United States Department of the Interior
FISH AND WILDLIFE SERVICE
Central Washington Field Office
215 Melody Lane, Suite 103
Wenatchee, Washington 98801

In Reply Refer To:
01EWFW00-2021-F-0063

Memorandum

To: Environmental Specialist, Columbia-Pacific Northwest Region
Boise, Idaho

From: *for* State Supervisor, Washington Fish and Wildlife Office JEFFREY KRUPKA
Lacey, Washington

Digitally signed by JEFFREY KRUPKA
Date: 2021.03.04 16:49:17 -08'00'

Subject: Formal Consultation for the Leavenworth National Fish Hatchery Surface Water Intake Fish Screens and Fish Passage (SWISP) Project
(HUC #170200110402, Icicle Creek)

This memorandum transmits the U. S. Fish and Wildlife Service's (USFWS) Biological Opinion on the proposed Leavenworth National Fish Hatchery (LNFH) Surface Water Intake Fish Screens and Fish Passage (SWISP) Project located in Chelan County, Washington, and its effects on bull trout (*Salvelinus confluentus*), and its designated critical habitat. Formal consultation was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). Your October 15, 2020, request for formal consultation was received on October 16, 2020.

The attached Biological Opinion is based on information provided in the October 15, 2020, Biological Assessment, the February 2021 administrative Final Environmental Impact Statement, telephone conversations, field investigations, and other sources of information as described in the Biological Opinion. A complete record of this consultation is on file at the USFWS' Central Washington Field Office in Wenatchee, Washington. An electronic copy of this Biological Opinion will be available to the public approximately 14 days after it is finalized and signed. A list of Biological Opinions completed by the (USFWS) since October 1, 2017 can be found on the (USFWS) Environmental Conservation Online System (ECOS) website at https://ecos.fws.gov/ecp/report/biological-opinion.html.

If you have any questions regarding the attached Biological Opinion or our shared responsibilities under the Act, please contact Cindy Raekes at the Central Washington Field Office in Wenatchee at (509) 665-3508, ext. 2009, or via e-mail at cynthia_raekes@fws.gov or Jeff Krupka at (509) 665-3508, ext. 2008 (jeff_krupka@fws.gov).

Attachment

cc:
USFWS, Leavenworth, WA, (J. Craig)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2021-F-0063

Leavenworth National Fish Hatchery Surface Water Intake Fish Screens and Fish Passage (SWISP) Project

Chelan County, Washington

Federal Action Agency:

U.S. Bureau of Reclamation

Consultation Conducted By:

U.S. Fish and Wildlife Service
Central Washington Fish and Wildlife Office
Wenatchee, Washington

JEFFREY KRUPKA Digitally signed by JEFFREY KRUPKA Date: 2021.03.04 16:50:08 -08'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Date

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ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BMP	Best Management Practices
CFR	Code of Federal Regulations
cfs	cubic feet per second
Act	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
USFWS	U.S. Fish and Wildlife Service
USBR	U.S. Bureau of Reclamation
WDOE	Washington State Department of Ecology
CHSU	Critical Habitat Subunit
CHU	Critical Habitat Unit
CIPP	Cure in Place Pipeline
City	City of Leavenworth
CM	Conservation Measure
USACE	U.S. Army Corps of Engineers
County	Chelan County
CWA	Clean Water Act
CUA	Contractor Use Area
cy	cubic yards
dB	Decibel
dBA	A-weighted decibel level
DPS	Distinct Population Segment
FEIS	Final Environmental Impact Statement
FMO	Foraging, Migration and Overwintering
FR	Federal Register
ft^2	square feet
GHG	greenhouse gas
GIS	Geographic Information System
IGDO	inter-gravel dissolved oxygen
IO&MA	Intake Operations and Maintenance Area
IPCC	Intergovernmental Panel on Climate Change
LNFH	Leavenworth National Fish Hatchery
MCRU	Mid-Columbia Recovery Unit
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity units
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
PCE	Primary Constituent Element
PISMA	Pipeline Intake and Sediment Management Area
Project	Leavenworth National Fish Hatchery (LNFH) Surface Water Intake Fish Screens and Fish Passage (SWISP) Project
RM	rivermile
RPM	Reasonable and Prudent Measures

ACRONYMS AND ABBREVIATIONS

SAT	Scientific Advisory Team
SPCC	Spill Prevention, Control and Countermeasures
TMDL	Total Maximum Daily Load
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WSDOT	Washington State Department of Transportation

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1 INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) based on our review of the proposed Leavenworth National Fish Hatchery (LNFH) Surface Water Intake Fish Screens and Fish Passage (SWISP) Project located in Chelan County, Washington. The Opinion addresses effects to bull trout (*Salvelinus confluentus*) and critical habitat for the bull trout, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). Your October 15, 2020, request for formal consultation was received on October 16, 2020.

This Opinion is based on information provided in the October 15, 2020, Biological Assessment (BA), the November 24, 2020, email addressing project elements absent from the BA, the February 2021 administrative Final Environmental Impact Statement (FEIS), telephone conversations, field investigations, and other sources of information as detailed below. A complete record of this consultation is on file at the USFWS' Central Washington Field Office in Wenatchee, Washington.

2 CONSULTATION HISTORY

The following is a summary of important events associated with this consultation:

October 23, 2019: 30 percent Design, Permitting, and Endangered Species Act Meeting. Attended by staff from U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), Yakama Nation, Confederated Tribes of the Colville Reservation, National Marine Fisheries Service (NMFS), Washington State Department of Natural Resources (WDNR), U.S. Army Corps of Engineers (USACE), Washing State Department of Ecology (WDOE), Washington Department of Fish and Wildlife (WDFW), and Chelan County.

February 19, 2020: 60 percent Design, Permitting and Endangered Species Act Meeting. Same attendees.

March 11, 2020: On-site permitting and Endangered Species act meeting. Attended by USBR, USFWS, USACE, WDFW, and EMPSi consultants.

April 14, 2020: Phone call with LNFH staff discussing proposals that provide for bull trout passage around cofferdam installations.

May 5, 2020: 90 percent Design, Permitting and Endangered Species Act Meeting. Attended by USBR, USFWS, Yakama Nation, Confederated Tribes of the Colville Reservation, NMFS, USACE, WDOE, WDFW, WDNR, and Chelan County.

May 21, 2020: Focused call between USBR project designers and hydrology staff, WDFW, NMFS, and USFWS to resolve 90 percent design issues for fish passage, specifically depth and velocity criteria.

June 11, 2020: Focused call between USBR and USFWS on criteria for fish passage around cofferdams.

August 17, 2020: USBR, USFWS, and EMPSi consultants meet to discuss BA outline.

September 28, 2020: USFWS reviews Draft BA.

October 2, 2020: USBR, USFWS, and EMPSi meet to discuss BA revisions.

October 7, 2020: Meeting with USBR, LNFH, and USFWS to discuss maintenance and operations of the new proposed SWISP Project facilities. USBR is the action agency for construction, and LNFH is the action agency for operations and maintenance, thus all parties agreed that the SWISP project would not include operations and maintenance of the new facilities in this consultation. USFWS will include operations and maintenance of the new SWISP components in the LNFH Operations and Maintenance consultation that is currently in progress.

October 15, 2020: The BA and request for consultation was received by USFWS.

November 13, 2020: Informal consultation was completed, and formal consultation was initiated.

November 24, 2020: USFWS received additional information necessary to complete consultation from EMPSi.

February 10, 2021: USBR, USFWS, and EMPSi meet to review draft Opinion. USBR and EMPSi shared updates to Project specifications developed, and data analysis completed since the Final BA and request for formal consultation were submitted. These updates are included in this final Opinion.

3 BIOLOGICAL OPINION

4 DESCRIPTION OF THE PROPOSED ACTION

A federal action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas (50 CFR 402.02).

The U.S. Bureau of Reclamation (USBR) is proposing to rehabilitate, replace, and modernize the Leavenworth National Fish Hatchery (LNFH) surface water intake and delivery system on Icicle Creek near Leavenworth, Washington. USBR proposes building new headworks, installing NMFS-compliant fish screens, constructing a creek-width roughened channel, and replacing and lining the surface water conveyance pipeline to the LNFH. The project description provided here is an abbreviated summary. For a more detailed description of the proposed action, refer to the Project BA.

The LNFH was designed and constructed in the late 1930s as mitigation for the construction and operation of Grand Coulee Dam, and is owned and operated by the US Fish and Wildlife Service (USFWS) and funded by USBR and Bonneville Power Administration. LNFH raises and releases 1.2 million Spring Chinook Salmon (*Oncorhynchus tshawytscha*) smolts annually into Icicle Creek. The LNFH's primary point of diversion and water delivery system on Icicle Creek is nearly 80 years old and is reaching or exceeding its operational life. Further, at this time the intake facility does not comply with current National Marine Fisheries Service (NMFS) criteria for anadromous salmonids (NMFS 2011). The NMFS Biological Opinion (Opinion) for LNFH operations (NMFS 2017; consultation WCR-2017-7345) requires the LNFH to have a surface water intake and delivery system that complies with NMFS current screening and fish passage criteria for anadromous fish passage facilities in place and operating by May 2023.

Construction of the SWISP Project will occur in three phases and includes both upland and in-water components. Phase I includes construction of the intake access road and rehabilitation of the intake structures and facilities (e.g., fish screens and fish passage). Phase I includes all proposed in-water work and will be conducted over two years including two in-water work periods between July 1 and November 15 in 2022 and 2023. Phase I construction activities could occur up to 24 hours per day and up to 7 days per week. Phase II includes replacement and lining of the conveyance pipeline in the upland environment. Sections of the nearly one mile pipeline will be repaired over a period of three years (2022, 2023, and 2024), and there will likely be temporary overlap between parts of Phase I and Phase II construction. For instance, in July 2022 it is likely that construction of the proposed intake facilities may overlap with pipeline replacement on the LNFH grounds. Phase III includes revegetation of upland and riparian areas that are proposed to be disturbed during earlier phases of construction, portions of which may occur in the fall of 2023 and to be completed in the fall of 2024. All Project components of the SWISP intake and water conveyance conclude at the control valve system; the sand settling basin and inside and outside screen chambers will remain unaltered.

Based on the characterization of the Project presented in the BA, the USFWS analyzed this Project in terms of seven Project Elements (PEs) described below. Staging and construction elements (i.e. PEs 1, 3, 4, 5, and 6) are depicted in Figure 1.

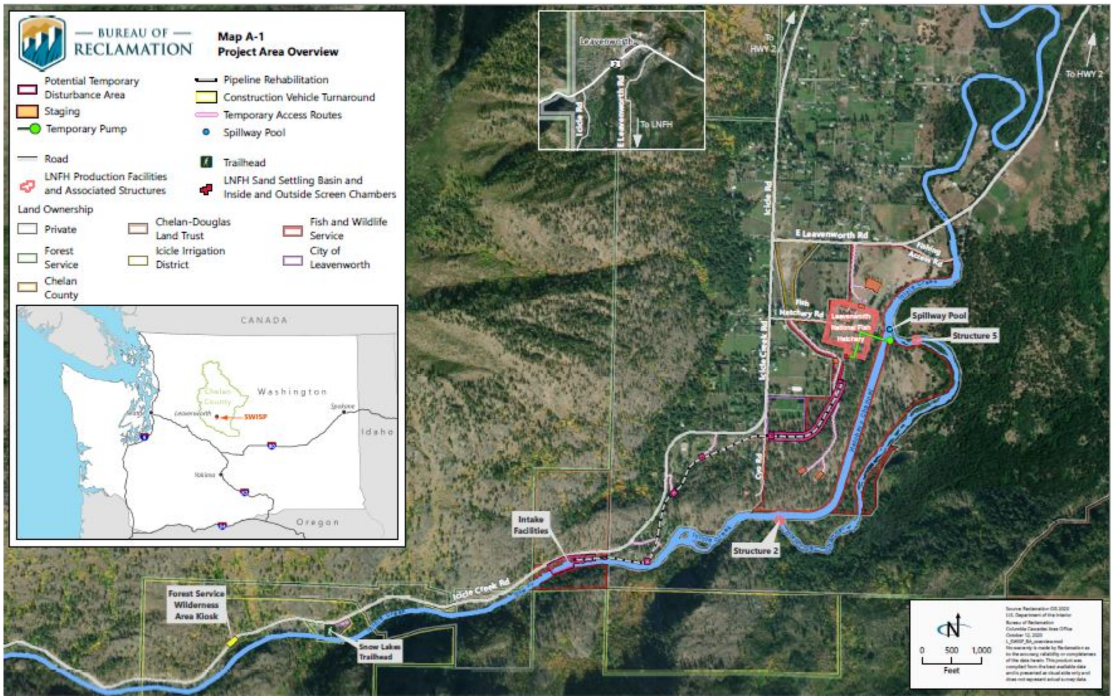

Figure 1. Map display of LNFH SWISP project activities
Source: Project BA (Appendix A)

PE 1 – Access and Staging: Staging and storage sites for construction equipment and materials, and construction staff administration and vehicle parking will be located at various locations on LNFH grounds. Trucks hauling construction equipment and containing construction materials will utilize a turn-around approximately 1.25 miles above the intake access road, at the Forest Service and Alpine Lakes Wilderness Area kiosks on Icicle Creek Road. Construction access to the conveyance pipeline will use existing roads, temporary access routes, and the pipeline right-of-way.

PE 2 – In-water work isolation and fish salvage: This PE is associated with in-water construction activities described in PE 3 and PE 4. Cofferdams will be installed to isolate the work areas from Icicle Creek streamflow. Cofferdam installations will be phased over two years per the schedule of construction activities described in PE 3 and PE 4; a conceptual drawing of cofferdam locations associated with the phased construction (Figure 2) and Table 1 describes the duration, area of impact, and purpose for each cofferdam. In Figure 2, Cofferdam Phase 1 is the same as cofferdam A in this Opinion, Cofferdam Phase 2 is cofferdam B, and Cofferdam Phase 3 is cofferdam C.

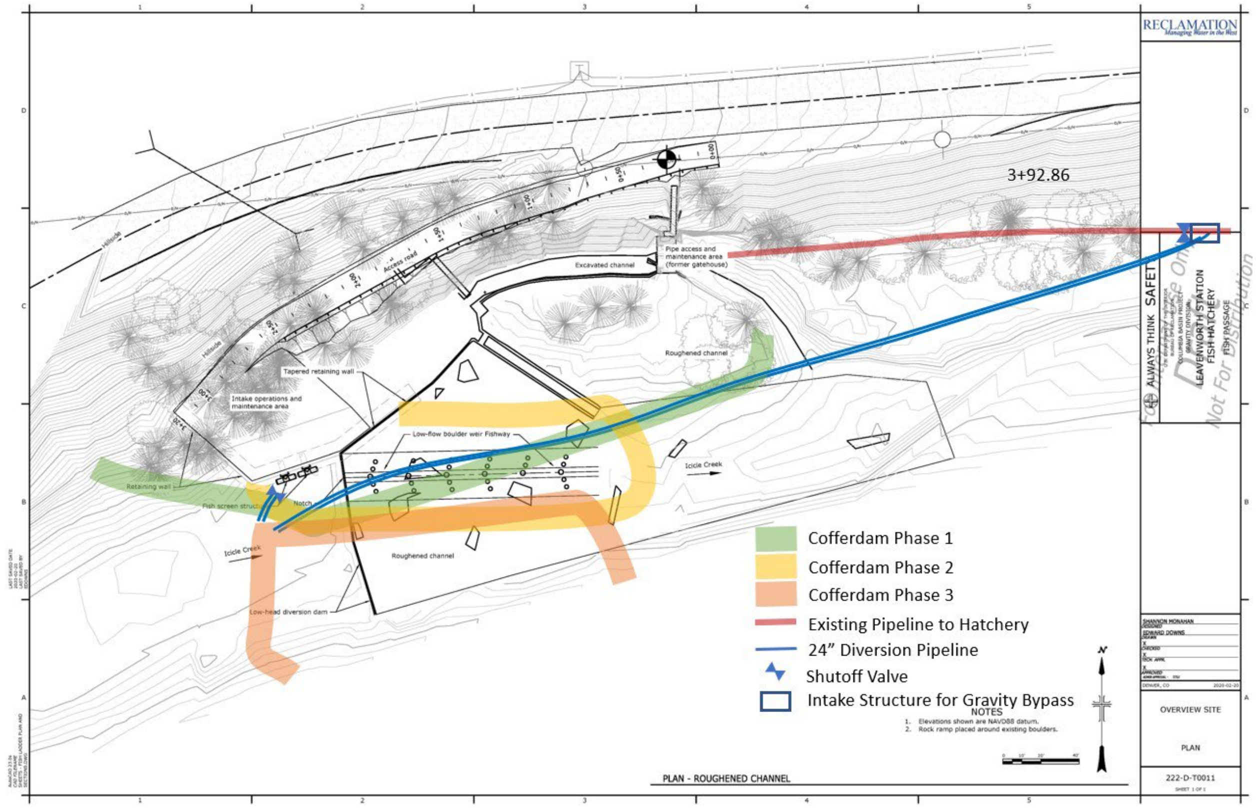

Figure 2. Temporary cofferdam locations
Source: USBR (Project BA, page 10)

Cofferdams will be approximately 12 feet wide at the base with a rising tapered width to approximately nine feet. Cofferdam configurations and height were modeled for a July through October construction timeframe; hydraulic modeling informed the height requirements to prevent overtopping and identified high velocity areas that may require additional stabilization to prevent breaching failure from lateral erosion. Temporary cofferdams will likely consist of geo-bags filled with clean, round river rock ("stream mix") stacked side-by side and one atop another to achieve the necessary dimensions. Once placed, the cofferdams will be wrapped with visqueen, or a similar material, eliminating interstitial spaces between the geo-bags to prevent impingement or entrapment of fish and reduce or prevent leakage. Due to the uneven, rocky nature of the Icicle Creek streambed, an excavator working from adjacent uplands (or for cofferdam C, within the dewatered work area of cofferdam B) will be used to level the streambed in the cofferdam footprint area. Large rocks may need to be fractured with a jackhammer; if this is necessary, the jackhammer will be used in the dewatered cofferdam area after the cofferdam is installed. Some of the streambed materials removed will be hauled to a staging area (Figure 1) and stockpiled for later use in construction of the roughened channel (PE 4), and material that cannot be reused will be removed and properly disposed of in a landfill. Once the streambed is prepared, cofferdam geo-bags will be placed by a crane or excavator operating from adjacent uplands (or from within a dewatered work area). There will be no wet crossings or heavy equipment use in live water during construction and removal of cofferdams, and fish passage will be maintained at all times (i.e., project design calls for maintaining the greatest width while maintaining a minimum depth of 0.8 feet in Icicle Creek for fish passage). Construction of, removal of, and access to and from the cofferdam C area may be done by a number of methods. For example, the construction contractor may use a long-reach excavator or crane to place the cofferdam from the intake headworks (PE 3) built during the 2022 in-water work window, or an excavator or crane working in the dewatered area behind cofferdam B may place cofferdam C. A temporary steel or wooden beam bridge constructed between the intake headworks and the cofferdam area may also provide access to cofferdam C. During cofferdam removal, the contractor may shift the cofferdam footprint incrementally, essentially creating a dewatered egress route.

Once cofferdams are installed, the USFWS Mid-Columbia Fish & Wildlife Conservation Office (MCFWCO) will salvage fish within the cofferdams following the protocols in Appendix C (USFWS 2012). Fish salvage will continue as the work area behind the cofferdams are dewatered using one or more sump pumps. Dewatering will also adhere to protocols in Appendix C. Pumps used to temporarily bypass water or to dewater work areas will be screened to prevent aquatic life from entering the pump intake. Fish screens or guards will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS and USFWS.

Table 1. Temporary cofferdam phasing and details

Cofferdam	Duration Installed	Approximate Dewatered Area	Purpose
A	Early July to mid-November 2022	0.4 acres	Partial demolition of low-head diversion dam, demolition of fish ladder/sediment sluice, construction and installation of headworks
B	Early July to late August 2023	0.3	Construction and installation of north half of roughened channel and low flow boulder weir fishway, fracture and removal of boulder, preparation of cofferdam C area
C	Late August to early October 2023	0.3	Construction and installation of south half of roughened channel
PISMA sluiceway work area isolation	Late July to mid-August 2022	0.1	Construction of the PISMA sluiceway, if necessary (e.g., this area is typically dry during the proposed work period).

Source: USBR (Project BA, page 11)

A fourth cofferdam may be necessary to isolate the work area of the sluiceway pipe installation associated with the PISMA. This will be a minimal cofferdam system, and constructed by hand with straw bales and visqueen (or similar methods).

Reintroduction of Icicle Creek flows to the previously dewatered work area will occur gradually to minimize the intensity of sediment mobilization and resultant turbidity downstream of construction. During cofferdam removal, turbidity monitoring will occur, and in-water construction will temporarily cease if turbidity levels are greater than expected.

PE 3 – Intake Facility Construction: This PE includes construction of the new intake facility comprised of the headworks (i.e., two self-cleaning rotary fish screens, retaining wall, and section of pipeline), intake operations and maintenance area (IO&MA), and a pipeline intake and sediment management area (PISMA) (Figure 3). These facilities are located within the footprint of the existing conveyance channel, fish ladder/sediment sluice, and gatehouse, and will convey LNFH's water supply from the existing diversion dam to the buried pipeline at the gatehouse. To facilitate construction of the headworks and PISMA, a portion of the existing low-head diversion dam will be removed, and the fish ladder/sediment sluice and gatehouse will be removed.

The headworks is a concrete structure that houses two self-cleaning cylindrical fish screens, conveyance pipeline and the IO&MA. The existing intake channel will be filled to cover a new section of pipeline connecting the headworks to the existing conveyance pipeline at the previous gatehouse location, and to create the IO&MA. Concrete surfaced areas will be limited to the IO&MA pad and the intake structure perimeter, adjacent to Icicle Creek. The remaining surfaces will be natural or gravel covered. The proposed dimension of the headworks is approximately 50 feet wide, by 165 feet long, by 20 feet high. Fill for the headworks consists of approximately 1,733 cubic yards (cy) of earthen material and 410 cy of reinforced concrete. Approximately 0.15 acres of Icicle Creek will be permanently lost due to construction of the proposed intake facilities.

The fish screens will be oriented parallel to Icicle Creek stream flow and installed at the point of diversion to provide NMFS-compliant fish screening (e.g. approach velocities and sweeping velocities). Mechanics to raise and lower the screens will be located on the working deck of the IO&MA. A vertical access pipe, located behind the fish screens, will be incorporated into the IO&MA to provide for future sediment management[1].

The PISMA will replace the existing gatehouse and is comprised of a series of pipes and valves to control the gravity fed water to LNFH, and to flush sediment through the intake pipeline back to Icicle Creek. A 24-inch diameter sluiceway pipe will extend approximately 30 feet from the PISMA into the outlet channel. The sluiceway pipe will be on grade with the outlet channel and discharge within the ordinary high water mark (OHWM) of Icicle Creek (i.e., during OHWM stage, Icicle Creek flows encompass the outlet channel). Demolition of the existing gatehouse and construction of the PISMA will mostly be contained within the existing gatehouse footprint, approximately 20 feet from the Icicle Creek ordinary high water mark, and outside of the 100-year floodplain.

Mobilization and site preparation will begin in March of 2022, and will be completed outside of and up to the OHWM of Icicle Creek. Site preparation includes installation of erosion control measures (see Appendix D in the Project BA), clearing and grubbing approximately 0.89 acres in the construction area, and grading and constructing the intake access road. A crane will unload construction materials from delivery trucks and move them to required construction areas. Access to the existing gatehouse/proposed PISMA location will also be graded.

[1] The Proposed Action includes construction of the SWISP Project only. It does not include associated operations and maintenance (O&M), such as sediment management or management of the proposed fish screens during icing conditions. O&M activities will be covered in a separate ESA Section 7 consultation.

Demolition will begin in late July 2022 and last approximately one month; formwork, reinforcing, and pouring concrete for the headworks and retaining walls will begin in August 2022 and last approximately two months. Concrete will cure for a minimum of four days, and screens will be installed in late October to early November 2022. An excavator will lift the screens into place from the working deck and will not require equipment in the water.

Most demolition activities will use 30-pound pneumatic tools (i.e., jackhammers). However, other tools may be approved by the Contracting Officer Representative (COR) for precise, partial demolition of the diversion dam (i.e., so as not to compromise the integrity of the dam). Jackhammers would likely be an attachment to the excavator, but, for smaller rocks, a hand-held jackhammer could be used. Demolition will be done from outside of the Icicle Creek ordinary high water mark, or in dewatered work areas, behind a temporary cofferdam. Demolished materials will be removed to an upland location for disposal in a landfill.

Construction may occur up to 24 hours per day. Diesel generators will power construction lighting for nighttime construction. Diesel generators will be located outside of Icicle Creek. In most cases, the generators will be located at least 50 feet away from the creek, and refill diesel will be at least 250 feet away. Generators placed in a secondary containment may be located closer to the creek. Water quality protection BMPs (see Section 4.1 Conservation Measures) will ensure fuels from generators do not enter Icicle Creek.

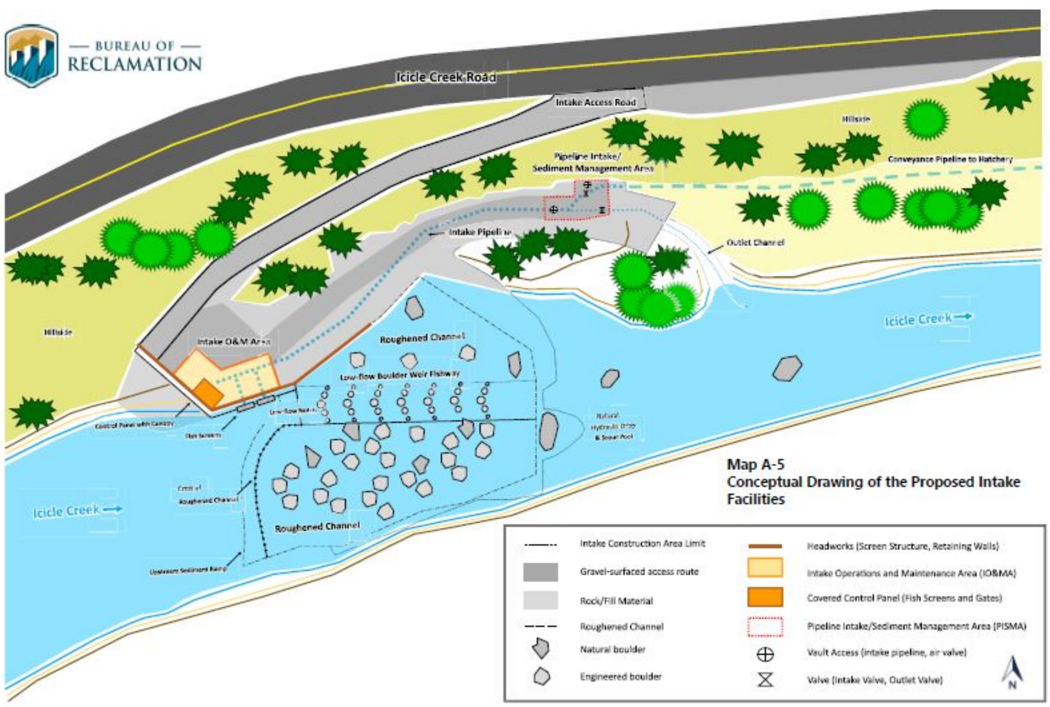

Figure 3. Conceptual drawing of proposed intake facilities and roughened channel/low-flow boulder weir fish passage improvements
Source: USBR (Appendix A Project BA)

PE 4 – Fish Passage Improvements: This PE includes construction of a creek-wide roughened channel and low-flow boulder weir fishway in 2023. Construction will begin with installation of cofferdam B (see PE 2) to construct the low-flow boulder fish weir and northern half of the roughened channel (late July to late August), followed by installation of cofferdam C to construct the southern half of the roughened channel (early September to late October). The roughened channel will be constructed over the existing low-head diversion dam with the low-flow boulder weir fishway incorporated into the roughened channel on the downstream left side of Icicle Creek to provide fish passage during typical low flows and the needed sweeping velocities in front of the fish screens (see PE 3 and Figure 3).

The low-flow boulder weir fishway will consist of a riprap rock-armored, concrete-grouted channel with chevron-shaped boulder weirs. Thirty-five cy of boulders will be placed by an excavator working from within the cofferdam B dewatered work area, or from the working deck of the intake headworks. The proposed dimensions of the low-flow boulder weir fishway are approximately 195 feet long by 20 feet wide. The boulder weirs will provide drops of 0.9 feet across each weir at the design flow. The boulder sizes vary up the cross-sectional slope of the fishway; the center, anchor boulder of each weir, at channel invert, is the largest. During construction, the anchor boulder will be used to fine tune the depth of the pool at the design flow. Concrete grouting of the boulders will be necessary to prevent movements with higher flows up to the 100-year discharge. Grouting will be placed using a concrete pumping truck from the shoreline or working deck of the intake headworks. A large boulder within cofferdam B will be fractured and removed from Icicle Creek, using a 30-pound jackhammer as described for demolition activities under PE 3.

The 195-foot long creek-width roughened channel (approximately 19,760 square feet) will be constructed with riprap rock and extend upstream of the existing diversion dam. Upstream of the dam, the roughened channel will slope in a 2:1 horizontal: vertical ramp to help mobilize sediment over the feature. The rock "cap" will increase the dam elevation slightly compared with the existing low-head diversion dam elevation and will be placed irregularly across the new crest to look more natural. Most boulders in the roughened channel will be loosely placed (i.e. not grouted with concrete). However, the crest of the roughened channel (i.e., the dam crest) will be grouted with concrete to help withstand high flows and anchor the larger rocks in place as well as to add smaller rocks on top of the larger rock to fill interstitial spaces and cover exposed concrete. Construction will be accomplished using excavators and front-end loaders, which will dump rock within the confines of the cofferdam B and C dewatered work areas. Suitable boulders removed from Icicle Creek during cofferdam installation and construction of the intake facilities will be reused for construction of the roughened channel. The northern half of the creek-width roughened channel will be constructed behind cofferdam B, and the southern half will be constructed behind cofferdam C. Cofferdams B and C will be removed no later than November 15, 2023. Rewatering work areas will follow the same procedures described for rewatering the cofferdam A work area, above.

Approximate 290 cubic yards of concrete will be used for construction of both the low-flow boulder weir fishway and the roughened channel. All concrete will be cured for a minimum of four days before reintroducing Icicle Creek streamflows to the work area.

As described under PE 3, construction could occur up to 24 hours per day and nighttime construction is expected requiring diesel generators to power construction lighting. Water quality protection BMPs (Section 4.1) will ensure fuels from generators do not enter Icicle Creek.

PE 5 – Temporary Water Supply for LNFH: During construction of the intake facilities (PE 3), a temporary water supply (40 cfs) for LNFH will primarily be supplied by a gravity-fed diversion. The 24-inch gravity bypass pipeline will divert water from Icicle Creek, and deliver it to the existing conveyance pipeline at a point approximately 300 feet below the existing gatehouse. The bypass pipeline intake will be placed in Icicle Creek, just upstream of the existing low-head diversion dam. It will be a rigid pipe weighted to keep it in place during variable flows, likely through attachment to ecology blocks or geo-bags. The gravity bypass pipeline will run from that point to the gravity bypass outlet on the exiting conveyance pipeline. The intake of the bypass pipeline will have a trashrack to prevent large debris from entering it, but it will not be screened. The bypass pipeline will be placed in Icicle Creek in mid-July 2022. After this time, there will be an approximate one-week period where diversion from the existing intake facilities are ceased, and pumping from the spillway pool (see Figure 1) will be used to supply the temporary Hatchery water supply of 40 cfs. This will be necessary as the bypass pipeline is connected to the existing conveyance pipeline. Two diesel-powered pumps, located outside of the OHWM of Icicle Creek at the spillway pool will be used to supply temporary water. At the end of this one-week period, in late July, the gravity bypass pipeline would be operational and supplying the temporary water supply of 40 cfs through early November 2022. A similar one-week switch to pumping from the spillway pool will occur while the bypass pipeline/conveyance pipeline connection point is removed, and flow is initiated through the newly installed intake structure and fish screens. At this point, the gravity bypass intake and pipeline will be removed.

A 20-cfs water supply to the LNFH will be maintained during replacement/relining of the conveyance pipeline (PE 6) between April 17 and May 20 in 2022, 2023, and 2024. This will be needed when lining the conveyance pipeline with CIPP, and pipeline interconnections are underway. This will be through pumping from the spillway pool as needed.

Pumps will be screened to prevent aquatic life from entering the intake, and screens will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS (Section 4.1), and diesel-powered pumps will be outside of the Icicle Creek OHWM and water quality BMPs will prevent fuels from entering Icicle Creek.

PE 6 – Conveyance Pipeline Construction: This PE includes replacement and lining of the existing water conveyance pipeline from the intake to the LNFH grounds. All construction will be in uplands, although in two locations, construction will be in close proximity to Icicle Creek (i.e., at the PISMA and at the Icicle RV Park).

The conveyance pipeline will be replaced using cut and cover trenching on USFWS property at the LNFH grounds and lined with cure-in-place pipe (CIPP) on USFWS property at the surface water intake and on private parcels. Construction of several temporary access points (contractor use areas [CUAs]) along the existing conveyance pipeline alignment will provide ingress and egress for pipe lining on private lands. These areas will be restored to preconstruction conditions following lining activities.

Approximately, 1,660 feet of the existing conveyance pipeline on the Hatchery grounds will be replaced. Construction, including mobilization, site preparation, pipeline replacement, site rehabilitation, and demobilization, will occur between May 2022 and April 2023. Site preparation will begin with installation of erosion control measures such as silt fencing (see Section 4.1 Conservation Measures) at the boundary of the construction area, and clearing and grubbing within the construction area. A new trench will be excavated using an excavator or backhoe parallel to the existing pipeline, and the new pipeline will be placed in this. The new pipeline will terminate at a new control valve vault at the sand settling basin. After control valve connections are made, the existing pipeline will be decommissioned and abandoned in place.

The remaining pipeline will be repaired with cure in place piping (CIPP). Access to work areas (Contractor Use Areas or CUAs) will be on existing paved and dirt access roads on private parcels, on which federal rights-of-way exist. No improvements are needed to existing roads and access routes. Several CUAs will be graded along the existing conveyance pipeline alignment to provide a construction area for pipe lining with CIPP on private parcels. Site preparation will occur at each CUA as described above. A small excavator or backhoe will be used to excavate down to the conveyance pipeline. A short section of the existing pipeline will then be cut using a concrete saw, and removed. This will provide access for lining with CIPP. Hot air blowers will completely dry out the existing pipeline prior to lining with CIPP. The CIPP lining is contained within a box truck. The lining material is an inert fiberglass cloth, impregnated with a styrene-free resin or epoxy. The flexible, uncured CIPP lining is inverted into the existing pipeline using cold water pressure, and filled with cold water to ensure it conforms to the inside dimensions of the existing pipeline. This process utilizes a water tank trunk to form a closed loop; after filling the pipe, the water is pumped from the pipe into the tank truck and hauled from the site for appropriate treatment and disposal. No water will be withdrawn or discharged on site or into Icicle Creek. Hot water is also pumped into the CIPP lining to cure the resin or epoxy. A catalyst may also be used during curing, at the discretion of the contractor. Water for this would be heated in a truck-mounted boiler and would be introduced and recirculated in the pipe using a truck-mounted recirculating system. Depending on the type of resin or epoxy used, the water may be clean or it may contain chemicals from the curing process. Project specifications require USBR approval of contractor selected resins/epoxies to ensure they are “fish friendly”. After curing the CIPP lining, hot water would be removed from the pipe and hauled from the site as above, for appropriate treatment/disposal.

Lining the conveyance pipeline with CIPP will occur between April and May in 2023 and 2024. Following lining activities, each CUA will be restored to preconstruction conditions. Disturbed areas on private land will be seeded with a seed mix and method determined by the property owners.

Preparations for replacement and lining, such as mobilization, site preparation, and excavating the existing pipeline, will likely begin several weeks to a month before the date ranges given above. Similarly, demobilization and site restoration will extend for several weeks to a month beyond these date ranges.

PE 7 – Construction Site Revegetation: Following construction of PE 3, disturbed areas that do not have a surface treatment (e.g., gravel) will be hydro seeded with an upland or riparian herbaceous seed mix, as appropriate. Seed mixes are described in Appendix C of the Project BA. Additional seeding and planting of riparian tree cuttings in the Icicle Creek riparian zone and planting containerized upland shrubs and trees in uplands within the intake construction area will occur after construction of the low-flow boulder weir fishway and roughened channel (PE 4) is complete in November 2023, or in fall 2024.

Of the approximately 0.89 acres of surface disturbance proposed under PE 3 and PE 4, the area to be revegetated is approximately 0.71 acres, most of which are uplands. Riparian tree cuttings will be planted along approximately 200 linear feet of the Icicle Creek streambanks in the intake construction area. The planting palette and methods are described in Appendix C of the Project BA.

4.1 Conservation Measures

When used in the context of the Act, conservation measures are actions that are included by the Federal agency as an integral part of the proposed action. Because conservation measures are pledged in the Project description by the action agency, their implementation is required under the terms of the consultation (USDI and USDC 1998, page 4-19). These include design specifications and Best Management Practices (BMPs) during construction that minimize the effects of the project on bull trout and their habitat. These measures are detailed in Appendix B of the FEIS and are incorporated here by reference.

1. Storage and Staging

    a. When not in use, vehicles and equipment containing oil, fuel, and/or chemicals will be stored in a staging area located at least 150 feet from wetlands and waterbodies. If possible, staging will be located at least 300 feet away from wetlands and waterbodies, and on impervious surfaces to prevent spills from reaching ground water. If moving equipment between the staging area and the worksite would create unacceptable levels of disturbance (for example, requiring multiple stream crossings, multiple passes over sensitive vegetation), a closer staging location with an adequate spill prevention plan may be proposed.

    b. Equipment will not be stored overnight in the instream channel.

    c. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff or can in any way encroach upon the watercourse.

d. Place oil or other petroleum product storage tanks at least 20 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source.

2. Erosion and Spill Prevention and Control

   a. A Temporary Erosion and Sediment Control plan and a Spill Prevention Control and Containment plan, commensurate with the size of the project, must be prepared and carried out to prevent pollution caused by surveying or construction operations.

   b. A Spill Prevention, Control, and Clean-Up plan will be prepared prior to construction. Spills or leaks will be cleaned up in a manner that complies with applicable Federal, State, and local laws and regulations.

   c. A supply of emergency erosion control materials will be on hand and temporary erosion controls will be installed and maintained in place until site restoration is complete.

   d. Establish methods for controlling sediment and erosion which address vegetative practices, structural control, silt fences, straw dikes, sediment controls, and operator controls as appropriate, and maintain in working order for the duration of the project.

   e. Divert stormwater runoff from upslope areas away from disturbed areas.

   f. Measures shall be taken to ensure that no petroleum products, hydraulic fluid, fresh cement, sediments, sediment-laden water, chemicals, or any other toxic or deleterious materials are allowed to enter or leach into waters.

   g. Wastewater from project activities and water removed from within the work area shall be routed to an upland disposal site (landward of the OHWM) to allow removal of fine sediment and other contaminants prior to being discharged to the waters.

   h. All waste material such as construction debris, silt, excess dirt or overburden resulting from this project will be deposited above the limits of flood water in an upland disposal site.

3. Dewatering/In-water work

   a. When dewatering the proposed in-water work areas, the construction contractor will adhere to the USFWS (2012) Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards for bull trout (Appendix C). All fish salvage activities will be conducted by the USFWS Mid-Columbia Fish & Wildlife Conservation Office. Should a dewatered work area become inundated during the course of construction activities, dewatering activities will take place again, following the same protocols as initial dewatering activities.

b. Pumps used to temporarily bypass water or to dewater work areas will be screened to prevent aquatic life from entering the intake. Fish screens or guards will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS.

c. During cofferdam installation and removal, no wet crossings or heavy equipment use will occur in Icicle Creek live water. Use of a long-reach excavator or crane will be used for constructing and removing the cofferdams, either from outside of the Icicle Creek ordinary high water mark, or from within a temporarily dewatered work area isolated from Icicle Creek by another cofferdam. Machinery and equipment will be removed from the dewatered work areas when not in active use, and during higher-flow conditions.

d. If supersacks are used for the temporary cofferdams or gravity bypass pipeline supports, the fill material must be clean, round river rock ("stream mix").

e. Turbidity monitoring will occur when turbidity-generating construction takes place (for example, installation of cofferdams and reintroducing water to dewatered work areas). The construction contractor will measure the duration and extent of the turbidity plume (visible turbidity above background) generated by turbidity-generating construction. Turbidity measurements will be taken in nephelometric turbidity units (NTUs), and data will be submitted to the USFWS following project construction. In accordance with Washington Administrative Code (WAC) 173-201A- 200(1)(e) - Aquatic life turbidity criteria, for the salmonid rearing and migration category, maximum allowable turbidity levels shall not exceed 10 NTU over background when the background is 50 NTU or less; or 20 percent increase in turbidity when the background turbidity is more than 50 NTU. The turbidity criteria established under WAC 173-201A-200(1)(e) shall be modified, without specific written authorization from the Washington State Department of Ecology, to allow a temporary area of mixing during and immediately after necessary in-water construction activities that result in the disturbance of in-place sediments. This temporary area of mixing is subject to the constraints of WAC 173-201A-400(4) and (6). It can occur only after the activity has received all other necessary local and state permits and approvals, and after the implementation of appropriate BMPs to avoid or minimize disturbance of in-place sediments and exceedances of the turbidity criteria. A temporary area of mixing shall be as follows:

   i. For waters up to 10 cfs flow at the time of construction, the point of compliance shall be 100 feet downstream from the activity causing the turbidity exceedance.

ii. For waters above 10 cfs up to 100 cfs flow at the time of construction, the point of compliance shall be 200 feet downstream of the activity causing the turbidity exceedance.

iii. For waters above 100 cfs flow at the time of construction, the point of compliance shall be 300 feet downstream of the activity causing the turbidity exceedance.

f. Should observed turbidity exceed allowable levels at the point of compliance, in-water construction will temporarily stop until turbidity has cleared. In-water construction could then recommence at a slower rate to minimize generated turbidity. Monitoring and additional temporary work stoppages would occur as needed in accordance with the conservation measure.

g. Project operations will cease under high flow conditions that could inundate the project area, except as necessary to avoid or minimize resource damage.

h. Contractor must develop a cofferdam monitoring plan that monitors weather and creek flow before pouring concrete and during the four-day curing period.

i. Re-watering of the construction site will occur at a rate that minimizes loss of surface water downstream as the construction site streambed absorbs water.

j. To the extent feasible, work requiring use of heavy equipment will be completed by working from the top of the bank (i.e. landward of the OHWM).

k. When conducting in-water or bank work, machine hydraulic lines will be filled with vegetable oil for the duration of the Project to minimize impacts of potential spills and leaks

l. Equipment shall be checked daily for leaks and any necessary repairs shall be completed prior to commencing work activities around the water.

4. Fisheries and Aquatic Life

a. Instream work is limited to July 1 to November 15.

b. A minimum depth of 0.8 feet shall be maintained within the greatest amount of the natural stream channel width at all times with placement of cofferdams to facilitate fish passage. Fish passage criteria in Icicle Creek Fish Passage Evaluation for the Leavenworth National Fish Hatchery (Anglin et al. 2013, p. 26-28) should be consulted for minimum depth and maximum velocity criteria. The maximum velocity criteria on pages 26-28 are conservative, but attempts should be made to provide fish passage to the greatest extent practical across the natural stream channel width and hydrograph.

c. Work site dewatering will follow the Dewatering and Fish Capture Protocol (Appendix D of NMFS and USFWS 2008). Fish removal from dewatered work sites would be overseen by a fisheries biologist. Electrofishing for fish relocation/work area isolation must follow the most recent NMFS guidelines. Record all incidents of listed fish being observed, captured, handled, and released to USFWS, Central Washington Field Office.

d. Re-watering of the construction site occurs at such a rate as to minimize loss of surface water downstream as the construction site streambed absorbs water.

e. The design of passage structures will follow the appropriate design standards in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual.

f. Roughened channels will be designed to standards contained in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual.

g. Post-construction monitoring of the low-flow fishway will be done to ensure effectiveness.

h. Boulder weirs will be low in relation to channel dimensions so that they are completely overtopped during channel-forming, bankfull flow events. Boulder weirs will be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream.

i. Boulder weirs will be constructed to allow upstream and downstream passage of all native listed fish species and life stages that occur in the stream at all flows.

j. Boulder weirs shall be designed and inspected by a multidisciplinary team (including a salmon or trout biologist) that has experience with these types of structures.

k. Screens, including screens installed in temporary pump intakes, will be designed to meet standards in the most current version of the NMFS Anadromous Salmonid Passage Facility Design manual.

l. Do not use jackhammers in excess of 30 pounds without USBR approval. Blasting is not permitted. Pile driving is not permitted.

m. Provide complete technical information and material data sheets on all CIPP lining materials, components, resins, catalysts, and all other components used in the work. Include written confirmation that all products used in the work are "fish friendly", and do not contain chemicals known to be hazardous to fish or aquatic life.

n. Include a statement that any water used for the installation, curing and testing of the CIPP lining shall not be provided from Icicle Creek, nor shall it be returned to Icicle Creek, discharged on project lands, or released into the Leavenworth National Fish Hatchery. Include details on the source, transportation, handling, removal, and discharge of this water.

o. During construction of PE 3, while the temporary gravity bypass pipeline connected to the conveyance pipeline is in use, monitoring, capture, and release of all bull trout entrained through the bypass will occur in the sand settling basin as follows:

  i. Weekly monitoring for bull trout presence in the sand settling basin shall occur. Monitoring may consist of visual observation (to determine if fish are present and capture and release is required) as long as the entire sand settling basin can be viewed. If any bull trout are detected, they shall be promptly captured and released.

  ii. Any bull trout captured in the sand settling basin shall be released downstream of RM 4.5.

5. The construction contractor will provide worker environmental training for all project workers and staff to inform personnel of the regulatory compliance requirements and responsibilities for conserving environmental resources. This program would include, but not be limited to, special status species information and conservation, worker compliance responsibilities, noncompliance penalties, and BMPs and conservation measures such as project speed limits, weed control, avoidance of wildlife buffers, species reporting, debris control, and hazardous waste management.

4.2 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 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. The action area for this proposed federal action is based on the geographic extent of instream and stream adjacent disturbance.

The action area is the area within the ordinary high water mark of Icicle Creek, from 230 feet upstream of the surface water intake at rivermile (RM) 4.5, to the Washington Department of Ecology (WDOE) compliance monitoring location at RM 2.3, downstream of LNFH (see Figure 1.). This area is expected to encompass and buffer all near and instream-related disturbances (e.g., visual and audible) and water quality impairments that may be detectable.

The action area is used by bull trout as foraging, migrating and overwintering (FMO) habitat.

5 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

5.1 Jeopardy Determination

In accordance with regulation (see 84 FR 44976), the jeopardy determination in this Biological Opinion relies on the following four components:

1. The *Status of the Species*, which evaluates the species' range-wide condition relative to its reproduction, numbers, and distribution, the factors responsible for that condition, and its survival and recovery needs; and explains if the species' current range-wide population is likely to persist while retaining the potential for recovery or is not viable;

2. The *Environmental Baseline*, which evaluates the condition of the species in the action area relative to its reproduction, numbers, and distribution without the consequences of the proposed action, 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 evaluates all future consequences to the species that are reasonably certain to be caused by the proposed action, including the consequences of other activities that are caused by the proposed action, and how those impacts are likely to influence the conservation role of the action area for the species; and

4. *Cumulative Effects*, which evaluates the consequences of future, non-federal activities reasonably certain to occur in the action area on the species, and how those impacts are likely to influence the conservation role of the action area for the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the consequences of the proposed federal action in the context of the species' current range-wide 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 by reducing its reproduction, numbers, or distribution. The key to making this finding is clearly establishing the role of the action area in the conservation of the species as a whole, and how the effects of the proposed action, taken together with cumulative effects, are likely to alter that role and the continued existence (i.e., survival) of the species.

The *Recovery Plan for the Coterminous United States Population of Bull Trout* (USFWS 2015a) identified six recovery units throughout the bull trout's range. Pursuant to USFWS policy, when an action impairs or precludes the capacity of a recovery unit from providing both the survival and recovery function assigned to it, that action may represent jeopardy to the species. When using this type of analysis, the biological opinion describes how the action affects not only the recovery unit's capability, but also the relationship of the recovery unit to both the survival and recovery of the listed species, in terms of its numbers, reproduction, and distribution. The analysis in the following sections applies the above approach and considers the relationship of the action area to the recovery unit and the relationship of the recovery unit to both the survival and recovery of the bull trout as a whole, as the context for evaluating the significance of the effects of the Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

5.2 Adverse Modification Determination

A final rule revising the regulatory definition of "destruction or adverse modification" (DAM) of critical habitat (CH) was published on August 27, 2019 (84 FR 44976). The final rule became effective on October 28, 2019. The revised definition states:

> "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species."

In accordance with policy and regulation, the destruction or adverse modification determination in this Biological Opinion relies on the following components:

1. The *Status of Critical Habitat*, which describes the range-wide condition of the CH in terms of essential habitat features, primary constituent elements, or physical and biological features that provide for the conservation of the listed species, the factors responsible for that condition, and the intended value of the CH as a whole for the conservation/recovery of the listed species;

2. The *Environmental Baseline*, which refers to the current condition of CH in the action area absent the consequences to CH caused by the proposed action, the factors responsible for that condition, and the conservation value of CH in the action area for the conservation/recovery of the listed species;

3. The *Effects of the Action*, which represents all consequences to CH that are reasonably certain to be caused by the proposed action, including the consequences of other activities that are caused by the proposed action, and how those impacts are likely to influence the conservation value of the affected CH; and

4. *Cumulative Effects*, which represent the consequences to CH of future, non-federal activities that are reasonably certain to occur in the action area and how those impacts are likely to influence the conservation value of the affected CH.

For purposes of making the DAM determination, the USFWS evaluates if the consequences of the proposed federal action on CH, taken together with cumulative effects, when added to the current range-wide condition of CH, are likely to impair or preclude the capacity of CH as a whole to serve its intended function for the conservation of the listed species. The key to making this finding is clearly establishing the role of CH in the action area relative to the value of CH as a whole, and how the effects of the proposed action, taken together with cumulative effects, are likely to alter that role.

6 STATUS OF THE SPECIES: Bull Trout

The bull trout was listed as a threatened species in the coterminous United States in 1999. Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alteration (associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, and poor water quality), incidental angler harvest, entrainment, and introduced non-native species (64 FR 58910 [Nov. 1, 1999]). Since the listing of bull trout, there has been very little change in the general distribution of bull trout in the coterminous United States, and we are not aware that any known, occupied bull trout core areas have been extirpated (USFWS 2015b, p. iii). The 2015 recovery plan for bull trout identifies six recovery units of bull trout within the listed range of the species (USFWS 2015b, p. 34). Each of the six recovery units are further organized into multiple bull trout core areas, which are mapped as non-overlapping watershed-based polygons, and each core area includes one or more local populations. Within the coterminous United States, we currently recognize 109 currently occupied bull trout core areas, which comprise 600 or more local populations (USFWS 2015b, p. 34). Core areas are functionally similar to bull trout meta-populations, in that bull trout within a core area are much more likely to interact, both spatially and temporally, than are bull trout from separate core areas.

The Service has also identified a number of marine or main-stem riverine habitat areas outside of bull trout core areas that provide foraging, migration, and overwintering (FMO) habitat that may be shared by bull trout originating from multiple core areas. These shared FMO areas support the viability of bull trout populations by contributing to successful overwintering survival and dispersal among core areas (USFWS 2015b, p. 35).

For a detailed account of bull trout biology, life history, threats, demography, and conservation needs, refer to Appendix A: Status of the Species: Bull Trout

7 STATUS OF CRITICAL HABITAT: Bull Trout

Bull trout critical habitat was designated in the coterminous United States in 2010. 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. Overall bull trout abundance is "stable" range-wide (USFWS 2015b, p. iii). However, 81 core areas have 1,000 or fewer adults, with 24 core areas not having surveys conducted to determine adult abundance (USFWS 2008a, p. 22; USFWS 2015a, p. 2). In addition, 23 core areas have declining populations, with 66 core areas having insufficient information (USFWS 2008a, p. 22; USFWS 2015a, p. 2). These values reflect the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to the degraded primary constituent elements (PCEs) of critical habitat, those that appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows:

1. Fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p.7);

2. Degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; The Montana Bull Trout Scientific Group (MBTSG) 1998, pp. ii-v, 20-45);

3. The introduction and spread of nonnative fish species, particularly brook trout (*S. fontinalis*) and lake trout (*S. namaycush*), 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 Puget Sound and Olympic Peninsula geographic regions where anadromous bull trout occur, degradation of main-stem 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.

For a detailed account of the status of designated bull trout critical habitat, refer to Appendix B: Status of Designated Critical Habitat: Bull Trout.

8 ENVIRONMENTAL BASELINE: Bull Trout and Designated Bull Trout Critical Habitat

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Characterizing the environmental baseline for highly mobile species requires a multi-scale analysis that evaluates the condition of all areas used by the affected population. For bull trout, the USFWS primarily considers two different spatial scales: (1) the "core area" scale, which typically incorporates multiple watersheds occupied by separate, but potentially interacting, local populations of bull trout, and (2) the watershed or specific reaches in a watershed affected by the proposed project. The watershed or reach scale is used to characterize habitat conditions near the proposed action.

The action area for this project is located in the Icicle Creek fifth field hydrologic unit code (HUC) watershed within the Wenatchee core area of the Mid-Columbia Recovery Unit (RU) for the bull trout. For context, we first discuss the baseline condition of the bull trout within the Wenatchee core area, followed by a discussion of baseline habitat conditions in the Icicle Creek HUC.

Information for the core area scale is drawn from the Bull Trout Draft Recovery Plan (USFWS 2002a, USFWS 2002b), the Five Year Status Review for the Bull Trout (USFWS 2008), the final critical habitat rule (70 FR 63898) and its supporting justification document (https://www.fws.gov/pacific/bulltrout/crithab/Jusitfication%20Docs.html), the Final Bull Trout Recovery Plan (USFWS 2015a), and the Mid-Columbia Recovery Unit Implementation Plan for Bull Trout (USFWS 2015b).

Information for the Icicle Creek HUC is drawn primarily from our 2011 Opinion (USFWS Reference: 13260-2011-F-0048), the Project BA, ongoing monitoring (e.g., spawning surveys and LNFH operations compliance monitoring), and assessments completed by various entities.

8.1 Status of Bull Trout in the Wenatchee Core Area

Seven local populations of bull trout are distributed throughout the Wenatchee core area (Figure 4). Fluvial, adfluvial, and resident life history strategies are all present in this core area and the migratory form (i.e. fluvial and adfluvial) is present in every local population in this core area, thus representing one of the most diverse assemblages of local populations in the geographic area (USFWS 2015b, p. C-317, Barrows et al. 2016, p. 70). Adult and subadult bull trout move seasonally throughout the Wenatchee core area using the full length of the Wenatchee River and both natal and non-natal tributaries (Barrows et al. 2016, p. 70-71). Lake Wenatchee in the upper Wenatchee sub-basin provides high quality FMO habitat for the Chiwawa, Little Wenatchee, White, and Nason local populations of the bull trout (Kelly Ringel et al. 2014, entire). Local populations in the lower basin (Chiwaukum, Icicle, and Peshastin creeks) are less likely to use Lake Wenatchee. Bull trout from theses local populations show a preference for the mainstem Wenatchee and Columbia Rivers for FMO habitat, based on radio-telemetry studies (Kelly Ringel et al. 2014, entire).

An estimated small percentage (15 to 20 percent) of bull trout from most local populations in the Wenatchee core area migrate long distances and into other core areas (e.g., Methow, Entiat, Yakima) for foraging and overwintering and may migrate back to spawning areas annually, semi-annually, or every few years (USFWS 2015b, p. C-317). Most populations in the core area spawn in the general window of mid-September to mid-October (USFWS 2015b, p. C-317).

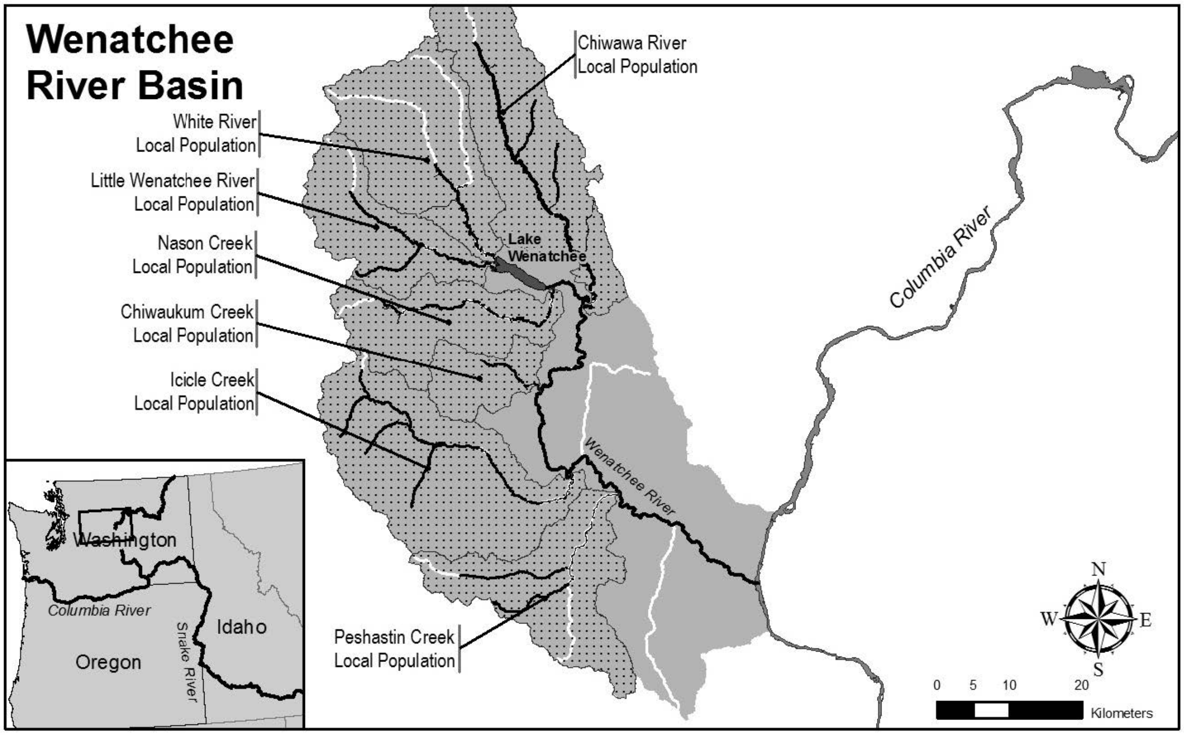

Figure 4. Map of bull trout local populations in the Wenatchee Core Area (Source: Barrows et al. 2016, page 72)

The Wenatchee core area population is stable with a "potential risk" for extirpation due to widespread low-severity threats (USFWS 2008, p. 35). The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity (i.e., trend in adult abundance), and 4) connectivity (USFWS 2004, p. 215).

8.1.1 Number and Distribution of Local Populations

Bull trout populations are found in seven of the nine major watersheds in the Wenatchee Core Area (not Chumstick or Mission Creeks) (Figure 4). As is the case in all bull trout core areas, the local populations in the Wenatchee Core Area are named after the waterway where spawning is centered, but bull trout from each local population likely use a variety of waterways within their core area, and some move among multiple core areas during their life cycle.

Multiple local populations distributed and interconnected within a core area provide a mechanism for spreading risk from stochastic events. Core areas with fewer than five connected local populations are at an increased risk of extinction, five to ten connected local populations are considered an intermediate risk, and core areas with greater than 10 interconnected local populations are at a diminished risk (USFWS 2002, pp. 50-51). In the Wenatchee core area there is good connectivity among most local populations (Kelly Ringel et al. 2014, entire), however the migratory (i.e., fluvial and adfluvial) life history is unevenly distributed in the core area, and low flow and physical barriers exist in Icicle Creek and Peshastin/Ingalls Creek for at least part of the year. Due to suppressed life history expression and connectivity issues among two of the seven local populations, the Wenatchee core area is an intermediate risk for local extirpations and extinction.

8.1.2 Adult Abundance

Information about population size comes primarily from redd surveys that have been conducted in selected areas of the Wenatchee River basin since 1988. In Table 2, we report the most complete record (2008-2019) for redd surveys in the Wenatchee core area. A bull trout generation is roughly 5 to 7 years and, therefore, a period of 12 years approximates roughly two bull trout generations. Although redd surveys are inconsistent throughout this period, we evaluate the mean redd count for each local population to assess adult abundance for each local population. Five of the seven local populations in the Wenatchee core area are small and decreasing, or stable at low abundances (i.e., less than 50 migratory redds, or approximately 100 individuals) including Peshastin, Icicle, Chiwaukum, Nason, and Little Wenatchee). Populations of this size have increased risk of inbreeding depression (USFWS 2002, p. 51).

Natural variability in fish populations can occur from year to year based on factors such as streamflow, weather patterns, and partial barriers (e.g., beaver dams, log jams) or complete barriers (e.g., dewatered reaches) that may redistribute spawning bull trout. Bull trout are particularly susceptible to these factors because they spawn in the late fall when spawning streams are typically at or near seasonal low flow volume (USFWS 2008, p. 24).

Table 2. Summary of redd counts in the Wenatchee Core Area 2008-2019.

Local Population	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Mean**
Icicle	8	3	2	4	2	2	-	2	0	0	-	-	3
Peshastin	-	-	-	-	-	-	-	4	2	-	-	-	3
Chiwaukum	33	34	18	29	37	57	-	14	14	35[1]	24[1]	34	30
Chiwawa	436	430	358	204	-	250	768	635	-	814	441[1]	407[1]	474[1]
Nason	2	3	1	8	-	0	1	-	11	-	10	10	5
Little Wenatchee	-	-	-	-	-	5	3	15	3	2	0	-	6
White	104	102	40	67	89	138	119	67	133	178[1]	120[1]	122[1]	107[1]
Total Core Area	**583**	**572**	**419**	**312**	**128**	**452**	**891**	**738**	**163**	**1029**	**595**	**573**	**538**

[1] Extrapolated redd counts from index reach survey.

Notes: Not all bull trout redd counts were complete, and length of stream surveyed has varied between some surveys, in many cases with new survey reaches added in recent years. (-) indicates no survey; these were not incorporated into the mean redd count.

8.1.3 Productivity

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage (i.e., redd counts of a spawning adult population, assuming two bull trout per redd). The direction and magnitude of this trend can represent the growth rate of the entire population (USFWS 2002b, p. 51). The USFWS considers a stable or increasing growth rate in a population to be viable and contributing to recovery (USFWS 2002b, p.52). The short-term population trend for the Wenatchee core area is stable with high interannual variation, with the Chiwawa River population significantly influencing the population trend for the entire core area. The USFWS established an abundance criterion for all local populations in the Wenatchee core area of between 1,876 to 3,176 migratory individuals (USFWS 2002b, p. viii). Our record of redd surveys (Table 2) although incomplete and highly variable indicate that the migratory bull trout are persisting within the lower range of this criterion.

8.1.4 Connectivity

Within the Wenatchee core area, the migratory life history form is predominant within existing local populations. Localized habitat problems (i.e., low flows) currently exist that impede connectivity in Icicle and Peshastin creeks for at least part of the year, and human-caused structures (dams, weirs) may contribute to spawning migration delays at Dryden Dam (i.e., Icicle and Peshastin local population), Tumwater Dam (i.e., Chiwaukum local population), and the Chiwawa weir (Chiwawa local population).

The population of resident bull trout in upper Icicle Creek has been mostly isolated by man-made barriers at LNFH since about 1940 (Brown 1992, WDFW 1998) and by other natural, thermal, or low flow barriers. For most of the time since 1940, all reproduction in the Icicle Creek bull trout local population likely depended on small, resident-only life history forms. In recent years (2001, 2006, and 2007, and possibly 2002 and 2004), some migratory-size bull trout passed upstream of the LNFH. Spawning by migratory bull trout has occurred in the upper Icicle since 2008, indicating that recent changes to LNFH operations have provided improved passage opportunities. Because the migratory form of bull trout is present in all local populations, the USFWS considers the core area to be functionally connected (USFWS 2008, p. 52).

8.1.5 Factors Affecting Bull Trout Populations in the Wenatchee Core Area

Like most core areas in the upper Mid-Columbia Recovery Unit (MCRU), the Wenatchee core area has been influenced by a wide variety of both legacy and ongoing threats that affect bull trout population performance via habitat modification and species interactions. The major reasons for the decline of the bull trout in the Wenatchee core area are:

High Road Densities: High road densities occur throughout watersheds in the subbasin, and roads on narrow floodplains contribute to sedimentation, habitat isolation, and stream constriction. Nason Creek and Chiwawa River HUC 5 watersheds are functioning at risk, and Peshastin Creek and the Wenatchee River HUC 5 watersheds are not properly functioning, based on overall road densities and percentage of roads located within RRs and/or adjacent to critical habitat (USFWS 2018, pp 44-45).

Diversions (irrigation and fish traps): Irrigation diversions result in passage impediments, dewatered or reduced streamflow, and increased water temperatures. Most irrigation intakes are screened, have been updated, and improved to meet USFWS and NMFS screening criteria, with the exception of irrigation, LNFH operation, and municipal water supply diversions in Icicle Creek. Inadequate fish protection devices and structures associated with these diversions can physically injure bull trout through entrainment in these water delivery and fish return systems. Other diversions and dams include fish traps (e.g., Dryden and Tumwater dams), which are primarily operated to monitor anadromous salmonids and may impede movement of bull trout under some operational conditions. Ladders intended to facilitate passage past these dams typically function well, but may delay bull trout under some flow conditions.

Forest Management: Legacy impacts from past forest management includes: roads (described above), channel changes and constriction, soil compaction, degradation of riparian areas, and decreases in large wood recruitment. Current federal, state, and private forest management generally has fewer impacts due to current land management plans and forest practices rules (e.g., Northwest Forest Plan for federal lands, and Forest Practices Habitat Conservation Plan for state and private lands). Short-term adverse effects to bull trout and their habitat (e.g., instream temperature, large wood, and sediment) and long-term beneficial effects on habitat access (as fish passage barriers are removed) will continue to occur in localized areas.

Grazing: Legacy effects from historic grazing throughout the subbasin may continue in some areas, but current grazing on public lands is mostly limited to the Chumstick watershed, where bull trout are very rare. However, downstream effects such as sediment and increased water temperatures are possible.

Residential Development: Numerous areas within the core area are experiencing a shift from an economy based on natural resources (agriculture, forestry, and mining) to an economy more dependent on industries associated with tourism, recreation, and general goods and services. Chelan County's population estimate has grown 6.1% since 2010 (https://www.census.gov/quickfacts/chelancountywashington, accessed July 28, 2020), and development is increasing in and around the towns of Plain and Leavenworth, the lower White River, Lake Wenatchee, and the Peshastin, Icicle, and Nason Creek areas.

Recreation: Developed and undeveloped (dispersed) recreation sites are extensive in the Wenatchee core area. Impacts include the degradation of streambanks, recreational dam construction that create passage barriers, and in some cases can lead to poaching. Particular areas of concern include Icicle Creek, the Chiwawa River, Nason Creek, the White River and the Little Wenatchee River (USFWS 2015b, p. C-92).

Fisheries: Migratory adults and emigrating sub-adults are exposed to spring Chinook, steelhead, and sockeye salmon fisheries in the core area. Spawning migrations coincide with spring Chinook fisheries in Icicle Creek. Post-spawning adult as well as sub-adult emigration coincides with steelhead fisheries on the Wenatchee River, and the Lake Wenatchee sockeye fishery occurs during a time of year when large numbers of bull trout aggregate in the lake and feed actively in preparation for spawning migrations into the Chiwawa, White, and Little Wenatchee rivers. The correspondence between bull trout migration timing and these fisheries increases the potential for adult bull trout to be incidentally hooked on each leg of its annual migration.

Mining: Small scale, recreational mining occurs in FMO habitat in Peshastin Creek, and the mainstem Chiwawa and Wenatchee Rivers and in spawning and rearing (SR) habitat in Chikamin and Etienne creeks. Legacy suction dredging practices have increased sediments and altered spawning and rearing habitat. Effective July 11, 2020, Washington State House Bill 1261 prohibits the use of motorized or gravity siphon aquatic mining in waters designated under the ESA as critical habitat for salmon, steelhead, and bull trout. Non-motorized prospecting may still occur in waters designated under the ESA as critical habitat for salmon, steelhead, and bull trout, as long as they are consistent with provisions in the Washington Department of Fish and Wildlife's "Gold and Fish" guidelines (WDFW 2020) or an individual Hydraulic Project Approval from WDFW.

Nonnative Fishes: Brook trout exist throughout the core area, increasing the potential for negative effects through competition and hybridization. Brook trout interactions present threats to the Icicle, Chiwaukum, Chiwawa, Nason, and Little Wenatchee local populations. Negative interactions occur with other introduced fish species (see hatchery programs).

Hatchery Programs: Seven hatchery programs operating in the core area have wide-ranging potential effects on local populations including: predation, competition, disease, capture, handling and delayed migration. Beneficial effects from hatchery programs include enhanced prey abundance for bull trout from hatchery smolt releases.

Mainstem Columbia River dams: Despite considerable research and monitoring effort, the effects of dams located on the mainstem Columbia River on bull trout from the Wenatchee Core Area and adjacent core areas remains uncertain. Bull trout use the mainstem Columbia River as a migratory corridor, raising the possibility of demographic and genetic connections among the Wenatchee, Entiat, and Methow core areas. Dams on the mainstem Columbia River have altered historic habitat conditions, may delay adult migration, and likely injure or kill sub-adults that pass downstream through turbines (USFWS 2002). Many questions about bull trout use of the mainstem Columbia River remain unanswered (Barrows et al. 2016, entire).

Forage Fish Availability: Many of the instream threats discussed above (dams, irrigation diversions, culverts) which impede bull trout passage also impede passage for potential native prey species. Hatchery smolt releases may both impact and benefit bull trout especially where low numbers of bull trout exist. Brook trout outcompete bull trout for habitat and food.

Ecological Interactions with Introduced Species: Brook, lake, and brown trout are non-native predators in the core area. Brook trout overlap with bull trout in both SR and FMO habitat. The distribution of lake and brown trout are unknown and may alter with climate change. Fisheries occur on brook, brown, and lake trout. Genetic analysis has identified brook x bull trout hybrids within the core area. Smolts released from hatcheries can residualize and can introduce species competition when large releases occur within small populations.

Natural Disturbance Regimes: Wildfires and flooding continue to have localized significant impacts on bull trout local populations and habitat. Additionally, severe declines in both spring Chinook salmon and steelhead reduce both the prey base for bull trout and a historic nutrient source coming into the subbasin.

Summary Integration of Population and Habitat Factors: Based on the existing abundance and diversity of life history forms, and habitat quality and distribution, we ranked the Wenatchee local populations in terms of their relative resiliency (in descending order): Chiwawa River, White River, Chiwaukum Creek, Little Wenatchee, Nason Creek, Peshastin Creek, and Icicle Creek. The extremes of this ranking contrasts a large, well-connected Chiwawa local population with excellent habitat and a long history of productivity (i.e., most resilient) while the Icicle Creek local population, which is partially isolated, has low abundance and is dominated by the resident life-history form (i.e., least resilient).

8.2 Bull Trout Status in the Action Area

Icicle Creek originates in Josephine Lake at 4,680 feet elevation near the crest of the Cascade Mountains. It flows easterly approximately 31.8 miles and enters the Wenatchee River at RM 25.6, near the town of Leavenworth. Eighty-seven percent of the watershed is in public ownership (74 percent of this is within the Alpine Lakes Wilderness) and managed by the Okanogan and Wenatchee National Forest. The remainder of the watershed is in private ownership consisting primarily of the city of Leavenworth and rural private parcels outside the city limits.

Icicle Creek is a narrow, steep, and glaciated valley characterized by a series of cascading step pools and falls, alternating with reaches of lower gradient pools and riffles. Upper Icicle Creek (i.e., above the boulder falls at RM 5.6) is characterized by steep gradients. The average gradient of the upper stream is nearly three percent and the gradient in the lower stream, which includes the action area, is 0.17 percent (Project BA, p. 28).

The Icicle Creek local population is comprised of both resident and migratory bull trout. The stream reach within the action area is FMO habitat; SR habitat for bull trout is limited to the upper subbasin, within the National Forest and above the boulder field natural barrier at RM 5.6.

For nearly 70 years, the resident form was the only reproducing life history in the upper Icicle as passage above LNFH structures was blocked, and a number of natural barriers above LNFH were believed to pose barriers to upstream migration. Greater opportunities for bull trout passage above the LNFH began in 2001, and large migratory-sized bull trout were observed above the LNFH in 2001, 2002, 2004, 2006, and 2007, although the extent of bull trout passage was uncertain (USFWS 2011, p. 67). The first documented spawning of migratory bull trout in the upper Icicle occurred in French Creek (Nelson et al. 2009 and 2011) following improved passage opportunities at LNFH structures in 2008.

Since 2008, surveyors have not observed migratory bull trout spawning but have enumerated migratory sized redds (Table 3). Migratory bull trout and redds are estimated to be of very low abundance, and Nelson and Sulack (2013) concluded that the majority of bull trout spawning is by resident bull trout. Records of redd surveys (Table 3), although incomplete and variable, indicate that bull trout are persisting in small numbers. Resident bull trout spawning is difficult to quantify, even with regular, repeated surveys (Howell and Sankovich 2012, entire); therefore, resident spawning activity is likely not reflected in the redd count data collected to date.

Table 3. Redd Count Survey Results in Spawning Tributaries in Icicle Creek 2008-2019.

Year	Count of Redds[1,2]
2008	8
2009	3
2010	2
2011	4
2012	2
2013	2
2014	-
2015	2
2016	0
2017	0
2018	-
2019	-
Average Annual Redd Count[3]	3

[1] Not all redd counts were complete, and the length of stream surveyed and number of survey reaches have varied. A dash (-) indicates no survey was conducted.
[2] Redds are in upper Icicle Creek, outside of the action area.
[3] Excludes non-survey years 2014, 2018, and 2019.

The majority of bull trout spawning and rearing habitat in the Icicle Creek watershed is thought to occur within Jack Creek (at approximate Icicle RM 16.8), above RM 1.0 in French Creek (approximate RM 21.2) and in Leland Creek (approximate RM 25.5) (Nelson and Sulak 2013, Vazquez and Nelson 2016). Bull trout spawning had previously been documented in Eightmile Creek, but recent detection efforts including environmental DNA (eDNA) sampling suggest that bull trout are not currently utilizing Eightmile Creek for spawning and rearing (Nelson and Vazquez 2016, p. 20; Rangewide Bull Trout eDNA Project: accessed at https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=6d5597b2755c4c00a35613b7a1849760).

In addition to redd counts, bull trout population data for Icicle Creek have been documented through annual snorkel surveys, and in annual monitoring reports prepared by LNFH. The MCFWCO conducts annual summer snorkel surveys in Icicle Creek with the primary objective of enumerating adult spring Chinook salmon and bull trout. The surveyed area begins at the Boulders Falls on Icicle Creek (approximate RM 5.6) and continues downstream to the Icicle Creek/Wenatchee River confluence. Surveys occur annually, one day between the last week of July and the first week of August. The range of size classes indicate subadult (i.e. less than 450 mm) and adult bull trout presence in specific reaches of Icicle Creek in late July/early August.

Table 4. Summary of Snorkel Survey Results in Icicle Creek, 2008 -2019[1].

	Boulder Falls to LNFH intake		LNFH intake to S2		Historic Channel (S2 to S5)		S5 to mouth	
Year	Total#	Range of size class	Total#	Range of size class	Total#	Range of size class	Total#	Range of size class
2019	1	290	4	300-350	0	-	28	290-450
2018	3	350-430	5	150-330	9	210-450	33	250-450
2017	4	190-410	8	210-510	2	250-470	15	250-630
2016	8	170-470	4	270-330	3	250-610	16	170-310
2015	26	230-750	3	310-610	0	-	52	250-630
2014	4	130-650	6	250-490	30	70-350	23	210-510
2013	8	310-650	3	230-450	1	610	14	110-490
2012	3	190-410	2	350-450	5	350-510	10	190-350
8/10/2011	0		0		6	170-310	4	210-450
8/31/2011					6	250-450	7	250-450
Grand Total	**57**		**35**		**62**		**202**	
Average	**6**		**4**		**6**		**20**	

[1] Snorkel surveys occur annually on one day between the last week of July and the first week of August.

Additional annual monitoring within the action area provide information about the periodicity of bull trout near the surface water intake. The current unscreened surface water diversion for the LNFH entrains fish through the conveyance pipeline to the hatchery, and LNFH staff monitor and rescue bull trout and other entrained fish from the sand settling basin and provide an annual report to the USFWS on bull trout encounters. Table 4 summarizes by month and year, the number of bull trout entrained through LNFH's water delivery system.

Table 5. Summary of bull trout entrained in LNFH water delivery system by month and year.

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Grand Total
2011								4		4
2012							1	2	2	5
2013		1				3				4
2014					2			3		5
2015		2			12	5	7	5		31
2016				1			1			2
2017	1		1			1		1	2	6
2018								3		3
2019						1	1	1		3
Grand Total	1	3	1	1	14	10	10	19	4	63
Average	1	2	1	1	7	3	3	3	2	7

Nelson and DeHaan (2015) analyzed bull trout genetic samples collected from Icicle Creek (including those entrained through the LNFH water delivery system, see Table 5), assigned them to the local population of origin, monitored their movements with passive integrated transponder (PIT) tags, and determined whether bull trout are able to access FMO and SR habitat upstream of the LNFH. The authors found that bull trout in Icicle Creek were assignable to eight local populations from three core areas: Chiwaukum, Chiwawa, Icicle, Nason, Etienne, and Ingalls Creeks of the Wenatchee core area; upper Entiat River of the Entiat core area; and Gold Creek of the Methow core area. Most Icicle population bull trout were entrained as they out-migrated during the fall but the smallest were entrained during spring and early summer, while bull trout from the other local populations were entrained during late summer and fall sometime after passing the headgate and intake diversion dam (Nelson and DeHaan 2015, p. 13).

Radio-telemetry studies indicate adult migratory bull trout from other local populations, including Entiat River, Chiwaukum Creek, Nason Creek, and Etienne Creek use lower Icicle Creek year-round (Nelson and DeHaan 2015, p. 1), and adult upstream migrations occur between May and early July followed by post-spawn out-migrations between October and February (Nelson et. al. 2012, p. 42).

Nelson and DeHaan (2015) also found that approximately 85 percent of sampled bull trout in Icicle Creek were less than 450 millimeters in length and categorized them as subadults (e.g., an immature bull trout that has migrated downstream from its natal area into a larger river system) Nelson and DeHaan 2015, p. 1). Finding bull trout from each of the core areas in the MCRU above LNFH facilities indicates that bull trout passage is possible under currently undefined stream flow conditions and/or operational improvements through LNFH structures that control flow through the hatchery channel (see Section 8.2.1.1).

Based on genetic analyses, PIT-tag interrogations, radio telemetry, and snorkel surveys described above, it is reasonable to assume that subadult and adult bull trout from local populations in the Wenatchee, Entiat, and Methow core areas are present year-round below the boulder field, utilizing the FMO habitat in the action area.

8.2.1 Factors Responsible for the Condition of the Species in the Action Area

The greatest influences on bull trout status in the action area include habitat access and migration barriers, reduction in flow and alteration of flow regimes, entrainment through surface water withdrawals, species interactions and hybridization, and water quality impairments.

8.2.1.1 Habitat Access and Migration Barriers

Fish passage includes the need for migratory bull trout to access spawning grounds, and the need for both migratory and resident bull trout to move locally for foraging purposes, redistribution due to density, and to access suitable habitat.

LNFH operations of structures at the upstream and downstream end of the historic channel (i.e., structures 2 and 5, respectively) can limit the potential for subadult and adult bull trout movement throughout FMO habitat, and adult upstream spawning migrations to the upper Icicle.

The USFWS estimated a passage window where adult migrants could access spawning habitat in the upper Icicle that encompassed about one week in early May and about six weeks in June and July (USFWS 2011, Figure 4, p 76), based on the LNFHs spring chinook salmon broodstock collection period from mid-May through June. Closure of structure 2 and 5 during the broodstock collection period to limit the passage of greater than 50 spring Chinook passage above the hatchery channel and/or forecasted low broodstock returns could influence up to 40 days of this passage window. Other structure manipulations (i.e., for smolt release, aquifer recharge, high flows, low flows) could limit FMO habitat for subadult and adult bull trout periodically throughout the remainder of the year (e.g. smolt releases in April, and aquifer recharge between September and March). LNFH also operates these structures to improve passage opportunities for bull trout during low streamflow periods.

Upstream of the action area (at RM 5.7), the Icicle-Peshastin Irrigation District (IPID) operates and shares, with the City of Leavenworth (COL), an irrigation diversion dam on Icicle Creek that presents a temporary barrier to summer and fall migration when low flow trickles over the crest of the dam, which has no fish ladder. As described later, the IPID and COL diversions also affect instream flow and can entrain fish through the improperly screened diversions.

Natural putative barriers upstream of LNFH become seasonal barriers to upstream migration once stream discharge drops (generally in July) affecting spawning migrations. Determining if a bull trout can successfully migrate from lower to upper Icicle Creek to spawn with its source population that same year depends on passage through the hatchery channel and structures 2 and 5 during the spring/summer reproductive migration period, and prior to low summer flows that "activate" other barriers in Icicle Creek above LNFH. These same natural barriers and human-made diversions can limit, at low flows, the movement of subadult and adult bull trout from the Icicle local population and other core areas seeking food, shelter, and cold-water refugia in Icicle Creek.

8.2.1.2 Reduction in Flow and Alteration of Flow Regimes

The Icicle watershed's hydrology is primarily driven by snowmelt where peak flows occur during late spring, and low flows occur during late summer, fall, and winter. The maximum discharge recorded at a USGS gage station (#12458000) located at RM 5.8 and upstream of all water diversions, was 19,800 cfs in a rain on snow event in November 1995.

Four water users have rights to Icicle Creek water. Rights to Icicle water began with Cascade Orchards Irrigation Company (COIC) in 1905, followed by IPID in 1910, COL in 1912, and LNFH in 1942. The IPID and COL together divert just over 120 cfs at RM 5.7; IPID uses its 117.7 cfs water right generally from mid-April through late September or early October, and the COL diverts three cfs year-round from a separate intake on the opposite bank. The LNFH and COIC share the point of diversion at RM 4.5 for their water rights. The LNFH uses 42 cfs of water year-round while the COIC uses 12 cfs of water generally from May through September. Thus, year-round, up to 45 cfs are withdrawn, and generally from May through September up to 175 cfs may be withdrawn. Supplemental flows from the Snow/Nada Lakes reservoir system provide 50 cfs in August and September ensuring LNFH can withdraw its full water right while maintaining flows in Icicle Creek during the natural low flow period. Despite 50 cfs

supplementation, water use coupled with naturally low instream flows can reduce flows in lower Icicle Creek to just 20 cfs in September (USFWS 2021, in prep.).
All water users in the subbasin (i.e., LNFH, IPID, COIC, and COL) as members of the Icicle Water Group are working toward an instream flow goal of 100 cfs. Projects to meet this goal are described in Section 10 (Cumulative Effects).

8.2.1.3 Entrainment Through Surface Water Withdrawals

Adequate fish protection devices and structures are lacking at Icicle Creek diversions. Screening of the LNFH and COIC intake is comprised of a grizzly rack (6 inch bar spacing) at the entrance of the conveyance channel and a fine rack (1 ½ inch bar spacing) in the intake building. Fish that are entrained through the water delivery system are removed at the sand settling basin. See Section 8.2 for a summary of the numbers of bull trout entrained in the LNFH water delivery system.

The IPID irrigation diversion dam at RM 5.7 does not currently meet NMFS and USFWS fish screening criteria. The fish screens are undersized, the mesh openings are too large, there is no sweeping flow, and the approach velocity is too high. Fish are at high risk of impingement if entrained. The irrigation ditch also lacks an adequate fish bypass to return fish that enter the ditch back to Icicle Creek. Currently, fish are returned to Icicle creek via a 15-foot drop onto a boulder that is not submerged for most of the irrigation season.

8.2.1.4 Species Interactions and Hybridization

For decades, brook trout have been stocked in a number of lakes and streams throughout Central Washington. Although that no longer occurs in waterways connected to occupied bull trout habitat, the legacy of this past program likely continues to impact bull trout through hybridization, competition, and predation. Hybridization between bull trout and brook trout has been documented in Icicle Creek (Nelson et al. 2009, Nelson and DeHaan 2015, Nelson and Vazquez 2016). In Icicle Creek, the local population of the bull trout appears to be very small and demographic and genetic risks are already very high despite the added stress of competition from other trout species. Snorkeling surveys in French and Jack Creek (Nelson and Vazquez 2016) found bull trout densities greater than brook trout densities indicating that the risk of hybridization and interspecific competition with brook trout may be minimal relative to Leland Creek and the mainstem upper Icicle Creek (Nelson and Vazquez 2016, p. 11 and 20).

8.2.1.5 Water Quality Impairments

Lower Icicle Creek has several listings on the current Washington State Department of Ecology water quality assessment and 303(d) list, including temperature, dissolved oxygen (DO) and pH. These impairments are being addressed under Ecology's Wenatchee River Watershed Dissolved Oxygen and pH TMDL Water Quality Improvement Report (Revised August 2009) and its associated addendum (March 2012; Chelan County and WDOE 2019) and the Wenatchee River Watershed Temperature Total Maximum Daily Load Water Quality Improvement Report (WDOE 2007). The LNFH has a NPDES permit to discharge wastewater from the hatchery into Icicle Creek (NPDES Permit WA0001902) at the hatchery outfall located at RM 2.7 (Chelan

County and WDOE 2019). Icicle Creek is very sensitive to any addition of nutrients, especially phosphorus. Each of these impairments can interact to degrade water quality, for instance DO may decrease with increased discharges of phosphorus and temperature. Water quality has likely improved as the LNFH operates and monitors its water discharge in compliance with its 2017 NPDES permit (No.WA0001902; effective date January 1, 2018). The permit contains limits concerning discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not degrade water quality.

8.3 Status of Bull Trout Critical Habitat in the Action Area

The action area is located in the Wenatchee critical habitat subunit (CHSU); a part of the Upper Columbia River Basin CHU (Unit 10), designated by the USFWS' October 18, 2010, final rule (75 FR 63893). The Upper Columbia CHU is located on the east slopes of the Cascade Range and west of the Columbia River in north central Washington. Each of the three major drainages in this geographic region, the Wenatchee, Entiat, and Methow, comprise a CHSU designated to support their respective core areas, including spawning, rearing, foraging, connectivity, and overwintering habitat. The Wenatchee CHSU supports one of the largest populations of bull trout and some of the most connected habitat in CHU 10. The entire length of the mainstem Wenatchee River is designated critical FMO habitat and is essential for all local populations in the core area to support multiple life histories, and is essential for connecting local populations in the Wenatchee core area as well as connectivity to the Columbia River and other core areas in CHU 10. Icicle Creek from its confluence with the Wenatchee River up to the boulder field at RM 5.7 is designated critical FMO habitat and is essential habitat for adult and subadult bull trout from the Icicle local population as well as other migratory populations from the Wenatchee, Entiat, and Methow core areas. Above the boulder field at RM 5.7, the mainstem Icicle Creek as well as the three spawning tributaries (Jack, French, and Leland) is designated critical SR habitat for the Icicle local population of bull trout (USFWS 2010). It is important to note that the mutually exclusive categories of SR and FMO are likely used by different life history stages in different ways. For example, SR habitat may be used by migratory bull trout not just for spawning, but also for foraging. While spawning may not occur throughout the entire segment of SR, the entire area may be important to rearing juvenile and sub-adult bull trout, thus the combined term SR. Juvenile and subadult bull trout may also use FMO habitat for rearing, whether their movements to these areas were a result of volitional emigration or their inability to remain in their natal reach due to environmental factors (e.g. peak flows that flush them downstream). Small resident bull trout, with their more limited physiological tolerance of elevated temperatures, more specific habitat needs, and limited swimming ability, typically rear (i.e., grow to sexual maturity) fairly close to their natal stream.

Within designated critical habitat, nine primary constituent elements (PCEs) were determined essential for the physical and biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. The status of each PCE relevant to the action area is briefly described below. We adopt the terminology from the Matrix of Pathways and Indicators (MPI) (USFWS 1998) to summarize the functionality of each PCE (e.g., functioning appropriately, functioning at risk, not properly functioning).

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

In addition to the multiple 303(d) listed impairments described above in Section 8.2.1.5, streamflow diversions for irrigation, municipal water supply for the City of Leavenworth, and water supply for the LNFH impair base flows in lower Icicle Creek, even when supplemented with water released from the Snow Lakes basin via Snow Creek. Other LNFH operations including groundwater well recharge and flow manipulation in the historical channel can reduce the connections between cooler groundwater with surface water. Excessive embeddedness in rearing substrates in the lower reaches of Icicle Creek have been reported to have negative impacts on hyporheic flows (USFWS 2011, p. 85). PCE 1 is *not properly functioning*.

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

Bull trout from all three core areas in the Upper Columbia CHU move seasonally throughout the Wenatchee CHSU using the full length of the Wenatchee River and tributaries, including Icicle Creek to forage and migrate to rearing and overwintering habitats. Operation of LNFH's structures 2 and 5 can limit bull trout passage and access to FMO habitat. Further, streamflow in Icicle Creek during low-flow periods (August through September) is too low for reliable fish passage at the existing LNFH intake facilities and the IPID diversion. Several natural putative barriers in upper Icicle Creek become seasonal barriers to upstream spawning migrations as discharge drops to base flows (generally in July). The Boulder Field Project permitted by ACOE and sponsored by Trout Unlimited (Corps Project Number NWS-2018-890, Service Reference Number 01EWFW00-2019-TA-1519) completed in November 2020 modified 150 feet of the left bank of Icicle Creek at RM 5.6 by constructing and reconfiguring existing boulders into a step-pool channel morphology to improve fish passage. The Boulder Field Project also relocated the City of Leavenworth intake and will install a NMFS-compliant fish screen in 2021.

With the exception of cold-water refugia created at the LNFH spillway pool from hatchery discharge, upstream diversions and LNFH streamflow manipulations in the historic channel, coupled with floodplain and riparian development in lower Icicle Creek, likely increase stream temperatures in lower Icicle Creek. Increased stream temperatures may impede migration by posing a thermal barrier. In summary, substantial impacts to the migratory corridor, from both human activities and natural conditions, suggest only a very narrow window of opportunity for upstream passage of migratory bull trout to spawning tributaries, and impaired movement in lower Icicle's FMO habitat. PCE 2 is *not properly functioning*.

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

Quantitative assessments of the bull trout food base are not available. However, water quality impairments (i.e., temperature and dissolved oxygen) and habitat impairments (reduced large, woody debris and minimal riparian vegetation) likely limit the prey base in the action area. Adult bull trout, and to a lesser extent subadult bull trout, likely experience periodic beneficial effects associated with enhanced prey from LNFH smolt releases. Monitoring has shown over 20 percent of migratory bull trout known to be present in the Wenatchee basin use the lower Icicle during the summer, likely to exploit foraging conditions and thermal refugia. Although temperature and riparian conditions are more favorable in upper Icicle Creek, competition with non-native brook trout and barriers that prevent access by bull trout and other native salmonids may limit the prey base available to bull trout. Overall, PCE 3 is *functioning at risk*.

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

Legacy effects from previous land uses in the historical floodplain and riparian zone have altered instream morphology and floodplain function, and degraded water quality, habitat-forming elements, channel dynamics, and hydrology. There is limited streambank complexity in the action area, with few slow-moving pools with overhanging banks, and much of the substrate is embedded with fine sediment or armored. Riparian vegetation removal has reduced the capacity of the riparian zone to provide most of the functions needed to maintain the integrity of aquatic habitats in the action area. Downstream of the action area, planting of native riparian vegetation and control of invasive non-native vegetation are efforts recently undertaken to improve riparian and streambank vegetation condition on private and state-owned lands however; the full benefits of these actions will not be realized for decades. Overall, PCE 4 is *functioning at risk*.

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

Icicle Creek is water quality impaired for stream temperature. Several Category 4a listings (already has an EPA-approved TMDL) occur in lower Icicle Creek including below Snow Creek (RM 5.7), downstream of the East Leavenworth Road Bridge (RM 2.3) and upstream of the Icicle Creek confluence with the Wenatchee River. In addition, there are Category 2 (some evidence of a water quality problem, but not enough to show persistent impairment) listings within and upstream of the hatchery channel. LNFH operations provide cool-water refugia in summer months when supplementation flows from the Snow Lake basin enter Icicle Creek at Snow Creek, and at the hatchery spillway pool where the effluent contains cooler well water. Where this cooler water joins Icicle Creek, the temperature in Icicle Creek is locally cooled. These temperature impairments likely influence bull trout behavior and habitat use, at least during some periods of the year. *PCE 5 is not properly functioning*, primarily because temperatures in areas used by adults during migration regularly exceed 15ºC.

PCE 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

Because critical habitat in the action area is designated FMO, PCE 6 does not apply to critical habitat in the action area.

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

In Section 8.2.1.2 above, we detail flow alterations due to streamflow diversions for irrigation, municipal water supply, and process water supply for the LNFH. These water uses can reduce the flow in the lower reaches to very low levels during August and September, having negative effects on the bull trout's temporal and spatial habitat use in the action area. PCE 7 is *not properly functioning* in the action area.

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

See PCE 5 and PCE 7. In addition, water quality is heavily influenced by several Category 4a and Category 2 water quality impairments for dissolved oxygen, pH, and phosphorus in lower Icicle Creek and the Hatchery channel.

The LNFH has a National Pollution Discharge Elimination System (NPDES) permit to discharge wastewater from the Hatchery into Icicle Creek at RM 2.7 (NPDES Permit WA0001902). The permit contains limits concerning discharge, monitoring and reporting requirements. The daily total phosphorus limit is 1.15 pounds (0.52 kilograms) per day and applies March 1 to May 31 and July 1 to October 31 each year. Monitoring has revealed effluent discharge violations over the last three years (https://www.epa.gov/npdes-permits/npdes-permit-leavenworth-national-fish-hatchery-washington accessed 11/25/2020). The LNFH has implemented several production changes to help reduce TP effluent including construction of a new abatement pond in 2020. Plans for additional infrastructure projects (i.e., a pilot partial reuse aquaculture system) are in development (pers. comm., M. Cappellini, May 2020).

Bull trout are very sensitive to environmental contaminants and require high water quality for their habitats (USFWS 2002a). In consultation with EPA regarding their issuance of a NPDES permit to the LNFH (USFWS Reference number 13260-2011-I-0056) the USFWS concurred with the determination by the EPA that LNFH discharges were "not likely to adversely affect" the bull trout and concluded that discharges are not expected to approach lethal concentrations for any regulated parameters in the NPDES permit. The discharge of contaminants can degrade water quality directly or by interaction with other parameters (e.g., dissolved oxygen may decrease with increased discharge of phosphorus and temperature). Although phosphorus levels are relatively low, they are consistently too high to meet the pH water quality standard; this in combination with other water quality impairments (i.e., temperature and DO) has likely caused bull trout to modify their habitat selection spatially and temporally. Presently PCE 8 is *not properly functioning*, although actions taken by the LNFH to reduce total phosphorus in effluent discharged to Icicle Creek may lead to an improved environmental baseline.

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

Brook trout overlap with bull trout in both SR and FMO habitat in Icicle Creek. The presence of brook trout poses a risk of hybridization and competition to bull trout. Genetic analysis had identified brook x bull trout hybrids in Icicle Creek; however, the extent of hybridization is not known. Predicted increases in stream temperature, as a result of climate change, can produce favorable conditions for brook trout and non-native rainbow trout that are more tolerant of warm water. PCE 9 is *functioning at risk* in Icicle Creek.

8.4 Conservation Role of the Action Area

Recovery goals for bull trout include managing threats in core areas (see Section 8.1.1) so that bull trout populations are geographically widespread and demographically stable within the range of natural variation, with their essential cold water habitats connected to allow their diverse life history forms to persist into the foreseeable future (USFWS 2015 p. viii). Recovery should demonstrate that the three primary principles of biodiversity have been met: (1) representation (conserving the genetic makeup of the species); (2) resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and (3) redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015, p. 33).

Icicle Creek provides essential bull trout spawning and rearing habitat in three headwater tributaries, serving an essential conservation role to maintain the distribution of bull trout within the Wenatchee core area and to contribute to recovery goals for numbers and reproduction of this core area. The quality of the SR habitat in the upper Icicle will likely be maintained over time due to US Forest Service land use allocations (i.e., wilderness) and land management goals and objectives outlined in the Northwest Forest Plan (USDA and USDI 1994) that emphasize conservation, thus providing refugia for bull trout now and in the future. Given the bull trout's persistence in Icicle Creek for over 70 years in the face of passage barriers, irrigation diversions and non-native species, it is likely that in the short-term the risk of extirpation for the Icicle Creek population is moderately low.

The action area, in lower Icicle Creek, is essential as a migratory corridor for the maintenance and expansion of the Icicle Creek local population of bull trout, and foraging/cold water refugia for all three core areas in CHU 10. Although habitat in Icicle Creek represents only a small portion of critical habitat in the CHU, it remains essential to maintain the connectivity and distribution of bull trout within the Wenatchee core area and CHU. Improving access through adaptive management of S2 and S5, and improving passage opportunities for the migratory life history form at the Boulder Field Project is likely to enhance the viability of this local population and its contribution to the survival and recovery needs of the bull trout at the core area, recovery unit, and range-wide scales. Connectivity between Icicle Creek and other bull trout populations in the core area will likely provide for a population increase, the reestablishment of multiple life history forms and minimize the potential deleterious effects of inbreeding within the Icicle Creek local population of bull trout, thus enhancing the resiliency and viability of the core area. Large populations with connectivity to other populations are more resilient to disturbances and may support other local populations within and between core areas. Multiple life history strategies in a population and/or core area help to maintain stability and persistence of environmental changes. Benefits to migratory bull trout include greater growth, greater fecundity, and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3).

As described in Sections 8.2.1.2 and 8.3, brook trout abundance in spawning and rearing habitat and low stream flows in the migratory corridor of mainstem Icicle Creek are on-going threats to the local population of bull trout in Icicle Creek. Ongoing monitoring and future actions may be required to ensure the physical and biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, and sheltering are present such that the Icicle local population can contribute to the Wenatchee core area's recovery goals.

8.5 Climate Change

Consistent with Service policy, our analyses under the Act include consideration of ongoing and projected changes in climate. The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2014a, pp. 119-120). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014a, p. 119). Various types of changes in climate can have direct or indirect effects on species and critical habitats. These effects may be positive, neutral, or negative, and they may change over time. The nature of the effect depends on the species' life history, the magnitude and speed of climate change, and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2014b, pp. 64, 67-69, 94, 299). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change and its effects on species and their critical habitats. We focus in particular on how climate change affects the capability of species to successfully complete their life cycles, and the capability of critical habitats to support that outcome.

In the Columbia Basin region, effects of climate change have already been observed; for example minimum and maximum temperatures have increased 0.18°C per decade for the 1950-2006 period, and are projected to warm, on average, by 2.1°C by 2040 (Raymond et al. 2014, pp. 27, 33). In the North Cascades (i.e., Mount Rainier north to the Canadian border), climate change is widely expected to threaten all salmonids, including bull trout, and their habitats through hydrologic changes. Among the key hydrologic changes projected for the 2040s and beyond are reduced mountain snowpack, earlier snowmelt, higher runoff and streamflow in winter and early spring, lower runoff and streamflow in summer, an extended summer low-flow period, and overall reductions in summer streamflow (Raymond et al. 2014, p. 237). By the 2080s, no snow-dominant subbasins will exist in the North Cascades (Raymond et al. 2014, p. 237). Forest vegetation will experience the integrated effects of changes in temperature, precipitation, and snow pack as well, resulting in reduced soil moisture, vulnerability to insects, increased mortality, and increased wildfires (Raymond et al. 2014, p. 121). Combining changes in vegetation cover with increases in winter and spring precipitation, more landslides at increasingly higher elevations may be a long-term effect of climate change (Raymond et al. 2014, p. 76).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. Shifts in timing, magnitude, and distribution of peak flows are likely to affect the quantity and quality of spawning and incubation habitat for local spawning populations of bull trout. Extreme flows during fall and winter can negatively affect bull trout egg-to-fry survival by scouring redds, crushing eggs with mobilized substrate, and smothering eggs with fine sediment (Raymond et al. 2014, p. 246). Although lower elevation rivers are not expected to experience as severe an impact from alterations in stream hydrology, projected temperature increases may increase thermal migration barriers and increase thermal stress for overwintering and foraging bull trout, especially in lower elevation streams and east side streams (Raymond et al. 2014, p. 243).

Climate change may directly threaten the integrity of the essential physical or biological features, formally known as PCEs as described in *Appendix B: Status of Designated Bull Trout Critical Habitat*. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Over a period of decades, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes). The likely degradation of aquatic habitats due to predicted climate change impacts highlights the importance of maintaining and improving functional riparian zones in FMO and SR habitat to naturally regulate stream temperature and water quality. The likely increase in frequency and intensity of floods and wildfires highlights the need to maintain and improve stream and floodplain complexity and processes to increase spawning habitat resilience and connectivity within and among core areas.

The University of Washington Climate Impacts Group (CIG) examined the changing streamflow in Icicle Creek as the result of climate change (Chelan County and WDOE 2019, p. 1-31). By 2030 under low and high greenhouse gas scenarios, higher average monthly flows are projected from December through April, with lower average monthly flows from May through November. Low flows are projected to be lower than what has been observed historically. Average peak flows are projected to occur in mid-April instead of in June, when the average peak flow has historically occurred. These trends are expected to become more extreme in the second half of the century. Systems may become flashier, with lower low flows and higher peak flows. Because runoff in Icicle Creek is projected to increase in the early part of the water year (October 1 to September 30) due to the warmer winters, less water would be available instream during critical low-flow months (Chelan County and WDOE 2019, p. 3-100). Current streamflow in Icicle Creek during low-flow periods is too low for fish passage and habitat availability; it is projected to worsen with climate change impacts and will likely limit connectivity with other local populations of bull trout in the core area and CHU.

Climate change is and will be an important factor affecting bull trout distribution and population dynamics. The quality and quantity of lower elevation SR and FMO habitat will be further degraded (USFWS 2015b, p. C-19) and long-term persistence of bull trout may only be possible in headwater areas that provide suitable habitat refugia (e.g., cold water).

9 EFFECTS OF THE ACTION: Bull Trout and Designated Bull Trout Critical Habitat

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action. (See § 402.17).

In this section we examine the response of bull trout to the various stressors and determine the effects these may have on individual bull trout, the core population, and the recovery unit. All effects are integrated and expressed in the common currency of changes in the numbers, distribution, and reproduction of bull trout.

To begin our analysis of effects, we deconstructed the Project into separate project elements (PEs) that trigger different impact mechanisms or stressors. We characterize this Project as consisting of seven PEs: 1) access and staging; 2) in-water work isolation and fish salvage; 3) intake facility construction; 4) fish passage improvements; 5) temporary water supply for LNFH; 6) conveyance pipeline construction; and 7) construction site revegetation.

9.1 Insignificant and/or Discountable Effects

The following effects from activities discussed in the project description are anticipated to be insignificant and/or discountable and not anticipated to adversely impact bull trout for the reasons described below. Although the USFWS determined these effects are insignificant and/or discountable, we consider them with all Project effects analyses in the jeopardy and adverse modification analyses of this Opinion.

9.1.1 <u>PE 1 – Access and Staging</u>

This PE relates to general access to deliver construction equipment and materials to construction sites and construction staff administration and vehicle parking at the LNFH grounds. Trucks hauling construction equipment and materials will use the paved Icicle Creek Road and a turn-around approximately 1.25 miles up valley from the intake construction site (PE 2). Equipment unloaded and staged near surface waters carries a risk of accidental spills of concrete, fuel, lubricants, hydraulic fluid, or similar contaminants into the riparian zone, or directly into the water, where they could injure or kill aquatic food organisms, or directly expose bull trout to hazardous materials. BMPs incorporated into the Project as described in the BA will minimize the potential for accidental spills. The contractor will keep construction equipment well maintained, inspecting construction equipment daily for leaks, developing and adhering to an approved spill prevention, containment, and control plan and keeping oil absorbent material on-site during construction. The contractor will conduct all refueling at least 150 feet from Icicle Creek and staging areas for equipment and materials will occur only in previously disturbed areas. No machinery will be stored below the OHWM. We expect implementing these BMPs will be effective at reducing adverse effects to insignificant levels, by preventing spills and expediting appropriate responses if a spill or leak does occur.

9.1.2 PE 6 – Conveyance Pipeline Construction

The conveyance pipeline will be replaced using cut and cover trenching on USFWS property on the LNFH grounds and lined with CIPP on USFWS property at the surface water intake and on private parcels. All construction will be in uplands, with the exception of two locations that are in close proximity to Icicle Creek (i.e., at the PISMA and at the Icicle River RV Resort); both of which will receive the CIPP prescription. To minimize sediment mobilization during excavation and grading, erosion control measures such as silt fencing will be erected prior to construction and maintained throughout the construction period at these work sites.

The process of CIPP lining involves hot air blowers to dry out the pipe followed by lining the existing pipe with an inert fiberglass cloth impregnated with a styrene-free resin or epoxy that utilizes a closed-water loop to form the lining to the existing pipe. The two locations in close proximity to Icicle Creek could introduce noise disturbance to bull trout from hot air blowers and the risk of contaminants entering Icicle Creek from the CIPP.

The Project BA reports that noise generated from the hot air blower would be 115 decibels (dB) at five feet from the source. Based on the standard reduction for point source noise of 6 dB per doubling of distance (WSDOT 2020, p. 7.7) we expect that at the closest location to Icicle Creek (approximately 50 feet) the source of the hot air blowers would emit a dB of approximately 95. Icicle Creek may absorb some of this sound, but the underwater sound level is not known. Recent guidelines on interim sound exposure criteria for fishes are based on research that show a general correlation between the extent of effects and the cumulative level of sound energy to which fish are exposed (Popper and Hawkins 2019; Popper et al. 2019). For species that rely on particle motion detection (such as bull trout), cumulative sound exposure levels of 203 dB (or greater than 206 dB peak) may result in recoverable injury; while cumulative sound exposure levels of greater than 186 dB may cause temporary threshold shifts and/or moderate masking effects[2] (Popper and Hawkins 2019, p. 704; Popper et al. 2019, p. 13, p. 121). Therefore, we are reasonably certain that noise from the hot air blower will not be of an intensity that would cause physical injury to bull trout. Bull trout may avoid this construction site and displace into nearby habitat, we expect this avoidance to be of a small scale and short duration such that effects to feeding and sheltering will be undetectable and insignificant.

Similar to PE 1, CIPP lining in close proximity to Icicle Creek carries a risk of accidental contaminant spills into the riparian zone, or directly into the water, where they could injure or kill aquatic food organisms, or directly expose bull trout to hazardous materials. To minimize the risk of toxicity to bull trout, conservation measures prohibit the use of styrene-based or other

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[2] A temporary threshold shift is a short-lived reduction in hearing sensitivity, associated with impact noise. Masking results from continuous sounds and prevents hearing of biologically important sounds (e.g., predators and prey, conspecifics).

resins harmful to fish and aquatic life (Section 4.1, Conservation Measure 4.o.). Additional specifications incorporated into the Project as described in the BA will require the contractor to haul in all water and fluids used in CIPP lining, utilizing a closed-loop system for installing the lining, and hauling off site to dispose properly. BMPs to minimize the potential for accidental spills include keeping construction equipment well maintained, inspecting construction equipment daily for leaks, and developing and adhering to an approved spill prevention, containment, and control plan. We expect implementing these Project specifications and BMPs will be effective at reducing adverse effects to insignificant levels, by prohibiting curing resins that are harmful to aquatic life and preventing spills and expediting appropriate responses if a spill or leak does occur.

9.1.3 PE 7 – Construction Site Revegetation

Most revegetation (including hydro seeding) will occur in upland habitats with no effect to bull trout. Approximately 200 linear feet of Icicle Creek streambanks will be hand planted with shrubs and trees. Planting could cause soil displacement to Icicle Creek but we expect that careful planting and mulching combined with the small footprint affected to minimize sediment movement off the banks to discountable levels.

9.2 Adverse Effects to Bull Trout

Project Elements that occur in water or below the OHWM have the greatest likelihood of contributing to direct injury or mortality of bull trout. Activities associated with these PEs can increase sound and light disturbance from construction activities, impair water quality through the introduction of sediment and chemical contaminants, and impair bull trout behavior through handling, entrainment, and exclusion from habitat. We address these stressors within the individual PE descriptions below. Conservation measures included in the Project should reduce the extent or likelihood of injury and mortality of bull trout. Despite these measures, disturbance and sub-lethal injury is reasonably certain to occur.

The proposed action is located in FMO habitat utilized by subadult bull trout from six local populations from the Wenatchee core area and one local population each from the Entiat and Methow core areas. Adult migratory bull trout from the Icicle local population are also found in the action area. SR habitat for the Icicle local population is located over 12 miles upstream of the action area, so the proposed action will avoid impacts to spawning bull trout, incubating bull trout eggs, alevins, and juveniles. Subadult bull trout are present year-round.

9.2.1 PE 2 – In-water Work Isolation and Fish Salvage

Worksite isolation includes installing cofferdams associated with PE 3 and PE 4, and fish removal inside the cofferdams during dewatering of the isolated work areas. The MCFWCO will capture and remove any bull trout encountered following the conservation measures in Appendix C. Handling activities, even when conducted carefully, are likely to result in abrasion and stress to all bull trout handled. All pumps used for dewatering will have fish screens or guards that comply with the most recent fish screening guidelines prescribed by NMFS and USFWS to protect bull trout from entrainment in the intakes. Worksite isolation and removal of fish are conservation measures designed to reduce the risk of fish stranding and other forms of injury (e.g., exposure to turbidity and entrainment in pump screens). However, isolation and removal techniques themselves can injure or kill fish.

Subadult and adult bull trout are likely to be exposed to physiological stress and injury from capture, handling, and relocation efforts that can lead to immediate or delayed mortality (lethal and sub-lethal effects). The netting or capturing, handling, and releasing of the bull trout can result in injury by increasing the potential for disease by removing the protective mucus coating on the skin, as well as increasing stress in affected individuals which can cause it to become susceptible to disease (and predators and competitors when released), and it can cause potential direct injury. Death can result if fish are handled roughly or kept out of water for extended periods of time. Electrofishing, as a capture method, can cause physical injury and cardiac or respiratory failure (Snyder 2003, p. 42).

Physiological stress caused by capture and handling of adult bull trout could delay upstream migration to spawning tributaries. Three upstream migration periods for bull trout in Icicle Creek have been estimated; June 22 to August 2 (Nelson 2008, p. 5), June 3 to July 29 (USFWS 2011), and May to early July (Nelson et. al. 2012, p. 42). All three of these periods depend on stream flows that allow bull trout to pass through both human-caused and natural barriers in Icicle Creek. Worksite isolation and fish salvage will occur between July 1 and July 15 in 2022 and 2023, overlapping the defined migration periods. The cofferdam installation and fish salvage in late August 2023 is not expected to impede adult upstream spawning migrations, as stream flows in August are generally too low for bull trout passage.

The compounded consequences of delayed migration, capture, and relocation on growth, reproduction, and ultimately the survival of fish is not understood (Clements et al. 2002, P. 915). However, more bull trout could be exposed to more severe effects (i.e., crushing, stranding, gill abrasions) if construction took place without work area isolation.

The proposed conservation measures (Appendix C, USFWS 2012) for worksite isolation and fish removal, which this Project incorporates into BMPs, should be effective at minimizing injury and mortality associated with worksite isolation, and ensure that most of the resulting stress is short-lived. Nonetheless, we anticipate that subadult and adult bull trout will experience sub-lethal and/or lethal effects.

9.2.2 PE 3 – Intake Facility Construction

This PE includes activities outside of the OHWM, but in close proximity to Icicle Creek, and activities below the OHWM. Activities below the OHWM include construction of the new intake facility comprised of the headworks (i.e., two self-cleaning rotary fish screens, retaining wall, and section of pipeline), intake operations and maintenance area (IO&MA), and a pipeline intake and sediment management area (PISMA). Activities below the OHWM can expose bull trout to stressors causing injury or death. These stressors include: crushing and stranding associated with cofferdam installation and worksite dewatering; impingement and/or impaired passage while cofferdams are in place; turbidity from cofferdam installation and removal; noise disturbance from demolition and construction, water quality impairments from construction equipment and materials, and light disturbance from 24 hour construction. Fish passage will be provided throughout construction (see Conservation Measure 4.b. in Section 4.1). At the conclusion of construction, long-term beneficial effects to bull trout are expected from reduced entrainment through the LNFH water delivery system.

9.2.2.1 Activities above OHWM

Activities above the OHWM include construction mobilization and site preparation, construction of the IO&MA and PISMA, and revegetation of disturbed areas. These activities will occur outside of but in close proximity to Icicle Creek. Mobilization and site preparation will begin in March 2022 and will include installation of erosion control measures, clearing and grubbing approximately 0.89 acres for the intake construction area, grading the access road (including breaking boulders and bedrock with jackhammers, and excavation and filling to the design grade) to widen and extend the existing access road. Access to the existing gatehouse/proposed PISMA location will also be graded. Bedrock geology shared by this construction area and Icicle Creek could transfer noise and vibrations into the Icicle Creek water column. Rock breaking could occur up to 24 hours a day over a period of two to four days between late March and mid-April 2022. The noise level of the jackhammer is approximately 85 dBA at 50 feet from the source. Similar to our discussion in section 9.1.2, we are reasonably certain that noise produced by the jackhammer will not be of an intensity that would cause physical injury to bull trout. Bull trout are likely to disperse into nearby habitat while noise and vibration activities occur. We expect this avoidance to be of a small scale and short duration such that effects to feeding and sheltering will be undetectable and insignificant.

The construction of the PISMA will be contained within the existing gatehouse footprint, approximately 20 feet from the OHWM of Icicle Creek. The proposed sluiceway pipe will extend from the PISMA approximately 30 feet into/below the OHWM of Icicle Creek at the existing grade to avoid creating an undercut or pond and to remove the existing fish stranding hazard. The area above the OHWM will be regraded and planted. Though the sluiceway pipe will extend 30 feet below/into the OHWM, this area is typically dry during the summer months when construction is proposed. However, if water is present during the construction period in late July to mid-August 2022, the construction area will be isolated from Icicle Creek with a minimal cofferdam system (e.g., consisting of weed-free straw bales and visqueen or similar materials). We include this potential cofferdam construction and removal in our analysis of effects for actions below the OHWM, specifically section 9.2.2.4. If isolation is needed, dewatering and fish removal will be conducted as described in Section 9.2.1.

Improvement of the existing access road and construction of the IO&MA and PISMA will remove approximately 20 to 25 mixed conifer and broadleaf trees and shrubs, and permanently replace approximately 0.18 acres with impermeable surfaces (e.g., gravel and concrete). The remaining 0.71 acres will be hydro seeded in the fall before there is snow on the ground, to stabilize soil and minimize sediment movement into Icicle Creek from the disturbed areas. In the fall of 2023 or 2024, native upland and riparian container-grown trees and shrubs, and riparian shrub cuttings will be planted across the 0.71 acres.

Sediment suspension resulting from construction activities above the OHWM is expected to be of minimal volume and BMPs will be installed prior to and during construction to minimize erosion and sediment inputs to Icicle Creek. The amount of impermeable surface in the action area will increase, however the footprint (0.18 acres) is small and not expected to concentrate runoff and increase sediment significantly in the action area. Bull trout, if exposed to minor and temporary amounts of sediment, will likely respond by avoiding the area.

We expect implementing the water quality BMPs will be effective at reducing adverse effects from contaminants to insignificant levels, by preventing spills and expediting appropriate responses if a spill or leak does occur.

We do not expect bull trout to be exposed to increases in stream temperature or experience reduced terrestrial food sources from the permanent removal of riparian vegetation (approximately six to eight mature trees and shrubs), as the impact is very localized and small in scale.

9.2.2.2 Crushing and Stranding

Fish removal as described in Section 9.2.1 will occur after cofferdam installation. Bull trout are strongly substrate oriented and all life stages often respond to disturbance by hiding in interstitial spaces in the substrate. This behavior can make bull trout difficult to capture and relocate. Bull trout could be exposed to lethal effects resulting from crushing during cofferdam placement and streambed leveling, and could go undetected during fish salvage and be stranded in the interstitial spaces of substrate after the area within the cofferdam is dewatered.

9.2.2.3 Impingement and/or Impaired Passage due to Cofferdam Placement

Once the cofferdam is in place, subadult and adult bull trout will be able to migrate through and forage throughout the action area. To minimize the potential for bull trout injury or mortality due to impingement on the exterior faces of the cofferdam, the exterior face of the cofferdam will be smooth and free of joints and visually inspected daily by the construction contractor. Any impinged or entrapped fish will be reported to USBR immediately and USBR will notify USFWS staff (i.e., LNFH, MCFWCO, and/or Central Washington Ecological Services Field Office). The contractor will implement any mitigation measures developed by USFWS, in consultation with USBR, to reduce or prevent further impingement or entrapment.

Fish passage while the cofferdam is in place (early July to mid-November) will be maintained over the greatest stream width as possible while maintaining a minimum water depth of 0.8 feet. The cofferdam will constrict the width of Icicle Creek. This constriction may improve passage opportunities around the cofferdam during the low-flow period (August to September) by increasing water depths in the remaining channel width and improve opportunities for upstream and downstream movement of bull trout. However, this beneficial effect may be partially offset if bull trout avoid the construction area during periods of noise-generating construction activities and 24-hour construction lighting (see 9.2.2.5 and 9.2.2.7).

9.2.2.4 Turbidity

Placement (including leveling the streambed prior to placement) and removal of the cofferdam A and the PISMA cofferdam, if needed, will mobilize sediments on the Icicle Creek streambed. Sediment movement from upland sites receiving water from the cofferdam enclosures could also introduce sediment to Icicle Creek if the pumping site is over-saturated or otherwise impermeable.

These sources of sediment could increase suspended sediments in and downstream of the work area temporarily, exposing bull trout to elevated levels of suspended sediments. Bash et al. (2001, pp 10-24) summarize numerous studies that describe a range of effects of turbidity in Pacific Northwest fish. They identify stressors that may cause lethal and sublethal effects, such as a loss or reduction of foraging capability, reduced growth and resistance to disease, reduced ability to detect and avoid predators, increased activity, physical abrasion and clogging of gills, and interference with orientation in homing and migration. The outcome of these stressors is dependent on factors such as the duration, frequency, and magnitude of exposure.

Elevated turbidity is expected to be highest during cofferdam A construction (up to 14 days in mid to late July for cofferdam and removal/rewatering of the isolated work area (up to five days in early November). Pumping from the dewatered work area may occur intermittently to daily over the duration of the cofferdam installation (mid-July to early November) to remove water that seeps into the dewatered work area. Construction of the PISMA is expected to occur over a period of three weeks in late July to early August. We expect much less sediment generation during construction and removal of this smaller hand built cofferdam. Bull trout exposure to increased turbidity is expected to have relatively greater effects in the summer at base flows, when background turbidity levels in Icicle Creek are low, and relatively little effect in the spring and fall when turbidity levels in Icicle Creek are relatively higher.

Suspended sediment levels are anticipated to extend 300 feet downstream of cofferdam A before sediment levels return to background levels (Project BA, p. 60). This 300-foot distance extends beyond the PISMA. The USFWS anticipates sub-lethal effects to bull trout during periods of maximum turbidity over the duration of the cofferdam installation and removal/rewatering. In mid to late July we expect adult bull trout may still be migrating through this construction area to upstream spawning tributaries (see Section 9.2.1), and subadult bull trout will be foraging and sheltering.

The duration and magnitude of bull trout exposure from these activities will be minimized through turbidity monitoring and sediment control measures in the uplands. Flows will be reintroduced gradually to minimize the intensity of sediment mobilization and resultant turbidity downstream. Should observed turbidity exceed allowable levels per WAC 173-201A (see Section 4.1) at the point of compliance specified in the conservation measure (which is between 100 and 300 feet downstream, based on the flow rate of Icicle Creek during construction), in-water construction will temporarily stop until turbidity has cleared. In-water construction could then recommence at a slower rate to minimize generated turbidity. Monitoring and additional temporary work stoppages will occur, as needed, in accordance with the conservation measure.

9.2.2.5 Noise Disturbance

Demolition of a portion of the existing low-head diversion dam and sediment sluice/fish ladder will begin in late July 2022 and continue for approximately one month. Construction of the headworks will follow including excavation into the Icicle Creek streambed to form the foundational base and stem walls of the headworks. Pouring concrete for the headworks will begin in August 2022 and last approximately two months. Following construction of the intake structure including four days of curing for the concrete, USBR will install the two cylindrical fish screens. All of this work will occur in isolation of streamflow from Icicle Creek as described above.

Construction equipment used to break apart boulders and partially demolish existing intake facilities include excavators, a 30-pound pneumatic tool (jackhammer), and upon COR approval, larger jackhammers or similar equipment. Jackhammers will generate impact sounds that result from a rapid release of energy when two objects hit one another. Generally, impact sound propagates in the air, when impact sounds are generated in water, sound waves and vibration will also propagate into the surrounding water. High levels of underwater sound can have negative physiological effects on fish. Some of these effects include tissue damage, temporary hearing loss, behavioral changes or even mortality (Hastings and Popper 2005, p. 4, p. 28-42). The severity of the effect depends on physical, environmental, and biological factors. The amount of noise and vibration that propagates into the Icicle Creek water column is likely to be muffled by the dense cofferdam; at their bases, cofferdams are anticipated to be approximately 12 feet wide. The sound level will also depend on the distance of the source from the Icicle Creek water column. Should the COR approve a larger jackhammer, design specifications limit the sound level to less than blasting. For our analysis, we consider the noise effect threshold up to the sound level of blasting. Washington State Department of Transportation (WSDOT) lists the maximum sound level at 50 feet from the source for mitigated rock fracturing (blasting) as 94 dBA (WSDOT 2020, p. 7.12). The USFWS (2016, p. 10) established peak dB noise thresholds for injury to bull trout at 206 dB for all size classes, and sound exposure levels (SELs) at 187 dB for bull trout greater than two grams, or 183 dB for bull trout less than two grams. Peak dB is expressed as the highest level or amplitude, or greatest absolute sound pressure level during the time of the observation. SEL is expressed as the total amount of energy the bull trout is exposed to in a day from elevated sound pressure levels. A comprehensive review of scientific literature about underwater sound and the effects of anthropogenic noise on the behavior, physiology, and anatomy of fishes concluded that the 206 dB peak level used in conjunction with, or as an alternative to SEL is likely well below the levels that will produce onset of physical effects (Popper et al., 2019, p. 89). It is important to note that the thresholds and studies described above are for underwater sound. The proposed demolition will occur for one month up to 24 hours a day, in the dry behind cofferdams. As described above (Section 9.1.2), Icicle Creek may absorb some of this sound, but the underwater sound level is not known. A large jackhammer may approach 94 dB peak at 50 feet from the source, which is well below the 206 dB established by USFWS for injury to bull trout thus, we believe that bull trout near the work area will not be injured and are likely to avoid the work area and displace into other habitat. Avoidance can cause reduced foraging and sheltering behavior and increase predation and competition in nearby habitat.

Sounds generated by general construction activities in the dewatered work areas during formwork, reinforcement, and pouring concrete, and including operation of sump pumps to dewater work areas, may also result in similar disturbance and displacement effects on nearby bull trout in the Icicle Creek water column. Effects are likely to be of lower intensity than those resulting from demolition, as generated noises are of lower intensity. These effects are expected to occur on a continuous basis, 24 hours a day while construction is ongoing over the in-water work window (July 15 to November 15). Fish within tens of meters of the construction area (both upstream and downstream of the construction area) will likely experience behavioral effects such as avoidance, described above.

9.2.2.6 Water quality – Contaminants and Spills

The use of heavy machinery increases the risk for accidental spills of concrete, fuel, lubricants, hydraulic fluid, or similar contaminants directly into the water, where they could injure or kill aquatic food organisms, or directly expose bull trout to hazardous materials. Similarly, water pumped from the dewatered areas can contain contaminants that are discharged into upland areas. Concrete is rich in calcium and also contains aluminum and iron; all three can readily bind phosphorus. To avoid increases in phosphorus or pH levels in Icicle Creek, concrete used in the intake construction, will be cured in place behind cofferdams for at least four days before exposure to Icicle Creek water.

Construction of the proposed intake facilities are anticipated to occur over a period of five months (July 15 to November 15, 2022). Passage for adult and subadult bull trout will be provided around the in-water work activities throughout the in-water construction period. Adherence to water quality BMPs (Section 4.1) and the construction stormwater pollution and prevention plan are expected to minimize the risk of toxic fuels, lubricants, and concrete spills entering Icicle Creek. Equipment refueling and repair activities will be located at least 150 feet from water bodies, and the use of vegetable-based oils for equipment operating below the OHWM reduce the chance of spilling toxic fuels and lubricants into Icicle Creek. Development and implementation of a pollution and erosion control plan will limit any potential adverse effects of a toxic material spill by ensuring that spill response materials are on site during all construction activities. Water pumped from the dewatering area will be discharged to an upland vegetated location where it can be dispersed and infiltrated, ensuring that potentially contaminated water will not be discharged back into Icicle Creek and that discharged water will not cause erosion. Concrete will be completely cured prior to re-wetting the channel. The USFWS does not anticipate additional effects to bull trout in the action area that have not already been described (e.g., avoidance behavior) (see Section 9.2.2.4 and 9.2.2.5).

9.2.2.7 Light Disturbance

Construction is proposed 24 hours per day during the in-water work period (July 15 to November 15) in 2022 and 2023, and will require lighting and diesel generators to power the lighting. All life stages of bull trout are benthic (stream bottom) and adapted to forage in low-light conditions; a strategy that likely represents optimization of feeding during periods of largest drift abundance while also reducing risk of predation (Banish et al. 2008 p. 182, Thurow et al. 2020 p. 3).

Water depths in the vicinity of the intake construction area are generally shallow, as the channel profile consists of numerous runs and riffles with occasional shallow pools. Consequently, construction lighting is likely to penetrate to the stream bottom in the construction area, affecting approximately 200 linear feet of Icicle Creek. This could have negative consequences for adult bull trout migrating to spawning tributaries in July. PIT-tag detections of bull trout moving upstream through the Chiwawa River weir between June and July (e.g., upstream spawning migration period) indicate that 80 percent move at night between the hours of 9:00 pm and 6:00 am (Unpublished data, on file at USFWS Wenatchee Office). However, this is a relatively short length of stream for adult bull trout to pass through to reach spawning habitat and travel through on their post-spawn migrations to FMO. We anticipate behavioral adjustments and potential migration delays to spawning habitat. Subadult bull trout will likely experience a loss of sheltering and feeding habitat for the duration of construction activities and will likely avoid the affected length of habitat.

9.2.2.8 Reduced Entrainment and Improved Fish Passage

At the conclusion of the 2022 construction season, the fish screens will be installed and a notch in the existing low-head dam will be cut. Under existing conditions, between 2011 and 2019, 63 bull trout were entrained in the LNFH water delivery system (Table 5). Installation of NMFS-compliant screens at the proposed intake facilities will prevent bull trout entrainment in the surface water intake and delivery system. This will prevent injury and stress to bull trout from entrainment in the conveyance pipeline and salvage from the sand settling basin. The proposed screens will be intermittently raised for maintenance or other purposes, such as protection from frazil ice, resulting in temporary unscreened water and possible bull trout entrainment. As discussed in Section 3.1, operation and maintenance activities are covered in a separate ESA Section 7 consultation currently in progress, so these effects are not described further here.

The new proposed fish screens will be located parallel to the flow of Icicle Creek and near the proposed low-flow boulder weir fishway. USBR developed a 2D model to assess fish passage and evaluate impingement risk for juvenile bull trout and steelhead (USBR 2020, pp 20 and 41-43), based on NMFS fish passage criteria (NMFS 2011). The recommended sweeping velocity of 0.8 feet per second, with an approach velocity of 0.4 feet per second will be achieved for an estimated 89 percent of annual flow conditions, or all flows greater than or equal to 100 cfs (58 cfs at the screen)[3]. Downstream migrations occur on the rising limb of the hydrograph in the spring and during fall freshets, when flows are higher and likely to meet sweeping velocity criteria. If downstream migration occurs during flows less than 58 cfs, the low-flow boulder weir fishway has been designed such that if the fish stays within the main current the fish is expected to be transported directly toward the fishway, away from the fish screens. Further, the computed exposure time along the screens at the critical design low flow is less than 60 seconds for all months evaluated for downstream migration (e.g., April, May, September, and October).

[3] Flow probabilities were developed using average mean daily flows in Icicle Creek above the existing intake, thus modeled flows reported for the low-flow boulder weir fishway and roughened channel are 42 cfs higher due to the LNFH withdrawal (e.g., a reported cfs of 100 would measure 58 cfs at the physical location of the intake and fishway/roughened channel). Throughout the remainder of this document, we apply the 42 cfs withdrawal and report modeled flows at the physical site.

This is an improvement over the existing condition where Icicle Creek flows directly into the unscreened and open conveyance channel, entraining bull trout through the water delivery system. Given the design considerations, we expect that all bull trout will be able to move past the fish screens without risk of impingement.

9.2.3 PE – 4 Fish Passage Improvements (Construction of the roughened channel and low-flow boulder weir fishway)

This PE includes construction of the roughened channel and low-flow boulder weir fishway to improve fish passage at the existing low-head diversion dam. This work will occur below the OHWM, in the same footprint as PE 3, and during the July 15 to November 15, 2023, construction season. Constructing these features will expose bull trout to the same stressors as described in 9.2.1. Thus, we do not repeat the effects analysis here for impingement and/or impaired passage while cofferdams are in place; turbidity from cofferdam installation and removal; noise disturbance from demolition and construction, water quality impairments from construction equipment and materials, and light disturbance from 24-hour construction. Fish passage will be provided throughout construction (see Conservation Measure 4.b. in Section 4.1) and similar to the discussion above, the presence of cofferdams B and then C may improve temporary fish passage during the construction window, by concentrating flows and increasing depth in the remaining channel width. However, as described above, this potential beneficial effect may be partially offset if bull trout avoid the area during periods of nighttime construction and noise generating construction. At the conclusion of construction, long-term beneficial effects to bull trout are expected from improved passage over the LNFH water diversion.

The remaining diversion structure crest (e.g., after PE 3 construction) will be buried beneath the proposed roughened channel. The roughened channel crest height will be at a constant elevation of 1,194 feet, the same as the existing diversion structure with stop logs. The upstream extent of the proposed roughened channel crest will be approximately 30 feet upstream of the existing diversion and gradually sloped both upstream and downstream to create a smooth transition and grouted to increase stability and limit seepage. Because of the high velocities present on Icicle Creek, the downstream end of the roughened channel will be tied into the natural boulder drop to prevent potential scour at the toe and headcutting that could erode the roughened channel.

The low-flow notch with a trapezoidal shape cut in the roughened channel crest at the upstream end of the low-flow fishway will encourage low flows to enter the low-flow boulder weir fishway and maintain adequate depths for upstream passage (rather than spilling over the entire crest and creating shallow depths). The low-flow boulder weir fishway is located on river left (looking downstream) so that during low flows, fish will be following the dominant downstream flow vectors in the creek with the fastest velocities to encourage quick transition into the fishway past the screens. The entrance to the fishway will be slightly offset from the intake screens to increase sweeping velocities past the screen at low flows. A series of seven steps created with 2.5 to 3.5-foot rocks with 2.5-foot gaps in between, are proposed to facilitate improved fish passage without requiring jumping over a weir. The downstream end of the fishway is in a backwater created by a natural boulder drop.

The roughened channel including the low-flow fishway is approximately 195 feet long with a 5.5 percent slope. Numerous five to eight foot diameter rocks will be placed in the roughened channel, outside of the low-flow boulder weir fishway, to create additional hydraulic roughness and increase resting areas for fish. Large natural boulders present in the existing channel will remain; except for one large 15-foot boulder that will be removed in the 2022 construction window (see PE 3). The cross-slope between the edge of the fishway to the natural top-of-bank on river right of the roughened channel is mild and varies longitudinally.

USBR (2020) evaluated upstream subadult and adult bull trout passage during high and low stream discharges with the following criteria: one foot depth, less than one foot hydraulic drops between boulder weirs, and flow velocities of less than three feet per second or four feet per second for distances between ten and 100 linear feet (Reclamation 2020, pp. 23-24, and 26-40). In the low-flow boulder weir fishway, fish are expected to burst through the boulder weirs (two to three feet), and then swim through the seven pools (15 feet each). On the roughened channel, fish are expected to burst between low velocity areas behind large boulders located throughout the channel. Recirculation zones (velocity vectors directed upstream) will form along the outer edges of the low-flow fishway and behind boulders in the roughened channel to provide resting areas as fish migrate upstream.

Currently, fish passage at the fish ladder/sediment sluice is impeded because the ladder is located outside of Icicle Creeks' flow path at lower flows. The low-flow boulder weir fishway will provide adequate upstream passage between flows of approximately 75 to 401 cfs (33 to 359 cfs at the fishway, see Footnote 3), meeting both depth and velocity criteria. This will be an improvement over current passage conditions for bull trout, especially at lower flows in the summer and fall. As discharge reaches 401 cfs, the depth criteria are still met but large portions of the fishway have velocity values greater than three feet per second. However, potential swimming paths are available where velocities are lower on the edge areas of the low-flow fishway and the middle portion of the proposed roughened channel where boulders slow velocities and depths would likely be similar to the natural channel.

At approximately 544 cfs, fish passage access shifts to the roughened channel because depths in the roughened channel become passable. At 544 cfs, distance between resting pools in the roughened channel is approximately 12 feet or less. As discharge increases from 544 to 864 cfs, the large boulders along the roughened channel provide adequate low velocity areas however, for the upstream-most 20 feet of the roughened channel, modeled velocity is greater than three feet per second and fish would be required to burst this remaining distance. For flows greater than 864 cfs, low velocity areas behind the large boulders continue to shrink, especially at the upstream end of the roughened channel. Although velocity criteria are not met for flows above 864 cfs, hydraulic conditions in the proposed roughened channel would likely be similar to the surrounding natural channel. Comparison to modeled reference regions downstream of the project area suggest that at most discharges, velocity values less than three feet per second in the natural reach are not attainable. Even at the modeled 1,600 cfs (1,558 cfs), a considerable portion of the roughened channel was below the three foot per second velocity criterion. At these discharges, it is likely that upstream migrating fish will be using low-velocity routes along the roughened channel margins, as they currently are required to in portions of the natural channel. Anglin et al. (2013, pp. 44-46) notes that the existing fish ladder is partially washed out at flows of approximately 1,200 cfs or greater and "…fluvial bull trout… could be moving upstream during the time period that the fishway is washed out, but passage directly over the dam is possible at these higher flows [up to 2,600 cfs]." The proposed roughened channel is expected to improve fish passage at higher flows over existing conditions. While the roughened channel does not meet the three feet per second criteria for the entire length at modeled flows greater than 864 cfs, there are multiple slower velocity zones created by the placed boulders that create velocities equivalent to or slower than adjacent reference areas in Icicle Creek (Reclamation 2020, Appendix D).

As described in our environmental baseline (Section 8.2.1) the greatest limiting factor for bull trout passage at RM 4.5 are low flows during the July through September window when all four water rights holders are exercising their full rights, totaling up to 175 cfs of Icicle Creek flow, and the hydrograph is waning to base flows. The low-flow boulder weir fishway provides passage opportunities at flows as low as 33 cfs, and will benefit adult upstream migration to spawning tributaries and increase access to higher quality FMO habitat above the LNFH intake facilities for subadult and adult bull trout.

9.2.4 PE – 5 Temporary Water Supply to LNFH

Two temporary water supplies for LNFH are proposed during the 2022, 2023, and 2024 construction seasons. In 2022, the primary temporary water supply for LNFH will be via a 24-inch gravity-fed bypass pipeline that will divert 40 cfs from Icicle Creek and deliver to the existing conveyance pipeline. This pipeline will supply the LNFHs water supply for the duration of the in-water work season (July 15 to November 15), with two exceptions to allow for connections and de-connections from the conveyance pipeline. When connections are made in late July 2022 and removed in early November 2022, 40 cfs will be supplied to LNFH by two diesel-powered pumps, located outside the OHWM of Icicle Creek at the spillway pool (RM 2.8). The spillway pool will also be used to maintain a 20 cfs water supply to the LNFH during the replacement/relining of the conveyance pipeline (PE 6) between April 17 and May 20 in 2022, 2023, and 2024. Pumping from the spillway pool will occur 24 hours per day.

The intake to the gravity bypass pipeline will have a trashrack to prevent large debris from entering it, but it will not be screened, and bull trout could be entrained through the bypass and carried through the existing conveyance pipeline to the sand settling basin on the LNFH grounds. This may affect subadult bull trout, and adult bull trout on pre-spawn migrations in July and post-spawn migrations in the fall. We do not expect migratory adult bull trout to be entrained through the bypass, but impingement on the trash rack is possible. Between 2011 and 2019, 63 bull trout were entrained through the existing, unscreened LNFH water delivery system. Most individuals (86 percent of the total) were salvaged between July and October; the other months each had four or less individuals over the nine-year period (Table 5). During construction, while the bypass pipeline is in use, the MCFWCO will monitor the sand settling basin weekly for bull trout and immediately relocate bull trout upstream of LNFH's Structure 2, into favorable habitat (i.e., sufficient depth and temperature). Bull trout that become entrained through the bypass pipeline and recovered in the sand settling basin may be injured due to abrasion in the pipeline and/or experience stress and injury associated with capture and salvage from the sand settling basin and return to Icicle Creek.

The spillway pool provides cool water refugia for bull trout in lower Icicle Creek, and annual snorkel surveys have detected large numbers of large migratory bull trout in this pool in late summer. This is likely because of the cooling effect of the LNFH effluent in the summer when groundwater is pumped into the hatchery and discharged to the river. All life stages of bull trout have been detected in the spillway pool year round. We assume higher numbers of bull trout are in the spillway pool during the summer and early fall when stream temperatures are high. The pump will have fish screens or guards that comply with the most recent fish screening guidelines prescribed by NMFS and USFWS to protect bull trout from entrainment in the intakes. As described in Section 9.2.2.6, the temporary hatchery water supply pump will be located outside of the Icicle Creek OHWM to prevent fuels from entering Icicle Creek. Sound vibrations generated by the pumps may penetrate the substrate and be detectable by bull trout in Icicle Creek. During pumping activities, all life stages of bull trout will be exhibiting FMO behaviors, and their normal behavior (feeding and sheltering) will likely be restricted during pumping. In late July, when stream temperatures are increasing and Icicle Creek is approaching base flow, large numbers of bull trout have been observed in the spillway pool (Table 6). Withdrawing 40 cfs from this pool 24 hours a day for up to one week could reduce the volume of water in the spillway pool. Bull trout, as a highly mobile species, are likely to disperse to other FMO habitat in Icicle Creek. However, in late July, deep cold-water pools are relatively limited compared to FMO habitat that will be available during the 20 cfs withdrawal that will occur in April and May of 2022, 2023, and 2024. The temporary water supply of 40 cfs in July 2022 could degrade this important cold water refugia and displace subadult and adult bull trout to lesser quality habitat causing thermal stress and reduced feeding. The temporary water supply of 20 cfs in 2023 and 2024, and November 2022, may cause bull trout to disperse from the spillway pool however, the adjacent FMO habitat will be more favorable and we do not expect significant impairment of feeding and sheltering behavior.

9.2.5 Summary of Adverse Effects to Bull Trout

Our analysis, identified stressors from the proposed project that can expose bull trout to adverse effects. The potential for impacts to bull trout and their critical habitat is greatest from construction activities below the OHWM. Specifically: fish capture and removal attempts (PE 2); inadvertent stranding and crushing of individuals in the work area (PE 3 and PE 4); degraded habitat (turbidity, chemical contaminants, noise and nighttime lighting) (PE 3 and PE 4); degraded habitat from temporary water supply at the spillway pool (PE 5); and entrainment through temporary water supply (PE 5).

Spatial and temporal patterns of habitat use by bull trout can help identify the life stages likely exposed to the PE stressors. Estimating numbers of individuals exposed and the relative severity of effects requires many assumptions. The most basic assumption is that average conditions in the past can be used as an index of conditions during Project implementation. For this analysis, we rely on the data presented in Section 8.2 to inform patterns of habitat use by bull trout and the potential for exposure to stressors caused by the action.

To estimate adult bull trout exposure, we rely on redd surveys (Table 3) and annual snorkel surveys (Table 4). For subadult exposure, we reviewed entrainment data (Table 5) and used the annual snorkel count data.

For PE 2 (in-water work isolation and fish salvage), the USFWS estimates the maximum number of adult bull trout that could experience physiological stress and or avoidance behaviors during cofferdam construction to be 16 (based on the maximum redd count of eight). As we discussed in Section 8.2, redd counts in Icicle Creek spawning tributaries are variable and incomplete, thus we err on the conservative side with our estimate based on the maximum redd count. We expect migratory adult bull trout to avoid the disturbance caused by the construction of the cofferdams, which could cause migration delays to spawning habitat. We do not expect adult bull trout to be salvaged from within the completed cofferdam due to their expected avoidance behavior to the construction. To estimate the number of subadults that could be captured and handled, we reviewed the annual snorkel survey that occurs in the last week of July or first week of August (e.g., close to the same time period as the cofferdam installations), for the two reaches encompassing the action area (e.g., boulder field to intake, and intake to structure 2). The annual snorkel survey reports include a range of size classes for bull trout including migratory adults, but do not enumerate subadult and adults separately. PIT-tag studies (Nelson and DeHaan, 2015) suggest that 85 percent of bull trout observed in Icicle Creek are subadults. The average number of bull trout observed in the 2012-2019 snorkel surveys is ten and ranges between five and 29; 85 percent of 29 is 25. For our analysis, we believe that 16 migratory adults and 25 subadults is a reasonable representation of bull trout in this vicinity that are likely to experience physiologic stress from cofferdam installation and/or injury from capture and handling stressors. These estimates are for both the 2022 and 2023 construction seasons. We do not expect a cofferdam installation at the PISMA because this area is typically dry during the summer months when construction is proposed (late July to mid-August). However, if isolation and fish capture is necessary, we estimate that a subset of the estimated 30 subadults in the action area once cofferdam A is constructed (see summary of PE 3 and PE 4, below) will experience a second stress event due to capture and handling. Similarly, in 2023, there will be two cofferdams installed (one in early July and one in late August), thus two fish salvage efforts. However, we estimate that a large proportion (75 percent) of subadult bull trout will avoid the area due to the construction-related disturbance occurring between cofferdam installations, and that there will not be additional adult bull trout migrating through during the second cofferdam installation. Thus, the second fish salvage in 2023 will expose six subadult bull trout to the stressors described above.

A subset of the subadults are likely to experience lethal effects from electrofishing, crushing during cofferdam installation, and stranding during dewatering if they are missed during the fish removal activities. We estimate that 10 percent of the subadults may be killed during electrofish capture methods (Snyder et al. 2003, p. 53) and/or crushing and stranding.

For PE 3 and PE 4, the USFWS anticipates sub-lethal effects to bull trout from degraded habitat conditions (e.g., during periods of maximum turbidity from cofferdam installation and removal/rewatering, and disturbance caused by increased sound and nighttime construction lighting). In mid to late July, sediment caused by cofferdam installation could cause behavioral responses to adult bull trout that may still be migrating through this construction area to upstream spawning tributaries. Post-spawn adults moving downstream will be exposed to stressors associated with construction noise, lighting, and sediment pulses when the cofferdams are removed in November. However, our estimate of affected individuals will not increase over the estimate identified for PE 2, as 16 adults represent the maximum number of migratory adults moving upstream to spawning tributaries in both years of construction. For subadult exposure, we use the entrainment data representing the period of construction (July through November) and extrapolate that number based on an estimated entrainment rate of 32 percent[4], because it is highly unlikely that all subadult bull trout are entrained through the water delivery system. These exposures are considered additive to those described for PE 2, to represent immigration and emigration over the period of construction since fish passage will be provided for. For the period July through November the average number of bull trout entrained is 18 (Table 6) therefore, we estimate 30 subadult bull trout will be exposed to degraded habitat conditions during the 2022 and 2023 construction seasons, and are likely to avoid the habitat. This will be a loss of approximately 730 feet (e.g., 200-foot construction footprint plus 230 feet upstream for light and sound buffer, and 300 feet downstream for turbidity plumes and a light and sound buffer) of FMO habitat for a four month period. Although passage will be provided, these disturbances are likely to cause forage disruption, and increased movement to seek shelter and prey. This affected area is inclusive of the PISMA construction disturbance and estimate of bull trout exposure.

For PE 5, we expect subadult life stages to experience the most severe effects from the unscreened gravity-fed bypass system. These include: impingement on the trash rack, resulting in physical injury or death, and entrainment into the water delivery system, resulting in physiologic stress, risk of injury due to abrasion in the pipeline, stress and potential for injury associated with capture and salvage and/or stranding and mortality in the sand settling basin. Unpublished records kept on file at the USFWS' Wenatchee Field Office, indicate that for the period between 2011 and 2019, there have been two occasions of bull trout mortalities associated with impingement on the intake rack and two mortalities in the sand settling basin. There are no records of live migratory adult impingement on the trash rack. For this PE, we estimate that 18 bull trout will be entrained through the temporary gravity-fed bypass based on the average annual count of bull trout entrainments (Table 5) during the July to November construction period, and that four will be killed based on unpublished monitoring data described above. We do not expect additional adult exposure to this PE.

There is a potential for degraded cold-water refugia habitat (reduced pool volume) when the spillway pool is used to provide 40 cfs of water to LNFH. During pumping activities, subadult and adult bull trout are likely to be present and exhibiting FMO behavior. The normal behavior of bull trout will likely be restricted during pumping, but this is expected to be minor, as the spillway pool comprises a very small portion of the available FMO habitat in Icicle Creek. The annual snorkel survey (Table 4) enumerated bull trout observations in three subreaches for the S5 to mouth reach which demonstrates the distribution of bull trout and availability of FMO habitat at a variety of flows in lower Icicle Creek in late July/early August (Table 6). At lower flows (see year 2019 and 2015 in Table 6), more bull trout occupy the spillway pool. Whether this is related to instream temperature or habitat availability is not known. Nonetheless, based on the observations there appears to be habitat available to bull trout in late July that bull trout can disperse to without significant impairment of feeding and sheltering behavior.

[4] We arrived at this value by examining the number of subadults observed during annual snorkel survey count described in PE 2 and the maximum number of bull trout entrained in July and August (Table 5).

Table 6. Distribution of bull trout observations in lower Icicle Creek during annual snorkel surveys in late July/early August.

	Spillway Pool		Spillway Pool to Stumphole		Stumphole to Mouth		Discharge measured at RM 2.2
Year	Total#	Range of size class	Total#	Range of size class	Total#	Range of size class	cfs
2019	26	300-450	2	300	0	-	78
2018	6	310-370	27	270-450	1	250	121
2017	7	250-330	8	310-630	0	-	198
2016	1	300	16	170-310	0	-	179
2015	33	270-630	18	250-450	1	470	103
2014	0	-	23	210-510	0	-	300
2013	1	290	6	110-490	7	250-410	160
2012	0	-	10	190-350	0	-	366
2011	1	450	3	210-410	0	-	530

9.3 Effects to Bull Trout Critical Habitat

Construction will result in approximately 1.1 acres of temporary disturbance to bull trout critical habitat within the Icicle Creek during the 2022 and 2023 in-water work windows as a result of temporary cofferdam installation. Approximately 0.3 acres of critical habitat will be permanently altered due to partial demolition of the existing intake facilities (i.e., low-head diversion dam and fish ladder/sediment sluice) and construction of the creek-width roughened channel and low-flow boulder weir fishway. Approximately 0.11 acres of critical habitat will be permanently lost due to construction of the proposed intake headworks, intake pipeline, and IO&MA. As described below, the Project is most likely to have effects on PCE 2 (Migratory Corridors), PCE 3 (Abundant Food Base), PCE 4 (Complex Habitats), and PCE 8 (Water Quality) of bull trout critical habitat. The USFWS considers these adverse effects to the PCEs to be limited to the action area scale.

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

The channel morphology near PE 3 and PE 4 construction is a step-pool channel type confined within a narrow bedrock canyon. The channel bed consists of large boulders and bedrock armor with sand, gravel and cobble deposits. Turbulence at boulder drops can drive pockets of hyporheic exchange in the streambed; however, the rates of exchange are often rapid and low in residence time (Buffington and Tonina 2009, p. 1043). Approximately 290 cy of concrete will be used in the construction of the creek-width roughened channel and the low-flow boulder weir fishway. Concrete will be used for the crest of the roughened channel (e.g., the existing low-head diversion dam) and at the boulder steps in the low-flow boulder fishway to withstand flood flows. The USFWS does not expect a permanent loss in hyporheic exchange from the concrete grouting as the rocks that will be grouted provide the plunging force to facilitate the hyporheic exchange.

The proposed Project will temporarily alter surface flow patterns during the worksite isolation phases but does not include any elements that will permanently alter surface and subsurface flow paths. Effects to PCE 1 are discountable.

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

During construction of PE 3 and PE 4, temporary migration impacts for subadult and adult bull trout are likely to occur. Although passage will be provided during in-water work periods, bull trout may avoid the construction area during periods of turbidity-generating construction and sound and light disturbance during the two in-water work periods. We consider these construction-related effects to this PCE to be adverse at the action area scale.

At project completion, the Proposed Action will have long-term beneficial effects through improved passage at the existing intake facilities at RM 4.5. The roughened channel and low-flow boulder fishway will improve passage for subadult and adult bull trout at a range of flows over the existing condition (see Section 9.2.3), thus improving access to over 20 miles of high-quality FMO and SR habitat in upper Icicle Creek and bull trout spawning tributaries. Nonetheless, during the 2022 and 2023 in-water work windows (July 1 to November 15), bull trout passage opportunities may be temporarily diminished.

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

Increased turbidity from temporary cofferdam installation and removal, and vegetation removal at the intake construction area will have adverse, short-term effects on the prey base, including benthic macroinvertebrates, and inputs of terrestrial invertebrates, into Icicle Creek. Approximately 0.89 acres of riparian habitat will be disturbed during construction. Following construction, native upland and riparian vegetation will be planted on approximately 0.71 acres; approximately 0.18 acres will be permanently developed. Our opinion is that the extent and severity of these adverse effects on the bull trout food base will result in short term negative impacts to habitat functionality for bull trout. At the scale of the CHSU, the permanent loss of 0.18 acres of near stream vegetation is insignificant to the bull trout's food base.

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

Approximately 0.15 acres of Icicle Creek will be permanently lost due to construction of the proposed intake facilities. The proposed retaining walls for the intake facility are located in the existing diversion's open conveyance channel. Approximately 1,733 cy of earthen material and 410 cy of reinforced concrete will fill this existing channel. The existing habitat in the conveyance channel is not complex and provides very little benefit to bull trout. The new, proposed intake will effectively reduce the width of Icicle Creek by about 25 feet, which may increase stream depth and complement the proposed roughened channel and low-flow boulder fishway habitat complexity (i.e., greater depth over substrate to increase resting and hiding cover).

Turbidity impacts will be short in duration and scale. We expect sediment releases that occur during post-construction precipitation and high-flow events to have insignificant effects on habitat quality due to the likely effectiveness of conservation measures (i.e. hydro seeding and planting). Further, restoration of riparian areas with native vegetation will provide complexity and diversity of habitat in the long-term benefitting future large wood inputs and streambank stability.

It is the USFWS opinion that there will be short-term adverse effects to this PCE. We believe that the long-term benefits described above compensate for the permanent loss of approximately 0.15 acres of poor quality habitat in Icicle Creek.

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

Construction of the intake facilities (PE 3) will permanently prevent the establishment of mature riparian vegetation on approximately 0.18 acres. However, we do not consider this significant relative to the temperature profile of Icicle Creek. In the action area, the steep canyon walls provide shade.

PCE 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

Because critical habitat in the action area is designated FMO, PCE 6 does not apply to critical habitat in the action area. The Proposed Action will have no effect on PCE 6.

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

Improvement of the existing intake access road and construction of the IO&MA and PISMA will increase the area of impermeable surfaces in the action area. Gravel surfacing of the access road will minimize the potential increases and concentration of runoff. The area affected is small and is not expected to influence flow regimes. Effects to this PCE are insignificant.

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

Construction activities will cause temporary flushes of sediment suspension and turbidity during construction and during removal of the cofferdam and rewatering of the work area in Icicle Creek. The introduction of sediment in excess of natural amounts can have multiple adverse effects on bull trout and their habitat (Berry et al. 2003 p. 7; Rhodes et al. 1994 p. 16-21). Low levels of sediment may result in sublethal and behavioral effects to bull trout. We believe that adverse effects to bull trout critical habitat from sediment suspension and turbidity will be reduced by conservation measures employed during the project, but that temporary adverse effects may still occur.

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

Brook trout are present in the action area and in upper Icicle Creek. However, we do not expect the Project to influence the abundance and productivity of brook trout. In the long-term, increased movement opportunities and access to habitat in upper Icicle Creek resulting from the Project, could increase female/male bull trout pairings and reduce the current hybridization between brook trout and bull trout.

9.3.1 Summary of Effects to Bull Trout Critical Habitat

Our opinion is that the Project effects to PCEs 2, 3, 4, and 8 are short-term adverse effects to designated critical habitat, because they reduce the functional capacity of the FMO critical habitat in the action area, which is essential to meet the bull trout conservation needs. While Project effects may reduce the capacity of the action area to support bull trout in the short-term, these adverse effects are limited in extent and unlikely to affect the functional capacity of the Wenatchee River CHSU to support the recovery of bull trout, or diminish the functional capacity of the Columbia River Basin CHU of designated critical habitat.

9.4 Summary of Effects

The proposed action has beneficial, insignificant and adverse effects to bull trout. The action area is essential as a migratory corridor for the maintenance and expansion of the Icicle Creek local population of bull trout, and foraging/cold water refugia for all three core areas in CHU 10. As we described in our Environmental Baseline (Section 8.2), individual bull trout from three core areas in the upper-Columbia region of the MCRU utilize habitat in the action area on a year-round basis. With the combination of GSI and PIT-tag detections, Nelson and DeHaan (2015) estimated that roughly 94 percent of the bull trout in lower Icicle Creek are comprised of individuals from six local populations in the Wenatchee core area (76 percent are from the Icicle and Chiwaukum local populations). The remaining six percent comprise a combination of single populations in both the Entiat and Methow core areas (Nelson and DeHaan 2015, p. 18).

The USFWS anticipates sub-lethal and lethal effects on individual bull trout present in Icicle Creek during the two in-water construction seasons for this Project. Subadult and adult bull trout will be present and exhibiting FMO behavior. Some individuals may experience multiple sub-lethal impacts (e.g., capture and handling, impaired migration, and habitat degradation) on more than one occasion in each construction season, but for the purpose of quantifying effects in Tables 7 and 8 the USFWS assumes all adverse effects (sublethal and lethal) are to different individuals.

Table 7. Bull trout exposure estimate for 2022 construction season.

Activity	Duration	# of Bull Trout Exposed	Severity
Cofferdam Construction and Fish Salvage (PE 2)	July 1-15, 2022[a]	16 adults 25 subadults	16 sublethal 22 sublethal/3 lethal 1 lethal[b]
Construction Disturbance/Degraded Habitat (noise, contaminants, turbidity, lights) (PE 3)	July 15-November 15 2022	30 subadults	30 sublethal
Entrainment (temporary bypass) (PE 5)	July 15-November 15, 2022	18 subadults	14 sublethal 4 lethal

[a] These dates represent the period when cofferdams will be installed, however the duration is not expected to be the whole period.
[b] This represents the fish salvage at the PISMA, if necessary. A subset of the 30 subadults in the action area that could be captured.

Table 8. Bull trout exposure estimate for 2023 construction season and 2024 spillway pumping

Activity	Duration	# of Bull Trout Exposed	Consequences
Cofferdam Construction and Fish Salvage (PE 2)	July 1-15, 2023[a]	16 adults 25 subadults	16 sublethal 22 sublethal/3 lethal
	August 15-30, 2023	6 subadults	5 sublethal/1lethal
Construction Disturbance (noise, contaminants, turbidity, lights) (PE 4)	July 15-November 15, 2023	30 subadults	30 sublethal

[a] These dates represent the period when cofferdams will be installed, however the duration is not expected to be the whole period.

During both construction seasons, the normal FMO behavior of subadult and adult bull trout is likely to be altered by exposure to degraded habitat (PE 3 and PE 4). We expect sublethal effects to be in the form of reductions in physiologic condition due to impairment of feeding and sheltering and behavior. This impact is expected to be minor, but not insignificant. Because bull trout in the adult and sub-adult life stages are highly mobile and relatively flexible in selecting the location, and frequency and duration of FMO use, they are not particularly susceptible to injury resulting from disturbance. We expect relatively mild effects of exposure will allow for complete recovery, and no additive effects of multiple exposures are expected.

Cofferdam construction will likely cause migratory adult bull trout to avoid the construction area and will likely delay the upstream migration of bull trout to their spawning tributaries. This can reduce the probability of larger, more fecund migratory bull trout accessing the habitat and contributing to the numbers, distribution, and reproductive potential of the Icicle Creek local population. However, the small local population of resident bull trout spawning in the headwater tributaries will not be affected by the Project. Overall, we do not expect to see a negative trend in the current distribution or reproductive success of the Icicle local population from in-water work in 2022 and 2023. Most downstream moving bull trout are anticipated to be engaged in FMO behaviors. The magnitude of this effect is smaller than the impacts to upstream migration in terms of implications to life history expression.

We expect sub-adult life stages to experience the most severe effects from the unscreened gravity-fed bypass system supplying the LNFH temporary water supply in the 2022 construction season. The nature of these effects include impingement on the trash rack, resulting in physical injury or death, and entrainment into the water delivery system, resulting in physiologic stress, risk of injury due to abrasion in the pipeline, stress and potential for injury associated with capture and salvage and/or stranding and mortality in the sand settling basin. We anticipate that subadult bull trout will also experience physical injury or death resulting from electrofishing and or crushing and stranding in dewatered work areas. We anticipate up to eight mortalities in 2022 and four mortalities in 2023.

Localized adverse effects to PCE 3 (food base) and PCE 8 (water quality) will occur from construction activities that produce sediment and turbidity in Icicle Creek. In-water construction will also result in short-term adverse effects to PCE 2 (migratory corridors) and PCE 4 (complex habitats). We expect there will be a decrease in utilization of FMO habitat by bull trout during construction (a four-month period in 2022 and 2023); however, these adverse effects are limited in extent and unlikely to affect the functional capacity of the Wenatchee River CHSU to support the recovery of bull trout. In the long-term, the proposed action will improve PCE 2 in the action area. There will also be a permanent loss of critical habitat (0.11 acres) however, this habitat does not currently provide complex habitat; instead it is a water diversion channel for LNFH. The passage improvements and the reduced potential for entrainment that this Project proposes, far outweigh temporary impairments, and long-term, insignificantly small areas of critical habitat removed at the action area scale. Although habitat in Icicle Creek represents only a small portion of critical habitat in the CHU, it remains essential to maintain the connectivity and distribution of bull trout within the Wenatchee core area and the upper Columbia MCRU.

Improving passage opportunities for the migratory life history form is likely to enhance the viability of this local population and its contribution to the survival and recovery needs of the bull trout at the core area, recovery unit, and range-wide scales. Connectivity between Icicle Creek and other bull trout populations will likely enhance the resiliency for core areas in the MCRU, by reestablishing multiple life history forms in the Icicle local population, and enhancing and expanding the FMO habitat in Icicle Creek. Large populations with connectivity to other populations are more resilient to disturbances and may support other local populations within and between core areas. Multiple life history strategies in a population and/or core area help to maintain stability and persistence of environmental changes. Benefits to migratory bull trout include greater growth, greater fecundity, and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3).

On balance, we acknowledge the adverse effects of the proposed action, but suggest the conservation of the species is being advanced, with expectations of increased abundance and distribution of bull trout over time. We suggest the proposed action does not appreciably reduce the likelihood of survival and recovery of the bull trout in the Wenatchee core area, or the upper Columbia region of the MCRU.

10 CUMULATIVE EFFECTS: Bull Trout and Designated Bull Trout Critical Habitat

Cumulative effects include the effects of future state or private activities, not involving federal activities that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Chelan County and WDOE prepared a Final Programmatic Environmental Impact Statement (PEIS) on January 3, 2019. The PEIS is the result of a group of stakeholders (the Icicle Work Group of IWG) representing local, state, and federal agencies; Native American Tribes; irrigation and agricultural interests; and environmental organizations. The IWG developed a water resource management strategy for the Icicle Creek watershed (the Icicle Strategy) aimed at balancing out-of-stream water uses, such as domestic and agricultural uses, with instream uses, such as fish habitat, recreation, and ecosystem processes while protecting treaty and non-treaty fishing interests. The PEIS developed a list of projects that address the water resource issues, and will be used to inform Chelan County, WDOE, and the IWG as work continues on the Icicle Strategy to ensure the guiding principles and goals of the program are met.

Because the action area encompasses an aquatic environment, potential impacts (both beneficial and negative) upstream and downstream may contribute to cumulative effects in the action area. Restorative projects identified in the PEIS that are in development and are expected to be implemented within five years, will likely have cumulative beneficial impacts to bull trout when considered with the improvements proposed with this Project. These include:

1. Actions associated with the Icicle Creek Boulder Field Project (described in Section 8.3). The City of Leavenworth (COL) will screen their diversion on Icicle Creek RM 5.7 in 2021. The COL shares the diversion dam with the Icicle-Peshastin Irrigation District (IPID), drawing their year-round three cfs from the opposite bank of IPIDs diversion. Additionally, the IPID, working with WDFW, will relocate and replace their diversion fish screen to bring the screens up to current state and federal criteria. This work is expected in the fall of 2021 or spring 2022. Currently, the fish bypass in the irrigation canal returns fish to Icicle Creek via a 15-foot drop onto a boulder that is not submerged for most of the irrigation season.

2. Following these screening projects, fish passage improvements are proposed at the diversion dam that diverts water to COL and IPID. Monitoring of fish passage at the boulder field is expected to inform project design for the IPID/COL diversion dam.

3. The IPID Irrigation Efficiencies Project includes traditional irrigation efficiency upgrades such as canal lining or piping of irrigation ditches. A water savings of approximately

10.1 cfs annually could be achieved in lower Icicle Creek, including the action area from implementing efficiency upgrades that will be identified in the IPID Comprehensive Water Conservation Plan (Chelan County and WDOE 2019).

4. The Cascade Orchards Irrigation Company (COIC) Irrigation Efficiencies Project consists of installing a piped and pressurized system, and replacing the current gravity-fed diversion shared with LNFH. Improvements would also include replacement of the open ditch system with a closed-pipe canal and laterals to improve efficiency. The COIC project would restore 11.9 cfs annually to lower Icicle Creek. The new diversion is located on private property at RM 1.9, approximately 0.4 miles downstream of the SWISP Project's action area. The SWISP Project design assumed that COICs new intake will be completed prior to LNFHs SWISP Project.

The overall purpose of these projects is to remove fish barriers and increase instream flows to improve fish passage to more than 20 miles of high quality habitat. Some of these actions may occur prior to SWISP construction in 2022, or concurrently with SWISP construction. Each construction action by itself may have localized impacts to bull trout, but taken together they may substantively improve the environmental baseline and habitat conditions for bull trout. Improving passage opportunities for the migratory life history form is likely to enhance the viability of the Icicle local population and its contribution to the survival and recovery needs of the bull trout at the core area, recovery unit, and range-wide scales.

As the human population in Washington State continues to grow, residential growth and demand for dispersed and developed recreation is likely to occur, including areas within the lower Icicle Creek watershed. This trend is likely to result in increasing habitat degradation from riparian development, levee building, bank armoring, and general recreation use. There are a number of State and private interest approaches that address potential impacts from urban development within the broader region encompassing the action area. These approaches include initiatives under Critical Areas Ordinances and measures associated with the State's Shoreline Management Act (SMA). Many cities and counties in Washington are required to adopt Critical Areas Ordinances under the State's Growth Management Act. Among other concerns, the ordinances address important fish and wildlife habitats, including wetlands, rivers, streams, lakes, and marine shorelines. The SMA seeks to prevent harm to identified resources due to haphazard development of State shorelines. The responsibilities of local governments under the SMA, with support and oversight provided by the Washington Department of Ecology, include: 1) administering a shoreline permit system for proposed substantial development; 2) conducting and compiling a shoreline inventory; and 3) developing a Shoreline Master Program for regulating the State's shorelines. Chelan County recently completed a river recreation study for portions of the Wenatchee River and Icicle Creek that flow through the city of Leavenworth, acknowledging that river recreation impacts habitat for Endangered Species Act species including bull trout (Chelan County 2020, entire). We expect that this survey will result in future actions to address the significant impact river recreation is having on the environment of these water bodies.

Despite these local permitting requirements and regulations, our observations are that the river recreation impacts will be the greatest challenge to manage in the near future. River recreation and associated activities tend to remove riparian vegetation, reduce stream shade (and increase stream temperature), and disturb stream bottom substrates. The direct effects to bull trout are not quantified, however the habitat effects coupled with direct disturbance to individuals from river recreation, can undermine the improvement in habitat conditions that are underway and planned that are necessary for bull trout to survive and recover.

11 INTEGRATION AND SYNTHESIS OF EFFECTS: Bull Trout and Designated Bull Trout Critical Habitat

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action and cumulative effects to the environmental baseline and, in light of the status of the species and critical habitat, formulate the Service's opinion as to whether the action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

USBR is proposing to rehabilitate, replace, and modernize the LNFH surface water intake and delivery system by constructing new intake facilities with fish screens, a creek-width roughened channel with low-flow fish passage, and replacing and lining the water conveyance pipeline to LNFH. The NMFS biological opinion for LNFH operations requires the LNFH to have a surface water intake and delivery system that complies with NMFS current screening and fish passage criteria for anadromous fish passage facilities in place and operating by May 2023. Conservation Measures described in Section 4.1 of this Opinion are proposed to prevent impacts to bull trout and their designated critical habitat during construction.

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering; road construction and maintenance, mining, and grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment; and introduced non-native species (64 FR 58910). The rangewide status of the bull trout is variable among and within the six recovery units that comprise the threatened coterminous U.S. Population. Each of these 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.

The proposed Project occurs in the upper Columbia geographic region of the MCRU. The current condition of bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g., irrigation, water withdrawals, livestock grazing), fish passage (e.g., dams, culverts), nonnative species, forest management practices, and mining. The MCRU is especially important to the survival and recovery of the bull trout because it contains nearly 80 percent of all core areas rangewide, and over 80 percent of all local populations within the coterminous U.S. range of the bull trout. The MCRU is large, and contains a mix of core areas with increasing, stable, and declining demographic trends. The Service expects climate change to continue to reduce the resilience and demographic performance of bull trout across the MCRU.

In the Environmental Baseline (Section 8.2), we established that the action area includes FMO habitat utilized by eight local populations in the MCRU, roughly 94 percent of the bull trout in Icicle Creek are from the Wenatchee core area; 76 percent are from the Icicle and Chiwaukum local populations (Nelson and DeHaan 2015, p. 18). Much smaller proportions of subadults from the Entiat and Methow core areas have been identified in the action area. Bull trout are widely distributed in the Wenatchee core area and local populations are connected to FMO habitat in Lake Wenatchee, the Wenatchee River, and the Columbia River. Nelson and DeHaan also demonstrated that the FMO habitat in Icicle Creek is connected to the stream network of the upper Mid-Columbia geographic region of the MCRU (Nelson and DeHaan 2015, entire).

Construction of the Project will cause adverse effects to bull trout. The baseline condition of the Icicle local population is the least resilient in the Wenatchee core area, due to its partial isolation resulting from low stream flows and instream barriers, low abundance, and dominance by the resident life-history form. At the same time, the Project will improve passage opportunities over the baseline condition and reduce entrainment in the LNFH water delivery system. These beneficial effects outweigh the short-term construction related impacts, and we suggest that the overall conservation of the species is advanced by addressing the primary threats to bull trout in Icicle Creek (e.g., low stream flow, passage, entrainment) with this Project and in combination with future restoration actions (see Section 10).

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898). The action area is located in the Wenatchee CHSU (Wenatchee core area). The Wenatchee CHSU supports one of the largest populations of bull trout and some of the most connected habitat in CHU 10. As described in the Environmental Baseline (Section 8.3), six of the eight PCEs related to FMO are "not properly functioning" in the action area. This suggests little resiliency to endure additional adverse effects at the local scale in terms of determining whether the conservation role of the entire CHSU is being fulfilled. However, the scale of the action area and impacts to critical habitat are small relative to the CHSU. Significant impacts (i.e., additional consumptive water use, additional passage barriers) would need to be proposed to change the current function of the CHSU. The Project will cause short-term adverse localized effects to PCE 2, 3, and 8 during construction. Positive aspects of the proposed action (i.e., improved passage opportunities, PCE 2) and future complementary actions that reduce entrainment, improve passage to higher quality habitat above RM 5.7, and increase streamflow, are more potent and long-term than the temporary, localized impacts caused by construction.

The proposed action will improve passage and reduce entrainment at the LNFH water supply diversion. The function of the FMO to provide connectivity for local populations in the Wenatchee core area will likely be improved. We expect more migratory bull trout to spawn in upper Icicle Creek in future years; increased spawning will increase abundance and genetic exchange over time. The proposed action will also improve the survival of multiple local populations in the upper Columbia MCRU, as fewer bull trout are entrained through the LNFH water supply. We believe that the scope and scale of these improvements are too limited at the CHSU scale to result in changes in the reproduction, numbers, or distribution of bull trout in the upper Columbia region of the MCRU.

12 CONCLUSION: Bull Trout and Designated Bull Trout Critical Habitat

After reviewing the current status of bull trout, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the USFWS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout or is not likely to destroy or adversely modify designated critical habitat.

13 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. *Harm* is defined by the USFWS as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the USFWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the USBR for the exemption in section 7(o)(2) to apply. The USBR has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the USBR fails to assume and implement the terms and conditions of the Incidental Take Statement, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USBR must report the progress of the action and its impact on the species to the USFWS as specified in this Incidental Take Statement [50 CFR 402.14(i)(3)].

14 AMOUNT OR EXTENT OF TAKE

In the 2022 construction season, the USFWS anticipates up to 89 bull trout will be taken as a result of implementing the Project. In 2023 up to 77 bull trout will be taken. The form of take will be caused by Project Elements (PEs) 2, 3, 4, and 5, as described in detail in Section 9.2, and summarized below:

1. PE 2 will harm up to 25 subadults in the 2022 construction season, from capture, handling, and release of affected bull trout during fish salvage within the constructed cofferdams. Up to 16 adult bull trout will be harmed from delayed spawning migration in addition to the stressors of capture and handling. We estimate that up to four subadults

will be killed from electrofishing and/or crushing during cofferdam installation and stranding within the dewatered cofferdam. This PE will be implemented again in 2023 and will require two fish salvage efforts (one in early July and one in late August). Up to 31 subadults and 16 adults will be harmed. We estimate that up to four bull trout will be killed from the two salvage efforts as a result of electrofishing or stranding and crushing.

2. PE 3 and PE 4 will harass up to 30 subadult bull trout by degrading habitat quality (i.e., sound and light disturbance, and turbidity) during construction of the new intake facilities (PE 3 in 2022) and the roughened channel and low flow fishway (PE 4 in 2023). Construction activities will last up to four months between July 1 and November 15, each year.

3. PE 5 will harm 18 subadult bull trout from entrainment into the unscreened gravity fed bypass at RM 4.5 supplying temporary water to LNFH in 2022 while the new intake facilities are constructed (mid-July to early November). Entrained bull trout will be captured and released from the sand settling basin. We estimate up to four mortalities.

The amount of incidental take expected to occur by year, and stratified by PE, severity of effect, and bull trout life history stage, is summarized in Table 9.

Table 9. Summary of anticipated incidental take of the bull trout by Project Element, severity of effect, and bull trout life history stage.

Life History Stage and Construction Year (CY)	PE 2: Cofferdam Construction and Fish Salvage		PE 3: Intake Construction	PE 4: Roughened Channel/Low Flow Channel Construction	PE 5: Temporary Water Supply	
	Harm (Lethal)	Harm (Sublethal)	Harassment	Harassment	Harm (Lethal)	Harm (Sublethal)
CY 2022						
Adult	0	16	0	N/A		
Subadult	4 [a]	21	30	N/A	4	14
Total (2022)	4	37	30	N/A	4	14
CY 2023						
Adult	0	16	N/A	0	0	0
Subadult	4	27	N/A	30	0	0
Total (2023)	4	43	N/A	30	0	0

[a] We estimate that one of the four bull trout reported here will be a mortality from the fish salvage at the PISMA, if dewatering that work area is necessary.

The USFWS anticipates incidental take caused by PE 3 and 4 will be difficult to detect for the following reason(s): the low likelihood of finding dead or injured adults and subadults; delayed mortality; and the sublethal nature of some of the effects. However, pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an Incidental Take Statement, provided three criteria are met: (1) measuring take impacts to a listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded.

The USFWS' regulations state that significant habitat modification or degradation caused by an action that results in death or injury to a listed species by significantly impairing its essential behavior patterns constitutes take in the form of harm. Those regulations further state that an intentional or negligent act or omission that creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt its normal behavioral patterns constitutes take in the form of harass. Such annoyance can be caused by actions that modify or degrade habitat conditions (e.g., excessive noise or smoke). In cases where this causal link between effects of a federal action to habitat and take of listed species is established, and the biological opinion or incidental take statement explains why it is not practical to express and monitor the level of take in terms of individuals of the listed species, the USFWS' regulations authorize the use of habitat as a surrogate for expressing and monitoring the anticipated level of take, provided a clear standard is established for determining when the level of anticipated take has been exceeded.

The following narrative presents the USFWS' analysis and findings with respect to the three regulatory criteria for use of a surrogate in this Incidental Take Statement (ITS) to express the anticipated level of take likely to be caused by PE 3 and PE4.

1. Measuring the amount of incidental take caused by PE 3 and PE 4 would result in more harassment to bull trout than the Project alone, as it would require capturing, tagging, and radio-tracking individual bull trout to monitor the take impacts to individual bull trout across the action area. Such an undertaking is outside the scope of the proposed action, is not practicable to implement, and would pose additional risk of harm through capture and handling of individuals.

2. A link is established between the effects of the action on water quality, habitat quality, and bull trout, and take of the bull trout. In the accompanying Opinion, we have provided a detailed analysis of how the anticipated habitat effects are reasonably certain to significantly disrupt normal bull trout behavior in FMO habitat, and how the anticipated habitat effects are reasonably certain to create a likelihood of injury caused by avoidance behaviors, abandonment of shelter, reductions in feeding, and/or gill irritation.

3. A clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded. In the accompanying analysis, we specifically identified the extent of the construction disturbance causing degraded FMO habitat. This includes the construction area estimated to be 200 feet long with a 230 foot buffer upstream and a 300 foot buffer downstream. Therefore, harassment take is limited to 230 feet upstream and 300 feet downstream of each cofferdam work area between July 1 and November 15, 2022 and 2023. If the work area increases and/or if the turbidity plume exceeds a distance greater than 300 feet, or activities below the OHWM occur before July 1 or continue beyond November 15, the level of take anticipated in this ITS will be exceeded, triggering reinitiation of formal consultation under section 7 of the Act.

The capture and handling of bull trout for salvage purposes described under PE 2 and PE 5 will result in direct take (kill, capture, injury). However, the direct take resulting from salvage operations will minimize the incidental take of individual bull trout from instream construction and dewatering activities. Monitoring the amount of incidental take caused by PE 2 and PE 5 shall consist of counting the number of individual bull trout captured during each fish salvage effort, and those entrained through the gravity fed bypass and captured in the sand settling basin in the 2022 construction season. If the number of bull trout handled exceeds the amounts by life stage and year in Table 9, the level of take anticipated in this ITS will be exceeded, triggering reinitiation of formal consultation under Section 7 of the Act.

15 EFFECT OF THE TAKE

In the accompanying Opinion, the USFWS determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

16 REASONABLE AND PRUDENT MEASURES

The conservation measures negotiated in cooperation with the USFWS and included as part of the proposed action (Section 4.1) constitute all of the reasonable measures necessary to minimize the impacts of incidental take. On that basis, no RPMs except for monitoring and reporting requirements are included in this Incidental Take Statement.

RPM 1: Monitor implementation of the proposed action and report the results of that monitoring to ensure that the level of take exemption provided under this Incidental Take Statement is not exceeded.

17 TERMS AND CONDITIONS

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

To implement RPM 1:

T&C 1. The USBR shall prepare a report describing the progress of the proposed Project, including implementation of the associated terms and condition, and impacts to the bull trout (50 CFR § 402.14(i)(1)(iv) and 402.14(i)(3). The report, which shall be submitted to the Central Washington Field Office on or before April 1 of the year following monitoring, shall list and describe:

1. Results of fish capture and handling for all fish removal events at the intake construction area, and for bull trout entrained in the temporary water supply and captured in the sand settling basin. Include number and life stages of affected individuals detected, condition, and release locations.

2. Observations of bull trout impinged on the cofferdam walls. Include number and life stages of affected individuals detected, condition, and release locations. Note, all adult migratory bull trout will be released upstream of block nets and the construction area at RM 4.5.

3. Any observations of injured and/or dead bull trout in the action area, beyond the situations described above. Include the number, location, and life stages of affected individuals.

4. Results of turbidity monitoring during cofferdam construction and removal.

5. Implementation of any conservation recommendations.

6. Submit reports to USFWS' Central Washington Field Office at the address below:

U.S. Fish and Wildlife Service
Central Washington Field Office
Attn: SWISP (01EWFW00-2021-F-0063)
215 Melody Lane, Suite 103
Wenatchee, WA 98801

The USFWS has determined that no more than 166 bull trout and 730 feet of Icicle Creek FMO habitat will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The federal agency must immediately provide an explanation of the causes of the taking and review with the USFWS need for possible modification of the reasonable and prudent measures.

The USFWS 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 USFWS' Central Washington Fish and Wildlife Office at (509) 665-3508.

18 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.

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

1. The spillway pool at RM 2.8, provides important cool water refugia for bull trout from local populations throughout the upper Columbia region of the MCRU. To minimize effects to this habitat while supplying the temporary water supply of 40 cfs to the LNFH in July of 2022, monitor the pool volume and do not exceed a 10 percent reduction in pool volume and/or ten percent of the surface flow from the source stream. This will provide adequate downstream flow to support fish, aquatic insects, amphibians, and other biota (Macedo 2001, p. 7).

2. The USFWS recommends that USBR include bull trout passage monitoring with their proposed annual effectiveness monitoring of the roughened channel and low-flow boulder weir fishway. We recommend coordination with the MCFWCO and Central Washington Field Office in developing the monitoring plan. The bull trout passage monitoring should include the time of year and corresponding stream flow when bull trout pass through these improved instream features.

3. While not federally listed, the Pacific lamprey (*Entosphenus tridentatus*) is of high value (culturally, ecologically, and environmentally) to many entities in the Pacific Northwest. The USFWS recommends the USBR consider the biological needs of lamprey for all projects requiring instream or near-stream projects, or projects that affect passage. Please see Appendix D for Conservation Recommendations for Pacific Lamprey.

4. While no species of freshwater mussels are federally listed in the Pacific Northwest, they are of high value (culturally, ecologically, and environmentally) to many entities. The USFWS recommends that the USBR consider the biological needs of all freshwater mussel species for all projects requiring instream or near-stream projects. Please see Appendix D for Conservation Recommendations for Freshwater Mussels.

19 REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request for formal consultation. As provided in 50 CFR 402.16, reinitiation of formal consultation is required and shall be requested by the federal agency or by the Service, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or (d) if a new species is listed or critical habitat designated that may be affected by the identified action.

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PERSONAL COMMUNICATIONS

Malenna Cappellini, Environmental Compliance Biologist, Leavenworth Fisheries Complex. May 19, 2020, email regarding alternative operations and additions to the LNFH abatement ponds.

APPENDIX A:
STATUS OF THE SPECIES: BULL TROUT

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Appendix: A
Status of the Species: Bull Trout

Taxonomy

The bull trout (*Salvelinus confluentus*) is a native char found in the coastal and intermountain west of North America. Dolly Varden (*Salvelinus malma)* and bull trout were previously considered a single species and were thought to have coastal and interior forms. However, Cavender (1978, entire) described morphometric, meristic and osteological characteristics of the two forms, and provided evidence of specific distinctions between the two. Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, there is little evidence of introgression (Haas and McPhail 1991, p. 2191). The Columbia River Basin is considered the region of origin for the bull trout. From the Columbia, dispersal to other drainage systems was accomplished by marine migration and headwater stream capture. Behnke (2002, p. 297) postulated dispersion to drainages east of the continental divide may have occurred through the North and South Saskatchewan Rivers (Hudson Bay drainage) and the Yukon River system. Marine dispersal may have occurred from Puget Sound north to the Fraser, Skeena and Taku Rivers of British Columbia.

Species Description

Bull trout have unusually large heads and mouths for salmonids. Their body colors can vary tremendously depending on their environment, but are often brownish green with lighter (often ranging from pale yellow to crimson) colored spots running along their dorsa and flanks, with spots being absent on the dorsal fin, and light colored to white under bellies. They have white leading edges on their fins, as do other species of char. Bull trout have been measured as large as 103 centimeters (41 inches) in length, with weights as high as 14.5 kilograms (32 pounds) (Fishbase 2015, p. 1). Bull trout may be migratory, moving throughout large river systems, lakes, and even the ocean in coastal populations, or they may be resident, remaining in the same stream their entire lives (Rieman and McIntyre 1993, p. 2; Brenkman and Corbett 2005, p. 1077). Migratory bull trout are typically larger than resident bull trout (USFWS 1998, p. 31668).

Legal Status

The coterminous United States population of the bull trout was listed as threatened on November 1, 1999 (USFWS 1999, entire). 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 (USFWS 1999, p. 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, entire; Rieman et al. 2007, entire; Porter and Nelitz. 2009, pages 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

Life History

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, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, p. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 1). 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, p. 1; Ratliff and Howell 1992, p. 10).

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, p. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). 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, p. 10). 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, Ch 2 pp.

23-24). 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.

Population Dynamics

Population Structure

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, p. 2). 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 (Goetz 1989, p. 15). 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, p. 138; Goetz 1989, p. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, p. i; WDFW et al. 1997, p. 16). 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, p. 135; Leathe and Graham 1982, p. 95; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream habitats. Resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Brenkman and Corbett 2005, pp. 1075-1076; Goetz et al. 2004, p. 105). 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, pp. 96, 98-106). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3). 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, p. 2).

Whitesel et al. (2004, p. 2) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003, entire) best summarized genetic information on bull trout population structure. Spruell et al. (2003, entire) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003, p. 17). They were characterized as:

i. "Coastal", including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.

ii. "Snake River", which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.

iii. "Upper Columbia River" which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003, p. 25) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003, p. 17) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999, entire) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003, p. 328) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell et al. (2003, p. 26) and the biogeographic analysis of Haas and McPhail (2001, entire). Both Taylor et al. (1999, p. 1166) and Spruell et al. (2003, p. 21) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the U.S. Fish and Wildlife Service (Service) identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011, p. 18). Based on a recommendation in the Service's 5-year review of the species' status (USFWS 2008a, p. 45), the Service reanalyzed the 27 recovery units identified in the draft bull trout recovery plan (USFWS 2002a, p. 48) by utilizing, in part, information from previous genetic studies and new information from additional analysis (Ardren et al. 2011, entire). In this examination, the Service applied relevant factors from the joint Service and National Marine Fisheries Service Distinct Population Segment (DPS) policy (USFWS 1996, entire) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (USFWS 2010, p. 63898). The six draft recovery units identified for bull trout in the coterminous United States include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. These six draft recovery units were also identified in the Service's revised recovery plan (USFWS 2015, p. vii) and designated as final recovery units.

Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 4). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991, entire). Burkey (1989, entire) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, entire; Burkey 1995, entire).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, p. 15; Dunham and Rieman 1999, entire; Rieman and Dunham 2000, entire). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994, pp. 189-190). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000, entire). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, pp. 10-12; Dunham and Rieman 1999, p. 645; Spruell et al. 1999, pp. 118-120; Rieman and Dunham 2000, p. 55).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999, entire). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999, entire) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000, pp. 56-57). Recent research (Whiteley et al. 2003, entire) does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho.

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 4). 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, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, p. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) 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, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, p. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 2; Spruell et al. 1999, entire). 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, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, p. 137; Pratt 1992, p. 5; Rieman and McIntyre 1993, p. 2).

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 (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, p. 4; Goetz 1989, p. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, p. 900) 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.

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, p. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and McIntyre 1995, p. 287). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

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, p. 137; Goetz 1989, p. 19; Hoelscher and Bjornn 1989, p. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, p. 238). Maintaining bull trout habitat requires natural stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, p. 364). 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, p. 141; Pratt 1992, p. 6; Pratt and Huston 1993, p. 70). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005, pp. 195-200). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 242-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Donald and Alger 1993, pp. 241-243; Fraley and Shepard 1989, pp. 135, 138; Leathe and Graham 1982, pp. 13, 50-56). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001, p. 204). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 105; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. 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, p. 25). 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, pp. 1078-1079; Goetz et al. 2004, entire).

Status and Distribution

Distribution and Demography

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, pp. 165-166; Bond 1992, p. 2). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992, p. 2). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, pp. 165-166; Brewin et al. 1997, entire).

Each of the following recovery units (below) 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. No new local populations have been identified and no local populations have been lost since listing.

Coastal Recovery Unit

The Coastal Recovery Unit is located within western Oregon and Washington. Major geographic regions include the Olympic Peninsula, Puget Sound, and Lower Columbia River basins. The Olympic Peninsula and Puget Sound geographic regions also include their associated marine waters (Puget Sound, Hood Canal, Strait of Juan de Fuca, and Pacific Coast), which are critical in supporting the anadromous[1] life history form, unique to the Coastal Recovery Unit. The Coastal Recovery Unit is also the only unit that overlaps with the distribution of Dolly Varden (*Salvelinus malma*) (Ardren *et al.* 2011), another native char species that looks very similar to the bull trout (Haas and McPhail 1991). The two species have likely had some level of historic introgression in this part of their range (Redenbach and Taylor 2002). The Lower Columbia River major geographic region includes the lower mainstem Columbia River, an important migratory waterway essential for providing habitat and population connectivity within this region. In the Coastal Recovery Unit, there are 21 existing bull trout core areas which have been designated, including the recently reintroduced Clackamas River population, and 4 core areas have been identified that could be re-established. Core areas within the recovery unit are distributed among these three major geographic regions (Puget Sound also includes one core area that is actually part of the lower Fraser River system in British Columbia, Canada) (USFWS 2015a, p. A-1).

The current demographic status of bull trout in the Coastal Recovery Unit is variable across the unit. Populations in the Puget Sound region generally tend to have better demographic status, followed by the Olympic Peninsula, and finally the Lower Columbia River region. However, population strongholds do exist across the three regions. The Lower Skagit River and Upper Skagit River core areas in the Puget Sound region likely contain two of the most abundant bull trout populations with some of the most intact habitat within this recovery unit. The Lower Deschutes River core area in the Lower Columbia River region also contains a very abundant bull trout population and has been used as a donor stock for re-establishing the Clackamas River population (USFWS 2015a, p. A-6).

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[1] Anadromous: Life history pattern of spawning and rearing in fresh water and migrating to salt water areas to mature.

Puget Sound Region

In the Puget Sound region, bull trout populations are concentrated along the eastern side of Puget Sound with most core areas concentrated in central and northern Puget Sound.

Although the Chilliwack River core area is considered part of this region, it is technically connected to the Fraser River system and is transboundary with British Columbia making its distribution unique within the region. Most core areas support a mix of anadromous and fluvial life history forms, with at least two core areas containing a natural adfluvial life history (Chilliwack River core area [Chilliwack Lake] and Chester Morse Lake core area). Overall demographic status of core areas generally improves as you move from south Puget Sound to north Puget Sound. Although comprehensive trend data are lacking, the current condition of core areas within this region are likely stable overall, although some at depressed abundances. Two core areas (Puyallup River and Stillaguamish River) contain local populations at either very low abundances (Upper Puyallup and Mowich Rivers) or that have likely become locally extirpated (Upper Deer Creek, South Fork Canyon Creek, and Greenwater River). Connectivity among and within core areas of this region is generally intact. Most core areas in this region still have significant amounts of headwater habitat within protected and relatively pristine areas (e.g., North Cascades National Park, Mount Rainier National Park, Skagit Valley Provincial Park, Manning Provincial Park, and various wilderness or recreation areas) (USFWS 2015a, p. A-7).

Olympic Peninsula Region

In the Olympic Peninsula region, distribution of core areas is somewhat disjunct, with only one located on the west side of Hood Canal on the eastern side of the peninsula, two along the Strait of Juan de Fuca on the northern side of the peninsula, and three along the Pacific Coast on the western side of the peninsula. Most core areas support a mix of anadromous and fluvial life history forms, with at least one core area also supporting a natural adfluvial life history (Quinault River core area [Quinault Lake]). Demographic status of core areas is poorest in Hood Canal and Strait of Juan de Fuca, while core areas along the Pacific Coast of Washington likely have the best demographic status in this region. The connectivity between core areas in these disjunct regions is believed to be naturally low due to the geographic distance between them.

Internal connectivity is currently poor within the Skokomish River core area (Hood Canal) and is being restored in the Elwha River core area (Strait of Juan de Fuca). Most core areas in this region still have their headwater habitats within relatively protected areas (Olympic National Park and wilderness areas) (USFWS 2015a, p. A-7).

Lower Columbia River Region

In the Lower Columbia River region, the majority of core areas are distributed along the Cascade Crest on the Oregon side of the Columbia River. Only two of the seven core areas in this region are in Washington. Most core areas in the region historically supported a fluvial life history form, but many are now adfluvial due to reservoir construction. However, there is at least one core area supporting a natural adfluvial life history (Odell Lake) and one supporting a natural, isolated, resident life history (Klickitat River [West Fork Klickitat]). Status is highly variable across this region, with one relative stronghold (Lower Deschutes core area) existing on the Oregon side of the Columbia River. The Lower Columbia River region also contains three watersheds (North Santiam River, Upper Deschutes River, and White Salmon River) that could potentially become re-established core areas within the Coastal Recovery Unit. Although the South Santiam River has been identified as a historic core area, there remains uncertainty as to whether or not historical observations of bull trout represented a self-sustaining population. Current habitat conditions in the South Santiam River are thought to be unable to support bull trout spawning and rearing. Adult abundances within the majority of core areas in this region are relatively low, generally 300 or fewer individuals.

Most core populations in this region are not only isolated from one another due to dams or natural barriers, but they are internally fragmented as a result of manmade barriers. Local populations are often disconnected from one another or from potential foraging habitat. In the Coastal Recovery Unit, adult abundance may be lowest in the Hood River and Odell Lake core areas, which each contain fewer than 100 adults. Bull trout were reintroduced in the Middle Fork Willamette River in 1990 above Hills Creek Reservoir. Successful reproduction was first documented in 2006, and has occurred each year since (USFWS 2015a, p. A-8). Natural reproducing populations of bull trout are present in the McKenzie River basin (USFWS 2008d, pp. 65-67). Bull trout were more recently reintroduced into the Clackamas River basin in the summer of 2011 after an extensive feasibility analysis (Shively et al. 2007, Hudson et al. 2015). Bull trout from the Lower Deschutes core area are being utilized for this reintroduction effort (USFWS 2015a, p. A-8).

Klamath Recovery Unit

Bull trout in the Klamath Recovery Unit have been isolated from other bull trout populations for the past 10,000 years and are recognized as evolutionarily and genetically distinct (Minckley et al. 1986; Leary et al. 1993; Whitesel et al. 2004; USFWS 2008a; Ardren et al. 2011). As such, there is no opportunity for bull trout in another recovery unit to naturally re- colonize the Klamath Recovery Unit if it were to become extirpated. The Klamath Recovery Unit lies at the southern edge of the species range and occurs in an arid portion of the range of bull trout.

Bull trout were once widespread within the Klamath River basin (Gilbert 1897; Dambacher et al. 1992; Ziller 1992; USFWS 2002b), but habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, and past fisheries management practices have greatly reduced their distribution. Bull trout abundance also has been severely reduced, and the remaining populations are highly fragmented and vulnerable to natural or manmade factors that place them at a high risk of extirpation (USFWS 2002b). The presence of nonnative brook trout (*Salvelinus fontinalis*), which compete and hybridize with bull trout, is a particular threat to bull trout persistence throughout the Klamath Recovery Unit (USFWS 2015b, pp. B-3-4).

Upper Klamath Lake Core Area

The Upper Klamath Lake core area comprises two bull trout local populations (Sun Creek and Threemile Creek). These local populations likely face an increased risk of extirpation because they are isolated and not interconnected with each other. Extirpation of other local populations in the Upper Klamath Lake core area has occurred in recent times (1970s). Populations in this core area are genetically distinct from those in the other two core areas in the Klamath Recovery Unit (USFWS 2008b), and in comparison, genetic variation within this core area is lowest. The two local populations have been isolated by habitat fragmentation and have experienced population bottlenecks. As such, currently unoccupied habitat is needed to restore connectivity between the two local populations and to establish additional populations. This unoccupied habitat includes canals, which now provide the only means of connectivity as migratory corridors. Providing full volitional connectivity for bull trout, however, also introduces the risk of invasion by brook trout, which are abundant in this core area.

Bull trout in the Upper Klamath Lake core area formerly occupied Annie Creek, Sevenmile Creek, Cherry Creek, and Fort Creek, but are now extirpated from these locations. The last remaining local populations, Sun Creek and Threemile Creek, have received focused attention. Brook trout have been removed from bull trout occupied reaches, and these reaches have been intentionally isolated to prevent brook trout reinvasion. As such, over the past few generations these populations have become stable and have increased in distribution and abundance. In 1996, the Threemile Creek population had approximately 50 fish that occupied a 1.4-km (0.9-mile) reach (USFWS 2002b). In 2012, a mark-resight population estimate was completed in Threemile Creek, which indicated an abundance of 577 (95 percent confidence interval = 475 to 679) age-1+ fish (ODFW 2012). In addition, the length of the distribution of bull trout in Threemile Creek had increased to 2.7 km (1.7 miles) by 2012 (USFWS unpublished data). Between 1989 and 2010, bull trout abundance in Sun Creek increased approximately tenfold (from approximately 133 to 1,606 age-1+ fish) and distribution increased from approximately 1.9 km (1.2 miles) to 11.2 km (7.0 miles) (Buktenica et al. 2013) (USFWS 2015b, p. B-5).

Sycan River Core Area

The Sycan River core area is comprised of one local population, Long Creek. Long Creek likely faces greater risk of extirpation because it is the only remaining local population due to extirpation of all other historic local populations. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). This core area's local population is genetically distinct from those in the other two core areas (USFWS 2008b). This core area also is essential for recovery because bull trout in this core area exhibit both resident2 and fluvial life histories, which are important for representing diverse life history expression in the Klamath Recovery Unit. Migratory bull trout are able to grow larger than their

[2] Resident: Life history pattern of residing in tributary streams for the fish's entire life without migrating.

resident counterparts, resulting in greater fecundity and higher reproductive potential (Rieman and McIntyre 1993). Migratory life history forms also have been shown to be important for population persistence and resilience (Dunham et al. 2008).

The last remaining population (Long Creek) has received focused attention in an effort to ensure it is not also extirpated. In 2006, two weirs were removed from Long Creek, which increased the amount of occupied foraging, migratory, and overwintering (FMO) habitat by 3.2 km (2.0 miles). Bull trout currently occupy approximately 3.5 km (2.2 miles) of spawning/rearing habitat, including a portion of an unnamed tributary to upper Long Creek, and seasonally use 25.9 km (16.1 miles) of FMO habitat. Brook trout also inhabit Long Creek and have been the focus of periodic removal efforts. No recent statistically rigorous population estimate has been completed for Long Creek; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 842 individuals (USFWS 2002b). Currently unoccupied habitat is needed to establish additional local populations, although brook trout are widespread in this core area and their management will need to be considered in future recovery efforts. In 2014, the Klamath Falls Fish and Wildlife Office of the Service established an agreement with the U.S. Geological Survey to undertake a structured decision making process to assist with recovery planning of bull trout populations in the Sycan River core area (USFWS 2015b, p. B-6).

Upper Sprague River Core Area

The Upper Sprague River core area comprises five bull trout local populations, placing the core area at an intermediate risk of extinction. The five local populations include Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek, and Brownsworth Creek. These local populations may face a higher risk of extirpation because not all are interconnected. Bull trout local populations in this core area are genetically distinct from those in the other two Klamath Recovery Unit core areas (USFWS 2008b). Migratory bull trout have occasionally been observed in the North Fork Sprague River (USFWS 2002b). Therefore, this core area also is essential for recovery in that bull trout here exhibit a resident life history and likely a fluvial life history, which are important for conserving diverse life history expression in the Klamath Recovery Unit as discussed above for the Sycan River core area.

The Upper Sprague River core area population of bull trout has experienced a decline from historic levels, although less is known about historic occupancy in this core area. Bull trout are reported to have historically occupied the South Fork Sprague River, but are now extirpated from this location (Buchanan et al. 1997). The remaining five populations have received focused attention. Although brown trout (*Salmo trutta*) co-occur with bull trout and exist in adjacent habitats, brook trout do not overlap with existing bull trout populations. Efforts have been made to increase connectivity of existing bull trout populations by replacing culverts that create barriers. Thus, over the past few generations, these populations have likely been stable and increased in distribution. Population abundance has been estimated recently for Boulder Creek (372 + 62 percent; Hartill and Jacobs 2007), Dixon Creek (20 + 60 percent; Hartill and Jacobs 2007), Deming Creek (1,316 + 342; Moore 2006), and Leonard Creek (363 + 37 percent;

Hartill and Jacobs 2007). No statistically rigorous population estimate has been completed for the Brownsworth Creek local population; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 964 individuals (USFWS 2002b). Additional local populations need to be established in currently unoccupied habitat within the Upper Sprague River core area, although brook trout are widespread in this core area and will need to be considered in future recovery efforts (USFWS 2015b, p. B-7).

Mid-Columbia Recovery Unit

The Mid-Columbia Recovery Unit (RU) comprises 24 bull trout core areas, as well as 2 historically occupied core areas and 1 research needs area. The Mid-Columbia RU is recognized as an area where bull trout have co-evolved with salmon, steelhead, lamprey, and other fish populations. Reduced fish numbers due to historic overfishing and land management changes have caused changes in nutrient abundance for resident migratory fish like the bull trout. The recovery unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. Major drainages include the Methow River, Wenatchee River, Yakima River, John Day River, Umatilla River, Walla Walla River, Grande Ronde River, Imnaha River, Clearwater River, and smaller drainages along the Snake River and Columbia River (USFWS 2015c, p. C-1).

The Mid-Columbia RU can be divided into four geographic regions the Lower Mid-Columbia, which includes all core areas that flow into the Columbia River below its confluence with the 1) Snake River; 2) the Upper Mid-Columbia, which includes all core areas that flow into the Columbia River above its confluence with the Snake River; 3) the Lower Snake, which includes all core areas that flow into the Snake River between its confluence with the Columbia River and Hells Canyon Dam; and 4) the Mid-Snake, which includes all core areas in the Mid-Columbia RU that flow into the Snake River above Hells Canyon Dam. These geographic regions are composed of neighboring core areas that share similar bull trout genetic, geographic (hydrographic), and/or habitat characteristics. Conserving bull trout in geographic regions allows for the maintenance of broad representation of genetic diversity, provides neighboring core areas with potential source populations in the event of local extirpations, and provides a broad array of options among neighboring core areas to contribute recovery under uncertain environmental change USFWS 2015c, pp. C-1-2).

The current demographic status of bull trout in the Mid-Columbia Recovery Unit is highly variable at both the RU and geographic region scale. Some core areas, such as the Umatilla, Asotin, and Powder Rivers, contain populations so depressed they are likely suffering from the deleterious effects of small population size. Conversely, strongholds do exist within the recovery unit, predominantly in the Lower Snake geographic area. Populations in the Imnaha, Little Minam, Clearwater, and Wenaha Rivers are likely some of the most abundant. These populations are all completely or partially within the bounds of protected wilderness areas and have some of the most intact habitat in the recovery unit. Status in some core areas is relatively unknown, but all indications in these core areas suggest population trends are declining, particularly in the core areas of the John Day Basin (USFWS 2015c, p. C-5).

Lower Mid-Columbia Region

In the Lower Mid-Columbia Region, core areas are distributed along the western portion of the Blue Mountains in Oregon and Washington. Only one of the six core areas is located completely in Washington. Demographic status is highly variable throughout the region. Status is the poorest in the Umatilla and Middle Fork John Day Core Areas. However, the Walla Walla River core area contains nearly pristine habitats in the headwater spawning areas and supports the most abundant populations in the region. Most core areas support both a resident and fluvial life history; however, recent evidence suggests a significant decline in the resident and fluvial life history in the Umatilla River and John Day core areas respectively. Connectivity between the core areas of the Lower Mid-Columbia Region is unlikely given conditions in the connecting FMO habitats. Connection between the Umatilla, Walla Walla and Touchet core areas is uncommon but has been documented, and connectivity is possible between core areas in the John Day Basin. Connectivity between the John Day core areas and Umatilla/Walla Walla/Touchet core areas is unlikely (USFWS 2015c, pp. C-5-6).

Upper Mid-Columbia Region

In the Upper Mid-Columbia Region, core areas are distributed along the eastern side of the Cascade Mountains in Central Washington. This area contains four core areas (Yakima, Wenatchee, Entiat, and Methow), the Lake Chelan historic core area, and the Chelan River, Okanogan River, and Columbia River FMO areas. The core area populations are generally considered migratory, though they currently express both migratory (fluvial and adfluvial) and resident forms. Residents are located both above and below natural barriers (*i.e.*, Early Winters Creek above a natural falls; and Ahtanum in the Yakima likely due to long lack of connectivity from irrigation withdrawal). In terms of uniqueness and connectivity, the genetics baseline, radio-telemetry, and PIT tag studies identified unique local populations in all core areas. Movement patterns within the core areas; between the lower river, lakes, and other core areas; and between the Chelan, Okanogan, and Columbia River FMO occurs regularly for some of the Wenatchee, Entiat, and Methow core area populations. This type of connectivity has been displayed by one or more fish, typically in non-spawning movements within FMO. More recently, connectivity has been observed between the Entiat and Yakima core areas by a juvenile bull trout tagged in the Entiat moving in to the Yakima at Prosser Dam and returning at an adult size back to the Entiat. Genetics baselines identify unique populations in all four core areas (USFWS 2015c, p. C-6).

The demographic status is variable in the Upper-Mid Columbia region and ranges from good to very poor. The Service's 2008 5-year Review and Conservation Status Assessment described the Methow and Yakima Rivers at risk, with a rapidly declining trend. The Entiat River was listed at risk with a stable trend, and the Wenatchee River as having a potential risk, and with a stable trend. Currently, the Entiat River is considered to be declining rapidly due to much reduced redd counts. The Wenatchee River is able to exhibit all freshwater life histories with connectivity to Lake Wenatchee, the Wenatchee River and all its local populations, and to the Columbia River and/or other core areas in the region. In the Yakima core area some populations exhibit life history forms different from what they were historically. Migration between local populations and to and from spawning habitat is generally prevented or impeded by headwater storage dams on irrigation reservoirs, connectivity between tributaries and reservoirs, and within lower portions of spawning and rearing habitat and the mainstem Yakima River due to changed flow patterns, low instream flows, high water temperatures, and other habitat impediments. Currently, the connectivity in the Yakima Core area is truncated to the degree that not all populations are able to contribute gene flow to a functional metapopulation (USFWS 2015c, pp. C-6-7).

Lower Snake Region

Demographic status is variable within the Lower Snake Region. Although trend data are lacking, several core areas in the Grande Ronde Basin and the Imnaha core area are thought to be stable. The upper Grande Ronde Core Area is the exception where population abundance is considered depressed. Wenaha, Little Minam, and Imnaha Rivers are strongholds (as mentioned above), as are most core areas in the Clearwater River basin. Most core areas contain populations that express both a resident and fluvial life history strategy. There is potential that some bull trout in the upper Wallowa River are adfluvial. There is potential for connectivity between core areas in the Grande Ronde basin, however conditions in FMO are limiting (USFWS 2015c, p. C-7).

Middle Snake Region

In the Middle Snake Region, core areas are distributed along both sides of the Snake River above Hells Canyon Dam. The Powder River and Pine Creek basins are in Oregon and Indian Creek and Wildhorse Creek are on the Idaho side of the Snake River. Demographic status of the core areas is poorest in the Powder River Core Area where populations are highly fragmented and severely depressed. The East Pine Creek population in the Pine-Indian-Wildhorse Creeks core area is likely the most abundant within the region. Populations in both core areas primarily express a resident life history strategy; however, some evidence suggests a migratory life history still exists in the Pine-Indian-Wildhorse Creeks core area. Connectivity is severely impaired in the Middle Snake Region. Dams, diversions and temperature barriers prevent movement among populations and between core areas. Brownlee Dam isolates bull trout in Wildhorse Creek from other populations (USFWS 2015c, p. C-7).

Columbia Headwaters Recovery Unit

The Columbia Headwaters Recovery Unit (CHRU) includes western Montana, northern Idaho, and the northeastern corner of Washington. Major drainages include the Clark Fork River basin and its Flathead River contribution, the Kootenai River basin, and the Coeur d'Alene Lake basin. In this implementation plan for the CHRU we have slightly reorganized the structure from the 2002 Draft Recovery Plan, based on latest available science and fish passage improvements that have rejoined previously fragmented habitats. We now identify 35 bull trout core areas (compared to 47 in 2002) for this recovery unit. Fifteen of the 35 are referred to as "complex" core areas as they represent large interconnected habitats, each containing multiple spawning streams considered to host separate and largely genetically identifiable local populations. The 15 complex core areas contain the majority of individual bull trout and the bulk of the designated critical habitat (USFWS 2010).

However, somewhat unique to this recovery unit is the additional presence of 20 smaller core areas, each represented by a single local population. These "simple" core areas are found in remote glaciated headwater basins, often in Glacier National Park or federally-designated wilderness areas, but occasionally also in headwater valley bottoms. Many simple core areas are upstream of waterfalls or other natural barriers to fish migration. In these simple core areas bull trout have apparently persisted for thousands of years despite small populations and isolated existence. As such, simple core areas meet the criteria for core area designation and continue to be valued for their uniqueness, despite limitations of size and scope. Collectively, the 20 simple core areas contain less than 3 percent of the total bull trout core area habitat in the CHRU, but represent significant genetic and life history diversity (Meeuwig et al. 2010). Throughout this recovery unit implementation plan, we often separate our analyses to distinguish between complex and simple core areas, both in respect to threats as well as recovery actions (USFWS 2015d, pp. D-1-2).

In order to effectively manage the recovery unit implementation plan (RUIP) structure in this large and diverse landscape, the core areas have been separated into the following five natural geographic assemblages.

<u>*Upper Clark Fork Geographic Region*</u>

Starting at the Clark Fork River headwaters, the *Upper Clark Fork Geographic Region* comprises seven complex core areas, each of which occupies one or more major watersheds contributing to the Clark Fork basin (*i.e.*, Upper Clark Fork River, Rock Creek, Blackfoot River, Clearwater River and Lakes, Bitterroot River, West Fork Bitterroot River, and Middle Clark Fork River core areas) (USFWS 2015d, p. D-2).

<u>*Lower Clark Fork Geographic Region*</u>

The seven headwater core areas flow into the *Lower Clark Fork Geographic Region*, which comprises two complex core areas, Lake Pend Oreille and Priest Lake. Because of the systematic and jurisdictional complexity (three States and a Tribal entity) and the current degree of migratory fragmentation caused by five mainstem dams, the threats and recovery actions in the Lake Pend Oreille (LPO) core area are very complex and are described in three parts. LPO-A is upstream of Cabinet Gorge Dam, almost entirely in Montana, and includes the mainstem Clark Fork River upstream to the confluence of the Flathead River as well as the portions of the lower Flathead River (*e.g.*, Jocko River) on the Flathead Indian Reservation. LPO-B is the Pend Oreille lake basin proper and its tributaries, extending between Albeni Falls Dam downstream from the outlet of Lake Pend Oreille and Cabinet Gorge Dam just upstream of the lake; almost entirely in Idaho. LPO-C is the lower basin (*i.e.*, lower Pend Oreille River), downstream of Albeni Falls Dam to Boundary Dam (1 mile upstream from the Canadian border) and bisected by Box Canyon Dam; including portions of Idaho, eastern Washington, and the Kalispel Reservation (USFWS 2015d, p. D-2).

Historically, and for current purposes of bull trout recovery, migratory connectivity among these separate fragments into a single entity remains a primary objective.

<u>*Flathead Geographic Region*</u>

The *Flathead Geographic Region* includes a major portion of northwestern Montana upstream of Kerr Dam on the outlet of Flathead Lake. The complex core area of Flathead Lake is the hub of this area, but other complex core areas isolated by dams are Hungry Horse Reservoir (formerly South Fork Flathead River) and Swan Lake. Within the glaciated basins of the Flathead River headwaters are 19 simple core areas, many of which lie in Glacier National Park or the Bob Marshall and Great Bear Wilderness areas and some of which are isolated by natural barriers or other features (USFWS 2015d, p. D-2).

<u>*Kootenai Geographic Region*</u>

To the northwest of the Flathead, in an entirely separate watershed, lies the *Kootenai Geographic Region*. The Kootenai is a uniquely patterned river system that originates in southeastern British Columbia, Canada. It dips, in a horseshoe configuration, into northwest Montana and north Idaho before turning north again to re-enter British Columbia and eventually join the Columbia River headwaters in British Columbia. The *Kootenai Geographic Region* contains two complex core areas (Lake Koocanusa and the Kootenai River) bisected since the 1970's by Libby Dam, and also a single naturally isolated simple core area (Bull Lake). Bull trout in both of the complex core areas retain strong migratory connections to populations in British Columbia (USFWS 2015d, p. D-3).

<u>*Coeur d'Alene Geographic Region*</u>

Finally, the *Coeur d'Alene Geographic Region* consists of a single, large complex core area centered on Coeur d'Alene Lake. It is grouped into the CHRU for purposes of physical and ecological similarity (adfluvial bull trout life history and nonanadromous linkage) rather than due to watershed connectivity with the rest of the CHRU, as it flows into the mid-Columbia River far downstream of the Clark Fork and Kootenai systems (USFWS 2015d, p. D-3).

Upper Snake Recovery Unit

The Upper Snake Recovery Unit includes portions of central Idaho, northern Nevada, and eastern Oregon. Major drainages include the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and the Weiser River. The Upper Snake Recovery Unit contains 22 bull trout core areas within seven geographic regions or major watersheds: Salmon River (10 core areas, 123 local populations), Boise River (two core areas, 29 local populations), Payette River (five core areas, 25 local populations), Little Lost River (one core area, 10 local populations), Malheur River (two core areas, eight local populations), Jarbidge

River (one core area, six local populations), and Weiser River (one core area, five local populations). The Upper Snake Recovery Unit includes 206 local populations, with almost 60 percent being present in the Salmon River watershed (USFWS 2015e, p. E-1).

Three major bull trout life history expressions are present in the Upper Snake Recovery Unit, adfluvial[3], fluvial[4], and resident populations. Large areas of intact habitat exist primarily in the Salmon drainage, as this is the only drainage in the Upper Snake Recovery Unit that still flows directly into the Snake River; most other drainages no longer have direct connectivity due to irrigation uses or instream barriers. Bull trout in the Salmon basin share a genetic past with bull trout elsewhere in the Upper Snake Recovery Unit. Historically, the Upper Snake Recovery Unit is believed to have largely supported the fluvial life history form; however, many core areas are now isolated or have become fragmented watersheds, resulting in replacement of the fluvial life history with resident or adfluvial forms. The Weiser River, Squaw Creek, Pahsimeroi River, and North Fork Payette River core areas contain only resident populations of bull trout (USFWS 2015e, pp. E-1-2).

Salmon River

The Salmon River basin represents one of the few basins that are still free-flowing down to the Snake River. The core areas in the Salmon River basin do not have any major dams and a large extent (approximately 89 percent) is federally managed, with large portions of the Middle Fork Salmon River and Middle Fork Salmon River - Chamberlain core areas occurring within the Frank Church River of No Return Wilderness. Most core areas in the Salmon River basin contain large populations with many occupied stream segments. The Salmon River basin contains 10 of the 22 core areas in the Upper Snake Recovery Unit and contains the majority of the occupied habitat. Over 70 percent of occupied habitat in the Upper Snake Recovery Unit occurs in the Salmon River basin as well as 123 of the 206 local populations. Connectivity between core areas in the Salmon River basin is intact; therefore it is possible for fish in the mainstem Salmon to migrate to almost any Salmon River core area or even the Snake River.

Connectivity within Salmon River basin core areas is mostly intact except for the Pahsimeroi River and portions of the Lemhi River. The Upper Salmon River, Lake Creek, and Opal Lake core areas contain adfluvial populations of bull trout, while most of the remaining core areas contain fluvial populations; only the Pahsimeroi contains strictly resident populations. Most core areas appear to have increasing or stable trends but trends are not known in the Pahsimeroi, Lake Creek, or Opal Lake core areas. The Idaho Department of Fish and Game reported trend data from seven of the 10 core areas. This trend data indicated that populations were stable or increasing in the Upper Salmon River, Lemhi River, Middle Salmon River-Chamberlain, Little Lost River, and the South

[3] Adfluvial: Life history pattern of spawning and rearing in tributary streams and migrating to lakes or reservoirs to mature.

[4] Fluvial: Life history pattern of spawning and rearing in tributary streams and migrating to larger rivers to mature.

Fork Salmon River (IDFG 2005, 2008). Trends were stable or decreasing in the Little-Lower Salmon River, Middle Fork Salmon River, and the Middle Salmon River-Panther (IDFG 2005, 2008).

Boise River

In the Boise River basin, two large dams are impassable barriers to upstream fish movement: Anderson Ranch Dam on the South Fork Boise River, and Arrowrock Dam on the mainstem Boise River. Fish in Anderson Ranch Reservoir have access to the South Fork Boise River upstream of the dam. Fish in Arrowrock Reservoir have access to the North Fork Boise River, Middle Fork Boise River, and lower South Fork Boise River. The Boise River basin contains two of the 22 core areas in the Upper Snake Recovery Unit. The core areas in the Boise River basin account for roughly 12 percent of occupied habitat in the Upper Snake Recovery Unit and contain 29 of the 206 local populations. Approximately 90 percent of both Arrowrock and Anderson Ranch core areas are federally owned; most lands are managed by the U.S. Forest Service, with some portions occurring in designated wilderness areas. Both the Arrowrock core area and the Anderson Ranch core area are isolated from other core areas. Both core areas contain fluvial bull trout that exhibit adfluvial characteristics and numerous resident populations. The Idaho Department of Fish and Game in 2014 determined that the Anderson Ranch core area had an increasing trend while trends in the Arrowrock core area is unknown (USFWS 2015e).

Payette River

The Payette River basin contains three major dams that are impassable barriers to fish: Deadwood Dam on the Deadwood River, Cascade Dam on the North Fork Payette River, and Black Canyon Reservoir on the Payette River. Only the Upper South Fork Payette River and the Middle Fork Payette River still have connectivity, the remaining core areas are isolated from each other due to dams. Both fluvial and adfluvial life history expression are still present in the Payette River basin but only resident populations are present in the Squaw Creek and North Fork Payette River core areas. The Payette River basin contains five of the 22 core areas and 25 of the 206 local populations in the recovery unit. Less than 9 percent of occupied habitat in the recovery unit is in this basin. Approximately 60 percent of the lands in the core areas are federally owned and the majority is managed by the U.S. Forest Service. Trend data are lacking and the current condition of the various core areas is unknown, but there is concern due to the current isolation of three (North Fork Payette River, Squaw Creek, Deadwood River) of the five core areas; the presence of only resident local populations in two (North Fork Payette River, Squaw Creek) of the five core areas; and the relatively low numbers present in the North Fork core area (USFWS 2015e, p. E-8).

Jarbidge River

The Jarbidge River core area contains two major fish barriers along the Bruneau River: the Buckaroo diversion and C. J. Strike Reservoir. Bull trout are not known to migrate down to the Snake River. There is one core area in the basin, with populations in the

Jarbidge River; this watershed does not contain any barriers. Approximately 89 percent of the Jarbidge core area is federally owned. Most lands are managed by either the Forest Service or Bureau of Land Management. A large portion of the core area is within the Bruneau-Jarbidge Wilderness area. A tracking study has documented bull trout population connectivity among many of the local populations, in particular between West Fork Jarbidge River and Pine Creek. Movement between the East and West Fork Jarbidge River has also been documented; therefore, both resident and fluvial populations are present. The core area contains six local populations and three percent of the occupied habitat in the recovery unit. Trend data are lacking within this core area (USFWS 2015e, p. E-9).

Little Lost River

The Little Lost River basin is unique in that the watershed is within a naturally occurring hydrologic sink and has no connectivity with other drainages. A small fluvial population of bull trout may still exist, but it appears that most populations are predominantly resident populations. There is one core area in the Little Lost basin, and approximately 89 percent of it is federally owned by either the U.S. Forest Service or Bureau of Land Management. The core area contains 10 local populations and less than 3 percent of the occupied habitat in the recovery unit. The current trend condition of this core area is likely stable, with most bull trout residing in Upper Sawmill Canyon (IDFG 2014).

Malheur River

The Malheur River basin contains major dams that are impassable to fish. The largest are Warm Springs Dam, impounding Warm Springs Reservoir on the mainstem Malheur River, and Agency Valley Dam, impounding Beulah Reservoir on the North Fork Malheur River. The dams result in two core areas that are isolated from each other and from other core areas. Local populations in the two core areas are limited to habitat in the upper watersheds. The Malheur River basin contains 2 of the 22 core areas and 8 of the 206 local populations in the recovery unit. Fluvial and resident populations are present in both core areas while adfluvial populations are present in the North Fork Malheur River. This basin contains less than 3 percent of the occupied habitat in the recovery unit, and approximately 60 percent of lands in the two core areas are federally owned. Trend data indicates that populations are declining in both core areas (USFWS 2015e, p. E-9).

Weiser River

The Weiser River basin contains local populations that are limited to habitat in the upper watersheds. The Weiser River basin contains only a single core area that consists of 5 of the 206 local populations in the recovery unit. Local populations occur in only three stream complexes in the upper watershed: 1) Upper Hornet Creek, 2) East Fork Weiser River, and 3) Upper Little Weiser River. These local populations include only resident life histories. This basin contains less than 2 percent of the occupied habitat in the recovery unit, and approximately 44 percent of lands are federally owned. Trend data from the Idaho Department of Fish and Game indicate that the populations in the Weiser core area are increasing (IDFG 2014) but it is considered vulnerable because local populations are isolated and likely do not express migratory life histories (USFWS 2015e, p.E-10).

St. Mary Recovery Unit

The Saint Mary Recovery Unit is located in northwest Montana east of the Continental Divide and includes the U.S. portions of the Saint Mary River basin, from its headwaters to the international boundary with Canada at the 49th parallel. The watershed and the bull trout population are linked to downstream aquatic resources in southern Alberta, Canada; the U.S. portion includes headwater spawning and rearing (SR) habitat in the tributaries and a portion of the FMO habitat in the mainstem of the Saint Mary River and Saint Mary lakes (Mogen and Kaeding 2001).

The Saint Mary Recovery Unit comprises four core areas; only one (Saint Mary River) is a complex core area with five described local bull trout populations (Divide, Boulder, Kennedy, Otatso, and Lee Creeks). Roughly half of the linear extent of available FMO habitat in the mainstem Saint Mary system (between Saint Mary Falls at the upstream end and the downstream Canadian border) is comprised of Saint Mary and Lower Saint Mary Lakes, with the remainder in the Saint Mary River. The other three core areas (Slide Lakes, Cracker Lake, and Red Eagle Lake) are simple core areas. Slide Lakes and Cracker Lake occur upstream of seasonal or permanent barriers and are comprised of genetically isolated single local bull trout populations, wholly within Glacier National Park, Montana. In the case of Red Eagle Lake, physical isolation does not occur, but consistent with other lakes in the adjacent Columbia Headwaters Recovery Unit, there is likely some degree of spatial separation from downstream Saint Mary Lake. As noted, the extent of isolation has been identified as a research need (USFWS 2015f, p. F-1).

Bull trout in the Saint Mary River complex core area are documented to exhibit primarily the migratory fluvial life history form (Mogen and Kaeding 2005a, 2005b), but there is doubtless some occupancy (though less well documented) of Saint Mary Lakes, suggesting a partly adfluvial adaptation. Since lake trout and northern pike are both native to the Saint Mary River system (headwaters of the South Saskatchewan River drainage draining to Hudson Bay), the conventional wisdom is that these large piscivores historically outcompeted bull trout in the lacustrine environment (Donald and Alger 1993, Martinez et al. 2009), resulting in a primarily fluvial niche and existence for bull trout in this system. This is an untested hypothesis and additional research into this aspect is needed (USFWS 2015f, p. F-3).

Bull trout populations in the simple core areas of the three headwater lake systems (Slide, Cracker, and Red Eagle Lakes) are, by definition, adfluvial; there are also resident life history components in portions of the Saint Mary River system such as Lower Otatso Creek (Mogen and Kaeding 2005a), further exemplifying the overall life history diversity typical of bull trout. Mogen and Kaeding (2001) reported that bull trout continue to inhabit nearly all suitable habitats accessible to them in the Saint Mary River basin in the United States. The possible exception is portions of Divide Creek, which appears to be intermittently occupied despite a lack of permanent migratory barriers, possibly due to low population size and erratic year class production (USFWS 2015f, p. F-3).

It should be noted that bull trout are found in minor portions of two additional U.S. watersheds (Belly and Waterton rivers) that were once included in the original draft recovery plan (USFWS 2002) but are no longer considered core areas in the final recovery plan (USFWS 2015) and are not addressed in that document. In Alberta, Canada, the Saint Mary River bull trout population is considered at "high risk," while the Belly River is rated as "at risk" (ACA 2009). In the Belly River drainage, which enters the South Saskatchewan system downstream of the Saint Mary River in Alberta, some bull trout spawning is known to occur on either side of the international boundary. These waters are in the drainage immediately west of the Saint Mary River headwaters. However, the U.S. range of this population constitutes only a minor headwater migratory SR segment of an otherwise wholly Canadian population, extending less than 1 mile (0.6 km) into backcountry waters of Glacier National Park. The Belly River population is otherwise totally dependent on management within Canadian jurisdiction, with no natural migratory connection to the Saint Mary (USFWS 2015f, p. F-3).

Current status of bull trout in the Saint Mary River core area (U.S.) is considered strong (Mogen 2013). Migratory bull trout redd counts are conducted annually in the two major SR streams, Boulder and Kennedy creeks. Boulder Creek redd counts have ranged from 33 to 66 in the past decade, with the last 4 counts all 53 or higher. Kennedy Creek redd counts are less robust, ranging from 5 to 25 over the last decade, with a 2014 count of 20 (USFWS 2015f, p. F-3).

Generally, the demographic status of the Saint Mary River core area is believed to be good, with the exception of the Divide Creek local population. In this local population, there is evidence that a combination of ongoing habitat manipulation (Smillie and Ellerbroek 1991, F-5 NPS 1992) resulting in occasional historical passage issues, combined with low and erratic recruitment (DeHaan et al. 2011) has caused concern for the continuing existence of the local population.

While less is known about the demographic status of the three simple cores where redd counts are not conducted, all three appear to be self-sustaining and fluctuating within known historical population demographic bounds. Of the three simple core areas, demographic status in Slide Lakes and Cracker Lake appear to be functioning appropriately, but the demographic status in Red Eagle Lake is less well documented and believed to be less robust (USFWS 2015f, p. F-3).

Reasons for Listing

Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992, pp. 2-3; Schill 1992, p. 42; Thomas 1992, entire; Ziller 1992, entire; Rieman and McIntyre 1993, p. 1; Newton and Pribyl 1994, pp. 4-5; McPhail and Baxter 1996, p. 1). Several local extirpations have been documented, beginning in the 1950s (Rode 1990, pp. 26-32; Ratliff and Howell 1992, entire; Donald and Alger 1993, entire; Goetz 1994, p. 1; Newton and Pribyl 1994, pp. 8-9; Light et al. 1996, pp. 6-7; Buchanan et al. 1997, p. 15; WDFW 1998, pp. 2-3). Bull trout were extirpated from the southernmost portion of their historic range, the McCloud River in California, around 1975 (Rode 1990, p. 32). Bull trout have been functionally extirpated (i.e., few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (USFWS 1998, pp. 31651-31652).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that depress bull trout populations and degrade habitat include the effects of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta et al. 1987, entire; Chamberlain et al. 1991, entire; Furniss et al. 1991, entire; Meehan 1991, entire; Nehlsen et al. 1991, entire; Sedell and Everest 1991, entire; Craig and Wissmar 1993pp, 18-19; Henjum et al. 1994, pp. 5-6; McIntosh et al. 1994, entire; Wissmar et al. 1994, entire; MBTSG 1995a, p. 1; MBTSG 1995b. pp. i-ii; MBTSG 1995c, pp. i-ii; MBTSG 1995d, p. 22; MBTSG 1995e, p. i; MBTSG 1996a, p. i-ii; MBTSG 1996b, p. i; MBTSG 1996c, p. i; MBTSG 1996d, p. i; MBTSG 1996e, p. i; MBTSG 1996f, p. 11; Light et al. 1996, pp. 6-7; USDA and USDI 1995, p. 2).

Emerging Threats

<u>*Climate Change*</u>

Climate change was not addressed as a known threat when bull trout was listed. The 2015 bull trout recovery plan and RUIPs summarize the threat of climate change and acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time due to anthropogenic climate change effects, and use of best available information will ensure future conservation efforts that offer the greatest long-term benefit to sustain bull trout and their required coldwater habitats (USFWS 2015, p. vii, and pp. 17-20, USFWS 2015a-f).

Global climate change and the related warming of global climate have been well documented (IPCC 2007, entire; ISAB 2007, entire; Combes 2003, entire). Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures and accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007, p. 253; Battin et al. 2007, p. 6720), we can no longer assume that climate conditions in the future will resemble those in the past.

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (ISAB 2007, entire; Hari et al. 2006, entire; Rieman et al. 2007, entire). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (Magnuson et al. 2000, p. 1743). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006, entire).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007, pp. 15-17). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers.

Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003, pp 216-217).

All life stages of the bull trout rely on cold water. Increasing air temperatures are likely to impact the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of other chars. Ground water temperature is linked to bull trout selection of spawning sites, and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Baxter 1997, p. 82). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer drier areas such as are found on the eastside of the Cascade Mountains. Bisson et al. (2003, pp. 216-217) note that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson et al. 2003, pp. 218-219).

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (Shuter and Meisner 1992. p. 11).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007, p. 6720). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing. As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007, p 7) although the scale of that variation may exceed that of States. For example, several studies indicate that climate change has the potential to impact ecosystems in nearly all streams throughout the State of Washington (ISAB 2007, p. 13; Battin et al. 2007, p. 6722; Rieman et al. 2007, pp. 1558-1561). In streams and rivers with temperatures approaching or at the upper limit of allowable water temperatures, there is little if any likelihood that bull trout will be able to adapt to or avoid the effects of climate change/warming. There is little doubt that climate change is and will be an important factor affecting bull trout distribution. As its distribution contracts, patch size decreases and connectivity is truncated, bull trout populations that may be currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007, pp. 1559-1560). Due to variations in land form and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. Bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change.

The ability to assign the effects of gradual global climate change to bull trout or to a specific location on the ground is beyond our technical capabilities at this time.

Conservation

<u>*Conservation Needs*</u>

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States: 1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable1 in six recovery units; 2) effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale such that bull trout are not likely to become endangered in the foreseeable future; 3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; 4) use that information to work cooperatively with our partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and 5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (USFWS 2015, p. v.).

Information presented in prior draft recovery plans published in 2002 and 2004 (USFWS 2002a, 2004) have served to identify recovery actions across the range of the species and to provide a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation.

The 2015 recovery plan (USFWS 2015) integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and integrates and updates previous bull trout recovery planning efforts across the range of the single DPS listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The USFWS has developed a recovery approach that: 1) focuses on the identification of and effective management of known and remaining threat factors to bull trout in each core area; 2) acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time; and 3) identifies and focuses recovery actions in those areas where success is likely to meet our goal of ensuring the certainty of conservation of genetic diversity, life history features, and broad geographical representation of remaining bull trout populations so that the protections of the Act are no longer necessary (USFWS 2015, p. 45-46).

To implement the recovery strategy, the 2015 recovery plan establishes categories of recovery actions for each of the six Recovery Units (USFWS 2015, p. 50-51):

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

Bull trout recovery is based on a geographical hierarchical approach. Bull trout are listed as a single DPS within the five-state area of the coterminous United States. The single DPS is subdivided into six biologically-based recover units: 1) Coastal Recovery Unit; 2) Klamath Recovery Unit; 3) Mid-Columbia Recovery Unit; 4) Upper Snake Recovery Unit; 5) Columbia Headwaters Recovery Unit; and 6) Saint Mary Recovery Unit (USFWS 2015, p. 23). A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015, p. 33).

Each of the six recovery units contain multiple bull trout core areas, 116 total, which are non-overlapping watershed-based polygons, and each core area includes one or more local populations. Currently there are 109 occupied core areas, which comprise 611 local populations (USFWS 2015, p. 3). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (USFWS 2015, p. 3). Core areas can be further described as complex or simple (USFWS 2015, p. 3-4). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and FMO habitats. Simple core areas are those that contain one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

A local population is a group of bull trout that spawn within a particular stream or portion of a stream system (USFWS 2015, p. 73). A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Recovery Units and Local Populations

The final recovery plan (USFWS 2015) designates six bull trout recovery units as described above. These units replace the 5 interim recovery units previously identified (USFWS 1999). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015a-f), which identify conservation actions and recommendations needed for each core area, forage/ migration/ overwinter areas, historical core areas, and research needs areas. Each of the following recovery units (below) 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.

Coastal Recovery Unit

The coastal recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015a). The Coastal Recovery Unit is located within western Oregon and Washington. The Coastal Recovery Unit is divided into three regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River Regions. This recovery unit contains 20 core areas comprising 84 local populations and a single potential local population in the historic Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011, and identified four historically occupied core areas that could be re-established (USFWS 2015, pg. 47; USFWS 2015a, p. A-2). Core areas within Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This recovery unit also contains ten shared FMO habitats which are outside core areas and allows for the continued natural population dynamics in which the core areas have evolved (USFWS 2015a, p. A-5). There are four core areas within the Coastal Recovery Unit that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River (USFWS 2015, p.79). These are the most stable and abundant bull trout populations in the recovery unit. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of non-native species. Conservation measures or recovery actions implemented include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or complete removal of dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats.

Klamath Recovery Unit

The Klamath recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015b). The Klamath Recovery Unit is located in southern Oregon and northwestern California. The Klamath Recovery Unit is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015, p. 39). This recovery unit currently contains three core areas and eight local populations (USFWS 2015, p. 47; USFWS 2015b, p. B-1). Nine historic local populations of bull trout have become extirpated (USFWS 2015b, p. B-1). All three core areas have been isolated from other bull trout populations for the past 10,000 years (USFWS 2015b, p. B-3. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices. Conservation measures or recovery actions implemented include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culvert replacement, and habitat restoration.

Mid-Columbia Recovery Unit

The Mid-Columbia recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015c). The Mid-Columbia Recovery Unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic Regions. This recovery unit contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and seven FMO habitats (USFWS 2015, pg. 47; USFWS 2015c, p. C-1–4). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining. Conservation measures or recovery actions implemented include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements.

Columbia Headwaters Recovery Unit

The Columbia headwaters recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015d, entire). The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene Geographic Regions (USFWS 2015d, pp. D-2 – D-4). This recovery unit contains 35 bull trout core areas; 15 of which are complex core areas as they represent larger interconnected habitats and 20 simple core areas as they are isolated headwater lakes with single local populations. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and isolated existence (USFWS 2015d, p. D-1). Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (USFWS 2015d, p. D-1), while others remain fragmented. Unlike the other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap. Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015d, p. D-41). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mostly historical mining and contamination by heavy metals, expanding populations of nonnative fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g. irrigation, livestock grazing), and residential development. Conservation measures or recovery actions implemented include habitat improvement, fish passage, and removal of nonnative species.

Upper Snake Recovery Unit

The Upper Snake recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015e, entire). The Upper Snake Recovery Unit is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 207 local populations (USFWS 2015, p. 47), with almost 60 percent being present in the Salmon River Region. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing). Conservation measures or recovery actions implemented include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration.

St. Mary Recovery Unit

The St. Mary recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015f). The Saint Mary Recovery Unit is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the Saskatchewan River watershed which the St. Mary flows into is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas, and seven local populations (USFWS 2015f, p. F-1) in the U.S. Headwaters. The current condition of the bull trout in this recovery unit is attributed primarily to the outdated design and operations of the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and, to a lesser extent habitat impacts from development and nonnative species.

Tribal Conservation Activities

Many Tribes throughout the range of the bull trout are participating on bull trout conservation working groups or recovery teams in their geographic areas of interest. Some tribes are also implementing projects which focus on bull trout or that address anadromous fish but benefit bull trout (e.g., habitat surveys, passage at dams and diversions, habitat improvement, and movement studies).

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APPENDIX B
STATUS OF BULL TROUT CRITICAL HABITAT

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Appendix: B
Status of Bull Trout Critical Habitat

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), “physical and biological features” (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The new critical habitat regulations (81 FR 7214) discontinue use of the terms “PCEs” or “essential features” and rely exclusively on use of the term PBFs for that purpose because that term is contained in the statute. To be consistent with that shift in terminology and in recognition that the terms PBFs, PCEs, and essential habit features are synonymous in meaning, we are only referring to PBFs herein. Therefore, if a past critical habitat designation defined essential habitat features or PCEs, they will be referred to as PBFs in this document. This does not change the approach outlined above for conducting the ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features.

Current Legal Status of the Critical Habitat

Current Designation

The U.S. Fish and Wildlife Service USFWS published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (USFWS 2010, entire); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on the Service’s website: (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species’ coterminous range, which includes the Coastal, Klamath, Mid-Columbia, Upper Snake, Columbia Headwaters and St. Mary’s Recovery Unit population segments. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table 1. Stream/Shoreline Distance and Reservoir/Lake Area Designated as Bull Trout Critical Habitat.

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

[1] No shore line is included in Oregon
[2] Pine Creek Drainage which falls within Oregon
[3] Total of freshwater streams: 18,975

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

The final rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (USFWS 2010, p. 63903). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

The Physical and Biological Features

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (USFWS 2010, p. 63898). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

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

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

Physical and Biological Features for Bull Trout

Within the designated critical habitat areas, the PBFs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the PBFs, as described within USFWS 2010, are essential for the conservation of bull trout. A summary of those PBFs follows.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 °C to 15 °C, with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these

conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The revised PBF's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PBF to address the presence of nonnative predatory or competitive fish species. Although this PBF applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

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

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

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

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

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by no longer serving the intended conservation role for the species or retaining those PBFs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PBFs to such an extent that the conservation value of critical habitat is appreciably reduced (USFWS 2010, pp. 63898:63943; USFWS 2004a, pp. 140-193; USFWS 2004b, pp. 69-114). The Service's evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, Ch. 4 p. 39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (USFWS 2010, pp. 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (USFWS 2010, pp. 63898:63943).

Current Critical Habitat Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (Ratliff and Howell 1992, entire; Schill 1992, p. 40; Thomas 1992, p. 28; Buchanan et al. 1997, p. vii; Rieman et al. 1997, pp. 15-16; Quigley and Arbelbide 1997, pp. 1176-1177). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (USFWS 1998, pp. 31648-31649; USFWS 1999, p. 17111).

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 PBFs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PBFs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Many of the PBFs for bull trout may be affected by the presence of toxics and/or increased water temperatures within the environment. The effects will vary greatly depending on a number of factors which include which toxic substance is present, the amount of temperature increase, the likelihood that critical habitat would be affected (probability), and the severity and intensity of any effects that might occur (magnitude).

The ability to assign the effects of gradual global climate change bull trout critical habitat or to a specific location on the ground is beyond our technical capabilities at this time.

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APPENDIX C

USFWS RECOMMENDED FISH EXCLUSION, CAPTURE, HANDLING, AND ELECTROSHOCKING PROTOCOLS

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

Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards

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June 19, 2012

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INTRODUCTION

The Washington Fish and Wildlife Office, U. S. Fish and Wildlife Service (FWS) recommends the following protocols and standards for fish exclusion, capture, handling, and relocation where conducted within the range of the federally listed as threatened bull trout. Electroshocking guidelines and references are also included in this document.

This guidance is to provide methods to isolate, capture, and move/relocate fish to minimize effects of construction activities to federally listed bull trout and unlisted species that are present within the affected area. These measures are intended to reduce exposure and risk of potential injury associated with construction activities. Although these measures may result in negative behavioral and, in some cases, physical injury or death to fish, proper implementation of these methods will reduce the likelihood of these effects. These measures are recommended where their implementation will result in the avoidance of the more severe effects fish would experience if they remained in the work area during construction. Implementation of less protective measures may result in additional requirements as part of the Endangered Species Act (ESA) consultation process and/or recommendations provided under the Fish and Wildlife Coordination Act.

WHEN TO USE THIS GUIDANCE

Work below the Ordinary High-Water Mark (or Mean Higher High-Water Mark) will typically be conducted in isolation from flowing waters. Exceptions to this general rule include the following:

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 are minimized without isolation from flowing waters[1].

3) Work conducted under a declared emergency or under emergency conditions.

4) Work conducted where flow conditions prevent safe implementation of work area isolation and fish capture and removal protocols.

[1] The applicant 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.

RESPONSIBILITIES AND TRAINING REQUIREMENTS

Implementation of the work area isolation and fish capture and removal protocols will be planned and directed by a qualified biologist (referred to in this document as the directing biologist), possessing all necessary knowledge, training, and experience. We also recommend that the project proponent/consulting agency coordinate with the FWS as early in the planning process as possible to determine the most appropriate in-water work window and identify any conflicts with effects to other listed species, such the marbled murrelet (*Brachyramphus marmoratus*) or the northern spotted owl (*Strix occidentalis caurina*).

If electrofishing is proposed as a means of fish capture, the directing biologist will have a minimum of 100 hours electrofishing experience in the field using similar equipment, and any individuals operating electrofishing equipment will have a minimum of 40 hours electrofishing experience under direct supervision. All individuals participating in fish capture and removal operations will have the training, knowledge, skills, and ability to ensure safe handling of fish, and to ensure the safety of staff conducting the operations.

STAGING AND SEQUENCING OF WORK

The directing biologist will work with the appropriate person (such as the construction and equipment operators for the project) to plan the staging and sequence for work area isolation, fish capture and removal, and dewatering. This plan will 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, hiding cover is limited, and/or conditions are conducive to fish capture6, 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, water is deeper, uncut banks and other hiding cover is present, 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 will 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 temperature extremes or reduced dissolved oxygen levels, risk of injury resulting from electrofishing, etc.).

The directing biologist will 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, or 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 will carefully consider whether to herd fish (and/or capture and release fish) upstream or downstream of the isolated work area to minimize effects to individuals. For example, if conditions upstream of the isolated work area may become unfavorable during construction, then fish will 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 will also consider whether planned in-water work presents a significant risk of downstream turbidity and sedimentation and exposure of fish herded or released to a downstream location.

If large numbers of fish are to be herded (and/or captured and released), and 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 will 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, including increased predation, during construction. On those rare occasions where relocation to a greater distance is deemed necessary, the entity will provide notice to the FWS field office[2] with jurisdiction in that area in advance of the operations.

Work Area Isolation - Block Nets

The directing biologist will 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") will be avoided if foreseeable flow conditions might overwhelm or dislodge the block nets, posts, or anchors.

[2] Lacey Field Office, Central Washington Field Office (Wenatchee), or Eastern Washington Field Office (Spokane)

The directing biologist will select suitable block nets. Type of material, length, and depth may vary based on site conditions. Typically block nets will be composed of 9.5 millimeter stretched nylon mesh and will 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. Block nets must be secured along both banks and the channel bottom to prevent erosion and failure due to 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.). 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 2 weeks). Native materials will not be used as fill for anchor bags. Any use or movement[3] of native substrates or other materials will be incidental and will not appreciably affect channel bed or bank conditions.

Except when planning and intending to herd fish upstream, an upstream block net will be placed first. With a block net secured to prevent movement of fish into the work area from upstream, a second block net will 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 in phases, 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 will 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).

Field staff will be assigned the responsibility of frequently checking and maintaining the nets for accumulated debris, general stability, and proper function. A qualified biologist, or other field staff trained in safe fish handling, will be assigned the responsibility of inspecting the nets and safely capturing and relocating any impinged fish. The frequency of these inspections will be determined by the directing biologist on a case-by-case basis, dependent upon the site, seasonal, and weather conditions. Block nets placed within a local population of bull trout (defined as areas used by bull trout for spawning and/or rearing) will be checked every 4 hours, 24 hours a day, for the duration the block net is in operation. If any bull trout are impinged or killed on or by the nets, the frequency of net inspection will be increased to once hourly, 24 hours a day, for the duration the block net is in operation. If any bull trout are impinged or killed on or by the nets, the frequency of net inspection will be increased to once hourly, 24 hours a day. In the event fish are found impinged on the net(s), or if weather or flow conditions change significantly, the directing biologist will re-consider and adjust the frequency of net inspections so as to

[3] Small instream boulders may be used temporarily to hold net in place and returned to their previous instream position upon removal of net.

minimize the risk of impinging and injuring fish. Block nets will remain in-place until work is complete and conditions are suitable for the reintroduction of fish[4].

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 upstream movement of fish into the work area. 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, a downstream block net will 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 will 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 will 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 to 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 will be staged in conjunction with fish capture and removal over a longer timeframe (e.g., 3 to 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 will be given sufficient time and a means to move downstream by their own

[4] 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 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).

choosing to reduce the total number of fish exposed to sources of stress and injury (including fish handling). Extra time needed for this voluntary fish movement needs to be considered and provided for as part of the dewatering process.

Dewatering and Flow Diversion

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

If pumps are used to temporarily bypass water or to dewater residual pools or cofferdams, pump intakes will be screened to prevent aquatic life from entering 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[5], 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 will address contingencies (i.e., extremes of flow or weather). These plans will include ready access to a larger or additional "back-up" pump with screened intake. If the directing biologist has 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. Use of an unscreened intake pump shall be documented.

Fish Capture and Removal

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. To avoid and minimize the risk of injury to fish, attempts to seine and/or net fish will 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 section 7 consultation (for example, due to an emergency), seining and netting are impracticable (i.e., electrofishing is deemed the only viable means of fish capture), and

[5] 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>>.

bull trout may be present, the directing biologist will provide notice to the FWS. This notice will be provided in advance of the operations, and will include an explanation of the unique site conditions or circumstances. Work conducted under a declared emergency (or emergency conditions) will follow established notification protocols under section 7 of the ESA.

Where bull trout and non-listed fish may be present, the directing biologist will 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 will be used.

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

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

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

5) A plan for achieving efficient return to appropriate habitat will be developed before the capture and removal process.

6) Every attempt will be made to release ESA-listed specimens first.

<u>Seining</u>

Seining will be the preferred method for fish capture. Other methods will be used when seining is not possible, or when/after attempts at seining have proven ineffective. Seines, once pursed, will remain partially in the water while fish are removed with dip nets. Seines with a "bag" minimize handling stress 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

Baited minnow traps are typically used before and in conjunction with seining. Traps may be left in the isolated work area overnight. Traps will be inspected at least four times daily to remove captured fish and thereby minimize predation within the trap. Traps will be checked more frequently if temperatures are in excess of 15 degrees C.

Predation within the trap may be an unacceptable risk when minnow traps are left in-place overnight; large sculpin and other predators that feed on juvenile fish are typically much more active at night. The directing biologist will consider the need and plan for work outside daylight hours (i.e., inspection and removal) before leaving minnow traps in-place overnight.

Dip Nets

Dip nets will 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 will coordinate fish capture operations with plans for dewatering or flow diversion. Plans for dewatering and/or flow diversion will proceed at a measured pace (within constraints), to encourage the volitional downstream movement of fish, and reduce the risk of stranding. The directing biologist shall monitor the dewatering process to insure that water is removed slowly to allow for fish capture and preclude stranding. Plans for dewatering and/or flow diversion will not proceed unless there are sufficient staff and materials on-site 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 will 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

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 3 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 will plan a strategy for focusing and concentrating fish in areas where they can be easily seined and netted, and will 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 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) will be removed to encourage volitional downstream movement of fish.

Electrofishing

Electrofishing will be performed only when other methods of fish capture and removal have proven impracticable or ineffective at removing all fish. The directing biologist will ensure that attempts to seine and/or net fish always precede the use of electrofishing equipment. Larger fish (i.e., adult and sub-adult 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 will confirm that other methods have been effective in removing most or all of the adult and sub-adult 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 will not be conducted under conditions that offer poor visibility (i.e., visibility of less than 0.5 meter).

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

1) Electrofishing will only be conducted when a directing biologist with at least 100 hours of electrofishing experience or completion of and/or certification from acceptable training[6] is on-site to conduct or direct all related activities. The directing biologist will 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 will have knowledge regarding galvanotaxis, narcosis and tetany, their relationships to injury/mortality rates, and will have the ability to recognize these responses when exhibited by fish.

[6] For example, the National Conservation Training Center's *Principles & Techniques of Electrofishing* course.

2) The directing biologist will ensure that electrofishing attempts use the minimum voltage, pulse width, and rate settings necessary to achieve the desired response (galvanotaxis). Water conductivity will be measured in the field prior to each electrofishing attempt to determine appropriate settings. Electrofishing methods and equipment will comply with guidelines outlined by the NMFS[7].

3) The initial and maximum settings identified below (Table 1) will serve as guidelines when electrofishing in waters that may support bull trout. Use only DC or pulsed DC current. [**Note**: some newer, late-model electrofishing equipment includes a "set-up" or initialization function; the directing biologist will have the discretion to use this function as a means to identify proper initial settings.]

Table 1. Guidelines for initial and maximum settings for backpack electrofishing.[8]

	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 will 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 will gradually be increased until the appropriate response is achieved (galvanotaxis). The lowest effective settings for pulse width, pulse rate, and voltage will be used to minimize risks to both personnel and fish. Safe implementation is a high priority. The directing biologist will 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 will provide direct assistance during electrofishing attempts.

4) Electrofishing will 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 bull trout will not be electrofished from October 15 through May 15, and resident waters from November 1 through May

7 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 >>.

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

15. If located within a local bull trout population (i.e., that support spawning and rearing[9]), seasonal limitations on the use of electrofishing equipment may be more restrictive; if you have questions, contact the FWS. If more restrictive work windows have been identified through consultation, those windows will apply. The directing biologist will 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.

5) An individual will 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). The nets will also be checked after all electrofishing is complete.

6) The operator will use caution 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 will not be attached to the anode, as this practice presents an increased risk of direct contact and injury. Extra care will be taken near in-water structures or undercut banks, in shallow waters, or where fish densities are high. Under these conditions, fish are more likely to come into close or direct contact with the anode and/or voltage gradients may be intensified. Re-adjust voltage and other settings 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 will be used to draw fish out of cover.

7) Electrofishing will be conducted in a manner that minimizes harm to fish. Once an appropriate fish response (galvanotaxis) is achieved, the isolated work area will be worked systematically. The number of passes will be kept to a minimum, but is dependent upon the numbers of fish and site characteristics and will be at the discretion of the directing biologist. Do not conduct electrofishing unless there are sufficient staff and materials on-site, to 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 will be taken to remove fish from the electrical field immediately and to avoid exposing the same fish repeatedly. Fish will 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

[9] See bull trout draft recovery plans for local population information. This information is available at http://www.fws.gov/pacific/bulltrout/Recovery.html.

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.]

8) Carefully observe and document the condition of captured fish. 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 will 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 will have the authority to postpone fish capture and removal operations[10]. Each fish must be capable of remaining upright and actively swimming prior to release (see Fish Handling, Holding, and Release).

9) Electrofishing will 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.

Fish Handling, Holding, and Release

- Fish will not be sampled or anesthetized, unless for valid purposes consistent with the entity's section 10 scientific collection permits.

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

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

- The operations will ensure that water quality conditions are adequate in the buckets, coolers, or holding tanks used to hold and transfer captured fish. The operations will use aerators to provide for clean, cold, well-oxygenated water, and/or will stage capture, temporary holding, and release to minimize the risks associated with prolonged holding. The directing biologist will ensure that

[10] 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.

conditions in the holding containers are monitored frequently and operations adjusted appropriately to minimize fish stress. If bull trout will be held for more than a few minutes prior to release, the directing biologist will consider using dark-colored, lidded containers only. Bull trout will 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. Bull trout will not be kept in the same holding container or area with aquatic species that may prey on or injure them.

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

- The release site(s) will be determined by the directing biologist. The directing biologist will 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, pre-spawn 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 will consider habitat connectivity, fish habitat requirements, seasonal flow, water temperature, 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 may become unfavorable during construction, then fish will not be released to an upstream location. However, the directing biologist will 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 **Staging and Sequencing of Work**.

- The directing biologist will 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 will be preserved and delivered to the appropriate authority upon request (see Documentation, p. 14; if applicable, see the reporting requirements of the associated Biological Opinion for the action).

- 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 will 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, the entity will 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, the entity will 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 will ensure that the block net(s) remain in-place until work is complete and conditions are suitable for the reintroduction of fish[5]. Flows will 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 will 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, the entity will 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.) will be removed at the completion of work. The directing biologist will document in qualitative terms the final condition of the isolated work area (including temporary bypass). The directing biologist will identify and document any obvious signs of channel bed or bank instability resulting from the work, and will report these conditions to the appropriate staff for remedy. The entity will 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 will ensure that all equipment and materials are cleaned and dried before transporting them for use at another site or waterbody.

DOCUMENTATION

- The directing biologist will document and maintain accurate records of the operations, including the following: project location, date, methods, personnel, water temperature, conductivity, visibility, electrofishing equipment settings, and other comments, fish species, number, age/size class estimate, condition at release, and release location.

- If at any time, fish are observed in distress, a fish kill occurs, or water quality problems develop (including equipment leaks or spills), the entity will provide immediate notification to the WDFW consistent with any provisions contained in the HPA (or applicable General HPA).

- Bull trout incidentally killed as a result of fish capture and removal operations will be documented with notification provided to the appropriate authority (FWS) within two working days. Initial notifications may consist of a phone call or voice mail message. Initial notifications will be directed to the following: the nearest FWS Law Enforcement Office, and the Washington Fish and Wildlife Office at (360) 753-9440. Any dead specimens will be kept whole and preserved on-ice or frozen until the entity receives a response and further directions from the appropriate authority; if the entity receives no response within 10 working days, the directing biologist will have the discretion to dispose of specimens. Initial notifications will be followed by a second notification in writing. All notifications will provide at a minimum the following: date, time, entity point-of-contact (the directing biologist and/or supervisor), project name (and FWS consultation tracking number), 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 will 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) will be documented in qualitative terms, including any obvious signs of channel bed or bank instability resulting from the work. The entity will document any additional actions taken to correct channel instability, and the final condition of the isolated work area (including temporary bypass).

APPENDIX D:
CONSERVATION RECOMMENDATIONS FOR PACIFIC LAMPREY AND FRESHWATER MUSSELS

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APPENDIX D:
CONSERVATION RECOMMENDATIONS FOR PACIFIC LAMPREY AND FRESHWATER MUSSELS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by implementing conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities designed to minimize or avoid adverse effects of a proposed action on listed species or designated critical habitat, to assist in the implementation of recovery plans or to obtain information.

Pacific Lamprey

While not federally listed, the Pacific lamprey (*Entosphenus tridentatus*) is of high value (culturally, ecologically, and environmentally) to many entities in the Pacific Northwest. The USFWS recommends Action Agencies consider the biological needs of lamprey for all projects requiring instream or near-stream projects, or projects that affect passage. Consideration of Pacific lamprey is important for many reasons:

- They have a high cultural significance to Native American tribes from California to Alaska and;
- They may serve as a primary food source for aquatic, mammal, and avian predators that also prey on ESA-listed salmonids and other recreational and commercially important fish species.
- Its abundance and distribution has significantly declined throughout its range over the past three decades, and efforts to reverse this decline are needed.

Pacific Lamprey Life History

As adults, Pacific lamprey return from the ocean to fresh water primarily during spring and summer months, generally moving at night. They often spend about 1 year in freshwater habitat before spawning, usually holding under large substrate (e.g., large boulders, bedrock crevices) associated with low water velocities until the following spring, when they move to spawning areas. Adult lamprey spawn between March and July in gravel bottom streams, typically at the upstream end of riffle habitat near suitable habitat for larval lamprey (ammocoetes), and die after spawning (Beamish 1980).

After hatching, the larval lamprey drift downstream to areas of low stream velocity and burrow into depositional areas with sand or silt substrate, and filter feed on algae, diatoms, and detritus for three to seven years. Larvae can be difficult to detect since they range in size from about .08 to 6 inches long. Larvae will move downstream during increased flow events, mostly at night. Many age classes of larvae will congregate together, often occurring in large clusters in depositional sites with fine sediments where habitats are optimal, making larval lamprey particularly susceptible to activities that involve dredging/excavating, stranding and use of toxic chemicals. Metamorphosis of larval lamprey into the sub-adult form or “macropthalmia” occurs from July through November but is variable depending on distance from salt water. Out-migration to the ocean occurs during or shortly after transformation (Beamish 1980). Out-migration peaks with rising stream and river flows in late winter or early spring (Kostow 2002).

Threats to Pacific Lamprey

Activities posing a threat to lamprey include:

- **Passage and entrainment.** Culverts, water diversions, hydroelectric dams and other passage barriers can impede upstream migrations by adult lamprey and downstream movement of larval lamprey and macropthalmia. Culverts that have a drop at the outlet, high velocities, inadequate attachment surfaces or insufficient resting areas, will block upstream passage but those that simulate streams will provide passage for all life stages. Fish ladders designed for salmonids are often impediments to lamprey passage as they do not have adequate surfaces for attachment, velocities are often too high and there are inadequate places for resting. Rounding corners, providing resting areas or providing a natural stream channel or wetted ramp for passage over the impediment have been effective in facilitating lamprey passage. Larval lamprey and macropthalmia may also become entrained at un-screened water diversions due to their size and weak swimming ability and adults can be blocked from moving upstream. All life stages can be impinged on screens resulting in injury or death. At present, there are no criteria for lamprey when designing fish screens; however, Rose and Mesa (2012) recommended perforated plate, vertical bar or interlocking bar screens over wire cloth to reduce entrainment.

- **De-watering and streamflow management from water diversions, instream projects and hydropower peaking** can cause rapid fluctuations in stream water levels and strand larval lamprey in the substrates. A single event can have a significant effect on a local lamprey population. Upstream passage can also be impacted, and nests can be dewatered, killing eggs and larvae.

- **Dredging from construction, channel maintenance and mining activities** can impact all age classes of larval lamprey. Removal of substrate with a backhoe or trackhoe could remove several hundred lamprey per bucket load.

- **Chemical poisoning from accidental spills or chemical treatment** can harm or kill larval lamprey burrowed in streams. As larval lamprey spend 3 to 7 years filter feeding, they may have a higher propensity for accumulating toxins such as PCBs, mercury, and other heavy metals (Bettaso and Goodman, 2008).

- **Poor water quality.** Water temperatures of 22º C (72º F) or higher may cause significant mortality or deformation of eggs or larval lamprey (Meeuwig et al 2005). Accumulated toxins in the lower reaches of streams and rivers may affect larval lamprey because they are often found in these areas.

- **Stream and floodplain degradation (channelization, loss of side channels, scouring)** can result in the loss of riffle, suitable stream edge and side channel habitats, reducing areas for spawning and larval lamprey rearing.

Conservation Recommendations for Lamprey:

While Pacific lamprey are anadromous like salmon, their life history has some unique aspects that are typically not considered during implementation of instream activities, even when using design considerations and best management practices for salmonids. Adjustments to minimize adverse effects to Pacific lamprey should be made at the project design phase to accommodate lamprey passage, lamprey spawning periods, existence of nests, upstream and downstream movement, and avoid direct mortality to larval lamprey burrowed in the substrate. The following recommendations are for Pacific lamprey, but may also benefit other species of lamprey (e.g. river lamprey (*Lampetra ayresii*), and western brook lamprey (*Lampetra richardsonii*)). The biological considerations of lamprey should be incorporated into project design, objectives, salvage and best management practices for the protection and conservation of this species. Currently there are several guidance documents available to assist in such actions:

- *Best Management Practices to minimize adverse effect to Pacific Lamprey* http://www.fws.gov/columbiariver/publications/BMP_Lamprey_2010.pdf (U.S. Fish and Wildlife Service and U.S. Forest Service 2010), which covers a broad spectrum of actions including biology, salvage during dewatering actions, habitat restoration, screening, and passage.

- *Practical guidelines for incorporating adult Pacific lamprey passage at fishways* (Pacific Lamprey Technical Workgroup 2017) (https://www.fws.gov/pacificlamprey/mainpage.cfm) provides specific guidance on providing upstream passage within existing fishways and in new fishway designs.

- *Design Guidelines for Pacific Lamprey Passage Structures* (Zobott et al. 2015) provides specific guidance for designing and installing lamprey ramps for upstream passage: http://www.uidaho.edu/~/media/UIdaho-Responsive/Files/cnr/FERL/technicalreports/2015/2015-5-LPS-Design.ashx

- *Pacific Lamprey Habitat Restoration Guide* (Crandall and Wittenbach 2015): (http://www.methowsalmon.org/Documents/PacificLampreyRestorationGuide_web.pdf) provides a detailed description of the biology, ecology, and cultural significance of lamprey, as well as threats to their population and best management practices to protect andrestore populations.

- *Effectiveness of common fish screen materials to protect lamprey ammocoetes* (Rose and Mesa 2012) found that wire cloth screens were the least successful in preventing entrainment of larval lamprey and recommended perforated plate, vertical bar or interlocking bar screens.

Additional documents, information, and materials may be found on the website for the Pacific Lamprey Conservation Initiative, hosted by the Service: https://www.fws.gov/pacificlamprey/mainpage.cfm

Lamprey Reporting

In order for the Service to be informed of actions that minimize or avoid adverse effects or that benefit Pacific lamprey, other lamprey species, and their habitats, the Service requests notification of the implementation of any of the above conservation recommendations, and copies of any relevant publications for conserving lamprey species and their habitats. Please send documents to:

State Supervisor
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
Attn: Ann Gray
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266

Freshwater Mussels

While no species of freshwater mussels are federally listed in the Pacific Northwest, they are of high value (culturally, ecologically, and environmentally) to many entities. The USFWS recommends that the Action Agencies consider the biological needs of all freshwater mussel species for all projects requiring instream or near-stream projects. There are six species of western freshwater mussels: the western pearlshell (*Margaritifera falcata*), the western ridged mussel (*Gonidea angulata*), the winged floater *Anodonta nuttalliana and* previously recognized *A. californiensis*), the Oregon floater (includes both *Anodontaoregonensis* and previously-recognized *A. kennerlyi)*, the Yukon floater *(Anodonta beringiana)*, and woebegone floater *(Anodonta dejecta)*. The Xerces Society for Invertebrate Conservation (Xerces Society) maintains a resource for western freshwater mussels at https://xerces.org/western freshwatermussels/. To paraphrase from the Xerces Society's website:

> "Freshwater mussels are experiencing a dramatic decline; 72% percent of North American freshwater mussels are considered extinct or imperiled, representing one of the most at-risk groups of animals in the United States. The decline of freshwater mussels has been well studied in eastern North America but has received very little attention in states west of the Rocky Mountains….
> "Native freshwater mussels have immense ecological and cultural significance. As filter-feeders, they can substantially improve water quality by filtering out harmful pollutants, which benefits both humans and aquatic ecosystems…. These animals can be highly sensitive to environmental changes and thus have great potential to be used as indicators of water quality. Freshwater mussels have been historically important sources of food, tools, and other implements for many Native American tribes. Native Americans in the interior Columbia Basin have harvested these animals for at least 10,000 years, and they remain an important cultural heritage for tribes today."

Conservation Recommendations for Freshwater Mussels:

The biological considerations of freshwater mussel species should be incorporated into project design, objectives, salvage and relocation, and best management practices for the protection and conservation of this species. The Xerces Society has developed a publication "Conservation the Gems of Our Waters: Best Management Practices for Protecting Native Western Freshwater Mussels during Aquatic and Riparian Restoration, Construction, and Land Management Projects and Activities, available on line at https://xerces.org/wp-content/uploads/2018/01/2018-001_Freshwater_Mussel_BMPs_XercesSociety.pdf (Blevins et al. 2017). This document includes information on determining if mussels are present at your site, project development and review, salvage and relocation, monitoring and practices for minimizing project impacts for several different activities (i.e. construction, vegetation management, flow management, restoration). The Xerces Society website also has an identification guide developed by the Xerces Society and Confederation Tribes of the Umatilla Indian Reservation at https://pnwmussels.org/wp-content/uploads/2016/07/QuickMusselGuide_CTUIR.pdf

Freshwater Mussels Reporting

In order for the USFWS to be informed of actions that minimize or avoid adverse effects or that benefit freshwater mussels, and their habitats, the Service requests notification of the implementation of any of the above conservation recommendations, and copies of any relevant publications for conserving mussel species and their habitats. Please send documents to:

State Supervisor
U.S. Fish and Wildlife Service
Oregon Fish and Wildlife Office
Attn: Ann Gray
2600 SE 98th Avenue, Suite 100
Portland, Oregon 97266

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