will be harassed between August 1 and September 30, 2011 (or the first year of construction), and between July 1 and September 30, 2012 (or the second year of construction).

6. Incidental take of bull trout in the form of ***harassment*** resulting from bank hardening, encroachment on the channel migration zone and floodplain, and associated permanent adverse effects to instream habitat.

- Approximately 1,000 linear ft of the White River's right bank, indefinitely and for the functional life of the constructed stream bed and stream bank stabilization measures.

We anticipate that take in the form harassment of marbled murrelets from Conservation Zones 1 and/or 2 is likely to result from the proposed action.

Incidental take of individual marbled murrelets will be difficult to detect or quantify. Using post-project habitat conditions as a surrogate indicator of take, we anticipate that the following forms of take will occur as a result of activities associated with the project:

7. Incidental take of marbled murrelet in the form of ***harassment*** resulting from temporary exposure to construction-related noise and activity (i.e., in-air sound and visual disturbance) sufficient to cause missed feedings or a flushing response (July 1 to September 15, 2011, or the first year of construction; and, April 1 to September 15, 2012, or the second year of construction).

- All breeding pairs and their nests located within approximately 220 ft of pile driving activities will be harassed. This area is comprised of approximately 6 acres of suitable and potentially occupied marbled murrelet nesting habitat.

EFFECT OF THE TAKE

In the accompanying Opinion, we determined that the level of anticipated take is not likely to result in jeopardy to the bull trout or marbled murrelet.

The proposed action incorporates design elements and conservation measures which we expect will reduce permanent effects to habitat and avoid and minimize impacts during construction. We expect that the Corps and WSDOT will fully implement these measures, and therefore they have not been specifically identified as Reasonable and Prudent Measures or Terms and Conditions.

REASONABLE AND PRUDENT MEASURES

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

1. Minimize and monitor incidental take caused by handling related to fish capture and removal operations.

2. Minimize and monitor incidental take caused by elevated underwater SPLs from impact driving and proofing of steel H- and sheet piles.

3. Minimize and monitor incidental take caused by elevated turbidity and sedimentation during construction.

The following RPMs are necessary and appropriate to minimize the impact of incidental take to marbled murrelet:

4. Minimize and monitor incidental take caused by exposure to in-air sound resulting from impact driving and proofing of steel H- and sheet piles.

TERMS AND CONDITIONS

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

The following terms and conditions are required for the implementation of RPM 1:

1. The Corps and WSDOT shall ensure that fish capture and removal operations are conducted by a qualified biologist, and that all staff participating in the operation have the necessary knowledge, skills, and abilities to ensure safe handling of fish. Fish capture and removal operations shall take all appropriate steps to minimize the amount and duration of handling. The operations shall maintain captured fish in water to the maximum extent possible during seining/netting, handling, and transfer for release, to prevent and minimize stress.

2. The Corps and WSDOT shall ensure that water quality conditions are adequate in the buckets or tanks used to hold and transport captured fish. The operations shall use aerators to provide for the circulation of clean, cold, well-oxygenated water, and/or shall stage fish capture, temporary holding, and release, to minimize the risks associated with prolonged holding.

3. The Corps and WSDOT shall only employ electrofishing if all other means of fish capture and removal have been determined impracticable, and only after a qualified biologist determines that adult and subadult fish have been effectively removed. Electrofishing methods shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish. Water conductivity shall be measured in the field before electrofishing to determine appropriate settings. Electrofishing equipment and methods shall comply with the WSDOT fish exclusion protocol (WSDOT 2009; Appendix A).

4. If, while conducting work below the OHWM, river conditions or other factors (e.g., breaching of the temporary diversion dam or channel) allow fish to re-enter the isolated work area, the Corps and WSDOT shall cease in-water work and attempt to capture and remove fish. In-water work shall not again commence until the Corps and WSDOT have confirmed that fish allowed to re-enter have been successfully removed from the isolated work area. These same procedures shall apply if, at any time during piling installation operations, fish are observed dying or in distress.

5. The Corps and WSDOT shall provide notice to the FWS's consulting biologist (Ryan

McReynolds, 360-753-6047) a minimum of ten days prior to fish capture and removal operations. Upon request, the Corps and WSDOT shall permit the Service or its designated representative to observe fish capture and removal operations.

6. The Corps and WSDOT shall document and report all bull trout or other salmonids encountered during fish capture and removal operations. The Corps and WSDOT shall submit a monitoring report to the FWS's consulting biologist (Ryan McReynolds, 360-753-6047) at the Washington Fish and Wildlife Office in Lacey, Washington, by November 30 following each in-water construction season.

The following terms and conditions are required for the implementation of RPM 2:

1. The Corps and WSDOT shall install steel H- and sheet piles with the use of a vibratory pile hammer to the fullest extent practicable. The Corps and WSDOT shall not revert to the use of an impact pile hammer unless and until site conditions prevent placement of piles (i.e., penetration) to the required depth.

2. The Corps and WSDOT shall not commence with the installation of piles within the White River's low-flow channel until they confirm that fish capture operations have successfully removed all or nearly all fish from the isolated work area. If river conditions or other factors (e.g., breaching of the temporary diversion dam or channel) allow fish to re-enter the isolated work area, the Corps and WSDOT shall cease in-water work and attempt to capture and remove fish. In-water work shall not again commence until the Corps and WSDOT have confirmed that fish allowed to re-enter have been successfully removed from the isolated work area. These same procedures shall apply if, at any time during piling installation operations, fish are observed dying or in distress.

3. The Corps and WSDOT shall submit a hydroacoustic monitoring plan at least 45 days prior to commencing piling installation operations. The hydroacoustic monitoring plan shall be prepared by someone with proven expertise in the field of underwater acoustics and data collection and shall include the name and qualifications of the biologist to be present during impact pile driving and proofing.

4. The Corps and WSDOT shall monitor in-water sound generation and attenuation while installing steel H- or sheet piles with an impact pile hammer. At least one hydrophone shall be positioned just outside the isolated work area, but otherwise in closest possible proximity to the pile(s) being driven.

5. If, at any time, sound levels monitored just outside the isolated work area reach or exceed a single-strike SPL of 206 dB_{peak}, or an accumulated SEL of 183 dB, then the amount of take authorized by the Incidental Take Statement will have been exceeded. The Corps and WSDOT shall cease all piling installation operations and provide immediate notice to the FWS's consulting biologist at the Washington Fish and Wildlife Office in Lacey, Washington (Ryan McReynolds; 360-753-6047). The Corps shall consult with the FWS regarding modifications to the proposed action, to ensure that sound levels don't result in

potential injury outside the isolated work area and thereby exceed take. The Corps shall implement agreed upon modifications and continue hydroacoustic monitoring.

6. The Corps and WSDOT shall submit a monitoring report to the Washington Fish and Wildlife Office (Lacey, Washington) within 60 days of completing hydroacoustic monitoring. The report shall include the following information:

    i) Size and type of piles driven and proofed;

    ii) The impact hammer force used to drive and proof piles;

    iii) A description of the monitoring equipment;

    iv) The distance between hydrophone and pile;

    v) The depth of the hydrophone;

    vi) The distance from the pile to the wetted perimeter;

    vii) The depth of water;

    viii) The depth into the substrate the pile was driven and proofed;

    ix) The physical characteristics of the bottom substrate into which the piles were driven and proofed; and

    x) The results of the hydroacoustic monitoring, including the frequency spectrum, SPLs, and single-strike and cumulative SEL. The report must also include the ranges and means for peak, rms, and SELs.

The following terms and conditions are required for the implementation of RPM 3:

1. The Corps and WSDOT shall monitor turbidity levels in the White River during sediment-generating activities. Monitoring shall be conducted at a distance of 1,000 ft downstream of sediment-generating activities.

2. Monitoring shall be conducted at 30-minute intervals from the start of sediment-generating activities. If turbidities measured over the course of three consecutive 30-minute sample intervals do not exceed 5 NTUs over background, then monitoring of sediment-generating activities will be conducted for the remainder of the workday at a frequency of once every 3 hours, or if there is a visually appreciable increase in turbidity.

3. If at any time monitoring conducted 1,000 ft downstream of sediment-generating activities indicates turbidity in excess of 5 NTUs over background, then monitoring shall instead be conducted at 2,000 ft downstream of sediment-generating activities.

Monitoring shall be conducted at 30-minute intervals until turbidity falls below 5 NTUs over background.

4. If turbidity levels measured at 2,000 ft downstream of sediment-generating activities exceed 5 NTUs over background for more than 7 hours cumulatively over any 10-hour workday, 13 NTUs over background for more than 3 hours, or 35 NTUs over background for more than 1 hour cumulatively over any 10-hour workday, then the amount of take authorized by the Incidental Take Statement will have been exceeded. Sediment-generating activities shall cease, and the Corps and/or WSDOT shall contact the FWS's consulting biologist at the Washington Fish and Wildlife Office in Lacey, Washington (Ryan McReynolds; 360-753-6047).

5. Monitoring shall be conducted to establish background turbidity levels away from the influence of sediment-generating activities. Background turbidity shall be monitored at least twice daily during sediment-generating activities. In the event of a visually appreciable change in background turbidity, an additional sample shall be taken.

6. The Corps and WSDOT shall submit a monitoring report to the Service's consulting biologist (Ryan McReynolds; Washington Fish and Wildlife Office, Lacey, Washington) by November 30 following each in-water construction season, to include at a minimum, the following: (a) dates and times of construction activities, (b) monitoring results, sample times, locations, and measured turbidities (in NTUs), (c) summary of construction activities and measured turbidities associated with those activities, and, (d) summary of corrective actions taken to reduce sediment/turbidity. The second of these monitoring reports (i.e. the report submitted after the second year of construction) shall also include a qualitative description of the final condition of the work area. The Corps and WSDOT shall document any obvious signs of channel bed or bank instability (e.g., headcutting) resulting from the work, any additional actions taken to correct this instability, and the final condition of the work area.

The following terms and conditions are required for the implementation of RPM 4:

1. The Corps and WSDOT shall install steel H- and sheet piles with the use of a vibratory pile hammer to the fullest extent practicable. The Corps and WSDOT shall not revert to the use of an impact pile hammer unless and until site conditions prevent placement of piles (i.e., penetration) to the required depth.

2. The Corps and WSDOT shall monitor in-air sound generation and attenuation while installing a minimum of 5 steel H- or sheet piles with an impact pile hammer.

3. The Corps and WSDOT shall submit a monitoring report to the Washington Fish and Wildlife Office (Lacey, Washington) within 60 days of completing acoustic monitoring. The report shall include the following information:

    i) Size and type of piles driven and proofed;

ii) The impact hammer force used to drive and proof piles;

iii) A description of the monitoring equipment;

iv) The distance between the monitoring equipment and piles;

v) A description of the "line-of-sight" between the monitoring equipment and piles, presence or absence of obstructions (e.g., dense vegetation), etc;

vi) The depth into the substrate the piles were driven and proofed;

vii) The physical characteristics of the bottom substrate into which the piles were driven and proofed; and

viii) The results of the acoustic monitoring, including the frequency spectrum and monitored in-air sound levels (dB_{peak} and dB_{rms}).

We expect that the amount or extent of incidental take described above will not be exceeded as a result of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps and WSDOT must provide an explanation of the causes of the taking and review with the FWS the need for possible modification of the reasonable and prudent measures.

The FWS is to be notified within three 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 Service's 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 a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The FWS recommends the following to the Corps:

1. The WSDOT and Corps should continue scoping and evaluating permanent solutions for other environmental deficiencies along SR 410, the White River, and its tributaries. We expect that the effects of future climate change could further exacerbate flooding and bed and bank instability throughout the middle and upper White River watershed. These effects could heighten existing river-road conflicts, create new conflicts, and further degrade and fragment the habitats which support our native fish populations.

2. The WSDOT and Corps should seek dedicated funding for the purpose of scoping and designing a replacement for the aging and functionally obsolete SR 410 bridge over the lower Greenwater River (at the extreme upper-end of the action area).

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

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR section 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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APPENDICES

Appendix A	WSDOT Fish Exclusion Protocols and Standards (June 2009)
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APPENDIX A: WSDOT Fish Exclusion Protocols and Standards (June 2009)

APPENDIX A
WSDOT Fish Exclusion Protocols and Standards

Work below the Ordinary High-Water Mark (or Mean Higher High-Water Mark) shall, in general, be conducted in isolation from flowing waters. Exceptions to this general rule or performance measure include: 1) implementation of the work area isolation and fish capture and removal protocols described in this document; 2) placement or removal of small quantities of material (e.g., wood or rock), or installation of structural best management practices (e.g., turbidity curtain), under site conditions where potential exposures and effects to fish life are minimized without isolation from flowing waters[1]; 3) work conducted under a declared emergency or under emergency conditions; or, 4) work conducted where flow conditions prevent safe implementation of work area isolation and fish capture and removal protocols.

Implementation of the work area isolation and fish capture and removal protocols shall be planned and directed by a WSDOT biologist, or qualified biologist under contract to WSDOT, possessing all necessary knowledge, training, and experience (the directing biologist). If electrofishing will or may be used as a means of fish capture, the directing biologist shall have a minimum of 100 hours electrofishing experience in the field using similar equipment, and any individuals operating electrofishing equipment shall have a minimum of 40 hours electrofishing experience under direct supervision. All individuals participating in fish capture and removal operations shall have the training, knowledge, skills, and ability to ensure safe handling of fish, and to ensure the safety of staff conducting the operations.

The directing biologist shall work with Maintenance, Construction, and/or Environmental staff (as appropriate) to plan the staging and sequence for work area isolation, fish capture and removal, and dewatering. This plan should consider the size and channel characteristics of the area to be isolated, the method(s) of dewatering (e.g., diversion with bypass flume or culvert; diversion with sandbag, sheet pile or similar cofferdam; etc.), and what sequence of activities will provide the best conditions for safe capture and removal of fish. Where the area to be isolated is small, depths are shallow, and conditions are conducive to fish capture, it may be possible to isolate the work area and remove all fish life prior to dewatering or flow diversion. Where the area to be isolated is large, depths are not shallow, where flow volumes or velocities are high, and/or conditions are not conducive to easy fish capture, it may be necessary to commence with dewatering or flow diversion staged in conjunction with fish capture and removal. The directing biologist shall use his/her best professional judgment in deciding what sequence of activities is likely to minimize exposure of fish to conditions causing stress or injury (including stranding, exposure to extremes of temperature or reduced dissolved oxygen, risk of injury resulting from electrofishing, etc.).

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[1] WSDOT shall make this determination with consultation or input from the regulatory agencies with jurisdiction, including the Washington State Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (FWS), and NOAA-National Marine Fisheries Service (NMFS) as appropriate; also, this exception shall not permit work that requires in-water excavation or that presents a risk of increased turbidity beyond the immediate work area or for a duration of more than 15 minutes.

The directing biologist shall plan work area isolation, fish capture and removal, and dewatering with consideration for the following: habitat connectivity and fish habitat requirements; the duration and extent of planned in-water work; anticipated flow and temperature conditions over the duration of planned in-water work; and, the risk of exposure to turbidity or other unfavorable conditions during construction. If the area to be isolated includes only a portion of the wetted channel width (e.g., large or deep rivers where diversion from the entirety of the wetted channel is difficult or impossible), or if the bypass flume or culvert will effectively maintain connectivity and fish passage for the duration of construction activities, it may be less important whether fish are herded (and/or captured and released) upstream or downstream of the isolated work area. However, if the area to be isolated includes the entire wetted channel width, and especially if conditions make it unlikely that connectivity (i.e., upstream/ downstream fish passage) can be effectively maintained for the duration of construction activities, then the directing biologist should carefully consider whether to herd fish (and/or capture and release fish) upstream or downstream of the isolated work area.

If conditions upstream of the isolated work area will or may become unfavorable during construction, then fish should not be herded or released to an upstream location; this situation is probably most common where the waterbody in question is small, where seasonal flows are substantially diminished, and conditions of elevated temperature and/or reduced dissolved oxygen are foreseeable. However, the directing biologist shall also consider whether planned in-water work presents a significant risk of downstream turbidity and sedimentation; fish herded or released to a downstream location may be exposed to these conditions.

If large numbers of fish are to be herded (and/or captured and released), and in order to avoid overcrowding or concentrating fish in areas where their habitat needs cannot be met, it may be appropriate to relocate fish both upstream and downstream of the isolated work area. At locations where habitat connectivity or quality is poor, including along reaches upstream and/or downstream of the isolated work area, the directing biologist should carefully consider whether relocated fish can meet their minimum habitat requirements for the duration of planned in-water work. On rare occasions it may be appropriate to relocate fish at a greater distance upstream and/or downstream (e.g., thousands of feet or miles), so as to ensure fish are not concentrated in areas where their habitat needs cannot be met, or where they may be exposed to unfavorable conditions during construction. On those rare occasions where relocation to a greater distance is deemed necessary, the WSDOT shall provide notice to the agencies with jurisdiction in advance of the operations.

Plans for staging work area isolation, fish capture and removal, and dewatering must comply with WSDOT safety requirements. Safe implementation is a high priority. The directing biologist shall design and adjust the plan as necessary to ensure the safety of all individuals implementing the plan. Under some conditions it may be appropriate to conduct work without isolation from flowing waters, without placement of block nets, fish capture or removal; for a fuller discussion of this topic see page 1.

In order to comply with WSDOT safety requirements, work in or around water outside of daylight hours is not generally permissible. If, under unusual circumstances, the directing biologist identifies work that will or may be necessary outside of daylight hours, he/she shall

coordinate and gain approval for this work with appropriate managers (including the WSDOT safety officer and/or supervisors with authority).

Work Area Isolation

The directing biologist shall determine appropriate locations for the placement of block nets, based on site characteristics and a consideration of the type and extent of planned in-water work. Sites that exhibit reduced flow volume or velocity, uniformity of depth, and good accessibility are preferred; sites with heavy vegetation, large cobble or boulders, undercut banks, deep pools, etc. should be avoided due to the difficulty of securing and/or maintaining nets. Sites with a narrow channel cross-section ("constriction") should be avoided if foreseeable flow conditions might overwhelm or dislodge the block nets, posts, or anchors.

Except when planning and intending to herd fish upstream, an upstream block net shall be placed first. With a block net secured to prevent movement of fish into the work area from upstream, a second block net should be used as a seine to herd fish in a downstream direction. Where the area to be isolated includes a culvert(s), deep pools, undercut banks, or other cover attractive to fish (e.g., thick overhanging vegetation, rootwads, logjams, etc.) it may be appropriate to isolate a portion or portions of the work area, rather than attempting to herd fish from the entirety of the work area in a single downstream pass. Fish capture and removal will be most successful if an effort is made to strategically focus and concentrate fish in areas where they can be easily seined and netted. Care shall be taken not to concentrate fish where they are exposed to sources of stress, or to leave them concentrated in such areas for a long duration (e.g., more than 30 minutes).

Depending upon site characteristics, and the planned staging and sequence for work area isolation and dewatering, it may or may not be necessary to place a downstream block net. Typically, however, site characteristics and/or the duration of planned in-water work will necessitate placement of a net(s) to prevent movement of fish into the work area from downstream. If groundwater seepage or site drainage has a tendency to re-wet the area, if the area to be isolated is low-gradient or subject to a backwatering influence, or if the area to be isolated is large and considerable effort will be expended in capturing and removing fish life, a downstream block net should be placed. If foreseeable flow conditions over the duration of planned in-water work might enable fish to re-enter the work area from downstream, a downstream block net should be placed.

In most instances where gradual dewatering or flow diversion is staged in conjunction with fish capture and removal, it is appropriate to delay installation of the downstream block net(s) until after fish have been given sufficient time to move downstream by their own choosing. If flows are reduced gradually over the course of several hours, or the length of an entire workday, some (perhaps many) fish will make volitional movements downstream beyond the area to be isolated. Gradual dewatering can be an effective means by which to reduce the risk of fish stress or injury. Gradual dewatering and the encouragement of volitional movement are particularly important where the area to be isolated is large and may hold many fish. However, where the area to be isolated includes a culvert(s), deep pools, undercut banks, or other cover attractive to fish, some (perhaps many) fish will not choose to move downstream regardless of how gradually flows are

reduced. The directing biologist should use his/her best professional judgment in deciding what sequence of activities is likely to minimize fish stress or injury (including stranding).

Where the area to be isolated is small, depths are shallow, and conditions are conducive to fish capture, it may be possible to remove all fish life prior to dewatering, or to implement plans for dewatering staged with fish capture over a relatively short timeframe (e.g., 1-2 hours). Where the area to be isolated is large, depths are not shallow, where flow volumes or velocities are high, and/or conditions are not conducive to easy fish capture, dewatering or flow diversion should be staged in conjunction with fish capture and removal over a longer timeframe (e.g., 3-6 hours). The largest areas and/or most difficult site conditions may warrant or require that plans for dewatering and fish capture proceed over the length of an entire workday, or multiple workdays. Where this is the case, fish shall be given sufficient time and a means to move downstream by their own choosing so as to reduce the total number of fish exposed to sources of stress and injury (including fish handling).

The directing biologist shall select suitable block nets. Type of material, length, and depth may vary based on site conditions. It may be necessary and appropriate to contact other WSDOT Regions or offices with access to nets (or other materials) suitable for placement under unique or unusual circumstances. Typically block nets will be composed of 9.5 millimeter stretched nylon mesh and should be installed at an angle to the direction of flow (i.e., not directly perpendicular to flow) so as to reduce the risk of impinging fish. Anchor bags filled (or half-filled) with clean, washed gravel are preferred over sandbags, especially for nets and anchors that will or may remain in-place for a long duration (i.e., more than two weeks). Any use or movement of native substrates or other materials found onsite should be incidental and shall not appreciably affect channel bed or bank conditions.

Block nets shall remain in-place until work is complete and conditions are suitable for the reintroduction of fish[2]. Block nets require frequent inspection and debris removal. A qualified biologist, or other field staff trained in safe fish handling, shall be assigned the responsibility of inspecting the nets and safely capturing and relocating any impinged fish. The frequency of these inspections shall be determined on a case-by-case basis. However, block nets shall, at a minimum, be inspected for impinged fish (especially juvenile fish) at least three times daily for the first 48 hours after installation (approximate), and for the first 24 hours after significant rainfall (or change in flow volume or velocity). In the event fish are found impinged on the net(s), or if weather or flow conditions change significantly, the directing biologist shall re-consider and adjust the frequency of net inspections so as to minimize the risk of impinging and injuring fish.

Field staff shall be assigned the responsibility of frequently checking and maintaining the nets for accumulated debris, general stability, and proper function. The frequency of these

[2] If plans for work area isolation and fish capture and removal include the installation of temporary cofferdams, and once the directing biologist has confirmed fish life have been successfully excluded from the entire area enclosed by the cofferdam(s), it may be appropriate to remove block nets and allow fish to re-enter the previously isolated work area; this approach is particularly relevant and appropriate where many weeks or months of construction are planned for completion within temporary cofferdams (i.e., isolated from flowing waters).

inspections shall be determined on a case-by-case basis, dependent upon the site, seasonal, and weather conditions. Block nets must be secured along both banks and the channel bottom to prevent failure as a result of debris accumulation, high flows, and/or flanking. Some locations may require additional block net support (e.g., galvanized hardware cloth, affixed metal fence posts, etc.).

Fish Capture and Removal

If dewatering and/or flow diversion are deemed necessary[1], this work (including related fish capture and removal operations) shall comply with any provisions contained in the Hydraulic Project Approval (HPA), or applicable General HPA, issued by the WDFW. If the FWS and/or NMFS have provided relevant Terms and Conditions from a Biological Opinion addressing the work (or action), this work shall also comply with those Terms and Conditions.

If pumps are used to temporarily bypass water or to dewater residual pools or cofferdams, pump intakes shall be screened to prevent aquatic life from entering the intake. Fish screens or guards shall comply with Washington State law (RCW 77.57.010 and 77.57.070), with guidelines prescribed by the NMFS[3], and any more stringent requirements contained in the HPA or General HPA issued by the WDFW. If pumps are to be used on a more permanent basis, as the primary or secondary method for diverting flow around the isolated work area, plans for dewatering shall address contingencies (i.e., extremes of flow or weather). These plans shall include ready access to a larger or additional "back-up" pump with screened intake. If the directing biologist has confirmed that all fish life has been successfully excluded from the area, if there is no risk of entraining fish, and adequate plans are in-place to address contingencies (including a routine schedule for inspection), then pumps may be operated without a screened intake.

<u>Fish Capture and Removal Methods</u>:

Methods for safe capture and removal of fish from the isolated work area are described below. These methods are given in order of preference. At most locations, a combination of methods will be necessary. In order to avoid and minimize the risk of injury to fish, attempts to seine and/or net fish shall always precede the use of electrofishing equipment. Visual observation techniques (e.g. snorkeling, surveying with polarized glasses or Plexiglas bottomed buckets, etc.) may be used to assess the effectiveness of these methods, to identify locations where fish are concentrating, or otherwise adjust methods for greater effectiveness.

If the planned fish capture and removal operations have not been addressed through consultation (or programmatic consultation), if seining and netting are impracticable (i.e., electrofishing is deemed the only viable means of fish capture), and fish listed under the ESA will or may be present, the directing biologist shall provide notice to the FWS and/or NMFS (as appropriate). This notice shall be provided in advance of the operations, and shall include an explanation of the unique site conditions or circumstances. Work conducted under a declared emergency (or

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[3] National Marine Fisheries Service. 1997. Fish screening criteria for anadromous salmonids. NMFS Southwest Region, January 1997, 12p. << http://swr.nmfs.noaa.gov/hcd/fishscrn.pdf >>.

emergency conditions) shall follow established ESA notification protocols.

Where fish listed under the ESA will or may be present, the directing biologist shall ensure that fish capture and removal operations adhere to the following minimum performance measures or expectations:

1) Only dip nets and seines composed of soft (non-abrasive) nylon material shall be used.

2) The operations shall not resort to the use of electrofishing equipment unless and until other, less injurious methods have been effective in removing most or all of the adult and subadult fish (i.e., fish in excess of 300 millimeters); the operations shall conduct a minimum of three complete passes without capture using seines and/or nets.

3) The operations shall confirm success of fish capture and removal before completely dewatering or commencing with other work within the isolated work area; the operations shall conduct a minimum of two complete passes without capture using electrofishing equipment.

4) Fish listed under the ESA shall not be held in containers for more than 10 minutes, unless those containers are dark-colored, lidded, and fitted with a portable aerator.

• **Seining** shall be the preferred method for fish capture. Other methods shall be used when seining is not possible, or when/after attempts at seining have proven ineffective. Seines, once pursed, shall remain partially in the water while fish are removed with dip nets. Seines with a "bag" minimize handling stress and are preferred. Seines with a bag are also preferred where obstructions make access to the water (or deployment/ retrieval of the seine) difficult.

In general, seining will be more effective if fish, especially juvenile fish, are moved (or "flushed") out from under cover. Methods which may increase effectiveness and/or efficiency include conducting seining operations at dawn or dusk (i.e., during low-light conditions), in conjunction with snorkeling, and/or flushing of the cover. In flowing waters, and especially where flow volume or velocity is high or moderately-high, seines that employ a heavy lead line and variable mesh size are preferred. Small mesh sizes are more effective across the full range of fish size (and age class), but also increase resistance and can make deployment/ retrieval more difficult in flowing waters. Seines which use a small mesh size in the bag (or body), and a larger, less resistant mesh size in the wings may under some conditions be most effective and efficient.

• **Baited Minnow Traps** are typically used before and in conjunction with seining. Traps may be left in the isolated work area overnight. Traps shall be inspected at least four times daily to remove captured fish and thereby minimize predation within the trap. Traps should be checked more frequently if temperatures are in excess of 15 degrees C. Predation within the trap may be an unacceptable risk when/ where minnow traps are left in-place over night; large sculpin and other predators that feed on juvenile fish are typically much more active at night. The directing

biologist shall consider the need and plan for work outside daylight hours (i.e., inspection and removal) before leaving minnow traps in-place over night.

• **Dip Nets** shall be used in conjunction with seining. This method is particularly effective when employed during gradual dewatering or flow diversion. To be most effective, and to minimize stress and risk of injury to fish (including stranding), the directing biologist shall coordinate fish capture operations with plans for dewatering or flow diversion. Plans for dewatering and/or flow diversion shall proceed at a measured pace (within constraints), to encourage the volitional downstream movement of fish, and reduce the risk of stranding. Plans for dewatering and/or flow diversion shall not proceed unless there are sufficient staff and materials onsite to capture and safely remove fish in a timely manner. Generally this will require a minimum of two persons (three if electrofishing), but the directing biologist may find that some sites (especially large or complicated sites) warrant or require a more intensive effort (i.e., additional staffing).

Once netted, fish shall remain partially in water until transferred to a bucket, cooler, or holding tank. Dip nets which retain a volume of water ("sanctuary nets") are preferred. However, sanctuary nets may be ineffective where flow volume or velocity is high or moderately-high (i.e., increased resistance lessens ability to net and capture fish). In addition, where water depths are very shallow and/or fish are concentrated in very small receding pools or coarse substrate, "aquarium" nets may be a better, more effective choice. Use of dip nets in conjunction with snorkeling, flushing of the cover, or around the hours of dawn or dusk (i.e., during low-light conditions), can be effective for capturing fish sheltered below cover.

• **Connecting Rod Snakes** may be used to flush fish out of stream crossing structures (i.e., culverts). Connecting rod snakes are composed of wood sections approximately three feet in length. Like other cover attractive to fish, culverts (especially long culverts), can present a challenge to fish capture and removal operations. The directing biologist should plan a strategy for focusing and concentrating fish in areas where they can be easily seined and netted, and should take active steps to prevent fish from evading capture. When first implementing plans for work area isolation, fish capture and removal, and dewatering, it may be appropriate to place block nets immediately upstream and/or downstream of culverts so as to minimize the number of fish that might seek cover within the culvert(s). Once most or all of the fish have been removed from other parts of the work area, the block net placed downstream of the culvert(s) should be removed to encourage volitional downstream movement of fish.

• **Electrofishing** shall be performed only when other methods of fish capture and removal have proven impracticable or ineffective at removing all fish. The directing biologist shall ensure that attempts to seine and/or net fish always precede the use of electrofishing equipment. Larger fish (i.e., adult and subadult fish with comparatively longer spine lengths) are more susceptible to electrofishing injury than smaller fish. To minimize the risk of injury (and the number of fish potentially injured), the directing biologist shall confirm that other methods have been effective in removing most or all of the adult and subadult fish before resorting to the use of electrofishing equipment; see the related performance measure appearing on page 6. As a general rule or performance measure, electrofishing should not be conducted under conditions that offer poor visibility (i.e., visibility of less than 0.5 meter).

The following performance measures shall apply to the use of electrofishing equipment as a means of fish capture and removal:

1. If the planned fish capture and removal operations have not been addressed through consultation (or programmatic consultation), and fish listed under the ESA will or may be present, WSDOT shall provide notice to the FWS and/or NMFS prior to the initiation of electrofishing attempts. Upon request, the WSDOT shall permit the FWS, NMFS, and/or their designated representative to observe fish capture and removal operations. Work conducted under a declared emergency (or emergency conditions) shall follow established ESA notification protocols.

2. Electrofishing shall only be conducted when a biologist with at least 100 hours of electrofishing experience is onsite to conduct or direct all related activities. The directing biologist shall be familiar with the principles of electrofishing, including the effects of voltage, pulse width and pulse rate on fish, and associated risk of injury or mortality. The directing biologist shall have knowledge regarding galvanotaxis, narcosis and tetany, their relationships to injury/mortality rates, and shall have the ability to recognize these responses when exhibited by fish.

3. The directing biologist shall ensure that electrofishing attempts use the minimum voltage, pulse width, and rate settings necessary to achieve the desired response (galvanotaxis). Water conductivity shall be measured in the field prior to each electrofishing attempt to determine appropriate settings. Electrofishing methods and equipment shall comply with guidelines outlined by the NMFS[4].

4. The initial and maximum settings identified below shall serve as guidelines when electrofishing in waters that may support ESA-listed fish. Only DC or pulsed DC current shall be used. [Note: some newer, late-model electrofishing equipment includes a "set-up" or initialization function; the directing biologist shall have the discretion to use this function as a means to identify proper initial settings.]

[4] National Marine Fisheries Service. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. NMFS Northwest Region, June 2000, 5p.
<< http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf >>.

Guidelines for initial and maximum settings for backpack electrofishing.[5]

	Initial Settings	Conductivity (µS/cm)	Maximum Settings
Voltage	100 V	≤ 300 > 300	800 V 400 V
Pulse Width	500 µs		5 ms
Pulse Rate	15 Hz		60 Hz [*In general*, exceeding 40 Hz will injure more fish.]

Each attempt shall begin with low settings for pulse width and pulse rate. If fish present in the area being electrofished do not exhibit a response, the settings shall be gradually increased until the appropriate response is achieved (galvanotaxis). The lowest effective settings for pulse width, pulse rate and voltage shall be used to minimize risks to both personnel and fish. Safe implementation is a high priority. The directing biologist shall ensure the safety of all individuals assisting with electrofishing attempts; this includes planning for and providing all necessary safety equipment and materials (e.g., insulated waders and gloves, first aid/cpr kit, a current safety plan with emergency contacts and phone numbers, etc.). Only individuals that are trained and familiar with the use of electrofishing equipment shall provide direct assistance during electrofishing attempts.

5. Electrofishing shall not be conducted where spawning adults or redds with incubating eggs may be exposed to the electrical current. As a general rule or performance measure, waters that support anadromous salmon should not be electrofished from October 15 through May 15, and resident waters from November 1 through May 15. If located within waters that support bull trout, especially waters located within a local bull trout population (i.e., that support spawning and rearing), seasonal limitations on the use of electrofishing equipment may be more restrictive; if you have questions, contact the FWS. If any, more restrictive work windows have been identified through consultation, those windows shall apply. The directing biologist shall ensure that electrofishing attempts are made only during appropriate times of year, and not where spawning adults or redds with incubating eggs may be exposed to the electrical current.

6. An individual shall be stationed at the downstream block net(s) during electrofishing attempts to recover stunned fish in the event they are flushed downstream and/or impinged against the block net(s).

7. The operator shall use caution so as to prevent fish from coming into direct contact with the anode. Under most conditions, the zone of potential fish injury extends approximately 0.5 meter from the anode. Netting shall not be attached to the anode, as this practice presents an increased risk of direct contact and injury. Extra care shall be taken near in-water structures or undercut banks, in shallow waters, or where fish densities are high. Under these conditions fish are more

[5] Adapted from NMFS (June 2000) and WDFW Electrofishing Guidelines for Stream Typing (May 2001).

likely to come into close or direct contact with the anode and/or voltage gradients may be intensified. Voltage and other settings shall be readjusted to accommodate changing conditions in the field, including channel depth. When electrofishing near undercut banks, overhanging vegetation, large cobble or boulders, or where structures provide cover, fish that avoid capture may be exposed to the electrical current repeatedly. Repeated or prolonged exposures to the electrical current present a higher risk of injury, and therefore galvanotaxis should be used to draw fish out of cover.

8. Electrofishing shall be conducted in a manner that minimizes harm to fish. Once an appropriate fish response (galvanotaxis) is achieved, the isolated work area shall be worked systematically. The number of passes shall be kept to a minimum, but is dependent upon the numbers of fish and site characteristics and shall be at the discretion of the directing biologist. Electrofishing shall not be conducted unless there are sufficient staff and materials onsite, to both minimize the number of passes required and to locate, net, recover, and release fish in a timely manner. Generally this will require a minimum of three persons, but the directing biologist may find that some sites (especially large or complicated sites) warrant or require a more intensive effort (i.e., additional staffing). Care shall be taken to remove fish from the electrical field immediately and to avoid exposing the same fish repeatedly. Fish shall not be held in dip nets while electrofishing is in progress (i.e., while continuing to capture additional fish). [Note: where flow velocity or turbulence is high or moderately-high (e.g., within riffles) it may be difficult to see and net fish; these fish may evade capture (resulting in repeated exposure), or may become impinged on the downstream block net(s); a "frame" net, or small and portable block net approximately 3 feet in width, can be effective under these conditions when held downstream in close proximity to the anode.]

9. The condition of captured fish shall be carefully observed and documented. Dark bands on the body and/or extended recovery times are signs of stress or injury. When such signs are noted, settings for the electrofishing unit may require readjustment. The directing biologist shall also review and consider changes to the manner in which the electrofishing attempt is proceeding. If adjustments to the electrofishing attempt do not lessen the frequency (or severity) of observed stress, the directing biologist shall have the authority to postpone fish capture and removal operations[6]. Each fish shall be capable of remaining upright and actively swimming prior to release (see Fish Handling, Holding and Release).

10. Electrofishing shall not be conducted when turbidity reduces visibility to less than 0.5 meter, when water conductivity exceeds 350 µS/cm, or when water temperature is above 18°C or below 4°C.

[6] If the FWS and/or NMFS have provided an Incidental Take Statement from a Biological Opinion addressing the work (or action), the directing biologist shall ensure limits on take have not been exceeded; if the limits on take are exceeded, or if take is approaching these limits, the directing biologist shall postpone fish capture and removal operations and immediately notify the federal agency (or agencies) with jurisdiction.

Fish Handling, Holding and Release:

• Fish handling shall be kept to the minimum necessary to remove fish from the isolated work area. Fish capture and removal operations shall be planned and conducted so as to minimize the amount and duration of handling. The operations shall maintain captured fish in water to the maximum extent possible during seining/netting, handling, and transfer for release.

• The directing biologist shall document and maintain accurate records of the operations, including: fish species, number, age/size class estimate, condition at release, and release location. Fish shall not be sampled or anesthetized, unless for valid purposes consistent with the WSDOT's Section 10 scientific collection permits.

• Individuals handling fish shall ensure that their hands are free of harmful and/or deleterious products, including but not limited to sunscreen, lotion, and insect repellent.

• The operations shall ensure that water quality conditions are adequate in the buckets, coolers, or holding tanks used to hold and transfer captured fish. The operations shall use aerators to provide for clean, cold, well-oxygenated water, and/or shall stage capture, temporary holding, and release to minimize the risks associated with prolonged holding. The directing biologist shall ensure that conditions in the holding containers are monitored frequently and operations adjusted appropriately to minimize fish stress. If fish listed under the ESA will or may be held for more than a few minutes prior to release, the directing biologist should consider using dark-colored, lidded containers only. Fish listed under the ESA shall not be held in containers for more than 10 minutes, unless those containers are dark-colored, lidded, and fitted with a portable aerator; small coolers meeting this description are preferred over buckets.

• The operations shall provide a healthy environment for captured fish, including low densities in holding containers to avoid effects of overcrowding. Large fish shall be kept separate from smaller fish to avoid predation. The operations shall use water-to-water transfers whenever possible.

• The release site(s) shall be determined by the directing biologist. The directing biologist should consider both site characteristics (e.g., flow, temperature, available refuge and cover, etc.) and the types of fish captured (e.g., out-migrating smolt, kelt, prespawn migrating adult, etc.) when selecting a release site(s). More than one site may be designated to provide for varying needs, and to separate prey-sized fish from larger fish. The directing biologist shall consider habitat connectivity and fish habitat requirements, seasonal flow and temperature conditions, and the duration and extent of planned in-water work when selecting a fish release site(s). If conditions upstream of the isolated work area will or may become unfavorable during construction, then fish should not be released to an upstream location. However, the directing biologist should also consider whether planned in-water work presents a significant risk of downstream turbidity and sedimentation; fish released to a downstream location may be exposed to these conditions. Site conditions may warrant releasing fish both upstream and downstream, or relocating fish at a greater distance (e.g., thousands of feet or miles), so as to ensure fish are not concentrated in areas where their habitat needs cannot be met. For a fuller discussion of this topic see page 2.

• The directing biologist shall ensure that each fish is capable of remaining upright and has the ability to actively swim upon release.

• Any ESA-listed fish incidentally killed as a result of fish capture and removal operations shall be preserved and delivered to the appropriate authority upon request (see Documentation).

• If the limits on take of ESA-listed species are exceeded (harm or harassment), or if incidental take is approaching and may exceed specified limits, the directing biologist shall postpone fish capture and removal operations and immediately notify the federal agency (or agencies) with jurisdiction. If dewatering or flow diversion is incomplete and still in-progress, WSDOT shall take remedial actions directed at maintaining sufficient quantity and quality of flow and lessening sources of fish stress and/or injury. If conditions contributing to fish stress and/or injury may worsen before the federal agency with jurisdiction can be contacted, WSDOT should attempt to move fish to a suitable location near the capture site while keeping fish in water and reducing stress as much as possible.

Reintroduction of Flow and Fish to the Isolated Work Area

If conducting work in isolation from flowing waters has required placement of a block net(s), fish capture and removal, and temporary dewatering, the directing biologist shall ensure that the block net(s) remain in-place until work is complete and conditions are suitable for the reintroduction of fish[2]. Flows shall be gradually reintroduced to the isolated work area, so as to prevent channel bed or bank instability, excessive scour, or turbidity and sedimentation. The directing biologist shall inspect the work area and downstream reach to ensure no fish are stranded or in distress during reintroduction of flows. If conditions causing or contributing to fish stress and/or injury are observed, WSDOT shall take remedial actions directed at lessening these sources of stress. This may include a more gradual reintroduction of flow, so as to reduce resulting turbidity and sedimentation.

All temporary structures and materials (e.g., block nets, posts, and anchors; bypass flume or culvert; sandbag, sheet pile or similar cofferdam; etc) shall be removed at the completion of work. The directing biologist shall document in qualitative terms the final condition of the isolated work area (including temporary bypass). The directing biologist shall identify and document any obvious signs of channel bed or bank instability resulting from the work, and shall report these conditions to the appropriate Maintenance, Construction, and/or Environmental staff for remedy. WSDOT shall document any additional actions taken to correct channel instability, and the final condition of the isolated work area (including temporary bypass).

To avoid and minimize the risk of introducing or spreading nuisance or invasive species, aquatic parasites, or disease, the directing biologist shall ensure that all equipment and materials are cleaned and dried before transporting them for use at another site or waterbody.

Documentation

• All work area isolation, and fish capture and handling shall be documented in a log book with the following information: project location, date, methods, personnel, water temperature, conductivity, visibility, electrofishing equipment settings, and other comments.

• All fish captured or handled shall be documented: species, number of each species, age/ size class estimate, condition at release, and location of release.

• If at any time, fish are observed in distress, a fish kill occurs, or water quality problems develop (including equipment leaks or spills), WSDOT shall provide immediate notification to the WDFW consistent with any provisions contained in the HPA (or applicable General HPA). Notification shall consist of a phone call or voice mail message directed to the Area Habitat Biologist identified on the HPA and/or the Washington Military Department Emergency Management Division at (800) 258-5990, as appropriate.

• Any ESA-listed fish incidentally killed as a result of fish capture and removal operations shall be documented with notification provided to the appropriate authority (FWS and/or NMFS) within two working days. Initial notifications may consist of a phone call or voice mail message. Initial notifications shall be directed to the following: (FWS) the nearest FWS Law Enforcement Office, and the Washington Fish and Wildlife Office at (360) 753-9440; (NMFS) the NMFS Office of Law Enforcement at (800) 853-1964, and the Washington State Habitat Office at (360) 753-9530. Any dead specimens shall be kept whole and preserved on-ice or frozen until WSDOT receives a response and further directions from the appropriate authority; if WSDOT receives no response within 5 working days, the directing biologist shall have the discretion to dispose of specimens. Initial notifications shall be followed by a second notification in writing. All notifications shall provide at a minimum the following: date, time, WSDOT point-of-contact (the directing biologist and/or supervisor), project name (and FWS and/or NMFS tracking number if available), precise location of any incidentally killed or injured and unrecovered fish, number of specimens and species, and cause of death or unrecoverable injury. If the limits on incidental take are exceeded (harm or harassment), the written notification shall also include an explanation of the circumstances causing or contributing to observed levels of take.

• The final condition of the isolated work area (including temporary bypass) shall be documented in qualitative terms, including any obvious signs of channel bed or bank instability resulting from the work. WSDOT shall document any additional actions taken to correct channel instability, and the final condition of the isolated work area (including temporary bypass).

APPENDIX B: Status of the Species (Bull Trout; Coterminous Range)

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Status of the Species (Bull Trout; Coterminous Range)

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. 4; Brewin and Brewin 1997, pp. 209-216; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

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; Rieman et al. 2007). 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; 2004a; 2004b). 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; 2004a; 2004b).

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; 2004a; 2004b) 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; 2004a; 2004b). 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; 2004a; 2004b).

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 2002b). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002b). The draft Klamath River bull trout recovery plan (USFWS 2002b) 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 2002b).

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997, p.1177). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game *in litt*. 1995). The draft Columbia River bull trout recovery plan (USFWS 2002d) 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).

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 2002c). 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 2002c). 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 2002c). The draft St. Mary-Belly bull trout recovery plan (USFWS 2002c) 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). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989; Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978; McPhail and Baxter 1996; WDFW et al. 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. 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; Leathe and Graham 1982; Pratt 1992; Rieman and McIntyre 1996).

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; Pratt 1985). 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). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Howell and Buchanan 1992; Pratt 1992; Rich 1996; Rieman and McIntyre 1993; Rieman and McIntyre 1995; Sedell and Everest 1991; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is

important to the persistence of bull trout (Mike Gilpin *in litt*. 1997; Rieman et al. 1997; Rieman and McIntyre 1993). 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; Spruell et al. 1999). 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; Pratt 1992; Rieman and McIntyre 1993).

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; Pratt 1992; Rieman et al. 1997; Rieman and McIntyre 1993). 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; Goetz 1989; McPhail and Murray 1979). 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; Fraley and Shepard 1989; Rieman et al. 1997; Rieman and McIntyre 1993; Rieman and McIntyre 1995). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart L. Gamett, Salmon-Challis National Forest, pers. comm. June 20, 2002).

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

indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt 1992; Pratt and Huston 1993). Pratt (1992) 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). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

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 in Stewart et al. 2007). 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; Frissell 1993; Goetz et al. 2004). 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; MBTSG 1998; Rieman and McIntyre 1993). 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 size fish with higher fecundity is lost (Rieman and McIntyre 1993).

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; Donald and Alger 1993; Goetz 1989). Subadult and adult migratory bull trout feed on various fish species (Brown 1994; Donald and Alger 1993; Fraley and Shepard 1989; Leathe and Graham 1982). Bull trout of all sizes other than fry have been found to eat fish 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; WDFW et al. 1997).

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; Goetz et al. 2004).

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, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) 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, and 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 C: Puyallup River Core Area (Bull Trout)

APPENDIX C
Puyallup River Core Area (Bull Trout)

Puyallup Core Area

The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within Mount Rainier National Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed.

Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Bull trout occur throughout most of the system although spawning occurs primarily in the headwater reaches. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within Puget Sound. Habitat conditions within the lower mainstem Puyallup and White Rivers have been highly degraded, retaining minimal instream habitat complexity. In addition, habitat conditions within Commencement Bay and adjoining nearshore areas have been severely degraded as well, with very little intact intertidal habitat remaining.

The Puyallup core area has the southernmost, anadromous bull trout population in the Puget Sound Management Unit (USFWS 2004). Consequently, maintaining the bull trout population in this core area is critical to maintaining the overall distribution of migratory bull trout in the management unit.

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

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

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Clearwater River is identified as a potential local population, as bull trout are known to use this river and it appears to provide suitable spawning habitat, but the occurrence of reproduction there is unknown (USFWS 2004).

Information about the distribution and abundance of bull trout in this core area is limited because observations have generally been incidental to other fish species survey work. Spawning occurs in the upper reaches of this basin where higher elevations produce the cold water temperatures required by bull trout egg and juvenile survival. Based on current survey data, bull trout spawning in this core area occurs earlier in the year (i.e., September) than typically observed in other Puget Sound core areas (Marks et al. 2002). The known spawning areas in local

populations are few in number and not widespread. The majority of spawning sites are located in streams within Mount Rainier National Park, with two exceptions, Silver Creek and Silver Springs (Marks et al. 2002; R. Ladley, *in litt*., 2006).

Rearing likely occurs throughout the Upper Puyallup, Mowich, Carbon, Upper White, West Fork White, and Greenwater Rivers. However, sampling indicates most rearing is confined to the upper reaches of the basin. The mainstem reaches of the White, Carbon, and Puyallup Rivers probably provide the primary freshwater foraging, migration, and overwintering habitat for migratory bull trout within this core area.

With fewer than 10 local populations, the Puyallup core area is considered to be at intermediate risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

Rigorous abundance estimates are generally not available for local populations in the Puyallup core area. Currently, fewer than 100 adults probably occur in each of the local populations in the White River system, based on adult counts at Mud Mountain Dam's Buckley Diversion fish trap. Although these counts may not adequately account for fluvial migrants that do not migrate downstream of the facility, these counts do indicate few anadromous bull trout and few mainstem fluvial bull trout return to local populations in the White River system. Therefore, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess adult abundance in each local population.

Productivity

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

Connectivity

Migratory bull trout are likely present in most local populations in the Puyallup core area. However, the number of adult bull trout expressing migratory behavior within each local population appears to be very low compared to other core areas. Although connectivity between the Upper Puyallup and Mowich Rivers local population and other Puyallup core area local populations was reestablished with the creation of an upstream fish ladder at Electron Dam in 2000, this occurred after approximately 100 years of isolation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap. The overall low abundance of migratory life history forms limits the possibility for genetic exchange and local population refounding, as well as limits more diverse foraging opportunities to increase size of spawners and therefore, overall fecundity within the population. Consequently, the bull trout population in the Puyallup core area is at intermediate risk of extirpation from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, the Service has issued Biological Opinions that exempted incidental take in the Puyallup core area. These incidental take exemptions were in the form of harm and harassment, primarily from hydrologic impacts associated with increased impervious surface, temporary sediment increases during in-water work, habitat loss or alteration, and handling of fish. None of these projects were determined to result in jeopardy to bull trout. The combined effects of actions evaluated under these Biological Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Of particular note, in 2003 the Service issued a Biological Opinion (FWS Ref. No. 1-3-01-F-0476) on the State Route 167 North Sumner Interchange Project. This project was located in Pierce County in the White River portion of the Puyallup watershed and was proposed by Washington State Department of Transportation. The project's direct and indirect impacts and cumulative impacts within the action area included urbanization of approximately 600 acres of land. We anticipated that conversion of this land to impervious surface would result in the permanent loss and/or degradation of aquatic habitat for bull trout and their prey species through reduced base flows, increased peak flows, increased temperatures, loss of thermal refugia, degradation of water quality, and the degradation of the aquatic invertebrate community and those species dependent upon it (bull trout prey species). These impacts will result in thermal stress and disrupt normal behavioral patterns. Incidental take of fluvial, adfluvial, and anadromous bull trout in the form of harassment due to thermal stress and the disruption of migrating and foraging behaviors was exempted for this project. These adverse effects were expected to continue in perpetuity.

Section 10(a)(1)(B) permits have also been issued for HCPs that address bull trout in this core area. Although these HCPs may result in both short and/or long-term negative effects to bull trout and their habitat, the anticipated long-term beneficial effects are expected to maintain or improve the overall baseline status of the species. Additionally, capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have directly affected some individual bull trout in this core area.
The number of non-Federal actions occurring within the Puyallup core area since the bull trout were listed is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance affect riparian and instream habitat which typically results in negative affects to bull trout and their habitat.

Threats

Threats to bull trout in the Puyallup core area include:

- Extensive past and ongoing timber harvest and harvest-related activities, such as road maintenance and construction, continue to affect bull trout spawning and rearing areas in the upper watershed.

- Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications continue to affect foraging, migration, and overwintering habitats for bull trout in the lower watershed.

- Dams and diversions have significantly affected migratory bull trout in the core area. Until upstream passage was recently restored, the Electron Diversion Dam isolated bull trout in the Upper Puyallup and Mowich Rivers local population for nearly 100 years and has drastically reduced the abundance of migratory bull trout in the Puyallup River. Buckley Diversion and Mud Mountain Dam have significantly affected the White River system in the past by impeding or precluding adult and juvenile migration and degrading foraging, migration, and overwintering habitats in the mainstem. Despite improvements to these facilities, passage related impacts continue today but to a lesser degree.

- Urbanization, road construction, residential development, and marine port development associated with the city of Tacoma, have significantly reduced habitat complexity and quality in the lower mainstem rivers and associated tributaries, and have largely eliminated intact nearshore foraging habitats for anadromous bull trout in Commencement Bay.

- The presence of brook trout in many parts of the Puyallup core area and their potential to increase in distribution, including into Mount Rainer National Park waters, are considered significant threats to bull trout. Because of their early maturation and competitive advantage over bull trout in degraded habitats, brook trout in the upper Puyallup and Mowich River's local population is of highest concern because of past isolation of bull trout and the level of habitat degradation in this area.

- Until the early 1990s, bull trout fisheries probably significantly reduced the overall bull trout population within this and other core areas in Puget Sound. Current legal and illegal fisheries in the Puyallup core area may continue to significantly limit recovery of the population because of the low numbers of migratory adults.

- Water quality has been degraded due to municipal and industrial effluent discharges resulting from development, particularly in the lower mainstem Puyallup River and Commencement Bay.

- Water quality has also been degraded by stormwater discharge associated with runoff from impervious surface. Impervious surface in the Puyallup watershed increased by 12 percent between 1990 and 2001 (PSAT 2007).

- Major flood events in November 2006 significantly impacted instream habitats within the Puyallup River system. These events are assumed to have drastically impacted bull trout brood success for the year, due to significant scour and channel changes that occurred after peak spawning. Significant impacts to rearing juvenile bull trout were also likely, further impacting the future recruitment of adult bull trout.

- In November 2006, an 18,000 gallon diesel spill in the head waters of Spring Creek (C. Hebert, *in litt*., 2006), a bull trout spawning area of the Upper White River local

population, likely impacted the available instream spawning habitat. The duration of ongoing contamination of instream habitats by residual diesel is unknown.

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APPENDIX D: Status of Critical Habitat (Bull Trout)

APPENDIX D
Status of Critical Habitat (Bull Trout)

STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

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

Legal Status

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

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

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

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

conservation.

Conservation Role and Description of Critical Habitat

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

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

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

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

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Note that only PCEs 1, 6, 7, and 8 apply to marine nearshore waters identified as critical habitat; and all except PCE 3 apply to FMO habitat identified as critical habitat.

The PCEs are as follows:

(1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32º to 72 ºF (0º to 22 ºC) but are found more frequently in temperatures ranging from 36º to 59 ºF (2º to 15 ºC). These temperature ranges may vary depending on bull trout life-history stage and form, geography,

elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.

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

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

(4) A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.

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

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

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

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

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

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

In marine habitat, critical habitat includes the inshore extent of marine nearshore areas between mean lower low-water (MLLW) and minus 10 meters (m) mean higher high-water (MHHW), including tidally influenced freshwater heads of estuaries. This refers to the area between the average of all lower low-water heights and all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore areas is based on the extent of

the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) relative to the MLLW.

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

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212, USFWS 2004). 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). Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments.

Current Condition Rangewide

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

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

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APPENDIX E: Status of the Species (Marbled Murrelet)

APPENDIX E
Status of the Species (Marbled Murrelet)

Legal Status

The murrelet was federally listed as a threatened species in Washington, Oregon, and northern California effective September 28, 1992 (57 FR 45328 [October 1, 1992]). The final rule designating critical habitat for the marbled murrelet (murrelet) (61 FR 26256 [May 24, 1996]) became effective on June 24, 1996. The U.S. Fish and Wildlife Service (Service) recently proposed a revision to the 1996 murrelet critical habitat designation (71 FR 44678 [July 31, 2008]). A final rule is expected in 2009. The species' decline has largely been caused by extensive removal of late-successional and old-growth coastal forests which serve as nesting habitat for murrelets. Additional listing factors included high nest-site predation rates and human-induced mortality in the marine environment from gillnets and oil spills.

The Service determined that the California, Oregon, and Washington distinct population segment of the murrelet does not meet the criteria set forth in the Service's 1996 Distinct Population Segment policy (61 FR 4722 [May 24, 1996]; (Beissinger and Nur 1997 in USFWS 2004). However, the murrelet retains its listing and protected status as a threatened species under the Act until the original 1992 listing decision is revised through formal rule-making procedures, involving public notice and comment.

Critical habitat was designated for the murrelet to addresses the objective of stabilizing the population size. To fulfill that objective, the Marbled Murrelet Recovery Plan (USFWS 1997b) (Recovery Plan), focuses on protecting adequate nesting habitat by maintaining and protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (USFWS 1997b, p. 119). The Recovery Plan identified six Conservation Zones throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6).

As explained in the Endangered Species Consultation Handbook (USFWS and NMFS 1998) and clarified for recovery units through Memorandum (USFWS 2006), jeopardy analyses must always consider the effect of proposed actions on the survival and recovery of the listed entity. In the case of the murrelet, the Service's jeopardy analysis will consider the effect of the action on the long-term viability of the murrelet in its listed range (Washington, Oregon, and northern California), beginning with an analysis of the action's effect on Conservation Zones 1 and 2 (described below).

<u>Conservation Zone 1</u>

Conservation Zone 1 includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border and extends inland 50 mi from the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Forest lands in the Puget Trough have been predominately replaced by urban development and the remaining suitable habitat in Zone 1 is typically a considerable distance from the marine environment, lending special importance to nesting habitat close to Puget Sound

(USFWS 1997b).

Conservation Zone 2

Conservation Zone 2 includes waters within 1.2 mi of the Pacific Ocean shoreline south of the U.S.-Canadian border off Cape Flattery and extends inland to the midpoint of the Olympic Peninsula. In southwest Washington, the Zone extends inland 50 mi from the Pacific Ocean shoreline. Most of the forest lands in the northwestern portion of Zone 2 occur on public (State, county, city, and Federal) lands, while most forest lands in the southwestern portion are privately owned. Extensive timber harvest has occurred throughout Zone 2 in the last century, but the greatest loss of suitable nest habitat is concentrated in the southwest portion of Zone 2 (USFWS 1997b). Thus, murrelet conservation is largely dependent upon Federal lands in northern portion of Zone 2 and non-Federal lands in the southern portion.

Life History

Murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Detailed discussions of the biology and status of the murrelet are presented in the final rule listing the murrelet as threatened (57 FR 45328 [October 1, 1992]), the Recovery Plan, Ecology and Conservation of the Marbled Murrelet (Ralph et al. 1995), the final rule designating murrelet critical habitat (61 FR 26256 [May 24, 1996]), and the Evaluation Report in the 5-Year Status Review of the Marbled Murrelet in Washington, Oregon, and California (McShane et al. 2004).

Physical Description

The murrelet is taxonomically classified in the family Alcidae (alcids), a family of Pacific seabirds possessing the ability to dive using wing-propulsion. The plumage of this relatively small (9.5 in to 10 in) seabird is identical between males and females, but the plumage of adults changes during the winter and breeding periods providing some distinction between adults and juveniles. Breeding adults have light, mottled brown under-parts below sooty-brown upperparts contrasted with dark bars. Adults in winter plumage have white under-parts extending to below the nape and white scapulars with brown and grey mixed upperparts. The plumage of fledged young is similar to the adult winter plumage (USFWS 1997b).

Distribution

The range of the murrelet, defined by breeding and wintering areas, extends from the northern terminus of Bristol Bay, Alaska, to the southern terminus of Monterey Bay in central California. The listed portion of the species' range extends from the Canadian border south to central California. Murrelet abundance and distribution has been significantly reduced in portions of the listed range, and the species has been extirpated from some locations. The areas of greatest concern due to small numbers and fragmented distribution include portions of central California, northwestern Oregon, and southwestern Washington (USFWS 1997b).

Reproduction

Murrelet breeding is asynchronous and spread over a prolonged season. In Washington, the murrelet breeding season occurs between April 1 and September 15 (Figure 1). Egg laying and incubation occur from late April to early August and chick rearing occurs between late May and late August, with all chicks fledging by early September (Hamer et al. 2003).

Murrelets lay a single-egg clutch (Nelson 1997), which may be replaced if egg failure occurs early (Hebert et al. 2003; McFarlane-Tranquilla et al. 2003). However, there is no evidence a second egg is laid after successfully fledging a first chick. Adults typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Hatchlings appear to be brooded by an adult for one to two days and are then left alone at the nest for the remainder of the rearing period, except during feedings. Both parents feed the chick, which receives one to eight meals per day (Nelson 1997). Most meals are delivered early in the morning while about a third of the food deliveries occur at dusk and intermittently throughout the day (Nelson and Hamer 1995b). Chicks fledge 27 to 40 days after hatching. The initial flight of a fledgling appears to occur at dusk and parental care is thought to cease after fledging (Nelson 1997).

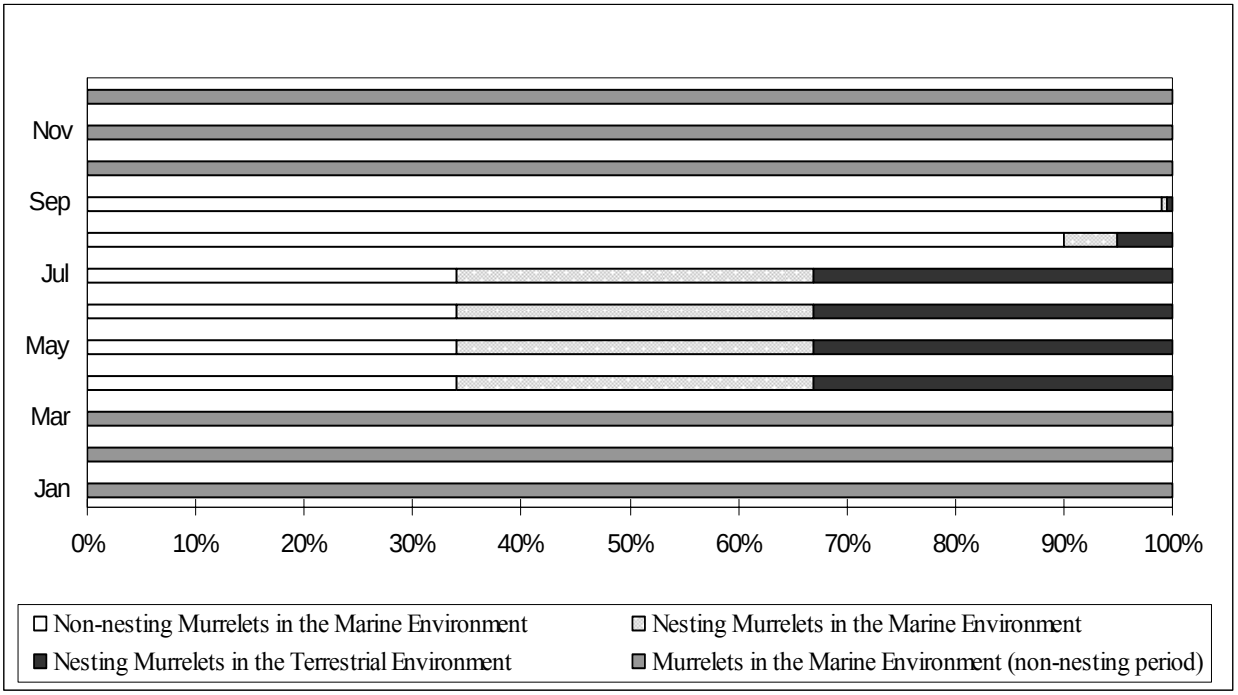

Figure 1. The seasonal changes in the relative proportion of breeding and non-breeding murrelets in the marine and terrestrial environments[7] within Washington State (Conservation Zones 1 and 2)

[7] Demographic estimates were derived from Peery et al. (2004) and nesting chronology was derived from Hamer and Nelson (1995) and Bradley et al. (2004) where April 1 is the beginning of the nesting season, September 15 is the end of the nesting season, and August 6 is the beginning of the late breeding season when an estimated 70 percent of the murrelet chicks have fledged.

Vocalization

Murrelets are known to vocalize between 480 Hertz and 4.9 kilohertz and have at least 5 distinct call types (Suzanne Sanborn, pers. comm. 2005). Murrelets tend to be more vocal at sea compared to other alcids (Nelson 1997). Individuals of a pair vocalize after surfacing apart from each other, after a disturbance, and during attempts to reunite after being separated (Strachan et al. 1995).

MURRELETS IN THE MARINE ENVIRONMENT

Murrelets are ususally found within 5 miles (8 kilometers) from shore, and in water less than 60 meters deep (Ainley et al. 1995; Burger 1995; Strachan et al. 1995; Nelson 1997; Day and Nigro 2000; Raphael et al. 2007). In general, birds occur closer to shore in exposed coastal areas and farther offshore in protected coastal areas (Nelson 1997). Courtship, foraging, loafing, molting, and preening occur in marine waters. Beginning in early spring, courtship continues throughout summer with some observations even noted during the winter period (Speckman 1996; Nelson 1997). Observations of courtship occurring in the winter suggest that pair bonds are maintained throughout the year (Speckman 1996; Nelson 1997). Courtship involves bill posturing, swimming together, synchronous diving, vocalizations, and chasing in flights just above the surface of the water. Copulation occurs both inland (in the trees) and at sea (Nelson 1997).

Loafing

When murrelets are not foraging or attending a nest, they loaf on the water, which includes resting, preening, and other activities during which they appear to drift with the current, or move without direction (Strachan et al. 1995). Strachan et al. (1995) noted that vocalizations occurred during loafing periods, especially during the mid-morning and late afternoon.

Molting

Murrelets go through two molts each year. The timing of molts varies temporally throughout their range and are likely influenced by prey availability, stress, and reproductive success (Nelson 1997). Adult (after hatch-year) murrelets have two primary plumage types: alternate (breeding) plumage and basic (winter) plumage. The pre-alternate molt occurs from late February to mid-May. This is an incomplete molt during which the birds lose their body feathers but retain their ability to fly (Carter and Stein 1995; Nelson 1997). A complete pre-basic molt occurs from mid-July through December (Carter and Stein 1995; Nelson 1997). During the pre-basic molt, murrelets lose all flight feathers somewhat synchronously and are flightless for up to two months (Nelson 1997). In Washington, there is some indication that the pre-basic molt occurs from mid-July through the end of August (Chris Thompson, pers. comm. 2003).

Flocking

Strachan et al. (1995) defines a flock as three or more birds in close proximity which maintain that formation when moving. Various observers throughout the range of the murrelet report flocks of highly variable sizes. In the southern portion of the murrelet's range (California, Oregon, and Washington), flocks rarely contain more than 10 birds. Larger flocks usually occur

during the later part of the breeding season and may contain juvenile and subadult birds (Strachan et al. 1995).

Aggregations of foraging murrelets are probably related to concentrations of prey. In Washington, murrelets are not generally found in interspecific feeding flocks (Strachan et al. 1995). Strong et al. (in Strachan et al. 1995) observed that murrelets avoid large feeding flocks of other species and presumed that the small size of murrelets may make them vulnerable to kleptoparasitism or predation in mixed species flocks. Strachan et al. (1995) point out that if murrelets are foraging cooperatively, the confusion of a large flock of birds could reduce foraging efficiency.

Foraging Behavior

Murrelets are wing-propelled pursuit divers that forage both during the day and at night (Carter and Sealy 1986; Gaston and Jones 1998; Henkel et al. 2003; Kuletz 2005). Murrelets typically forage in pairs, but have been observed to forage alone or in groups of three or more (Carter and Sealy 1990; Strachan et al. 1995; Speckman et al. 2003). Strachan et al. (1995) believe pairing enhances foraging success through cooperative foraging techniques. For example, pairs consistently dive together during foraging and often synchronize their dives by swimming towards each other before diving (Carter and Sealy 1990) and resurfacing together on most dives. Strachan et al. (1995) speculate pairs may keep in visual contact underwater. Paired foraging is common throughout the year, even during the incubation period, suggesting that breeding murrelets may temporarily pair up with other foraging individuals (non-mates) (Strachan et al. 1995; Speckman et al. 2003).

Murrelets can make substantial changes in foraging sites within the breeding season, but many birds routinely forage in the same general areas and at productive foraging sites, as evidenced by repeated use over a period of time throughout the breeding season (Carter and Sealy 1990; Whitworth et al. 2000; Becker et al. 2001; Hull et al. 2001; Mason et al. 2002; Piatt et al. 2007). Murrelets are also known to forage in freshwater lakes (Nelson 1997). Activity patterns and foraging locations are influenced by biological and physical processes that concentrate prey, such as weather, climate, time of day, season, light intensity, up-wellings, tidal rips, narrow passages between islands, shallow banks, and kelp (*Nereocystis* spp.) beds (Ainley et al. 1995; Strong et al. 1995; Burger 1995; Speckman 1996; Nelson 1997).

Juveniles are generally found closer to shore than adults (Beissinger 1995) and forage without the assistance of adults (Strachan et al. 1995). Kuletz and Piatt (1999) found that in Alaska, juvenile murrelets congregated in kelp beds. Kelp beds are often with productive waters and may provide protection from avian predators (Kuletz and Piatt 1999). McAllister (in litt. in Strachan et al. 1995) found that juveniles were more common within 328 ft of shorelines, particularly, where bull kelp was present.

Murrelets usually feed in shallow, near-shore water less than 30m (98 ft) deep (Huff et al. 2006), but are thought to be able to dive up to depths of 47 m (157 ft) (Mathews and Burger 1998). Variation in depth and dive patterns may be related to the effort needed to capture prey. Thick-billed murres (*Uria lomvia*) and several penguin species exhibit bi-modal foraging behavior in that their dive depths mimic the depth of their prey, which undergo daily vertical migrations in the water column (Croll et al. 1992; Butler and Jones 1997). Jodice and Collopy's (1999) data suggest murrelets follow this same pattern as they forage for fish that occur throughout the water column but undergo daily vertical migrations (to shallower depths at night and back to deeper depths during the day). Murrelets observed foraging in deeper water likely do so when upwelling, tidal rips, and daily activity patterns concentrate the prey near the surface (Strachan et al. 1995).

The duration of dives appears to depend upon age (adults vs. juveniles), water depth, visibility, and depth and availability of prey. Murrelet dive duration ranges from 8 seconds to 115 seconds, although most dives last between 25 and 45 seconds (Thorensen 1989; Jodice and Collopy 1999; Watanuki and Burger 1999; Day and Nigro 2000).

Adults and subadults often move away from breeding areas prior to molting and must select areas with predictable prey resources during the flightless period (Carter and Stein 1995; Nelson 1997). During the non-breeding season, murrelets disperse and can be found farther from shore (Strachan et al. 1995). Little is known about marine-habitat preference outside of the breeding season, but use during the early spring and fall is thought to be similar to that preferred during the breeding season (Nelson 1997). During the winter there may be a general shift from exposed outer coasts into more protected waters (Nelson 1997), for example many murrelets breeding on the exposed outer coast of Vancouver Island appear to congregate in the more sheltered waters within the Puget Sound and the Strait of Georgia in fall and winter (Burger 1995). However, in many areas, murrelets remain associated with the inland nesting habitat during the winter months (Carter and Erickson 1992) and throughout the listed range, murrelets do not appear to disperse long distances, indicating they are year-round residents (McShane et al. 2004).

Prey Species

Throughout their range, murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in marine waters although they have also been detected on rivers and inland lakes (Carter and Sealy 1986); 57 FR 45328 [October 1, 1992]). In general, small schooling fish and large pelagic crustaceans are the main prey items. Pacific sand lance *(Ammodytes hexapterus)*, northern anchovy *(Engraulis mordax),* immature Pacific herring *(Clupea harengus)*, capelin *(Mallotus villosus)*, Pacific sardine (*Sardinops sagax*), juvenile rockfishes (*Sebastas* spp.) and surf smelt (Osmeridae) are the most common fish species taken. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey. Murrelets are able to shift their diet throughout the year and over years in response to prey availability (Becker et al. 2007). However, long-term adjustment to less energetically-rich prey resources (such as invertebrates) appears to be partly responsible for poor marbled murrelet reproduction in California (Becker and Beissinger 2006).

Breeding adults exercise more specific foraging strategies when feeding chicks, usually carrying

a single, relatively large (relative to body size) energy-rich fish to their chicks (Burkett 1995; Nelson 1997), primarily around dawn and dusk (Nelson 1997; Kuletz 2005). Freshwater prey appears to be important to some individuals during several weeks in summer and may facilitate more frequent chick feedings, especially for those that nest far inland (Hobson 1990). Becker et al. (Becker et al. 2007) found murrelet reproductive success in California was strongly correlated with the abundance of mid-trophic level prey (e.g. sand lance, juvenile rockfish) during the breeding and postbreeding seasons. Prey types are not equal in the energy they provide; for example parents delivering fish other than age-1 herring may have to increase deliveries by to up 4.2 times to deliver the same energy value (Kuletz 2005). Therefore, nesting murrelets that are returning to their nest at least once per day must balance the energetic costs of foraging trips with the benefits for themselves and their young. This may result in marbled murrelets preferring to forage in marine areas in close proximity to their nesting habitat. However, if adequate or appropriate foraging resources (i.e., "enough" prey, and/or prey with the optimum nutritional value for themselves or their young) are unavailable in close proximity to their nesting areas, marbled murrelets may be forced to forage at greater distances or to abandon their nests (Huff et al. 2006, p. 20). As a result, the distribution and abundance of prey suitable for feeding chicks may greatly influence the overall foraging behavior and location(s) during the nesting season, may affect reproductive success (Becker et al. 2007), and may significantly affect the energy demand on adults by influencing both the foraging time and number of trips inland required to feed nestlings (Kuletz 2005).

Predators

At-sea predators include bald eagles (*Haliaeetus leucocephalus*), peregrine falcons (*Falco peregrinus*), western gulls (*Larus occidentalis*), and northern fur seals (*Callorhinus ursinus*) (McShane et al. 2004). California sea lions (*Zalophus californianus*), northern sea lions (*Eumetopias jubatus*), and large fish may occasionally prey on murrelets (Burger 2002).

Murrelets in the Terrestrial Environment

Murrelets are dependent upon old-growth forests, or forests with an older tree component, for nesting habitat (Ralph et al. 1995; Hamer and Nelson 1995; McShane et al. 2004). Sites occupied by murrelets tend to have a higher proportion of mature forest age-classes than do unoccupied sites (Raphael et al. 1995). Specifically, murrelets prefer high and broad platforms for landing and take-off, and surfaces which will support a nest cup (Hamer and Nelson 1995). The physical condition of a tree appears to be the important factor in determining the tree's suitability for nesting (Ralph et al. 1995); therefore, presence of old-growth in an area does not assure the stand contains sufficient structures (i.e. platforms) for nesting. In Washington, murrelet nests have been found in conifers, specifically, western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*) (Hamer and Nelson 1995; Hamer and Meekins 1999). Nests have been found in trees as small as 2.6 ft in diameter at breast height on limbs at least 65 ft from the ground and 0.36 ft in diameter (Hamer and Meekins 1999).

Murrelet populations may be limited by the availability of suitable nesting habitat. Although no data are available, Ralph et al. (1995) speculate the suitable nesting habitat presently available in

Washington, Oregon, and California may be at or near carrying capacity based on: 1) at-sea concentrations of murrelets near suitable nesting habitat during the breeding season, 2) winter visitations to nesting sites, and 3) the limitation of nest sites available in areas with large amounts of habitat removal.

Murrelets have been observed visiting nesting habitat during non-breeding periods in Washington, Oregon, and California (Naslund 1993; Nelson 1997) which may indicate adults are defending nesting sites and/or stands (Ralph et al. 1995). Other studies provide further insight to the habitat associations of breeding murrelets, concluding that breeding murrelets displaced by the loss of nesting habitat do not pack in higher densities into remaining habitat (McShane et al. 2004). Thus, murrelets may currently be occupying nesting habitat at or near carrying capacity in highly fragmented areas and/or in areas where a significant portion of the historic nesting habitat has been removed (Ralph et al. 1995).

Unoccupied stands containing nesting structures are important to the population for displaced breeders or first-time breeding adults. Even if nesting habitat is at carrying capacity, there will be years when currently occupied stands become unoccupied as a result of temporary disappearance of inhabitants due to death or to irregular breeding (Ralph et al. 1995). Therefore, unoccupied stands will not necessarily indicate that habitat is not limiting or that these stands are not murrelet habitat (Ralph et al. 1995) and important to the species persistence.

Radar and audio-visual studies have shown murrelet habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low edge and fragmentation, proximity to the marine environment, total watershed area, and increasing forest age and height (McShane et al. 2004). In California and southern Oregon, areas with abundant numbers of murrelets were farther from roads, occurred more often in parks protected from logging, and were less likely to occupy old-growth habitat if it was isolated (more than 3 miles or 5 km) from other nesting murrelets (Meyer et al. 2002). Meyer et al. (2002) also found at least a few years passed before birds abandoned fragmented forests.

Murrelets do not form dense colonies which is atypical of most seabirds. Limited evidence suggests they may form loose colonies or clusters of nests in some cases (Ralph et al. 1995). The reliance of murrelets on cryptic coloration to avoid detection suggests they utilize a wide spacing of nests in order to prevent predators from forming a search image (Ralph et al. 1995). However, active nests have been seen within 328 ft (100 m) of one another in the North Cascades in Washington and within 98 ft (30 m) in Oregon (Kim Nelson, Oregon State University, pers. comm. 2005). Estimates of murrelet nest densities vary depending upon the method of data collection. For example, nest densities estimated using radar range from 0.007 to 0.104 mean nests per acre (0.003 to 0.042 mean nests per ha), while nest densities estimated from tree climbing efforts range from 0.27 to 3.51 mean nests per acre (0.11 to 1.42 mean nests per ha) (Nelson 2005).

There is little data available regarding murrelet nest site fidelity because of the difficulty in locating nest sites and observing banded birds attending nests. However, murrelets have been detected in the same nesting stands for many years (at least 20 years in California and 15 years in Washington), suggesting murrelets have a high fidelity to nesting areas, most likely at the watershed scale (Nelson 1997). Use of the same nest platform in successive years as well as multiple nests in the same tree have been documented, although it is not clear whether the repeated use involved the same birds (Nelson and Peck 1995; Divoky and Horton 1995; Nelson 1997; Manley 2000; Hebert et al. 2003). The limited observed fidelity to the same nest depression in consecutive years appears to be lower than for other alcids, but this may be an adaptive behavior in response to high predation rates (Divoky and Horton 1995). Researchers have suggested fidelity to specific or adjacent nesting platforms may be more common in areas where predation is limited or the number of suitable nest sites are fewer because large, old-growth trees are rare (Nelson and Peck 1995; Singer et al. 1995; Manley 1999).

Ralph et al. (1995) speculated that the fidelity to nest sites or stands by breeding murrelets may be influenced by the nesting success of previous rearing attempts. Although murrelet nesting behavior in response to failed nest attempts is unknown, nest failures could lead to prospecting for new nest sites or mates. Other alcids have shown an increased likelihood to relocate to a new nest in response to breeding failure (Divoky and Horton 1995). However, murrelets likely remain in the same watershed over time as long as stands are not significantly modified (Ralph et al. 1995).

It is unknown whether juveniles disperse from natal breeding habitat (natal dispersal) or return to their natal breeding habitat after reaching breeding age (natal philopatry). Natal dispersal distance can be expected to be as high or higher than other alcids given 1) the reduced extent of the breeding range, 2) the overlap between the wintering and breeding areas, 3) the distance individuals are known to move from breeding areas in the winter, 4) adult attendance of nesting areas during the non-breeding season where, in theory, knowledge of suitable nesting habitat is passed onto prospecting non-breeders, and 5) the 3-year to 5-year duration required for the onset of breeding age allowing non-breeding murrelets to prospect nesting and forage habitat for several years prior to reaching breeding age (Divoky and Horton 1995). Conversely, Swartzman et al. (1997 in McShane et al. 2004)) suggested juvenile dispersal is likely to be low, as it is for other alcid species. Nevertheless, the presence of unoccupied suitable nesting habitat on the landscape may be important for first-time nesters if they disperse away from their natal breeding habitat.

Murrelets generally select nests within 37 mi (60 kilometers (km) of marine waters (Miller and Ralph 1995). However, in Washington, occupied habitat has been documented 52 mi (84 km) from the coast and murrelets have been detected up to 70 mi (113 km) from the coast in the southern Cascade Mountains (Evans Mack et al. 2003).

When tending active nests during the breeding season (and much of the non-breeding season in southern parts of the range), breeding pairs forage within commuting distance of the nest site. Daily movements between nest sites and foraging areas for breeding murrelets averaged 10 mi in Prince William Sound, Alaska (McShane et al. 2004), 24 mi in Desolation Sound, British Columbia, Canada (Hull et al. 2001), and 48 mi in southeast Alaska. In California, Hebert and

Golightly (2003) found the mean extent of north-south distance traveled by breeding adults to be about 46 mi.

Murrelet nests have been located at a variety of elevations from sea level to 5,020 ft (Burger 2002). However, most nests have been found below 3,500 ft. In Conservation Zone 1, murrelets have exhibited "occupied" behaviors up to 4,400 ft elevation and have been detected in stands up to 4,900 ft in the north Cascade Mountains (Peter McBride, WDNR, *in litt*., 2005). On the Olympic Peninsula, survey efforts for nesting murrelets have encountered occupied stands up to 4,000 ft within Conservation Zone 1 and up to 3,500 ft within Conservation Zone 2. Surveys for murrelet nesting at higher elevations on the Olympic Peninsula have not been conducted. However, recent radio-telemetry work detected a murrelet nest at 3,600 ft elevation on the Olympic Peninsula in Conservation Zone 1 (Martin Raphael, USFWS, pers. comm. 2005).

Population Status in the Coterminous United States

Population Abundance

Research on murrelet populations in the early 1990s estimated murrelet abundance in Washington, Oregon, and California at 18,550 to 32,000 (Ralph et al. 1995). However, consistent population survey protocols were not established for murrelets in the coterminous United States until the late 1990s following the development of the marine component of the Environmental Monitoring (EM) Program for the NWFP (Bentivoglio et al. 2002). As a consequence, sampling procedures have differed and thus the survey data collected prior to the EM Program is unsuitable for estimating population trends for the murrelet (McShane et al. 2004).

The development of the EM Program unified the various at-sea monitoring efforts within the 5 Conservation Zones encompassed by the NWFP. The highest total population estimate for this area (20,500 +/- 4,600 birds at the 95 percent confidence interval) was in 2004 and the lowest total population estimate (17,400 +/- 4,600 birds at the 95 percent confidence interval) was in 2007 (Gary Falxa, *in litt*., 2008). The most recent population estimate for Conservation Zone 6 is 400 (+/- 140 birds at the 95 percent confidence interval) (Peery et al. 2008).

Population Trend

Estimated population trends within each Conservation Zone or for the entire coterminous population are not yet available from the marine survey data. Trend information will eventually be provided through the analysis of marine survey data from the EM Program (Bentivoglio et al. 2002) and from survey data in Conservation Zone 6 once a sufficient number of survey years have been completed. Depending on the desired minimum power (80 or 95 percent), at least 8 to 10 years of successive surveys are required for an overall population estimate and thus detection of an annual decrease, while 7 to 16 years are required for Conservation Zones 1 and 2 (Huff et al. 2003).

In the interim, demographic modeling has aided attempts to analyze and predict population trends and extinction probabilities of murrelets. Incorporating important population parameters

and species distribution data (Beissinger 1995; Beissinger and Nur 1997 in USFWS 1997b; Cam et al. 2003; McShane et al. 2004), demographic models can provide useful insights into potential population responses from the exposure to environmental pressures and perturbations. However, weak assumptions or inaccurate estimates of population parameters such as survivorship rates, breeding success, and juvenile-to-adult ratios (juvenile ratios), can limit the use of models. Thus, a cautious approach is warranted when forecasting long-term population trends using demographic models.

Most of the published demographic models used to estimate murrelet population trends employ Leslie Matrix modeling (McShane et al. 2004). Two other more complex, unpublished models (Akcakaya 1997 and Swartzman et al. 1997 in McShane et al. 2004) evaluate the effect of nest habitat loss on murrelets in Conservation Zone 4 (McShane et al. 2004). McShane et al. (2004) developed a stochastic Leslie Matrix model (termed "Zone Model") to project population trends in each murrelet Conservation Zone. The Zone Model was developed to integrate available demographic information for a comparative depiction of current expectations of future population trends and probability of extinction in each Conservation Zone (McShane et al. 2004). Table 1 lists rangewide murrelet demographic parameter values from four studies all using Leslie Matrix models.

Table 1. Rangewide murrelet demographic parameter values based on four studies all using Leslie Matrix models

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997*	Beissinger and Peery *in litt.* 2003	McShane et al. 2004
Juvenile Ratios	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	(See nest success)
Nest Success			0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 % – 90%	85 % – 88 %	82 % - 90 %	83 % – 92 %

*in (USFWS 1997b)

Regardless of model preference, the overall results of modeling efforts are in agreement, indicating murrelet abundance is declining (McShane et al. 2004, p. 6-27). The rates of decline are highly sensitive to the assumed adult survival rate used for calculation (Steven R. Beissinger and M. Z. Peery *in litt*., 2003). The most recent modeling effort using the "Zone Model" (McShane et al. 2004) suggests the murrelet zonal sub-populations are declining at a rate of 3.0 to 6.2 percent per year.

Estimates of breeding success are best determined from nest site data, but difficulties in finding nests has led to the use of other methods, such as juvenile ratios and radio-telemetry estimations, each of which have biases. The nest success data presented in Murrelet Table 1 under McShane et al. (2004) was derived primarily from radio telemetry studies; however the nests sampled in these studies were not representative of large areas and specifically did not include Washington

or Oregon. In general, telemetry estimates are preferred over juvenile ratios for estimating breeding success due to fewer biases (McShane et al. 2004), but telemetry data are not currently available for Washington or Oregon. Therefore, it is reasonable to expect that juvenile ratios derived from at-sea survey efforts best represent murrelet reproductive success in Washington, Oregon, and California.

Beissinger and Peery (Beissinger and Peery, *in litt*., 2003) performed a comparative analysis using data from 24 bird species to predict the juvenile ratios for murrelets of 0.27 (confidence intervals ranged from 0.15 to 0.65). Demographic models suggest murrelet population stability requires a minimum of 0.18 to 0.28 chicks per pair per year (Beissinger and Nur 1997 in USFWS 1997b). The lower confidence intervals for both the predicted juvenile ratio (0.15) and the stable population juvenile ratio (0.18) are greater than the juvenile ratios observed for any of the Conservation Zones (0.02 to 0.09 chicks per pair) (Beissinger and Nur 1997 in USFWS 1997b; Beissinger and Peery, *in litt*., 2003). Therefore, the juvenile ratios observed in the Conservation Zones are lower than predicted and are too low to obtain a stable population in any Conservation Zone. This indicates murrelet populations are declining in all Conservation Zones and will continue to decline until reproductive success improves.

Demographic modeling, the observed juvenile ratios, and adult survivorship rates suggests that the number of murrelets in Washington, Oregon, and California are too low to sustain a murrelet population. The rate of decline for murrelets throughout the listed range is estimated to be between 2.0 to 15.8 percent (Beissinger and Nur 1997 in USFWS 1997b; McShane et al. 2004).

<u>Murrelets in Washington (Conservation Zones 1 and 2)</u>

Population estimates

Historically, murrelets in Conservation Zones 1 and 2 were "common" (Rathbun 1915 and Miller et al. 1935 in USFWS 1997b), "abundant" (Edson 1908 and Rhoades 1893 in USFWS 1997b), or "numerous" (Miller et al. 1935 in McShane et al. 2004). Conservation Zone 1, encompassing the Puget Sound in northwest Washington, contains one of the larger murrelet populations in the species' listed range, and supports an estimated 41 percent of the murrelets in the coterminous United States (Huff et al. 2003). The 2007 population estimate (with 95 percent confidence intervals) for Conservation Zone 1 is 7,000 (4,100 – 10,400) and Conservation Zone 2 is 2,500 (1,300 – 3,800) (Falxa, *in litt.,* 2008). In Conservation Zone 2, a higher density of murrelets occurs in the northern portion of the Zone (Huff et al. 2003) where the majority of available nesting habitat occurs. In Conservation Zone 1, higher densities of murrelets occur in the Straits of Juan de Fuca, the San Juan Islands, and the Hood Canal (Huff et al. 2003), which are in proximity to nesting habitat on the Olympic Peninsula and the North Cascade Mountains.

Although population numbers in Conservation Zones 1 and 2 are likely declining, the precise rate of decline is unknown. The juvenile ratio derived from at-sea survey efforts in Conservation Zone 1 is 0.09. The juvenile ratios was not collected in Conservation Zone 2; however, the juvenile ratio for Conservation Zone 3 is 0.08. Therefore, it is reasonable to infer that the juvenile ratio for Conservation Zone 2 is likely between 0.08 and 0.09. These low juvenile ratios infer there is insufficient juvenile recruitment to sustain a murrelet population in Conservation

Zones 1 and 2. Beissinger and Peery (Beissinger and Peery, *in litt*., 2003) estimated the rate of decline for Conservation Zone 1 to be between 2.0 to 12.6 percent and between 2.8 to 13.4 percent in Conservation Zone 3. It is likely that the rate of decline in Conservation Zone 2 is similar to that of Conservation Zones 1 and 3.

Juvenile ratios in Washington may be skewed by murrelets coming and going to British Columbia. At-sea surveys are timed to occur when the least number of murrelets from British Columbia are expected to be present. However, recent radio-telemetry information indicates 1) murrelets nesting in British Columbia forage in Washington waters during the breeding season (Bloxton and Raphael 2008) and could be counted during at-sea surveys; and 2) adult murrelets foraging in Washington during the early breeding season moved to British Columbia in mid-June and mid-July (Bloxton and Raphael 2008) and would not have been counted during the at-sea surveys. The movements of juvenile murrelets in Washington and southern British Columbia are unclear. Therefore, until further information is obtained regarding murrelet migration between British Columbia and Washington, we will continue to rely on the at-sea derived juvenile ratios to evaluate the population status in Conservation Zones 1 and 2.

Habitat Abundance

Estimates of the amount of available suitable nesting habitat vary as much as the methods used for estimating murrelet habitat. McShane et al. (2004) estimates murrelet habitat in Washington State at 1,022,695 acres, representing approximately 48 percent of the estimated 2,223,048 acres remaining suitable habitat in the listed range. McShane et al. (2004) caution about making direct comparisons between current and past estimates due to the evolving definition of suitable habitat and methods used to quantify habitat. As part of the ongoing pursuit to improve habitat estimates, information was collected and analyzed by the Service in 2005 resulting in an estimated 751,831 acres in Conservation Zone 1 and 585,821 acres in Conservation Zone 2 (Table 2).

Table 2. Estimated acres of suitable nesting habitat for the murrelet managed by the Federal and non-Federal land managers in Conservation Zones 1 and 2

Conservation Zone	Estimated acres of suitable murrelet habitat by land management category *				
	Federal	State	Private*	Tribal	Total
Puget Sound (Zone 1)	650,937	98,036	2,338	520	751,831
Western Washington Coast Range (Zone 2)	485,574	82,349	9,184	8,714	585,821
Total	1,136,511	180,385	11,522	9,234	1,337,652

*Estimated acres of private land represents occupied habitat. Additional suitable nesting habitat considered unoccupied by nesting murrelets is not included in this estimate.

Estimated acreages of suitable habitat on Federal lands in Table 2 are based on modeling and aerial photo interpretation and likely overestimate the actual acres of suitable murrelet habitat because 1) most acreages are based on models predicting spotted owl nesting habitat which include forested lands that do not have structures suitable for murrelet nesting, and 2) neither modeling or aerial photo interpretation can distinguish microhabitat features, such as nesting platforms or the presence of moss, that are necessary for murrelet nesting. The amount of high quality murrelet nesting habitat available in Washington, defined by the Service as large, old, contiguously forested areas not subject to human influences (e.g., timber harvest or urbanization) is expected to be a small subset of the estimated acreages in Table 2. Murrelets nesting in high-quality nesting habitat are assumed to have a higher nesting success rate than murrelets nesting in fragmented habitat near humans.

Other Recent Assessments of Murrelet Habitat in Washington

Two recent assessments of murrelet potential nesting habitat were developed for monitoring the Northwest Forest Plan (Raphael et al. 2006). This study provides a provincial-scale analysis of murrelet habitat derived from vegetation base maps, and includes estimates of habitat on State and private lands in Washington for the period of 1994 to 1996. Using vegetation data derived from satellite imagery, Raphael et al. (2006) developed two different approaches to model habitat suitability. The first model, or the Expert Judgment Model, is based on the judgment of an expert panel that used existing forest structure classification criteria (e.g., percent conifer cover, canopy structure, quadratic mean diameter, forest patch size) to classify forests into four classes of habitat suitability, with Class 1 indicating the least suitable habitat and Class 4 indicating the most highly suitable habitat. Raphael et al. (2006) found that across the murrelet range, most habitat-capable land (52 percent) is classified as Class 1 (lowest suitability) habitat and 18 percent is classified as Class 4 (highest suitability) habitat. In Washington, they found that there were approximately 954,200 acres of Class 4 habitat in between 1994 and 1996 (Table 3). However, only 60 percent of known nest sites in their study area were located in Class 4 habitat.

The second habitat model developed by Raphael et al. (2006) used the Biomapper Ecological Niche-Factor Analysis model developed by Hirzel et al. (2002). The resulting murrelet habitat suitability maps are based on both the physical and vegetative attributes adjacent to known murrelet occupied polygons or nest locations for each Northwest Forest Plan province. The resulting raster maps are a grid of 269 ft^2-cells (25 m^2-cells) (0.15 acres per pixel). Each cell in the raster is assigned a value of 0 to 100. Values closer to 100 represent areas that match the murrelet nesting locations while values closer to 0 are likely unsuitable for nesting (Raphael et al. 2006). These maps do not provide absolute habitat estimates, but rather a range of habitat suitability values, which can be interpreted in various ways. Raphael et al. (2006) noted that the results from the Ecological Niche Factor Analysis (ENFA) are not easily compared to results from the Expert Judgment Model because it was not clear what threshold from the habitat suitability ranking to use. Raphael et al. (2006) elected to display habitat suitability scores greater than 60 (HS >60) as a "generous" portrayal of potential nesting habitat and a threshold greater than 80 (HS >80) as a more conservative estimate. In Washington, there were over 2.1 million acres of HS >60 habitat, but only 440,700 acres of HS >80 habitat (Table 3). It is important to note that HS >60 habitat map captures 82 percent of the occupied nests sites in

Washington, whereas the HS >80 habitat map only captures 36 percent of the occupied nests in Washington.

Table 3. Comparison of different habitat modeling results for the Washington nearshore zone (0 to 40 mi inland or Northwest Forest Plan Murrelet Zone 1)

Murrelet Habitat Model	Habitat Acres on Federal Reserves (LSRs, Natl.Parks)	Habitat Acres on Federal, Non-Reserves (USFS Matrix)	Total Habitat Acres on Federal Lands	Total Habitat Acres on Non-Federal Lands (City, State, Private, Tribal)	Total Habitat Acres - All Ownerships	Percent of Total Habitat Acres on Non-Federal Lands	Percent of Known Murrelet Nest Sites in Study Area Occurring in this Habitat Classification
ENFA* HS >80	284,300	18,600	302,900	137,800	440,700	31%	36%
EJM* Class 4	659,200	40,700	699,900	254,300	954,200	11%	60%
EJM Class 3 and Class 4	770,600	54,700	825,300	535,200	1,360,500	16%	65%
ENFA HS >60	927,000	85,300	1,012,300	1,147,100	2,159,400	53%	82%

*ENFA = Ecological Niche Facto Analysis. EJM = Expert Judgment Model. Results were summarized directly from Tables 4 and 5 and Tables 9 and 10 in Raphael et al (2005). All habitat estimates represent 1994-1996 values.

Because the HS >60 model performed best for capturing known murrelet nest sites, Raphael et al. (2006) suggest that the ENFA HS >60 model yields a reasonable estimate of potential murrelet nesting habitat. However, we found that large areas in southwest Washington identified in the HS >60 model likely overestimates the actual suitable habitat in this landscape due to a known lack of old-forest in this landscape. Despite the uncertainties associated with interpreting the various map data developed by Raphael et al. (2006), it is apparent that there is a significant portion of suitable habitat acres located on non-Federal lands in Washington, suggesting that non-Federal lands may play a greater role in the conservation needs of the species than has previously been considered. Using the most conservative criteria developed by Raphael et al. (2006) the amount of high-quality murrelet nesting habitat on non-Federal lands in Washington varies from 11 percent to as high as 31 percent (Table 3).

Raphael et al. (2006) note that the spatial accuracy of the map data are limited and that the habitat maps are best used for provincial-scale analysis. Due to potential errors in vegetation mapping and other potential errors, these maps are not appropriate for fine-scale project mapping.

Conservation Zone 1

The majority of suitable murrelet habitat in Conservation Zone (Zone) 1 occurs in northwest Washington and is found on Forest Service and National Park Service lands, and to a lesser extent on State lands. The majority of the historic habitat along the eastern and southern shores of the Puget Sound has been replaced by urban development resulting in the remaining suitable habitat further inland from the marine environment (USFWS 1997b).

Conservation Zone 2

Murrelet nesting habitat north of Gray's Harbor in Zone 2 occurs largely on State, Forest Service, National Park Service, and Tribal lands, and to a lesser extent, on private lands. Alternatively, the majority of habitat in the southern portion of Zone 2 occurs primarily on State lands, with a small amount on private lands.

Threats

Murrelets remain subject to a variety of anthropogenic threats within the upland and marine environment. They also face threats from low population numbers, low immigration rates, high predation rates, and disease.

Threats in the Marine Environment

Threats to murrelets in the marine environment include declines in prey availability; mortality associated with exposure to oil spills, gill net and other fisheries; contaminants suspended in marine waters; and visual or sound disturbance from recreational or commercial watercrafts (57 FR 45328 [October 1, 1992]; (Ralph et al. 1995; USFWS 1997b; McShane et al. 2004). Activities, such as pile driving and underwater detonations, that result in elevated underwater sound pressure levels may also pose a threat to murrelets.

Prey Availability

Many fish populations have been depleted due to overfishing, reduction in the amount or quality of spawning habitat, and pollution. As of 2004, only 50 percent of the Puget Sound herring stocks were classified as healthy or moderately healthy, with north Puget Sound's stock being considered depressed and the Strait of Juan de Fuca's stocks being classified as critical (WDFW 2005d). Natural mortality in some of these stocks has increased (e.g. the mean estimated annual natural mortality rate for sampled stocks from 1987 through 2003 averaged 71 percent, up from 20 to 40 percent in the late 1970s) (WDFW 2005c). There is currently only one commercial herring fishery which operates primarily in south and central Puget Sound (WDFW 2005b) where herring stocks are healthier. Unfortunately, the decline of some herring stocks may be affecting the forage base for murrelets in Puget Sound. There is limited information available for the coastal herring populations, but these populations appear to have relatively high levels of abundance (WDFW 2005a). There are herring fisheries in Willapa Bay and Grays Harbor, but no direct harvest is allowed in the coastal waters.

While there are commercial and recreational fisheries for surf smelt, the amount of harvest does

not appear to be impacting the surf smelt stocks (Bargmann 1998). There are no directed commercial fisheries for sand lance (Bargmann 1998). Anchovies are taken commercially within coastal and estuarine waters of Washington. While the current harvest level doesn't appear to be impacting anchovy stocks, there is no current abundance information (Bargmann 1998).

In addition to fishing pressure, oceanographic variation can influence prey availability. While the effects to murrelets from events such as El Niño have not been well documented, El Niño events are thought to reduce overall prey availability and several studies have found that El Niño events can influence the behavior of murrelets (McShane et al. 2004). Even though changes in prey availability may be due to natural and cyclic oceanographic variation, these changes may exacerbate other threats to murrelets in the marine environment.

Shoreline development has affected and will continue to effect coastal processes. Shipping, bulkheads, and other shoreline developments have contributed to the reduction in eelgrass beds and other spawning and rearing areas for forage species.

Oil Spills

Murrelet mortality from oil pollution is a conservation issue in Washington (USFWS 1997b). Most oil spills and chronic oil pollution that can affect murrelets occur in areas of high shipping traffic, such as the Strait of Juan de Fuca and Puget Sound. There have been at least 47 oil spills of 10,000 gal or more in Washington since 1964 (WDOE 2004). However, the number of oil spills has generally declined since passage of the U.S. Oil Pollution Act in 1990. The estimated annual mortality of murrelets from oil spills in Washington has decreased from 3 to 41 birds per year (between 1977 and 1992) to 1 to 2 birds per year (between 1993 and 2003) (McShane et al. 2004).

Since the murrelet was listed, the amount of oil tanker and shipping traffic has continued to increase (USFWS 1997b; Burger 2002). Large commercial ships, including oil tankers, cargo ships, fish processing ships, and cruise ships, enter Washington waters more than 7,000 times each year, bound for ports in Puget Sound, British Columbia, Grays Harbor, and the Columbia River (WDOE 2004). Additionally, 4,500 tank-barge transits, 160,000 ferry transits, and military vessel traffic occur in these same waters each year (WDOE 2004). Individually these vessels may carry up to 33 M gal of crude oil or refined petroleum products, but collectively, they carry about 15.1 B gal across Puget Sound waters each year (WDOE 2004). These numbers are expected to increase as the human population and commerce continues to grow. Currently, there are State and Federal requirements for tug escorts of laden oil tankers transiting the waters of Puget Sound east of Dungeness Spit. However, the Federal requirements do not apply to double-hulled tankers and will no longer be in effect once the single-hull tanker phase-out is complete (WDOE 2005). Washington State is considering revising their tug escort requirements (WDOE 2005); however, the current tug escort requirements remain in place until the Washington State Legislature makes a change.

The U.S. Coast Guard rated the Dungeness area in the Strait of Juan de Fuca as being in the top

five high-risk areas of the United States for being impacted by oil spills (USFWS 2003b). Therefore, even though the threat from oil spills appears to have been reduced since the murrelet was listed, the risk of a catastrophic oil spill remains, and could severely impact adult and/or juvenile murrelets in Conservation Zones 1 and 2.

Gillnets

Murrelet mortality from gillnet fishing has been considered a conservation issue in Washington (USFWS 1997b; Melvin et al. 1999). Murrelets can also be killed by hooking with fishing lures and entanglement with fishing lines (Carter et al. 1995). There is little information available on murrelet mortality from net fishing prior to the 1990s, although it was known to occur (Carter et al. 1995). In the mid 1990s, a series of fisheries restrictions and changes were implemented to address mortality of all species of seabirds, resulting in a lower mortality rate of murrelets (McShane et al. 2004). Fishing effort has also decreased since the 1980s because of lower catches, fewer fishing vessels, and greater restrictions (McShane et al. 2004), although a regrowth in gill net fishing is likely to occur if salmon stocks increase. In most areas, the threat from gill net fishing has been reduced or eliminated since 1992, but threats to adult and juvenile murrelets are still present in Washington waters due to gill net mortality (McShane et al. 2004).

Entanglement in derelict fishing nets, which are nets that have been lost, abandoned or discarded in the marine environment, may also pose a threat. Derelict gear can persist in the environment for decades and poses a threat to marine mammals, seabirds, shellfish, and fish. A recent survey estimated 3,900 derelict nets need to be removed from Puget Sound annually (Northwest Straits Foundation 2007) and each year the number of new derelict nets increases faster than the number removed. Over 50 percent of the derelict nets in Puget Sound occur in waters where murrelet densities are the highest in Washington. Derelict fishing gear also occurs along the Washington coast and the outer Straits of Juan de Fuca. While this high energy environment may reduce the time a derelict net remains suspended compared to a lower energy environment like the inner Puget Sound where gear may persist for years (NRC 2007), the amount of time a derelict net poses a threat to marine species depends on the length and type of the net and cause of entanglement.

Marine Contaminants

The primary consequence from the exposure of murrelets to contaminants is reproductive impairment. Reproduction can be impacted by food web bioaccumulation of organochlorine pollutants and heavy metals discharged into marine areas where murrelets feed and prey species concentrate (Fry 1995). However, murrelet exposure is likely a rare event because murrelets have widely dispersed foraging areas and they feed extensively on transient juvenile and subadult midwater fish species that are expected to have low pollutant loads (McShane et al. 2004). The greatest exposure risk to murrelets may occur at regular feeding areas near major pollutant sources, such as those found in Puget Sound (McShane et al. 2004).

Disturbance

In coastal and offshore marine environments, vehicular disturbance (e.g., boats, airplanes,

personal watercraft) is known to elicit behavioral responses in murrelets of all age classes (Kuletz 1996; Speckman 1996; Nelson 1997). Aircraft flying at low altitudes and boating activity, in particular motorized watercraft, are known to cause murrelets to dive and are thought to especially affect adults holding fish (Nelson 1997). It is unclear to what extent this kind of disturbance affects the distribution, movements, foraging efficiency, and overall fitness of murrelets. However, it is unlikely this type of disturbance has decreased since 1992 because the shipping traffic and recreational boat use in the Puget Sound and Strait of Juan de Fuca has continued to increase.

Marine projects that include seismic exploration, pile driving, detonation of explosives and other activities that generate percussive sounds can expose murrelets to elevated underwater sound pressure levels (SPLs). High underwater SPLs can have adverse physiological and neurological effects on a wide variety of vertebrate species (Yelverton et al. 1973; Yelverton and Richmond 1981; Steevens et al. 1999; Fothergill et al. 2001; Cudahy and Ellison 2002; U.S. Department of Defense 2002; Popper 2003). High underwater SPLs are known to injure and/or kill fish by causing barotraumas (pathologies associated with high sound levels including hemorrhage and rupture of internal organs), as well as causing temporary stunning and alterations in behavior (Turnpenny and Nedwell 1994; Turnpenny et al. 1994; Popper 2003; Hastings and Popper 2005). During monitoring of seabird response to pile driving in Hood Canal, Washington, a pigeon guillemot (*Cepphus columba*) was observed having difficulty getting airborne after being exposed to underwater sound from impact pile driving (Entranco and Hamer Environmental 2005). In controlled experiments using underwater explosives, rapid change in SPLs caused internal hemorrhaging and mortality in submerged mallard ducks (*Anas platyrhnchos*) (Yelverton et al. 1973). Risk of injury appears related to the effect of rapid pressure changes, especially on gas filled spaces in the bodies of exposed organisms (Turnpenny et al. 1994). In studies on ducks (*Anas spp.*) and a variety of mammals, all species exposed to underwater blasts had injuries to gas filled organs including eardrums (Yelverton and Richmond 1981). These studies indicate that similar effects can be expected across taxonomical species groups.

Physical injury may not result in immediate mortality. If an animal is injured, death may occur several hours or days later, or injuries may be sublethal. Sublethal injuries can interfere with the ability of an organism to carry out essential life functions such as feeding and predator avoidance. Diving birds are able to detect and alter their behavior based on sound in the underwater environment (Ross et al. 2001) and elevated underwater SPLs may cause murrelets to alter normal behaviors, such as foraging. Disturbance related to elevated underwater SPLs may reduce foraging efficiency resulting in increased energetic costs to all murrelet age classes in the marine environment and may result in fewer deliveries or lower quality food being delivered to nestlings.

Threats in the Terrestrial Environment

Habitat

Extensive harvest of late-successional and old-growth forest was the primary reason for listing the murrelet as threatened. Due primarily to extensive timber cutting over the past 150 years, at least 82 percent of the old-growth forests existing in western Washington and Oregon prior to the 1840s have been harvested (Teensma et al. 1991; Booth 1991; Ripple 1994; Perry 1995). About 10 percent of pre-settlement old-growth forests remain in western Washington (Norse 1990; Booth 1991). Although the Northwest Forest Plan has reduced the rate of habitat loss on Federal lands, the threat of continued loss of suitable nesting habitat remains on Federal and non-Federal lands through timber harvest and natural events such as wildfire, insect outbreaks, and windthrow.

Natural disturbance has the potential to affect the amount and quality of murrelet nesting habitat. Wildfire and windthrow result in immediate loss of habitat and can also influence the quality of adjacent habitat. Global warming, combined with long-term fire suppression on Federal lands, may result in higher incidences of stand-replacing fires in the future (McShane et al. 2004). As forest fragmentation increases, the threat of habitat loss due to windthrow is likely to increase. In addition, insects and disease can kill complete stands of habitat and can contribute to hazardous forest fire conditions.

Between 1992 and 2003, the loss of suitable murrelet habitat totaled 22,398 acres in Washington, Oregon, and California combined, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane et al. 2004). The data presented by McShane represented losses primarily on Federal lands, and did not include data for most private lands within the murrelets' range. Habitat loss and fragmentation is expected to continue in the near future, but at an uncertain rate (McShane et al. 2004). Raphael et al. (2006) recently completed a change analysis for marbled murrelet habitat on both Federal and non-Federal lands for the period from 1992 to 2003, based on stand disturbance map data developed by Healey et al. (2003). Raphael et al. (2006) estimated that habitat loss ranging from 60,000 acres up to 278,000 acres has occurred across the listed range of the species, with approximately 10 percent of habitat loss occurring on Federal lands, and 90 percent occurring on non-Federal lands. The variation in the acreage estimates provided by Raphael et al. (2006) are dependant upon the habitat model used (Table 3) to evaluate habitat change over time.

Gains in suitable nesting habitat are expected to occur on Federal lands over the next 40 to 50 years, but due to the extensive historic habitat loss and the slow replacement rate of murrelets and their habitat, the species is potentially facing a severe reduction in numbers in the coming 20 to 100 years (USFS and USBLM 1994a; Beissinger 2002). In addition to direct habitat removal, forest management practices can fragment murrelet habitat; this reduces the amount and heterogeneous nature of the habitat, reduces the forest patch sizes, reduces the amount of interior or core habitat, increases the amount of forest edge, isolates remaining habitat patches, and creates "sink" habitats (McShane et al. 2004). There are no estimates available for the amount of suitable habitat that has been fragmented or degraded since 1992. However, the ecological consequences of these habitat changes to murrelets can include effects on population viability

and size, local or regional extinctions, displacement, fewer nesting attempts, failure to breed, reduced fecundity, reduced nest abundance, lower nest success, increased predation and parasitism rates, crowding in remaining patches, and reductions in adult survival (Raphael et al. 2002).

Predation

Predation is expected to be the principal factor limiting murrelet reproductive success and nest site selection (Ralph et al. 1995; Nelson and Hamer 1995a). Murrelets are believed to be highly vulnerable to nest predation compared to other alcids and forest nesting birds (Nelson and Hamer 1995a; USFWS 1997b). Murrelets have no protection at nest sites other than the ability to remain hidden. Nelson and Hamer (1995a) hypothesized that small increases in murrelet predation will have deleterious effects on murrelet population viability due to their low reproductive rate (one egg clutches).

Known predators of adult murrelets in the forest environment include the peregrine falcon (*Falco peregrinus*), sharp-shinned hawk (*Accipiter striatus*), common raven (*Corvus corax*), northern goshawk (*Accipiter gentilis*), and bald eagle (*Haliaeetus leucocephalus*). Common ravens and Stellar's jays (*Cyanocitta stelleri*) are known to take both eggs and chicks at the nest, while sharp-shinned hawks have been found to take chicks. Common ravens account for the majority of egg depredation, as they appear to be the only predator capable of flushing incubating or brooding adults from a nest (Nelson and Hamer 1995a). Suspected nest predators include great horned owls (*Bubo virginianus*), barred owls (*Strix varia*), Cooper's hawks (*Accipiter cooperi*), northwestern crows (*Corvus caurinus*), American crows (*Corvus brachyrhynchos*), and gray jays (*Perisoreus canadensis*) (Nelson and Hamer 1995a; Nelson 1997; Manley 1999). Predation by squirrels and mice has been documented at artificial nests and these animals cannot be discounted as potential predators on eggs and chicks (Luginbuhl et al. 2001; Raphael et al. 2002; Bradley and Marzluff 2003).

Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure (Nelson and Hamer 1995a; McShane et al. 2004). The risk of predation by avian predators appears to be highest in complex structured landscapes in proximity to edges and human activity, where many of the corvid (e.g., crows, ravens) species are in high abundance. Predation rates are influenced mainly by habitat stand size, habitat quality, nest placement (on the edge of a stand versus the interior of a stand), and proximity of the stand to human activity centers. The quality of murrelet nest habitat decreases in smaller stands because forest edge increases in relation to the amount of interior forest, while forest stands near human activity centers (less than 0.62 mi or 1 km), regardless of size, are often exposed to a higher density of corvids due to their attraction to human food sources (Marzluff et al. 2000). The loss of nest contents to avian predators increases with habitat fragmentation and an increase in the ratio of forest edge to interior habitat (Nelson and Hamer 1995a; McShane et al. 2004). For example, Nelson and Hamer (1995a) found successful nests were farther from edges (greater than 55 m) and were better concealed than unsuccessful nests.

The abundance of several corvid species has increased dramatically in western North America as a result of forest fragmentation, increased agriculture, and urbanization (McShane et al. 2004). It

is reasonable to infer that as predator abundance has increased, predation on murrelet chicks and eggs has also increased, and murrelet reproductive success has decreased. It is also reasonable to assume that this trend will not be interrupted or reversed in the near future, as forest fragmentation, agriculture, and urbanization continue to occur.

Other Threats

Murrelets are subject to additional threats from diseases, genetics, low population numbers, and low immigration rates. To date, inbreeding (mating between close genetic relatives) and/or hybridizing (breeding with a different species or subspecies) have not been identified as threats to murrelet populations. However, as abundance declines, a corresponding decrease in the resilience of the population to disease, inbreeding or hybridization, and other perturbations may occur. Additionally, murrelets are considered to have low recolonization potential because their low immigration rate makes the species slow to recover from local disturbances (McShane et al. 2004).

The emergence of fungal, parasitic, bacterial, and viral diseases has affected populations of seabirds in recent years. West Nile virus disease has been reported in California which is known to be lethal to seabirds. While the amount of negative impact this disease may bring is unknown, researchers agree that it is only a matter of time before West Nile virus reaches the Washington seabird population. Effects for murrelets from West Nile virus and other diseases are expected to increase in the near future due to an accumulation of stressors such as oceanic temperature changes, overfishing, and habitat loss (McShane et al. 2004).

Murrelets may be sensitive to human-caused disturbance due to their secretive nature and their vulnerability to predation. There are little data concerning the murrelet's vulnerability to disturbance effects, except anecdotal researcher observations that indicate murrelets typically exhibit a limited, temporary behavioral response (if any) to noise disturbance at nest sites and are able to adapt to auditory stimuli (Long and Ralph 1998; Golightly et al. 2002; Singer et al. 1995 in McShane et al. 2004). In general, responses to auditory stimuli at nests sites have been modifications of posture and on-nest behaviors (Long and Ralph 1998). While the unique breeding biology of the murrelet is not conducive to comparison of the reproductive success of other species, studies on other alcid and seabird species have revealed detrimental effects of disturbance to breeding success and the maintenance of viable populations (Cairns 1980; Pierce and Simons 1986; Piatt et al. 1990; Beale and Monaghan 2004).

Research on a variety of other species, including other seabirds, indicate an animal's response to disturbance follows the same pattern as its response to encountering predators, and anti-predator behavior has a cost to other fitness enhancing activities, such as feeding and parental care (Frid and Dill 2002). Some authors indicate disturbance stimuli can directly affect the behavior of individuals and indirectly affect fitness and population dynamics through increased energetic costs (Carney and Sydeman 1999; Frid and Dill 2002). Responses by murrelet adults and chicks to calls from corvids and other potential predators include no response, alert posturing, aggressive attack, and temporarily leaving a nest (adults only) (McShane et al. 2004). However, the most typical behavior of chicks and adults in response to the presence of a potential predator is to flatten against a tree branch and remain motionless (Nelson and Hamer 1995a; McShane et

al. 2004). Therefore, researcher's anecdotal observations of little or no physical response by murrelets are consistent with the behavior they will exhibit in response to a predator. In addition, there may have been physiological responses researchers cannot account for with visual observations. Corticosterone studies have not been conducted on murrelets, but studies on other avian species indicate chronic high levels of this stress hormone may have negative consequences on reproduction or physical condition (Wasser et al. 1997; Kitaysky et al. 2001; Marra and Holberton 1998 in McShane et al. 2004).

Although detecting effects of sub-lethal noise disturbance at the population level is hindered by the breeding biology of the murrelet, the effect of noise disturbance on murrelet fitness and reproductive success should not be completely discounted (McShane et al. 2004). In recently completed analyses, the Service concluded the potential for injury associated with disturbance (visual and sound) to murrelets in the terrestrial environment includes flushing from the nest, aborted feeding, and postponed feedings (USFWS 2003a). These responses by individual murrelets to disturbance stimuli can reduce productivity of the nesting pair, as well as the entire population (USFWS 1997b).

Conservation Needs

The Recovery Plan outlines the conservation strategy for the species. In the short-term, specific actions necessary to stabilize the population include maintaining occupied habitat, maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance.

Long-term conservation needs include increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size; increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat; protecting and improving the quality of the marine environment; and reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea. The Service estimates recovery of the murrelet will require at least 50 years (USFWS 1997b).

The Recovery Plan states that four of the six Conservation Zones (Zones) must be functional in order to effectively recover the murrelet in the short- and long-term; that is, to maintain viable populations that are well-distributed. However, based on the new population estimates, it appears only three of the Zones contain relatively robust numbers of murrelets (Zones 1, 3, and 4). Zones 1 and 4 contain the largest number of murrelets compared to the other four Zones. This alone would seem to indicate a better condition there, but areas of concern remain. For example, the population in Zone 4 was impacted when oil spills killed an estimated 10 percent of the population (Bentivoglio et al. 2002; Ford et al. 2002), small oil spills continue to occur in Zone 1, and the juvenile ratios in both of these Zones continue to be too low to establish stable or increasing populations (Beissinger and Peery, *in litt*., 2003).

Murrelets in Zones 3, 5, and 6 have suffered variously from past oil spills which killed a large number of murrelets (Zone 3) (Ford et al. 2001), extremely small population sizes (Zones 5 and 6), and alarmingly low reproductive rates (Zone 6) (Peery et al. 2002). These factors have brought the status of the species to a point where recovery in Zones 5 and 6 may be precluded

(Beissinger 2002). The poor status of murrelet populations in the southern Zones emphasizes the importance of supporting murrelet populations in Zones 1 and 2 in order to preserve the opportunity to achieve murrelet recovery objectives.

Conservation Strategy

Marine Environment

Protection of marine habitat is a component of the recovery strategy. The main threat to murrelets in the marine environment is the loss of individuals through death or injury, generally associated with oil spills and gill-net entanglements. The recovery strategy recommends providing protection within marine waters in such a way as to reduce or eliminate murrelet mortality (USFWS 1997b). The recovery strategy specifically recommends protection within all waters of Puget Sound and Strait of Juan de Fuca, and within 1.2 mi of shore along the Pacific Coast from Cape Flattery to Willapa Bay. However, newer information indicates the majority of murrelet activity along the Washington Coast occurs within 5 mi (8 km) of shore (Raphael et al. 2007), suggesting that protections should be extended to encompass this area. Management strategies could include exclusion of vessels, stricter hull requirements, exclusion of net fisheries, or modification of fishing gear.

In Washington State, the Washington Fish and Game Commission requires the use of alternative gear (i.e., visual alerts within the upper 7 ft of a multifilament net), prohibits nocturnal and dawn fishing for all non-treaty gill-net fisheries, and closes areas to gill-net fishing in order to reduce by-catch of murrelets. The Olympic Coast National Marine Sanctuary was established in 1994 along the outer Washington coast from Cape Flattery south to approximately the Copalis River and extending between 25 mi and 40 mi offshore. Oil exploration and development are prohibited within this Sanctuary (NOAA 1993).

Terrestrial Habitat Management

The loss of nesting habitat (old-growth/mature forest) has generally been identified as the primary cause of the murrelet population decline and disappearance across portions of its range (Ralph et al. 1995). Logging, urbanization, and agricultural development have all contributed to the loss of habitat, especially at lower elevations.

The recovery strategy for the murrelet is contained within the Marbled Murrelet Recovery Plan (Recovery Plan) (USFWS 1997b) relies heavily on the Northwest Forest Plan (NWFP) to achieve recovery on Federal lands in Washington, Oregon, and California. However, the Recovery Plan also addresses the role of non-Federal lands in recovery, including Habitat Conservation Plans, State forest practices, and lands owned by Native American Tribes. The importance of non-Federal lands in the survival and recovery of murrelets is particularly high in Conservation Zones, where Federal lands, and privately held conservation lands (e.g., The Nature Conservancy Teal Slough, Ellsworth, Washington), within 50 mi of the coastline are sparse, such as the southern half of Conservation Zone 2.

Lands considered essential for the recovery of the murrelet within Conservation Zones 1 and 2

are 1) any suitable habitat in a Late Successional Reserve (LSR), 2) all suitable habitat located in the Olympic Adaptive Management Area, 3) large areas of suitable nesting habitat outside of LSRs on Federal lands, such as habitat located in the Olympic National Park, 4) suitable habitat on State lands within 40 mi of the coast, and 5) habitat within occupied murrelet sites on private lands (USFWS 1997b).

Northwest Forest Plan

When the U.S. Forest Service (USFS) and Bureau of Land Management incorporated the NWFP as the management framework for public lands, a long-term habitat management strategy for murrelets (USFS and USBLM 1994a; USFS and USBLM 1994b) was established. The NWFP instituted pre-project surveys of murrelet habitat in areas planned for timber harvest and the protection of existing habitat at sites determined through surveys to be occupied by murrelets.

In the short-term, all known-occupied sites of murrelets occurring on USFS or Bureau of Land Management lands under the NWFP are to be managed as Late Successional Reserves (LSRs). In the long-term, unsuitable or marginally suitable habitat occurring in LSRs will be managed, overall, to develop late-successional forest conditions, thereby providing a larger long-term habitat base into which murrelets may eventually expand. Thus, the NWFP approach offers both short-term and long-term benefits to the murrelet.

Over 80 percent of murrelet habitat on Federal lands in Washington occurs within land management allocations that protect the habitat from removal or significant degradation. Scientists predicted implementation of the NWFP would result in an 80 percent likelihood of achieving a well-distributed murrelet population on Federal lands over the next 100 years (USFS and USBLM 1994a). Although the NWFP offers protection of known-occupied murrelet sites, concerns over the lingering effects of the historic widespread removal of suitable habitat will remain until the habitat recovers to late-successional characteristics. Habitat recovery will require over 100 years in many LSRs.

Habitat Conservation Plans

Four Habitat Conservation Plans (HCP) addressing murrelets in Washington have been completed for private/corporate forest land managers within the range of the murrelet: West Fork Timber Corporation (Murray Pacific Corporation 1993; Murray Pacific Corporation 1995; USFWS 1995) (Mineral Tree Farm HCP); Plum Creek Timber Company (Plum Creek Timber Company, L.P. 1996; USFWS 1996a; Plum Creek Timber Company, L.P. 1999; USFWS 1999) (Cascades HCP; I-90 HCP); Port Blakely Tree Farms, L.P. (Port Blakely Tree Farms, L.P. 1996; USFWS 1996b) (R.B. Eddy Tree Farm HCP); and Simpson Timber Company (Simpson Timber Company 2000; USFWS 2000b) (Olympic Tree Farm HCP). Habitat Conservation Plans have also been completed for two municipal watersheds, City of Tacoma (USFWS 2001; Tacoma Public Utilities 2001) (Green River HCP) and City of Seattle (USFWS 2000a; City of Seattle 2001) (Cedar River HCP), and the Washington Department of Natural Resources (WDNR 1997; USFWS 1997a). The HCPs which address murrelets cover approximately 500,000 acres of non-Federal (private/corporate) lands, over 100,000 acres of municipal watershed, and over 1.6 million acres of State-managed lands. However, only a portion of these lands contain suitable

murrelet habitat.

The WDNR HCP addresses murrelets in Conservation Zones 1 and 2. All of the others address murrelets in Conservation Zone 1. Most of the murrelet HCPs in Washington employ a consistent approach for murrelets by requiring the majority of habitat to be surveyed prior to timber management. Only poor-quality marginal habitat (with a low likelihood of occupancy) is released for harvest without survey. All known occupied habitat is protected to varying degrees, but a "safe-harbor-like" approach is used to address stands which may be retained as, or develop into, suitable habitat and become occupied in the future. This approach would allow future harvest of habitat which is not currently nesting habitat.

Washington State Forest Practices Regulations

Under Washington Forest Practices Rules, which apply to all non-Federal lands not covered by an HCP (WFPB 2005), surveys for murrelets are required prior to the harvest of suitable nesting habitat. These criteria vary depending on the location of the stand. For stands found to be occupied or known to be previously occupied, the WDNR makes a decision to issue the permit based upon a significance determination. If a determination of significance is made, preparation of a State Environmental Policy Act Environmental Impact Statement is required prior to proceeding. If a determination of non-significance or mitigated determination of non-significance is reached, the action can proceed without further environmental assessment.

Tribal Management

The management strategy of the Bureau of Indian Affairs for the murrelet focuses on working with Tribal governments on a government-to-government basis to develop management strategies for reservation lands and trust resources. The Bureau of Indian Affairs' management strategy typically focus on avoiding harm to murrelets when feasible, to facilitate the trust responsibilities of the United States. However, other factors must be considered. Strategies must foster Tribal self-determination, and must balance the needs of the species and the environmental, economic, and other objectives of Indian Tribes within the range of the murrelet (Renwald 1993). For example, one of the Bureau of Indian Affairs' main goals for murrelet protection includes assisting Native American Tribes in managing habitat consistent with tribal priorities, reserved Indian rights, and legislative mandates.

Summary

Demographic modeling results indicate murrelet populations are declining within each Conservation Zone and throughout the listed range. The juvenile to adult ratios observed at sea in the Conservation Zones are too low to obtain a stable population in any Conservation Zone, which indicates murrelet abundance in all Conservation Zones will continue to decline until reproductive success improves. In other words, there is insufficient recruitment of juveniles to sustain a murrelet population in the listed range of the species.

Some of the threats to the murrelet population may have been reduced as a result of the species' listing under the Act, such as the passage of the Oil Pollution Act and implementation of the NWFP. However, no threats have been reversed since listing and in some areas threats, such as predation and West Nile Virus, may be increasing or emerging. Threats continue to contribute to murrelet population declines through adult and juvenile mortality and reduced reproduction. Therefore, given the current status of the species and background risks facing the species, it is reasonable to assume that murrelet populations in Conservation Zones 1 and 2 and throughout the listed range have little resilience to deleterious population-level effects and are at high risk of extirpation.

Considering the life history characteristics of the murrelet, with the aggregate effects of inland habitat loss and fragmentation and at-sea mortality, the species' capability to recover from lethal perturbations at the population or metapopulation (Conservation Zone) scale is extremely low. The low observed reproductive rates make the species highly susceptible to local extirpations when exposed to repeated perturbations at a frequency which exceeds the species' loss-replacement rate. Also troublesome is the ineffectiveness of recovery efforts at reversing the ongoing lethal consequences in all demographic classes from natural and anthropogenic sources. Despite the relatively long potential life span of adult murrelets, the annual metapopulation replacement rates needed for long-term metapopulation maintenance and stability is currently well below the annual rate of individuals being removed from each metapopulation. As a result, murrelet metapopulations are currently not self-sustaining or self-regulating.

Accordingly, the Service concludes the current environmental conditions for murrelets in the coterminous United States appear to be insufficient to support the long-term conservation needs of the species. Although information is not sufficient to determine whether murrelets are nesting at or near the carrying capacity in the remaining nest habitat, activities which degrade the existing conditions of occupied nest habitat or reduce adult survivorship and/or nest success of murrelets will be of greatest consequence to the species. Actions resulting in the further loss of occupied nesting habitat, mortality to breeding adults, eggs, or nestlings will reinforce the current murrelet population decline throughout the coterminous United States.

STATUS OF THE SPECIES: MARBLED MURRELET
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APPENDIX F: Framework for Assessing Sediment Impacts (2006)

APPENDIX F
Framework for Assessing Sediment Impacts (2006)

The general impacts of sedimentation within an aquatic system are well known. When a biologist reviews a Biological Assessment or Biological Evaluation under section 7 of the Endangered Species Act, effects are evaluated based on the data or information provided. In most cases, specific information is not supplied by the action agency, or is not available for the biologist to conduct a thorough review and make that vital link between the project and the effect on listed fishes, specifically bull trout (*Salvelinus confluentus*) and their habitat.

Specific information needed by a biologist is related to the physical and biological effects of sediment in a stream. The physical questions include the following:

1. Will the project increase sediment input into the stream?
2. How much sediment will result and for what duration?
3. How far downstream will the sediment move?

Based on these physical questions, the biological effects to listed fish species can then be determined. The biological questions include the following:

1. What life stage(s) are affected by the sediment input?
2. What levels of sedimentation cause adverse effects?
3. What are the biological effects of sediment on fish and their habitat?

SEDIMENT CLASSIFICATIONS AND DEFINITIONS

Sediment within a stream can be classified into a variety of different categories: turbidity, suspended sediment, bedload, deposited sediment, and wash load (Waters 1995; Bash et al. 2001). A geomorphologist may classify sediment differently than a fisheries biologist. Sediment category definitions include:

- Turbidity - Optical property of water which results from the suspended and dissolved materials in the water that cause 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, and thus, significant quantities are not found in the bed.

Suspended sediment, turbidity, and deposited sediment are not mutually exclusive as to particle size, because they will overlap considerably depending on velocity, turbulence, and gradient (MacDonald et al. 1991; Waters 1995). 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). Turbidity and suspended sediment affect the light available for photosynthesis, visual capability of aquatic animals, gill abrasion and physiological effects to fish. Suspended and deposited sediment affect the habitat available for macroinvertebrates, quality of gravel for fish spawning, and amount of habitat for fish rearing (Waters 1995).

Particle size is also important. Particle diameters less than 6.4 mm are generally defined as "fines" (Bjornn et al. 1977; Bjornn and Reiser 1991; Shepard et al. 1984; Hillman et al. 1987; Chapman 1988; Reiman and McIntyre 1993; Castro and Reckendorf 1995; MBTRT 1998). The quantity of fines within a stream ecosystem is usually associated with the degradation of a fish population (Castro and Reckendorf 1995).

INFORMATION SOURCES

To determine the overall impact of a project on bull trout, and to specifically understand whether increased sediment may adversely affect bull trout, the biologist will need to review specific information relating to the watershed and stream in which the project is located.

The following documents are important to review:

1. Washington State Conservation Commission's Limiting Factors Analysis. The 1998 Washington State Legislative session produced a number of bills aimed at salmon recovery. One bill was to identify the limiting factors to salmonid populations within watersheds in Washington State. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon." Limiting factors analyses have been developed for numerous watersheds. The status of the limiting factors analyses for each Water Resource Inventory Area (WRIA) can be found at http://salmon.scc.wa.gov. The Endangered Species Division has final copies of completed documents.

2. Washington Department of Fish and Wildlife's (1998) Salmonid Stock Inventory. The Washington Department of Fish and Wildlife (WDFW) inventoried bull trout and Dolly Varden (*S. malma*) stock status throughout the State. The intent of the inventory is to help identify available information and to guide future restoration planning and implementation. Salmonid Stock Inventory defines the stock within the watershed, life

history forms, status and factors affecting production. Spawning distribution and timing for different life stages are provided (migration, spawning, etc.), if known.

3. U.S. Fish and Wildlife Service's (USFWS 1998a) Matrix of Diagnostics/Pathways and Indicators (MPI). The MPI was designed to facilitate and standardize determination of project effects on bull trout. The MPI provides a consistent, logical line of reasoning to aid in determining when and where adverse affects occur and why they occur. The MPI provides levels or values for different habitat indicators to assist the biologist in determining the level of effects or impacts to bull trout from a project and how these impacts may cumulatively change habitat within the watershed.

4. Individual Watershed Resource Publications. Other resources may be available within a watershed that will provide information on habitat, fish species, and recovery and restoration activities being conducted. Local groups can provide valuable information specific to the watershed.

5. Washington State Department of Ecology (WDOE) Water Quality Database. The WDOE has long and short term water quality data for different streams within the State. Data can be found at www.ecy.wa.gov/programs/eap/fw_riv/rv_main. Clicking on a stream or entering a stream name will provide information on current and past water quality data. This information will be useful for determining the specific turbidity/suspended sediment relationship for that stream (more information below).

6. WDOE Stream Conditions Database. The WDOE has also been collecting benthic macroinvertebrates and physical habitat data to describe conditions under natural and anthropogenic disturbed areas. Data can be found at www.ecy.wa.gov/programs/eap/fw_benth/93-98. Clicking on a stream or entering a stream name will provide habitat and macroinvertebrate data.

7. U.S. Forest Service (USFS) Watershed Analysis Documents. The USFS is required by the Record of Decision for Amendments to the USFS and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl to conduct a watershed analysis for watersheds located on USFS lands. The watershed analysis determines the existing condition of the watershed and makes recommendations for future projects that move the landscape towards desired conditions. Watershed analysis documents are available from individual National Forests or from the Washington Fish and Wildlife Office, Forest Plan Branch.

8. U.S. Fish and Wildlife Service Bull Trout Recovery Plans and Critical Habitat Designations. The draft Bull Trout Recovery Plan for the Coastal-Puget Sound Distinct Population Segment and the final critical habitat designations provide current species status, habitat requirements, and limiting factors for bull trout within specific individual recovery units. These documents are available from the Washington Fish and Wildlife Office and the Service's web page (www.fws.gov).

These documents and websites provide information on stream and watershed conditions as of

2005. This information is critical to understanding baseline conditions and determining future sediment impacts to the aquatic system. A stream has a natural amount of sediment that is transported through the system. This amount of sediment is based on numerous factors: precipitation, topography, geology, streamflow, riparian vegetation, stream geomorphological characteristic, human disturbance, etc (Bash et al. 2001). However, baseline or background levels need to be analyzed with respect to the limiting factors within the watershed.

Different watersheds have different levels of turbidity or suspended sediment. A glaciated stream will have higher sediment levels than a spring-fed stream. Aquatic organisms are adapted to the natural variation in sediment load that occurs seasonally within their stream habitat (ACMRR 1976; Birtwell 1999). Field experiments have found a thirty-fold increase in tolerance of fish to suspended solids between August and November when naturally occurring concentration are expected to be high (Cederholm and Reid 1987). The question at hand is whether additional input of sediment may result in increased bull trout impacts.

Sediment levels in excess of natural amounts can have multiple adverse effects on channel conditions and bull trout (Rhodes et al. 1994). The effect can be fatal at high levels. Low levels may result in sublethal effects such as loss or reduction of foraging capability, reduced growth, reduced resistance to disease, increased stress, and interference with orientation in homing and migration (McLeay et al 1987; Newcombe and McDonald 1991; Bash et al. 2001).

Work-timing windows are usually incorporated into projects to minimize construction impacts to fish. Work-timing windows are time periods when salmonids are at a stage in their life cycle when they are least sensitive to disturbances or are least likely to be present. This is typically outside of the spawning or egg incubating period. Work-timing windows allow the fish to either move away from impacts or to better cope with short term, minimal changes to the habitat and/or decreased water quality. The work-timing windows are usually in July through September. This time may reduce impacts to spawning fish and egg incubating periods, but may exacerbate impacts to juveniles, subadults, and adults. Protective mucous secretions are inadequate during the summer months, when natural sediment levels are low in a stream system, and thereby sediment introduction at this time may increase fish risk to stress and disease (Bash et al. 2001).

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). Specific effects of sediment on fish and their habitat can be put into three classes that include (Newcombe and MacDonald 1991; Waters 1995; Bash et al. 2001):

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

ecosystem to produce fish and future 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.

Environmental factors affecting sediment impacts on individual fish 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). Aquatic systems are complex interactive systems, and isolating the effects of sediment on fish populations is difficult (Castro and Reckendorf 1995). Determining which environmental variables act as limiting factors has made it difficult to establish the specific effects of sediment impacts on fish populations (Chapman 1988). For example, excess fines in the 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 a mixed salmonid population, or in species communities composed of salmonids and nonsalmonids (Everest et al. 1987). Bull trout have more spatially restrictive biological requirements than other salmonids at both the individual and population levels (USFWS 1998b). 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 (Reiman and McIntyre 1993). Fish are common in the diet of individual bull trout that are over 110 millimeters or longer. Large bull trout can feed almost exclusively on fish. Therefore, when analyzing impacts of sediment on bull trout, it is very important to consider other fish species. 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, which are potential prey species for bull trout. The following effects of sediment are not just bull trout specific. All salmonids can be affected similarly.

Direct effects

Gill trauma

High levels of suspended sediment and turbidity can cause fish mortality by damaging and clogging gills. Fish gills are delicate and easily damaged by abrasive silt particles (Bash et al. 2001). 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). 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).

Spawning, redds, eggs, and alevins

When suspended sediment deposits in a redd, it can reduce water flow, smothering eggs or alevins or impeding fry emergence, depending on the sediment particle sizes of the spawning habitat (Bjornn and Reiser 1991). 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.

Egg survival depends upon a continuous supply of well oxygenated water through the streambed gravels (Cederholm and Reid 1987). Eggs and alevins are generally more susceptible than adults to stress from suspended solids. Accelerated sedimentation can reduce the flow of water and, therefore, oxygen to eggs and alevins which can decrease egg survival, decrease fry emergence rates (Cederholm and Reid 1987; Chapman 1988; Bash et al. 2001), delay development of alevins (Everest et al. 1987), reduce growth and cause premature hatching and emergence (Birtwell 1999). Fry delayed in their timing of emergence are less able to compete for environmental resources than other fish that have undergone normal development and emergence (intra- or interspecific competition) (Everest et al. 1987).

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, 23, and 12 percent, respectively (Slaney et al. 1977). Substrates containing 20 percent fines can reduce emergence success by 30-40 percent (MacDonald et al. 1991). 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).

Although bull trout generally have a narrow, specific spawning habitat requirement and therefore, spawn in a small percentage of the stream habitat available to them (MBTRT 1998), they seem to be more tolerant of sedimentation during development and emergence than other salmonids. Survival of bull trout embryos through emergence appears to be unaffected when the percentage of fines comprise up to 30 percent of the streambed. However, at levels above 30

percent, embryo survival through emergence dropped off sharply with survival below 20 percent for substrates with 40 percent fine material (Shepard et al. 1984).

Indirect effects

Macroinvertebrates

Macroinvertebrates are a significant food source for salmonids. Turbidity and suspended solids can affect macroinvertebrates in multiple ways through increased invertebrate drift, feeding impacts, respiratory problems, and loss of habitat (Cederholm and Reid 1987). Salmonids favor certain groups of macroinvertebrates, such as mayflies, caddisflies, and stoneflies. These species prefer large substrate particles in riffles and are negatively affected by fine sediment (Everest et al. 1987; Waters 1995).

The effect of light reduction from turbidity has been well documented as increasing invertebrate drift (Waters 1995; Birtwell 1999). 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).

Increased suspended sediment can abrade the respiratory surface of macroinvertebrates and interfer with food uptake for filter-feeders (Birtwell 1999). 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). Invertebrates living in the substrate are also subject to scouring or abrasion which can damage respiratory organs (Bash et al. 2001).

Benthic invertebrates inhabit the stream bottom. Therefore, any modification of the streambed by deposited sediment will most likely have a profound effect upon the benthic invertebrate community (Waters 1995). Increased sediment can affect macroinvertebrate habitat by filling interstitial space and rendering attachment sites unsuitable. This may cause invertebrates to seek a more favorable habitat (Rosenberg and Snow 1975). The degree to which substrate particles are surrounded by fine material was strongly correlated with macroinvertebrate abundance and composition (Birtwell 1999). At an embeddedness of one-third, insect abundance can decline by about 50 percent, especially for riffle-inhabiting taxa (Waters 1995).

Feeding Efficiency

Increased turbidity and suspended sediment can affect salmonid feeding rates, reaction distance, and prey selection (Bash et al. 2001). Changes in feeding behavior are primarily related to the reduced visibility 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.

Distance of prey capture and prey capture success both were found to decrease significantly when turbidity was increased (Berg and Northcote 1985). Waters (1995) states that the loss of visual capability, leading to reduced feeding, is one of the major sublethal effects of high

suspended sediment. Increases in turbidity was reported to decrease the percentage of prey captured (Bash et al. 2001). At 0 NTUs, 100 percent of the prey items were consumed. At 20 to 60 NTUs, significant delay in the response of fish to prey was observed. At 10 NTUs, fish were frequently unable to capture prey species; at 60 NTUs, only 35 percent of the prey items were captured. Loss of visual capability and capture of prey leads to depressed growth and reproductive capability.

Sigler et al. (1984) 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, other complex mechanisms, such as the quality of light, may also affect feeding success rates. Redding et al. (1987) 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 (Reiman and McIntyre 1993). 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, temperature, and the presence of migration corridors (Reiman and McIntyre 1993).

The physical effects of sediment in streams include degradation of spawning and rearing habitat, simplification and damage to habitat structure and complexity, loss of habitat, and decreased connectivity between habitat (Bash et al. 2001). Biological implications of this habitat damage include underutilization of stream habitat, abandonment of traditional spawning habitat, displacement of fish from their habitat, and avoidance of habitat (Newcombe and Jensen 1996).

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). 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). 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). These processes, in turn, contribute to increased erosion and sediment deposition which further degrade salmonid habitat.

Loss of acceptable habitat and refugia, as well as decreased connectivity between habitat reduces the carrying capacity of streams for salmonids (Bash et al. 2001). In systems lacking adequate number, distribution, and connectivity of habitat, fish may travel longer distances or use less desirable habitat and may encounter a variety of other conditions that can increase biological demands.

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; Bash et al. 2001). Similarly, the inverse relationship between fine sediment and densities of rearing Chinook salmon indicate how high sediment loads effect important winter habitat (Bjornn et al. 1977). As fine sediments filled 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). Deposition of sediment on substrate may lower winter carrying capacity for bull trout (Shepard et al. 1984). Food production in the form of aquatic invertebrates may also be reduced.

Juvenile bull trout densities are highly influenced by substrate composition (Shepard et al. 1984; Reiman and McIntyre 1993; MBTRT 1998). 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). Any loss of interstitial space or streambed complexity through the deposition of sediment would result in a loss of summer and winter habitats (MBTRT 1998). The reduction in rearing habitats ultimately reduces the potential number of recruited juveniles and ultimately reduces population numbers (Shepard et al. 1984).

Although fish avoidance in response to increased sediment may be an initial adaptive survival strategy, displacement from cover could be detrimental. The possible 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, where they also become stressed and more vulnerable to predation (Birtwell 1999).

Physiological Effects

Sublethal levels of suspended sediment may cause undue physiological stress to fish, reducing the ability of the fish to perform vital functions (Cederholm and Reid 1987). At the individual fish level, stress can reduce growth, increase disease, and reduce the ability to tolerate additional stress (Bash et al. 2001). At the population level, the effects of stress may include reduced spawning success, increased larval mortality, reduced recruitment to succeeding life stages and, therefore, overall population declines (Bash et al. 2001).

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). 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 the concentration of oxygen available in the water decreases. Therefore, fish tolerance of suspended sediment may be primarily related to the capacity of the fish 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 (Serizi and Martens 1991).

Redding et al. (1987) observed higher mortality in young steelhead trout exposed to a combination of suspended sediment (2500 mg/l) and a bacterial pathogen, than when exposed to the bacteria alone. Physiological stress in fishes appears to decrease immunological competence, growth, and reproductive success (Bash et al. 2001).

Behavioral effects

Increased turbidity and suspended sediment may also cause behavior changes in salmonids. Avoidance, distribution, and migration may be affected. Many behavioral effects result from changes in stream habitat as well (see Habitat effects section). As suspended

Table 1 – Severity of effects (SEV).

	Nil Effect
0	No behavioral effects
	Behavioral Effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
	Sublethal Effects
4	Short-term reduction in feeding rates; short-term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate and/or feeding success; poor condition
	Lethal & Paralethal Effects
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to sever habitat degradation
11	> 20 – 40% mortality
12	> 40 – 60% mortality
13	> 60 – 80% mortality
14	> 80 – 100% mortality

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). Sediment pulses result in downstream migration of fish, which disrupts social structures, and causes downstream displacement of other fish (McLeay et al 1987; Bash et al. 2001). Loss of territoriality and the breakdown of social structure can lead to secondary effects of decreased growth and feed rates, which may lead to mortality (Berg and Northcote 1985; Bash et al. 2001).

To the contrary, when not motivated by excess sediment, downstream migration by bull trout can provide access to more prey, better protection from avian and terrestrial predators, and alleviate potential intraspecific competition or cannibalism in rearing areas (MBTRT 1998). 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. Such migration exposes fish to many new hazards, including passage of sometimes difficult and unpredictable physical barriers, increased vulnerability to predators, exposure to introduced species, exposure to pathogens, and the challenges of new and unfamiliar habitats (MBTRT 1998).

High turbidity can also 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).

EFFECTS DETERMINATION

The point at which adverse effects to fish occur from a specific project can be difficult to determine without adequate data. There are numerous variables that affect the determination, and for which data may be unavailable. These include project specific sediment input, existing sediment conditions, stream conditions (velocity, depth, etc.) during construction, weather or climate conditions (precipitation, wind, etc.), fish presence or absence (bull trout plus prey species), effectiveness of the best management practices employed, plus many others.

The Washington Fish and Wildlife Office (WFWO) is currently drafting protocol to obtain specific project related sediment data. This protocol will be used to identify project related sediment input during construction, as well as long term sedimentation that may result after completion of the project (i.e. high-flow events, channel adjustments, etc.). Following the protocol will provide consistent information on project-related sediment input to assist in evaluating effects and quantifying incidental take in biological opinions.

Newcombe and Jensen (1996) provide a basis for determining when a project will be “likely to adversely affect” bull trout. They conducted a literature review of pertinent documents on sediment effects to salmonids and nonsalmonids, and developed a model that calculated the severity of effect (SEV) based on the suspended sediment dose (exposure) and concentration.

A 15-point scale is used to qualitatively rank the effects of sediment on fish (Table 1). Specific SEV levels will be used to determine when a project is “likely to adversely affect” bull trout.

The following procedure will be used:

1. Select either a. or b. below.

    a. Based on water quality monitoring data, determine the amount of sediment and the duration of sediment input into the stream. (Currently not enough data are available to use this step. As more project specific data becomes available this step will be used).

    b. Use State water quality standards. Because action agencies must meet State water quality standards you can use the standard for determining sediment input into the stream. The Washington State water quality standards for turbidity are provided in Table 2.

The State water quality standard allows for a mixing zone downstream of the project site. The point of compliance is based on stream discharge (Table 3).

The water quality standard must be converted from turbidity (NTUs) to suspended solids (mg/l). A ratio of 1:1 to 1:5 has been derived for converting turbidity to suspended solids (Birtwell 1999). Washington Department of Ecology or U.S. Geological Survey data should be used to determine specific turbidity:suspended solid ratios for the stream on which the project will be conducted (see Documents and Background Information section). If site specific ratios can not be determined use worse case ratio of 1:4 or 1:5.

2. Based on the background information gathered, determine what life stage(s) of bull trout will be affected by sedimentation (see Documents and Background Information section). Use Figures 1 through 4 to determine what SEV level will result for the life stage affected by the project.

3. Use Table 4 to determine what ESA determination is made for the life stage affected.

4. If a LAA determination is made, then the rationale for adverse effects is based on the SEV value obtained. The rationale is not just for that specific level (SEV = 6), but includes previous SEVs as well.

5. Table 5 summarizes the project-specific water quality monitoring data received by the Service for individual projects and indicates that, in some cases, adverse effects that rise to the level of "incidental take" may occur up to at least 600 ft downstream of project locations. Water quality monitoring data can indicate, by analogy, typical levels of sediment impacts for different project types, and can be used to estimate the minimum extent of impact. The data include the distance from the project where water quality

sampling occurred and the maximum NTU levels were observed. Additional monitoring data will be incorporated when available.

Table 2 - Turbidity water quality standards for various classes of surface waters in the State of Washington.

Washington State Classes for Surface Waters	**Turbidity Characteristic**
Class AA (extraordinary)	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 10 percent increase in turbidity when the background turbidity is > 50 NTU.
Class A (excellent)	Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 10 percent increase in turbidity when the background turbidity is > 50 NTU
Class B (good)	Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is ≤ 50 NTU or have > 20 percent increase in turbidity when the background turbidity is > 50 NTU

Table 3 - Turbidity mixing zones for turbidity water quality standards.

Waterbody Type	Point of Compliance
Stream:	
≤ 10 cfs Stream Flow at Time of Construction	100 ft downstream of activity causing turbidity exceedance
>10 cfs up to 100 cfs Stream Flow at Time of Construction	200 ft downstream of activity causing turbidity exceedance
> 100 cfs Stream Flow at Time of Construction	300 ft downstream of activity causing turbidity exceedance

Figure 1 - Severity-of-ill-effect scores for juvenile and adult salmonids.

Juvenile and Adult Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	10	11	11	12	12	13	14	14	-	-	-
59874	9	10	10	11	12	12	13	13	14	-	-
22026	8	9	10	10	11	11	12	13	13	14	-
8103	8	8	9	10	10	11	11	12	13	13	14
2981	7	8	8	9	9	10	11	11	12	12	13
1097	6	7	7	8	9	9	10	10	11	12	12
403	5	6	7	7	8	9	9	10	10	11	12
148	5	5	6	7	7	8	8	9	10	10	11
55	4	5	5	6	6	7	8	8	9	9	10
20	3	4	4	5	6	6	7	8	8	9	9
7	3	3	4	4	5	6	6	7	7	8	9
3	2	2	3	4	4	5	5	6	7	7	8
1	1	2	2	3	3	4	5	5	6	7	7
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 2 - Severity-of-ill-effect scores for adult salmonids.

Adult Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	11	11	12	12	13	13	14	14	-	-	-
59874	10	10	11	11	12	12	13	13	14	14	-
22026	9	10	10	11	11	12	12	13	13	14	14
8103	8	9	9	10	10	11	11	12	12	13	13
2981	8	8	9	9	10	10	11	11	12	12	13
1097	7	7	8	8	9	9	10	10	11	11	12
403	6	7	7	8	8	9	9	10	10	11	11
148	5	6	6	7	7	8	8	9	9	10	10
55	5	5	6	6	7	7	8	8	9	9	9
20	4	4	5	5	6	6	7	7	8	8	9
7	3	4	4	5	5	6	6	7	7	7	8
3	2	3	3	4	4	5	5	6	6	7	7
1	2	2	3	3	4	4	5	5	5	6	6
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 3 - Severity-of-ill-effect scores for juvenile salmonids.

Juvenile Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	9	10	11	11	12	13	14	14	-	-	-
59874	9	9	10	11	11	12	13	14	14	-	-
22026	8	9	9	10	11	11	12	13	13	14	-
8103	7	8	9	9	10	11	11	12	13	13	14
2981	6	7	8	9	9	10	11	11	12	13	13
1097	6	6	7	8	9	9	10	11	11	12	13
403	5	6	6	7	8	9	9	10	11	11	12
148	4	5	6	6	7	8	9	9	10	11	11
55	4	4	5	6	6	7	8	8	9	10	11
20	3	4	4	5	6	6	7	8	8	9	10
7	2	3	4	4	5	6	6	7	8	8	9
3	1	2	3	4	4	5	6	6	7	8	8
1	1	1	2	3	4	4	5	6	6	7	8
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Figure 4 - Severity-of-ill-effect scores for eggs and alevins of salmonids.

Eggs and Alevins of Salmonids
Average severity-of-ill-effect scores

Concentration (mg/l)											
162755	7	9	10	11	12	13	14	-	-	-	-
59874	7	8	9	10	12	13	14	-	-	-	-
22026	7	8	9	10	11	12	13	-	-	-	-
8103	7	8	9	10	11	12	13	14	-	-	-
2981	6	7	8	10	11	12	13	14	-	-	-
1097	6	7	8	9	10	11	12	14	-	-	-
403	6	7	8	9	10	11	12	13	14	-	-
148	5	6	7	9	10	11	12	13	14	-	-
55	5	6	7	8	9	10	12	13	14	-	-
20	5	6	7	8	9	10	11	12	13	-	-
7	4	5	7	8	9	10	11	12	13	14	-
3	4	5	6	7	8	10	11	12	13	14	-
1	4	5	6	7	8	9	10	11	13	14	-
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

Table 4 - ESA Effect calls for different bull trout life stages in relation to the duration of effect and severity-of-ill-effect.

Life Stage	SEV	ESA Effect Call
Egg/alevin	1 to 4 5 to 14	not applicable - alevins are still in gravel and are not feeding. LAA - any stress to egg/alevin reduces survival
Juvenile	1 to 4 5 to 14	NLAA LAA
Subadult and Adult	1 to 5 6 to 14	NLAA LAA

Table 5 - Water quality monitoring data received by the Washington Fish and Wildlife Office showing distance downstream where data were recorded and the maximum magnitude of turbidity observed.

Project	Distance downstream from project that data were recorded	Distance downstream that State water quality standards are met, or the maximum turbidity levels observed.
Debris jam removal (SR - 20)	Not provided	Met standard
Rock placed in stream (Hoh River emergency bank protection)	100 ft - 200 ft	Met standard
Bridge construction (SR - 90) Stated removal of coffer dams and diversion resulted in increased turbidity.	Not provided	Maximum daily magnitude measured: 25 NTUs over standard.
River scour protection (SR 12) Contract no. C-6186	300 ft and 600 ft	Maximum daily magnitude measured: 9.3 NTUs over standard.
Bridge construction	200 ft	Maximum daily magnitude measured: 169 NTUs.
Culvert replacement project not described (SR241) - Contract # 6270 - Sulfur Cr.	100 ft and 200 ft	Maximum daily magnitude measured: over 30 NTUs.
Bank stabilization (Saxon Cr.)	300 ft	Maximum daily magnitude measured: 35.2 NTUs over standard.
Culvert replacement – (Stossel Cr Way.)	Not provided	Maximum daily magnitude measured: 24 NTUs over background.
Culvert Replacement – (Stevens Creek)	178 ft and 576 ft	Maximum daily magnitude measured: 185 NTUs over background.
Culvert Replacement – (Sunbeam Creek)	72 ft and 147 ft	Maximum daily magnitude measured: 454 NTUs over background.
Culvert Replacement – (Unnamed Waddell Creek Tributary)	62 ft	Maximum daily magnitude measured: 600 NTUs over background.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

JUN - 7 2010

In Reply Refer To:
13410-2008-F-0384

Michelle Walker
Department of the Army
Seattle District, Corps of Engineers
ATTN: Rebecca McAndrew
P.O. Box 3755
Seattle, Washington 98124-3755

Dear Ms. Walker:

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) based on our review of the proposed State Route 410 White River CED (MP 41.4 - 42.0) project in Pierce and King Counties, Washington, and its effects on the bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), and bull trout critical habitat, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Your request for initiation of formal consultation, dated May 28, 2008, was received in our office on May 29, 2008. The U.S. Army Corps of Engineers (Corps) provided information in support of "may affect, likely to adversely affect" determinations for the bull trout, marbled murrelet, and northern spotted owl (*Strix occidentalis caurina*), and a "may affect, not likely to adversely affect" determination for bull trout critical habitat. On December 8, 2008, we received additional information from the Washington State Department of Transportation (WSDOT) and Corps, and initiated formal consultation on the project.

The enclosed Opinion addresses the proposed action's adverse effects on the bull trout and marbled murrelet, and includes mandatory terms and conditions intended to minimize certain adverse effects. In addition, the Opinion finds that the action's foreseeable effects on northern spotted owl behaviors, its habitat, and prey base are insignificant. No measurable adverse effects to the northern spotted owl or its habitat are anticipated.

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These portions of the White River are currently excluded from the bull trout critical habitat designation. Recently, however, the Service proposed revisions to designated bull trout critical habitat (75 FR 2270 [January 14, 2010]), and it is uncertain at this time whether the Service will continue to exclude these waters from the final designation. The Opinion addresses the proposed action's adverse effects on bull trout critical habitat, and concludes that the proposed action "will not destroy or adversely modify" bull trout critical habitat. The WSDOT and Corps should notify the Service if this portion of the White River is included in the final bull trout critical habitat re-designation prior to completion of the proposed project. Assuming there have been no changes to the project with significance for bull trout critical habitat, and the basis for this conference remains unchanged, no additional information should be needed to concur with a "may affect, likely to adversely affect" determination.

If you have any questions regarding the Opinion or your responsibilities under the Endangered Species Act, please contact Ryan McReynolds at (360) 753-6047 or Emily Teachout at (360) 753-9583 of this office.

Sincerely,

Martha L. Jensen

for Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc:
WSDOT – NW Region, Seattle, Washington (B. Bigler)
WSDOT – Environmental Services Office, Olympia, Washington (P. Wagner)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference: 13410-2008-F-0384

State Route 410, White River CED (MP 41.4 - 42.0)

Pierce and King County, Washington

Agency:

U.S. Army Corps of Engineers, Seattle District
Seattle, Washington

Consultation Conducted By:

U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

for Martha L. Jensen

Ken S. Berg, Manager
Washington Fish and Wildlife Office

6/7/10
Date