United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

JUN 14 2017

In Reply Refer To:
01EWFW00-2015-F-0120
X. Ref: 01EWFW00-2016-I-0500
01EWFW00-2016-I-0850

Robert P. Jones, Jr., Chief
Anadromous and Inland Fisheries Program
Sustainable Fisheries Division
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, Washington 98115

Dear Mr. Jones:

Subject: National Marine Fisheries Service 4(d) rule determination for the Washington Department of Fish and Wildlife and Tulalip Tribes Salmon Hatchery Programs in the Snohomish River Watershed

This letter transmits the U. S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) on the proposed National Marine Fisheries Service (NMFS) 4(d) rule determination for the Washington Department of Fish and Wildlife (WDFW) and Tulalip Tribes salmon hatchery programs in the Snohomish River watershed located in Snohomish County, Washington, and its effects on bull trout (*Salvelinus confluentus*) and designated critical habitat for the bull trout. The NMFS determined that operation of the hatchery facilities would "adversely affect" bull trout and bull trout critical habitat, and would "not likely adversely affect" the marbled murrelet (*Brachyramphus marmoratus*). Further, the NMFS determined that the project would have "no effect" on the northern spotted owl (*Strix occidentalis caurina*). There is no requirement for the USFWS to concur with "no effect" determinations, as these determinations rest with the action agency. Formal consultation on the proposed action 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 November 12, 2014 letter requesting formal consultation was received on November 17, 2014.

The enclosed Biological Opinion is based on information provided in the March 3, 2016, Biological Assessment, the January 17, 2017, draft Environmental Assessment, relevant Hatchery and Genetic Management Plans, telephone conversations, email communications, and other sources of information cited in the Biological Opinion. A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Lacey, Washington.

If you have any questions regarding the enclosed Opinion, our response to your concurrence request(s), or our shared responsibilities under the Act, please contact Mark Celedonia at (360) 534-9327, or Martha Jensen at 360-753-9000.

Sincerely,

for

Eric . Rickerson, State Supervisor
Washington Fish and Wildlife Office

Enclosure

cc:
NOAA, Lacey, WA (T. Tynan)
WDFW, Olympia, WA (E. Kinne)
Tulalip Tribes, Tulalip, WA (M. Crewson)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2015-F-0120

NMFS 4(d) Rule Determination for WDFW and Tulalip Tribes Salmon Hatchery Operations in the Snohomish River Watershed

Snohomish County, Washington

Federal Action Agency:

National Marine Fisheries Service

Consultation Conducted By:

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

for Eric V. Rickerson, State Supervisor
Washington Fish and Wildlife Office

14 JUNE 2017
Date

TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

Act	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
BA	Biological Assessment
CFR	Code of Federal Regulations
cfs	cubic feet per second
EPA	U.S. Environmental Protection Agency
FL	fork length
FMO	foraging, migration, and overwintering
FR	Federal Register
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetics Management Plan
HSRG	Hatchery Scientific Review Group
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
Opinion	Biological Opinion
PBF	physical or biological features
PCE	Primary Constituent Element
pHOS	proportion of hatchery-origin spawners
PNI	proportionate natural influence
RM	river mile
RPM	Reasonable and Prudent Measures
RU	bull trout Coastal Recovery Unit
TSS	total suspended solids
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington State Department of Ecology

INTRODUCTION

This document represents the U. S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) based on our review of the National Marine Fisheries Service (NMFS) proposed 4(d) rule determination for the Washington Department of Fish and Wildlife (WDFW) and Tulalip Tribes salmon hatchery programs and operations in the Snohomish River watershed, Snohomish County, Washington. We evaluated the effects of the proposed action on bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), and designated 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). The NMFS requested formal consultation on November 12, 2014.

This Opinion is based on information provided in the Biological Assessment (dated March 3, 2016), draft Environmental Assessment (NMFS 2017a), telephone conversations, emails, and other sources of information as detailed below. A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Lacey, Washington.

The NMFS is proposing to authorize the WDFW's and Tulalip Tribes' Snohomish River watershed Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and chum salmon (*O. keta*) hatchery programs under Limit 6 of the Act's section 4(d) rule for listed salmon and steelhead trout (*O. mykiss*) (50 CFR 223.203(b)(6)). Limit 6 allows for exemption of take of listed salmon and steelhead trout associated with joint Tribal/State fishery management plans developed under the United States v. Washington or United States v. Oregon settlement process. To be exempt under Limit 6, the joint fishery management plans must meet specific criteria and be subject to NMFS review and authorization. The NMFS proposes to determine that the Snohomish River hatchery programs and associated facilities are consistent with Limit 6. The proposed hatchery operations will affect the bull trout, bull trout critical habitat, and the marbled murrelet. The effects of these hatchery operations on the bull trout, bull trout critical habitat, and the marbled murrelet are entirely encompassed by the effects of the NMFS determination.

CONSULTATION HISTORY

The USFWS completed the following two separate consultations that are related to the present consultation:

- Consultation number 01EWFW00-2016-I-0500 was completed with the NMFS for WDFW steelhead trout hatchery operations in the Snohomish River watershed on March 29, 2016.
- Consultation number 01EWFW00-2016-I-0850 was completed with the U.S. Environmental Protection Agency for reissuance of a general wastewater discharge permit for discharges from 25 federal aquaculture facilities and aquaculture facilities located in Indian Country in Washington State, including three facilities included in the present consultation (Bernie Kai-Kai Gobin Tulalip Tribal Salmon Hatchery, Tulalip Creek Ponds, and Battle (Mission) Creek Pond).

A summary of important events associated with the present consultation concerning WDFW and Tulalip Tribes salmon hatchery operations in the Snohomish River watershed is provided below:

November 12, 2014. The USFWS received a request from the NMFS to initiate formal consultation on Pacific salmon hatchery programs operated by WDFW and the Tulalip Tribes in the Snohomish River watershed.

January 6, 2015. The USFWS received a partial draft Biological Assessment (BA) (dated December 24, 2014) which included only WDFW programs and facilities. The draft BA did not include any information on Tulalip Tribes programs and facilities.

November 25, 2015. The USFWS received a revised draft BA, updated to include Tulalip Tribes facilities and programs.

March 4, 2016. The USFWS received a revised draft BA that included corrections to erroneous information pertaining to historical bull trout observations at the Wallace River Hatchery.

April 21, 2016. The NMFS identified a target consultation completion date of September 2016.

May 9, 2016. The USFWS provided specific comments on the draft BA to the WDFW and the Tulalip Tribes. Necessary clarifications, additional details needed, and additional information needs were identified. Specific needs included the following: 1) bull trout handling protocols; 2) planned capital improvements to the Wallace River Hatchery weirs, intake screens, and pollution abatement systems; 3) whether the Eagle Creek rearing facility would be included in the consultation and, if so, pertinent details regarding the facility and its operation; 4) pertinent details regarding the Everett Bay Net Pen facility and its operation; 5) details regarding the configuration and operation of the weirs at the Wallace River Hatchery; 6) frequency of broodstock collection activities; 7) operational details of fish traps on Battle/Mission Creek and Tulalip Creek; and, 8) habitat conditions in the Wallace River.

May 12 to October 24, 2016. The WDFW and the Tulalip Tribes provided the additional details and information requested by the USFWS on May 9, 2016.

August 3, 2016. The NMFS changed the target consultation completion date to March 2017 due to internal delays.

October 26, 2016. The NMFS changed the target consultation completion date to June 2017 due to internal delays.

January 26, 2017. The USFWS requested additional information regarding pinniped barriers in Tulalip Bay. The Tulalip Tribes provided the requested information on the same date.

February 3, 2017. The NMFS notified the USFWS of a “no effect” determination for the marbled murrelet and the northern spotted owl.

February 27, 2017. The WDFW notified the USFWS of a significant change in planned capital improvement projects for the Wallace River Hatchery, affecting analyses of effects to bull trout. Specifically, the WDFW noted that volitional downstream passage at the Wallace River and May Creek weirs would not be incorporated into the capital improvement projects to be completed by 2020. Previously, on May 9, 2016, the WDFW indicated that volitional downstream fish passage was to be provided as part of these projects.

March 2 to 7, 2017. The WDFW provided additional requested information needed to assess effects to bull trout of the February 27, 2017 change to the proposed action.

April 11, 2017. The NMFS notified the USFWS that, upon further review, they changed their effect determination for the marbled murrelet from "no effect" to "may affect, not likely to adversely affect." The NMFS provided sufficient information supporting the effect determination.

CONCURRENCES

Marbled Murrelet

The areas around the Wallace River and Eagle Creek facilities contain mostly pasture, open fields, light to moderate residential development, roads, and young second-growth forest. The Bernie Kai-Kai Gobin Hatchery is in a forested area consisting of young second-growth forest. The Battle (Mission) Creek Pond facility is in the City of Tulalip adjacent to some stands of young second-growth forest. The Everett net pen and Tulalip Ponds facilities are in urbanized areas. Based on habitat suitability modelling (Raphael et al. 2016), there are some small, fragmented areas of "moderately high" quality nesting habitat more than 350 feet from the Battle (Mission) Creek facility and more than 500 feet from the Eagle Creek facility. There is also a limited amount of fragmented "marginal" habitat near the Eagle Creek and Wallace River facilities. There is some fragmented "marginal" habitat more than 500 feet from the Bernie Kai-Kai Gobin Hatchery.

Operations at hatchery facilities generally occur between the hours of 8 am to 5 pm. Noise-generating activities may include grounds maintenance (e.g., lawn mowing and trimming), operation of personal motor vehicles, and occasional use of chainsaws, generators, heavy equipment (e.g., cleaning out ponds), or other similarly-loud machinery. Such activities, when conducted greater than 333 feet from suitable habitat where marbled murrelets may be nesting, are not expected to result in adverse effects (USFWS 2013, pp. 5-6). Marbled murrelets nesting at distances greater than 333 feet from the noise-generating activities are expected to exhibit only minor behavioral responses, such as head-turning or increased vigilance for short periods (USFWS 2003, p. 274). These minor behavioral responses are considered to have insignificant effects to nesting marbled murrelets. Effects from noise-generating activities at the Bernie Kai-Kai Gobin Hatchery are therefore considered insignificant. At the Wallace River, Eagle Creek, and Battle (Mission) Creek Pond facilities, sound levels from routine hatchery activities are very similar to the surrounding residential, agricultural, and traffic noise and will not exceed background levels in the adjacent forest stands. Therefore, we do not expect sound levels generated from the proposed actions to measurably exceed background levels in suitable habitat. No mature conifers will be cut and the operations will not alter suitable habitat. Because temporary exposures and effects from the action are not expected to measurably disrupt normal marbled murrelet behaviors while in the terrestrial environment, effects to nesting marbled murrelets are considered insignificant.

The Tulalip Creek Ponds and Battle (Mission) Creek Pond contain components - pinniped barriers - that are situated in nearshore marine areas of Tulalip Bay. These barriers consist of permanently-installed PVC frames and removable black nylon nets that fit on the frame. The nets are in the water during the offseason when broodstock is not being collected. The Tulalip Creek Pond barrier is wholly within the upper third of the intertidal zone and is close to shore, within 90 feet of the Higher High Water Line. The Battle (Mission) Creek barrier is in the creek channel, 230 feet upstream from the creek's mouth at Tulalip Bay. Total length of the barriers in the intertidal zone is approximately 280 feet. Marbled murrelets are unlikely to be close to shore in upper intertidal areas of Tulalip Bay (USFWS 2017, pp. 68-69). In addition, the PVC frames and black nets are highly visible and avoidable by marbled murrelets. The low probability of marbled murrelets being directly exposed to the barriers, combined with the high visibility of the nets, lead us to conclude that adverse effects are extremely unlikely to occur. Direct effects of the pinniped barriers on the marbled murrelet are therefore considered discountable.

The Everett net pen is a small facility (17-feet wide by 27-feet long) located in the Everett Marina. It is situated between the shoreline and a 12-foot-wide pier that runs parallel to the shoreline. The distance between the pier and the shoreline is 85 feet. The net pen is adjacent to a walkway that runs from the shoreline to the pier. All net pen operations are conducted from land or the walkway. Marbled murrelets are extremely unlikely to use a confined area (i.e., between shore and pier) close to shore along a heavily developed shoreline with high levels of human activity. Direct effects to the marbled murrelet from net pen operations are therefore considered discountable.

The net pen and the pinniped barriers may have small, localized effects to prey resources. However, at the pinniped barriers, net installation and removal does not occur during the herring spawning period. No other forage fish are known to spawn in or near the pinniped barriers. Operation of net pens can simplify and alter substrate habitats due to accumulation of feces and uneaten food, and alteration of water chemistry (Nash 2001). These effects are minimized by having an annual fallow period during which time the net pen is not in operation. The Everett net pen facility is small and does not operate from June through December. However, there may be some small, localized effects to substrate aquatic communities that diminish marbled murrelet forage resources. The facility is located in a highly altered and disturbed area and there is no suitable forage fish spawning habitat nearby. Any effects from net pen operation are expected to be indistinguishable from current baseline conditions. For these reasons, effects of the pinniped barriers and net pen operations on marbled murrelets via effects to prey resources are not expected to be measurable, and are therefore considered insignificant.

BIOLOGICAL OPINION

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).

Introduction

The proposed action is determination by the NMFS (NMFS 2017a; 2017b) whether the WDFW and the Tulalip Tribes salmon hatchery programs in the Snohomish River watershed adequately address the criteria established for Limit 6 of the Act's section 4(d) rule for listed salmon and steelhead trout (50 CFR 223.203(b)(6)). The effects of the hatchery operations on bull trout are entirely encompassed by the effects of the NMFS determination. The NMFS determination will be made for the WDFW's and Tulalip Tribes' on-going hatchery programs that release non-listed Pacific salmon into the Snohomish River watershed and nearby areas in Puget Sound. The determination would authorize the continued operation of the hatchery programs as described in the WDFW's and Tulalip Tribes' Hatchery and Genetic Management Plans (HGMP) (Tulalip Tribes 2012; Tulalip Tribes 2013a; Tulalip Tribes 2013b; WDFW 2013a; WDFW 2013b; WDFW 2016c), and by the NMFS in their Environmental Assessment (NMFS 2017a). All activities necessary for broodstock collection, incubation, rearing, release, facility maintenance, and research, monitoring and evaluation of the Snohomish River watershed salmon hatchery program at sites and facilities affiliated with these programs would be authorized through the NMFS determination. These are summarized below and described in detail in the Biological Assessment (WDFW 2016a) and the HGMPs.

Programs and Facilities

The following six programs are included in this consultation:

- Tulalip coho salmon (Tulalip Tribes 2013a)
- Everett Net Pen coho salmon (WDFW 2013b)
- Tulalip chum salmon (Tulalip Tribes 2013b)
- Tulalip Summer Chinook salmon (Tulalip Tribes 2012)
- Wallace River coho salmon (WDFW 2016c)
- Wallace River Summer Chinook salmon (WDFW 2013a)

All six programs are production-oriented, intended to provide fish for harvest. The Tulalip chum salmon program is a segregated program intended to keep hatchery-origin and naturally-reproducing fish genetically isolated from one another. The other five programs are integrated programs, intended to maintain genetic uniformity between hatchery- and naturally-produced fish. These programs are expected to operate in perpetuity.

The following six facilities support these programs and are proposed for operation and maintenance as part of the action:

- Wallace River Hatchery, owned and operated by the WDFW, is a fully functional hatchery facility located on the Wallace River at river mile (RM) 4 at the confluence with May Creek. The Wallace River is a tributary to the Skykomish River at RM 36. This facility includes the following features: a channel-spanning weir on the Wallace River that directs upstream-moving fish into a fish ladder and a series of three holding ponds; an in-stream trap on May Creek that includes two step-type ladders on the lower end of the trap, and a picket-type rack and "V"-notch weir at the upper end of the trap; surface water withdrawals from the Wallace River and May Creek; a pollution abatement settling pond; and return water (effluent) that is discharged into the Wallace River and May Creek. The weirs on the Wallace River and May Creek contain removable portions that are in place during broodstock collection (described below), and that are removed during other times of the year.

  The following two deficiencies at the Wallace River Hatchery have previously been identified by the NMFS and the WDFW: 1) surface water intake screens are not in compliance with current NMFS standards (NMFS 2011a); and, 2) the pollution abatement pond is undersized which contributes to occasional exceedances of National Pollution Discharge Elimination System (NPDES) limits for total suspended solids (TSS). The WDFW has submitted a high-priority capital improvement project for the Wallace River Hatchery that will address both of these issues. Elements of this project include adding a larger pollution abatement pond and installing intake screens that meet current NMFS standards. The project is anticipated to be funded in the 2017 to 2019 biennium, with construction completed by fall 2020. For the purposes of this consultation, we will consider that these projects will be completed by the fall of 2020. However, effects associated with construction of these projects are not included in this consultation.

- Bernie Kai-Kai Gobin Tulalip Tribal Salmon Hatchery (Tulalip Hatchery), owned and operated by the Tulalip Tribes, is a fully functional hatchery facility located on Tulalip Creek at RM 1.2, a tributary to Puget Sound's Tulalip Bay.

- Tulalip Creek Ponds (Upper and Lower), owned and operated by the Tulalip Tribes, is an in-stream facility at the mouth of Tulalip Creek, a tributary to Puget Sound's Tulalip Bay. This facility started as a dam built in the 1920's by the Bureau of Indian Affairs at the site of what was believed to be an impassable falls that excluded anadromous fish from Tulalip Creek. This pond facility is used for juvenile rearing and adult broodstock collection, and is equipped with a fish ladder to allow returning adults to access a holding area on the downstream side of the lower pond. No fish are passed into Tulalip Creek above the pond facility. At the base of the fish ladder is a constructed earthen intertidal pond where returning adults can hold prior to ascending the ladder. A pinniped exclusion barrier surrounds the pond to prevent predation on holding adults.

- Battle (Mission) Creek Pond, owned and operated by the Tulalip Tribes, is an in-stream facility near the mouth of Battle (Mission) Creek at RM 0.1. Battle (Mission) Creek is a tributary to Puget Sound's Tulalip Bay. The creek was not believed to support any anadromous fish species, and no fish are passed into the creek above the facility. The facility was constructed in the 1980s and includes, from upstream to downstream, the following: a juvenile rearing pond, a dam, an adult chum salmon collection facility, a concrete oval adult holding pond, a picket-type rack and "V"-notch weir, several in-river adult holding ponds made of large rocks, and a pinniped exclusion barrier.

- Everett Marina Salmon Rearing Net Pen (Everett net pen) is a marine net pen facility attached to a fixed pier in the Port of Everett's Everett Marina in Port Gardner Bay near the mouth of the Snohomish River. The facility is 17-feet wide by 27-feet long, and annually rears 20,000 juvenile coho salmon from January through late May. Juvenile salmon are obtained from the WDFW's Wallace River Hatchery coho salmon program.

- Eagle Creek Rearing Pond is an off-channel incubation and rearing facility that includes a 55-gallon barrel incubator, a small rearing pond, and a second, larger earthen rearing pond that measures 100-feet long by 50-feet wide. The facility is located on Eagle Creek 1.3 miles upstream from the Skykomish River at RM 7. The facility uses surface water from Eagle Creek. There are no weirs or structures in the stream that could obstruct upstream or downstream fish movement. Coho salmon incubated and reared at the facility are provided by the WDFW's Wallace River Hatchery. The facility is privately operated by local sportsman and fisheries enhancement cooperatives.

Some broodstock for the summer Chinook salmon and coho salmon programs (WDFW and Tulalip Tribes) are obtained from the WDFW's trap-and-haul facility at Sunset Falls, although this is not the facility's primary purpose. This facility is located at RM 51.5 on the South Fork Skykomish River at the base of Sunset Falls, which is a natural impassable fish barrier. The trap-and-haul facility began operation in 1958 to provide access for anadromous fish to approximately 69 miles of previously inaccessible spawning and rearing habitat upstream of Sunset Falls. This remains the primary purpose of the operation. The trap-and-haul operation captures, handles, and passes bull trout in accordance with the current Act Section 6 cooperative agreement between the USFWS and the WDFW for the conservation of endangered and threatened fish and wildlife species. The use of the facility to collect broodstock for the hatchery programs considered in this consultation is ancillary to the facility's primary purpose and function, and imposes no additional effects to bull trout. For these reasons, the Sunset Falls trap-and-haul facility will not be considered in this consultation.

Hatchery broodstock collection

The Wallace River weir is installed seasonally and operates from June through October 1. Permanent features of the weir include a concrete apron and supports that are folded down during the off-season. When the weir is operated, the supports are raised and panels are added. This is done by hand and might include some machinery operated from the bank. No equipment or machinery is operated below the ordinary high water mark. The May Creek weir and trap is mostly a permanent structure; several panels are removed to permit fish passage during the offseason. May Creek weir operations begin in June and extend through mid-March to mid-April. Neither the Wallace River nor May Creek weirs currently allow for downstream fish movement during seasonal operations, other than juvenile fish small enough to pass through the picket spaces (1-3/4 inch space) or during occasional high flow events. When high flow events are anticipated, some panels are temporarily removed on the Wallace River weir to prevent damage to the weir structure. This typically only occurs in September. On the May Creek weir, panels may similarly be removed and/or high flow events may overtop the weir.

During operation, traps are checked daily for the presence of fish. Non-target species, such as bull trout, are removed within 24 hours of capture. Natural-origin adult salmonids that enter the traps and holding ponds and that are not needed for broodstock are placed back in their river or stream of origin on the upstream side of the weirs, with two exceptions: 1) natural-origin Chinook salmon are not passed above the May Creek weir due to disease concerns at the hatchery, warm water temperatures, and limited habitat; and, 2) per the section 6 agreement with the USFWS, any captured bull trout would be placed on the downstream side of the weirs, although no bull trout have been captured at either trap to date.

Beach seining in the Wallace River below the hatchery weir may also be used to collect hatchery-origin Chinook salmon for use as broodstock in years with insufficient hatchery returns. Natural-origin Chinook salmon are not targeted. Historically, this was not necessary because enough fish entered the hatchery traps and holding ponds to support the programs. However, beach seining has been needed three times since 2009 to augment low returns into the hatchery. When needed, seining and removal of hatchery-origin adults may occur several times during mid- to late-August. A beach seine with 3-1/2 inch mesh is used.

Adult chum salmon are collected annually from the Tulalip Creek Ponds and the Battle (Mission) Creek Pond facilities during November and December for use as broodstock. At both facilities, removable nets on the pinniped exclusion barriers in Tulalip Bay prevent fish from entering the intertidal holding ponds during most of the year. The nets are removed during broodstock collection activities. Coho and Chinook salmon broodstock may also be collected from the Tulalip Creek Ponds facility during June through August. Historically, coho salmon and Chinook salmon broodstock collection was not necessary at the Tulalip Creek Ponds because broodstocking at the Wallace River Hatchery was sufficient to support the programs. However, broodstock collection at the Tulalip Creek Ponds was needed four times between 2009 and 2015 to augment low returns to the Wallace River Hatchery.

Release of hatchery juveniles

The majority of hatchery-reared fish are released into the Wallace River from the Wallace River Hatchery, or into Tulalip Bay from the Tulalip Tribes' facilities (Table 1). Some coho salmon are also released at the mouth of the Snohomish River from the Everett Marina Net Pen, and into Eagle Creek from the rearing ponds. Table 1 shows release location, species and age class released, target number of fish released, target size of fish at release, and month of release. Monitoring, reporting, and control of specific fish pathogens are conducted in accordance with up-to-date, scientifically-based disease control policies approved by the co-managers. These policies are currently detailed in *The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 2006), which requires fish to be certified as pathogen-free prior to release.

Table 1. Proposed hatchery releases for Snohomish River watershed facilities, including release location, species, age class, and month of release.

Release location	**Fish size**			
Species, age class	**fpp**[a]	**mm FL**[b,c]	**Number**[d]	**Date**
Wallace Hatchery				
Chinook, subyearling	70	83	1 million	June
Chinook, yearling	8	160	500,000	April
Coho, yearlings	17	131	150,000	May
Tulalip Bay (Tulalip and Battle/Mission Creeks)				
Chinook, subyearling	80	80	2.4 million	May
Coho, yearling	16-18	140	1-2 million[e]	May-June
Chum, fry	300-550	50-60	8-12 million[f]	April-May
Everett Marina Net Pen				
Coho, yearling	15	150	20,000	May-June
Eagle Creek Rearing Pond				
Coho, yearling	15	146	54,000	April

a Target number of fish per pound.

b Fork length (FL) of fish, in millimeters.

c Approximate mean size of released fish based on generalized conversion from target number of fish per pound.

d Numbers represent production goals. For purposes of this consultation, we will consider that the actual number of released fish may vary by plus or minus 10 percent of the production goal.

e The current annual release goal is 1.0 million yearling coho salmon. The comanager-agreed proposed annual coho salmon production level under evaluation by the NMFS for 4(d) authorization is up to up to 2.0 million yearling smolts.

f The current annual release goal is 8 million chum salmon fry. The comanager-agreed proposed annual chum salmon production level under evaluation by the NMFS for 4(d) authorization is up to 12 million fry.

The Wallace River Hatchery provides coho salmon eggs (1.7 million) and subyearlings (305,000) to the Squaxin Island Tribe's South Sound Net Pen program. Broodstock collection, egg incubation, and juvenile rearing activities for the South Sound Net Pen program are the same as and integrated with those for the Snohomish River hatchery programs. The scope of the NMFS 4(d) Snohomish authorization and USFWS section 7 consultation thus includes the entirety of operations and activities at the Wallace River Hatchery regardless of egg or subyearling transfers. Activities associated with the South Sound Net Pen program that occur outside of the Snohomish River watershed are included in a separate NMFS 4(d) authorization (Deep South Sound).

The Wallace River Hatchery provides coho salmon eggs for use in numerous educational programs at local schools. These programs incubate eggs in classroom settings and release hatched fry into local streams. Programs are typically small, on the order of 500 to 1,000 eggs, although one program uses 10,000 eggs. The Wallace River Hatchery also provides coho salmon fry for planting into area streams and rivers by local organizations (e.g., Snohomish Sportsmen).

Water withdrawal and discharge

Water usage at all facilities is non-consumptive. The Wallace River Hatchery withdraws surface water from the Wallace River (up to 40 cubic feet per second [cfs]) and May Creek (up to 14 cfs). The surface water intakes are upstream from the weirs on the Wallace River and May Creek. Intake screening is not in compliance with current NMFS (2011a) standards, but meets superseded standards (NMFS 1995; 1996). Screening will be in compliance with current standards (NMFS 2011a) by the fall of 2020 (see above). All water used at the hatchery is discharged back into the Wallace River (10 feet downstream from the intake) and May Creek (25 to 150 feet downstream from the intake). Water rights for the Wallace River Hatchery are regulated by Washington Department of Ecology (WDOE) permits. Effluent discharge points are the Wallace River weir site and 80 feet upstream from the May Creek trap. The hatchery operates under the "Upland Fin-Fish Hatching and Rearing" NPDES general permit administered by the WDOE, number WAG 13-3006, Wallace River Hatchery. From 2008 through 2012, Wallace River Hatchery effluent exceeded TSS limits on three occasions. Heavy rains and an undersized abatement pond contributed to the three exceedances. A new abatement pond will be constructed by fall 2020 (see above) to reduce the risk of TSS limit exceedance in the future.

The Eagle Creek Rearing Pond facility uses up to 0.9 cubic feet per second (cfs) of gravity-fed surface water from Eagle Creek. The intake is screened to current NMFS (2011a) standards. All water used at the facility is discharged back into Eagle Creek approximately 170 feet downstream from the intake. The facility does not require an NPDES permit as it is under the 20,000 pound annual fish production and 5,000 pound monthly feed thresholds set by the WDOE[1].

The Tulalip Tribal facilities are in streams where bull trout and other adult salmonids are prevented from entering due to channel-spanning weirs. Therefore, the non-consumptive water usage at these facilities is not pertinent to this consultation. The facilities discharge water into adjacent streams. Discharge is regulated under NPDES Permit WAG130000, Federal Aquaculture Facilities and Aquaculture Facilities Located in Indian Country within the Boundaries of Washington State, administered by the U.S. Environmental Protection Agency (EPA). The EPA reissues this permit every 5 years, and each reissuance requires Section 7 consultation with the USFWS. The USFWS last completed consultation with the EPA on June 2, 2016 (USFWS consultation number 01EWFW00-2016-I-0850).

[1] The facility produces approximately 2,000 to 5,000 pounds of fish annually.

Pathogen control

All facilities operate in accordance with up-to-date, scientifically-based disease control policies approved by the co-managers. These policies are currently detailed in *The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 2006). This policy details current minimum best management practices for monitoring, managing, and minimizing pathogens in the hatchery, and for minimizing amplification of pathogens in the hatchery and release of elevated pathogen loads into receiving waterbodies.

Maintenance Activities

Routine maintenance is required for "watered" facilities such as ponds, troughs, incubators, pumps, water diversions, outfalls, plumbing, and the weirs, as well as buildings and grounds. Removal of minor debris accumulations from surface water diversion structures and from discharge outfall structures is necessary to maintain their integrity and performance. Removal of large sediment accumulations requiring use of heavy equipment is not covered in this consultation, as this is not considered normal hatchery maintenance. Minor repairs and adjustments to the weirs are also required on occasion. Bank armoring or construction activities using heavy equipment that impact aquatic environments, shorelines, substrates or riparian vegetation are not considered routine hatchery operation and maintenance activities and are not proposed under this action. These types of activities would require individual consultations.

Maintenance of ponds and raceways at the Wallace River Hatchery and the Tulalip Hatchery are regular occurrences. This involves the vacuuming and removal of accumulated sediment on the bottoms of hatchery ponds and raceways. Each facility has pollution abatement systems that prevent sediment-laden water from reaching surface waters. Solids are periodically removed from the abatement structures and disposed of at upland locations on the hatchery grounds or at commercial sites (Wallace River Hatchery), or at a sewage treatment facility (Tulalip Hatchery). Heavy equipment is not used for these activities, is not considered normal hatchery maintenance, and is not considered in this consultation.

Other facility maintenance includes building and grounds maintenance, including painting, minor building repairs, security repairs such as lighting and fence repair, and weeding and mowing. Typical chemicals that are used during grounds maintenance at the Wallace River Hatchery include Roundup and Rodeo. All applications are performed during dry conditions (i.e., not raining or expected to rain) using a backpack sprayer following the chemical manufacturer's label. Roundup is used around buildings and landscaped areas, and is not applied within 300 feet of water. Rodeo is used for applications closer to water. Approximately 2.5 gallons of Rodeo may be applied during summer months at the Wallace River Hatchery. At the Tulalip Tribes' facilities, no herbicides or chemicals are used during grounds maintenance or applied near water.

Conservation Measures

Conservation measures and best management practices to minimize effects to the aquatic ecosystem and naturally-reproducing fish populations are integrated within hatchery operations. These are described as appropriate throughout this document.

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 broodstock collection, water withdrawal, effluent discharge, fish release, facility maintenance, research, monitoring and evaluation, and disturbances associated with these activities, including bull trout capture and handling, dewatering of stream channels, sediment disturbance, in-air sound, and inter-species interactions between released hatchery fish and bull trout. This generally includes anadromous reaches of rivers and streams in the Snohomish River watershed as well as Port Gardner Bay and Tulalip Bay (Figure 1). The USFWS anticipates that these are the areas in which physical or chemical effects due to the proposed action, including interrelated and interdependent actions, may be measurable. We anticipate that salmon released from the hatcheries will distribute themselves in the marine environment in concert with local currents. Beyond this area and extending out into the Pacific Ocean, effects quickly become diluted and are no longer measurable even though individual salmon released as part of these programs may venture widely.

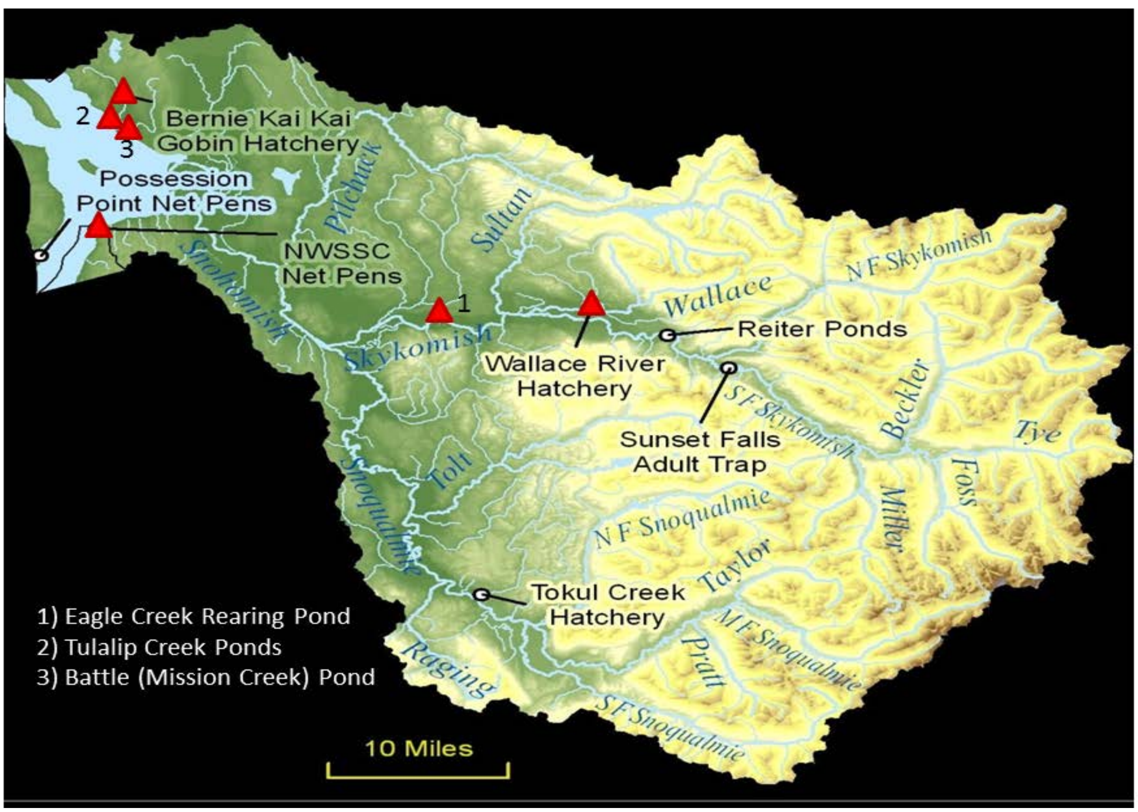

Figure 1. Map of the Snohomish River watershed and WDFW's and Tulalip Tribes' salmon hatchery facilities (red triangles) included in this consultation. Other facilities are shown for reference only. The facility labeled NWSSC Net Pens is termed the Everett Marina Salmon Rearing Net Pen in the text. The action area comprises the portions of the watershed accessible to anadromous fish and adjacent marine nearshore areas. See text for a complete definition of the action area.

Term of Consultation

The NMFS 4(d) rule, Limit 6 take authorization is open-ended in duration and is valid in perpetuity, subject to the permitee's compliance with program operational requirements and take limits specified in the NMFS determination, and required annual reporting.

The effects of the hatchery operations evaluated by this Opinion cannot reasonably be evaluated beyond 20 years. This is because climate change is expected to have substantial implications to baseline conditions, Snohomish and Skykomish core area bull trout, hatchery operations, and success of recovery programs. Because the nature and extent of climate change and the effects of climate change cannot be predicted with adequate certainty beyond 20 years, we cannot evaluate effects of the action on bull trout after this time. Therefore, this consultation will expire 20 years from issuance, at which point consultation on these actions must be reinitiated.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

The following analysis relies on the following four components: (1) the *Status of the Species*, which evaluates the rangewide condition of the listed species addressed, the factors responsible for that condition, and the species' survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-federal activities in the action area on the species.

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

The jeopardy analysis in this Opinion emphasizes the rangewide survival and recovery needs of the listed species and the role of the action area in providing for those needs. It is within this context that we evaluate the significance of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), "physical or 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. However, the shift in terminology does not change the approach used in conducting a destruction or adverse modification analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features. For those reasons, in this biological opinion, references to PCEs should be viewed as synonymous with PBFs. Either term characterizes the key components of critical habitat that provide for the conservation of the listed species.

Our analysis of effects to critical habitat relies on the following four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of PCEs or PBFs, the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs or PBFs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-federal activities in the action area on the PCEs or PBFs and how that will influence the recovery role of affected critical habitat units.

For purposes of making the destruction or adverse modification finding, the effects of the proposed Federal action, together with any cumulative effects, are evaluated to determine if the critical habitat rangewide would remain functional (or retain the current ability for the PBFs to be functionally re-established in areas of currently unsuitable but capable habitat) to serve its intended conservation/recovery role for bull trout.

STATUS OF THE SPECIES: Bull Trout

Status of the Species Rangewide

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 2015a, p. iii).

The 2015 recovery plan for bull trout identifies six recovery units of bull trout within the listed range of the species (USFWS 2015a, 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 2015a, p. 34). Core areas are functionally similar to bull trout metapopulations, 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 mainstem 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 2015a, 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.

STATUS OF CRITICAL HABITAT: Bull Trout

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

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded the primary constituent elements (PCEs), those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout (*Salvelinus 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 (*Salvelinus fontinalis*), 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 anadromous 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.

ENVIRONMENTAL BASELINE: Bull Trout and designated Bull Trout Critical Habitat

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

General Features and Characteristics of the Action Area

The Snohomish River watershed, Puget Sound's second largest tributary, encompasses approximately 1,880 square miles. The two main tributaries - the Skykomish River (835 square miles) and the Snoqualmie River (703 square miles) - join to form the Snohomish River at river mile (RM) 20.5. The Snohomish River enters the Puget Sound near the City of Everett. The Wallace River (59 square miles) is a tributary to the Skykomish River at RM 36. Eagle Creek is a small tributary to the Skykomish River at RM 28.5. The watershed includes steep, mountainous terrain in the upper watershed, foothills in the middle, and a broad valley and alluvial fan adjacent to Puget Sound. Upper watershed areas to the east lie on the west slope of the Cascade Mountains, and include the headwaters of both the Skykomish and Snoqualmie Rivers. The flow regime is characterized by high flows from snowmelt in late spring and early summer, and variable high flows in late fall and winter from rainfall. Lowest annual river discharges usually occur during August and September. Much of the basin is situated on top of thick alluvial deposits.

The upper Snohomish River watershed - above RM 50 on the Skykomish River and RM 40 on the Snoqualmie River - are primarily in federal ownership, comprised of the Mt. Baker - Snoqualmie National Forest. Approximately half of these national forestlands are protected within designated wilderness areas. The middle watershed, down to the confluence of the Skykomish and Snoqualmie Rivers, are comprised primarily of lands in agricultural production and rural development in valley bottoms, and privately-owned commercial timberlands and second growth forests in the uplands. The lower watershed is predominantly used for agriculture, rural residential and urban development within and near the cities of Everett, Marysville, Snohomish, and Monroe. Over 90 percent of the wetlands within the original floodplain in the lower Snohomish have been drained, filled, or channeled to accommodate development and farming.

Impacts to Salmonid Habitat

The lower watershed, including the estuary, has been considerably altered from historical, pre-disturbance conditions, and currently provides substantially reduced habitat quantity and quality for salmon, trout, and char (Haring 2002). The main channel of the river is confined and highly simplified. With some exceptions, it is generally lacking in large wood and physical and hydraulic complexity. Valuable and highly-productive side channel and off-channel habitat has been reduced. One of the most significant factors contributing to these conditions was the construction of levees and dikes along both banks of the river and estuarine distributary channels. These levees and dikes have disconnected distributary channels and disconnected the river from the floodplain and side channels, substantially reducing the quantity and quality of salmonid habitat, increasing flood flow velocities and depths, impairing large wood recruitment, and reducing subsurface flows and groundwater inputs. Other contributors to the current state of the lower river include the following: historical removal of large wood from the main channel and tributaries; widespread logging and deforestation of riparian, floodplain, and upland areas throughout the watershed; installation and maintenance of riverbank protection (i.e., riprapped banks); surface water diversion for irrigation and municipal use; groundwater extraction; and polluted runoff and contaminated groundwater from widespread agricultural operations. Logging and logging roads in the upper watershed likely increase sediment inputs and contribute to increased fine sediments throughout the watershed. Much of the lower river floodplain has been converted to agriculture, rural residential development, and urban development, which limits future restoration opportunities.

The middle and some upper portions of the watershed have been subject to large-scale commercial timber extraction since the early- to mid-1900s. Some areas of high-quality habitat, primarily on public lands, still remain. Timber extraction and deficient construction and management of logging roads have resulted in unstable slopes, mass wasting, erosion, and high inputs of fine sediments in some areas. Timber extraction and road construction and maintenance practices have improved, in part through the 1990 Land and Resource Management Plan, as amended by the 1994 Northwest Forest Plan and its associated Aquatic Conservation Strategy. However, logging roads that were constructed prior to these plans taking effect continue to degrade water quality and aquatic habitats in some places. The U.S. Forest Service has identified and implemented restoration projects, including road decommissioning, tree planting, and culvert replacements, to help address these issues. The high-quality habitat found in the middle and upper reaches of the watershed allow the Snohomish River watershed to support relatively abundant populations of some species of naturally-reproducing salmonids, including coho salmon and bull trout, although abundances are below historical levels and bull trout numbers have been declining in recent years (see below).

The altered state of the estuary, river channel, riparian areas, and floodplain along the mainstems Snohomish, Skykomish, and Snoqualmie Rivers and lower reaches of their tributaries is one of the primary factors that have contributed to the decline of salmonid populations in the watershed. Abundance of naturally-reproducing anadromous salmon and steelhead trout populations in the Snohomish River watershed are below historical levels, and abundances of Chinook salmon and steelhead trout are particularly low. Nutrient pulses and other ecological services related to returning adult anadromous salmonids in freshwater have been identified as primary drivers of individual growth and population productivity in salmonids (e.g., Moore et al. 2008; Rinella et al. 2012; Walters et al. 2013, p. 516; Nelson and Reynolds 2014), including bull trout (Zimmerman and Kinsel 2010, p. 30; Copeland and Meyer 2011, pp. 937-938). Thus, habitat degradation and diminished salmonid abundance may operate synergistically to persistently suppress salmonid populations.

The Congressionally-established Pacific Coastal Salmon Recovery Fund and other funding from State and Tribal sources, have contributed to a variety of completed, underway, and planned salmonid habitat restoration efforts in the estuary and along the mainstems and in tributaries

(NMFS 2011c; NMFS 2017b, pp. 56-58). These have included large wood additions, planting trees and creating riparian buffers, conservation easements, levee setbacks, and dike breaches. However, with continued human population growth projected in the region, threats to salmonid populations and the loss and degradation of their habitat will persist. Areas along the mainstem and lowland tributaries are most likely to be affected by growth and development pressures. When riverine lands are converted to residential and urban areas, forest cover and ecosystem processes are altered or lost and the change is commonly permanent.

The effects of habitat degradation described in this subsection on salmon, trout, and char are expected to be exacerbated by climate change. The climate in the Pacific Northwest is changing, and some anticipated effects of climate change on aquatic habitats are apparent in many waterways across the region (Mauger et al. 2015, and references therein), including the Snohomish River watershed (e.g., Luce and Holden 2009). Climate change is expected to continue for many decades into the future, with substantial negative implications to freshwater and marine habitats and the species that currently inhabit these waters. See the Climate Change subsection below for additional information.

Fisheries

The bull trout 4(d) rule, implemented at the time of bull trout listing in 1999, exempts take associated with fisheries operated in accordance with applicable State, National Park Service, or Native American Tribal laws and regulations. In accordance with the 4(d) rule, the WDFW currently operates a recreational catch-and-keep fishery for bull trout in the Snohomish River watershed. The fishery is open for 6 to 7 months per year in the Snohomish River, the mainstem of the Skykomish River (excluding the North and South Forks), and the Wallace and Sultan Rivers (the two major tributaries to the Skykomish River). Months of operation include June through August, and November through January or February, depending on location. These are time periods when bull trout are most likely to be in these areas. The daily limit is two fish, and the minimum size limit is 20 inches. The WDFW has no data on how many bull trout are captured during these fisheries.

Various commercial, Tribal, and recreational fisheries for salmon and steelhead are open annually in the Snohomish River watershed and nearby marine waters (WDFW 2016a; 2016b). Fishing regulations, including when and where the fishing seasons are open, may change from year to year. Most, if not all, of these fisheries are supported by WDFW and Tribal hatchery programs in the Snohomish River area and have been ongoing since before bull trout were listed. The USFWS considers fisheries supported by the WDFW and Tribal hatchery programs as meeting requirements for exemption under the 4(d) rule. Therefore, for the purposes of this consultation, effects from hatchery-supported fisheries are considered part of the baseline and not interrelated and interdependent effects of the hatchery operations.

Bull trout are highly susceptible to incidental capture in fisheries targeting other species when those fisheries overlap in time and space with bull trout. Incidentally-captured bull trout are exposed to inadvertent injury and immediate and delayed mortality associated with hooking, suffocation (e.g., from gill nets), handling, stress and physical exhaustion, and predation (e.g., Arlinghaus et al. 2007, pp. 105-134). Poaching and intentional killing (i.e., from anglers that believe bull trout are a threat to their preferred target species or confuse them with other species) are also a concern in some areas. Specific effects to and take of bull trout from fisheries in the Snohomish River watershed were not evaluated or determined at the time of listing and 4(d) rule implementation. At least some of the fisheries that operate in the area overlap in time and space with bull trout presence. By-catch of bull trout in commercial and Tribal fisheries is not reported, and creel surveys to evaluate fishing pressure and incidental capture of bull trout in recreational fisheries have not been performed. Thus, impacts from salmon and steelhead fisheries are likely, but cannot be determined with any certainty.

Hatcheries

The WDFW and the Tulalip Tribes have produced and released coho, chum, and Chinook salmon and steelhead trout in the Snohomish River watershed for decades. The Tulalip Tribes' chum salmon program began in 1976, the coho salmon program in 1981, and the summer Chinook salmon program in 1998. The Tulalip Tribes previously operated a fall Chinook program that began in 1978 but was phased out in the early 2000's and discontinued completely in 2004. The WDFW's coho salmon program began in the early 1900's, the summer Chinook salmon program in 1972, and the steelhead trout programs in the early 1970's. The WDFW previously operated a fall Chinook program that began in the early 1900's but was discontinued in 1997. In 2000, the U.S. Congress established the Pacific Northwest Hatchery Reform Project to help reduce negative effects of salmon and steelhead trout hatchery operations on naturally-reproducing populations. Toward this end, the Project's independent scientific review panel - the Hatchery Scientific Review Group (HSRG) - evaluated State, Tribal, and federal hatchery operations throughout the region, including those in the Snohomish River watershed. Based in part on HSRG findings, the WDFW and the Tulalip Tribes implemented changes to many of their programs. More details on the history of the programs and modifications resulting from HSRG review can be found in the HSRG report (HSRG 2004, Appendix I, pp. 121-146) and in the HGMPs for each hatchery program.

Current Condition of Bull Trout in the Action Area

Central Puget Sound

Bull trout are distributed throughout most of the large rivers within Puget Sound, with the exception of the Nisqually River, where only a few observations have been reported (USFWS 2004, p. 46). Anadromous bull trout require access to marine waters, estuaries, and lower reaches of rivers to forage and overwinter (USFWS 2004, p. 134). It is believed that some level of mixing and interaction within marine waters occurs among anadromous individuals from the various core areas identified in Puget Sound.

Three facilities - the Everett Marina Salmon Rearing Net Pen, Tulalip Creek Ponds, and Battle Creek Pond - are wholly or partially within marine portions of the bull trout Coastal Recovery Unit (RU). Bull trout present in the action area are expected to be from the Lower Skagit River, Stillaguamish River, and Snohomish and Skykomish Rivers core areas. Bull trout occurrence in marine nearshore waters is unique to the Coastal RU. Marine nearshore areas support the complex migratory behaviors and requirements of the anadromous form of bull trout. As such, these areas are critical to the persistence of that life history form.

Anadromous juvenile, sub-adult, and adult bull trout utilize marine waters of the action area for foraging, migration, and overwintering. In two telemetry studies documenting the extent of anadromy in bull trout within portions of the Coastal RU, approximately 55 percent of the fish tagged in freshwater emigrated to saltwater (Brenkman and Corbett 2005; Goetz et al. 2007). Results from these studies also demonstrate that anadromous bull trout inhabit a diverse range of estuarine, freshwater, and marine habitats.

Marine waters provide important habitat for anadromous bull trout for extended periods of time. Data for bull trout from Puget Sound indicate that the majority of anadromous bull trout tend to migrate into marine waters in the early spring and return to rivers in the late spring or early summer period. Although, less frequent, tagged fish have been detected in Puget Sound nearshore marine waters during December and January, which indicates that some fish remain in marine waters during the winter or return to the marine environment shortly after spawning (Goetz et al. 2007; USGS 2008). It is thought that warmer water temperatures in the summer may be an environmental cue that stimulates bull trout to return to freshwater. Other factors that may influence marine residency for bull trout include prey availability, predation risks, and spawn timing.

In general, anadromous bull trout use shallow nearshore, subtidal, and intertidal waters. In two acoustic telemetry projects, the greatest bull trout densities were at depths greater than 6.6 to 8.2 ft, with some individuals found at depths as great as 82 ft (Goetz et al. 2004; USGS 2008). Upon entering marine waters, bull trout can make extensive, rapid migrations, usually in nearshore marine areas. However, individual bull trout have also been tracked crossing Puget Sound at depths greater than 600 ft (Goetz et al. 2012).

During the majority of their marine residency, anadromous bull trout have been found to occupy territories ranging in size from approximately 33 ft to more than 2 miles within 330 to 1,300 ft of the shoreline (USGS 2009). Aquatic vegetation and substrate common to bull trout marine habitat include eelgrass, green algae, sand, mud, and mixed fine substrates. Forage fish occurrence is also correlated with these habitat features. Bull trout prey on surf smelt (*Hypomesus pretiosus*), Pacific herring (*Clupea pallasii*), Pacific sand lance (*Ammodytes hexapterus*) (sand lance), and other small schooling fish (Kraemer 1994). In general, forage fish, bottom fish, and wild salmon have declined in the Puget Sound. Part of this decline has been attributed to human encroachment and development of nearshore areas that has resulted in the loss of nearshore habitat. It is likely that anadromous bull trout have been impacted by the decline in forage base and loss of habitat in this marine environment.

Some level of mixing or interaction within marine waters occurs among anadromous individuals from various core areas and bull trout from several core areas may be present in the action area simultaneously (Goetz et al. 2004; Brenkman and Corbett 2005; Brenkman and Corbett 2007; Goetz et al. 2007). We expect that bull trout from the Stillaguamish River, Snohomish and Skykomish Rivers, and Lower Skagit River core areas could occur in the action area. The status of the Snohomish and Skykomish Rivers core area is discussed below. The status of the Stillaguamish River and Lower Skagit River core areas are discussed in Appendices C and D, respectively.

Numerous bull trout have been captured and/or tracked in saltwater areas in and near the mouth of the Snohomish River, Port Gardner Bay, and adjacent areas of Puget Sound (USFWS 2010). These observations indicate that bull trout utilize the action area and may be exposed to project-related stressors. Given the proximity of the mouth of the Snohomish River and the size of the bull trout population in the Snohomish and Skykomish Rivers core area, we expect that the majority of bull trout in the action area would be from the Snohomish and Skykomish Rivers core area. Although the mouths of the Stillaguamish and the Skagit Rivers are farther from the action area, bull trout from these rivers may also use the action area due to their migratory behavior. Bull trout abundance within the Snohomish and Skykomish Rivers core area is estimated to be between 500 and 1,000 individuals (see below). The anadromous portion (55 percent) is approximated to be 275 to 550 individuals.

The Everett Marina Salmon Rearing Net Pen is in a highly modified and disturbed area. Bank armoring and overwater structures are predominant along the shoreline within the marina, effectively eliminating most, if not all, natural nearshore habitat function. Riparian areas in and adjacent to the marina consist exclusively of roads, parking lots, and commercial facilities. There is no functional riparian or aquatic vegetation or suitable forage fish spawning habitat in the vicinity of the net pens. No bull trout have been observed in the immediate area affected by the net pen, although surveys are extremely limited and bull trout are known use the general area.

The areas in Tulalip Bay near the Tulalip Creek Ponds and Battle (Mission) Creek Pond facilities are moderately disturbed. There is very little bank armoring in these areas. There are no overwater structures, other than a small bridge over Battle (Mission) Creek. Riparian areas include residences, roads, mature trees, and other vegetation. Pacific herring spawn throughout Tulalip Bay. During acoustic telemetry studies conducted in the early 2000's, several tagged bull trout were observed in and near Tulalip Bay. It is uncertain how near the tagged fish were to the Tulalip Bay hatchery facilities. There are no historical observations of bull trout in the areas immediately adjacent to the facilities. Tulalip Bay currently supports a spawning population of Pacific herring, as well as sand lance spawning along approximately 1,000 feet of shoreline on the opposite side of the bay from the hatchery facilities. These forage resources may attract bull trout into the bay.

Snohomish and Skykomish Rivers Core Area

Core areas represent the closest approximation of a biologically functioning unit for bull trout and consist of habitats needed to supply all of the necessary elements for every life stage of bull trout (e.g., spawning, rearing, migration, overwintering, foraging). Core areas have one or more local populations of bull trout, and are also the basic units upon which to gauge recovery within a bull trout recovery unit.

The action area completely overlaps the Coastal Recovery Unit's Snohomish and Skykomish Rivers core area, which supports four local populations of bull trout. Anadromous, fluvial, and likely resident bull trout from all of these local populations are present in the action area.

The Snohomish and Skykomish Rivers core area comprises the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout occur throughout the Snohomish River system downstream of barriers to anadromous fish. Bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River. Bull trout did not occur above Sunset Falls on the South Fork Skykomish River prior to 1958, when the Washington Department of Fisheries (now Washington Department of Fish and Wildlife) implemented a trap-and-haul program for anadromous salmonids. This program is still operating.

Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish and Skykomish Rivers core area. A large portion of the migratory segment of this population is anadromous. There are no lake systems within the basin that support typical adfluvial populations; however, anadromous and fluvial forms occasionally forage in a number of lowland lakes having connectivity to the mainstem rivers (USFWS 2004, p. 99).

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

The Snohomish and Skykomish Rivers core area population is considered at "potential risk" for extirpation (USFWS 2008b, p. 35; USFWS 2015c). Since 2008, some of the key status indicators have declined. 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, and 4) connectivity (USFWS 2004, p. 215).

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

Four local populations are recognized within the Snohomish and Skykomish core area (USFWS 2004, pp. 99-105; USFWS 2015b, p. A-14): 1) North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), 3) Salmon Creek, and 4) South Fork Skykomish River. Core areas with fewer than 5 interconnected local populations are at increased risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218). Three of the four Snohomish and Skykomish core area local populations are interconnected (see Connectivity section below).

Adult Abundance

The Snohomish and Skykomish Rivers core area probably supports between 500 and 1,000 adults. In 2008, it was believed that this core area supported just over 1,000 adults (USFWS 2008a, p. 2; USFWS 2008b, p. 35). However, abundance indices in the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have substantially declined since then (WDFW 2017a) (Figure 2). From 2002 to 2007, North Fork redd counts averaged 305 redds, peaking at 538 redds in 2002. In contrast, from 2009 to 2014, counts averaged 90 redds, with a minimum of 17 redds observed in 2013, the lowest single-year count since surveys began in 1988. During the same time, adult counts at the South Fork Skykomish River trap declined from a mean of 94 fish from 2002 to 2007, to a mean of 44 fish from 2012 to 2016. The Troublesome Creek local population is mainly a resident population upstream of a natural migration barrier. Adult abundance is unknown for this local population. The Salmon Creek local population likely has fewer than 100 adults.

The Snohomish and Skykomish Rivers core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 218-224). Two local populations (South Fork Skokomish River, Salmon Creek) are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 218-224). The North Fork Skykomish River local population is not at risk from inbreeding depression. Risk from inbreeding depression to the Troublesome Creek local population is unknown.

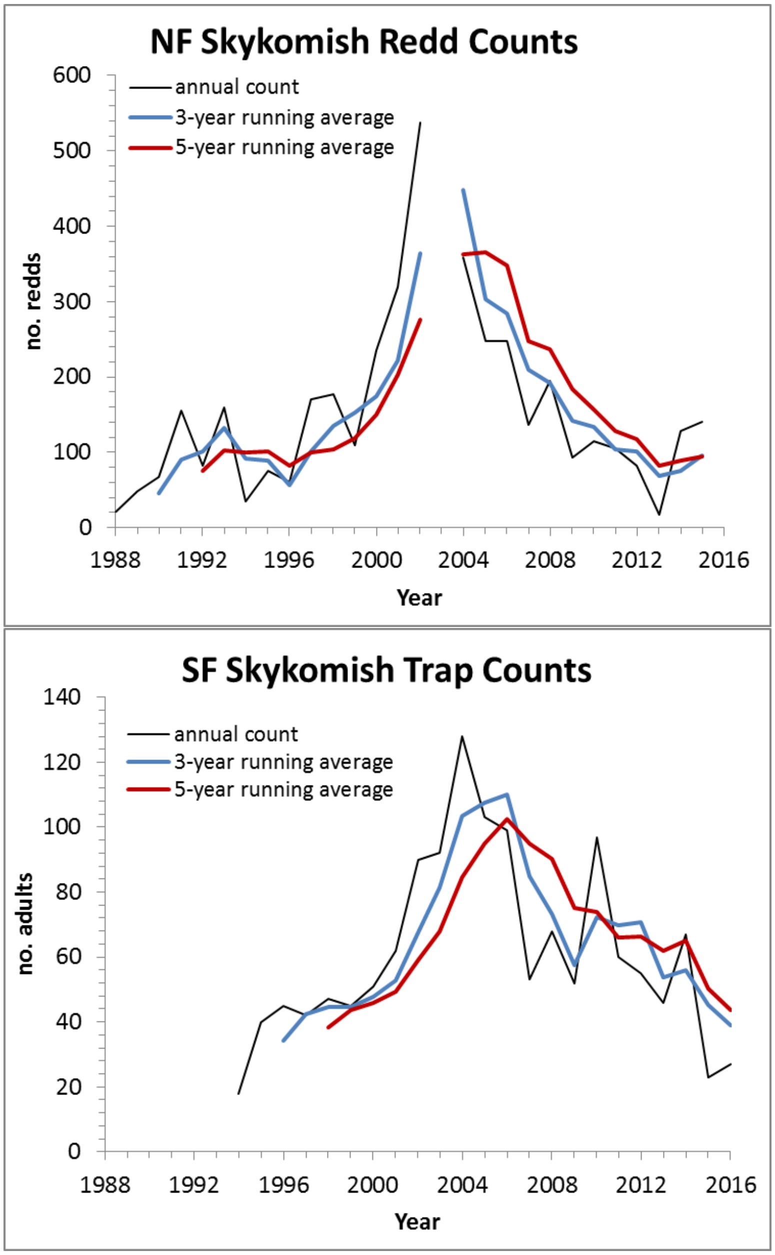

Figure 2. Annual counts, and 3-year and 5-year running averages for bull trout redds in the North Fork Skykomish River (top panel), and adult bull trout captured in the Sunset Falls trap-and-haul facility and transported upstream in the South Fork Skykomish River (bottom panel). Source: Washington Department of Fish and Wildlife (WDFW 2017a).

Productivity

Population trends for the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have been in decline since peaking in the early- to mid-2000's (Figure 2). Long-term redd counts for the North Fork Skykomish River local population increased from the time of listing, peaked between 2001 and 2004, and have generally been in decline since. Recent five-year running averages (83 to 95 redds) have been equivalent to pre-listing levels (75 to 118 redds) despite a sharp peak in the mid-2000s (348 to 366 redds). A similar trend is evident in adult counts at the South Fork Skykomish River trap. In addition, the number of fish caught in the trap for the most recent two years (2015, 2016) was the lowest since 1994. It is believed that the South Fork Skykomish River local population is continuing to colonize new spawning and rearing habitat, which may offset the declining productivity trend in coming years. Productivity of the Troublesome Creek and Salmon Creek local populations is unknown but presumed stable, as the available spawning and early rearing habitats are considered to be in good to excellent condition. The Snohomish and Skykomish Rivers core area is at increased risk of extirpation due to declining productivity (USFWS 2004, pp. 224-225).

Connectivity

Migratory bull trout occur in three of the four local populations in the Snohomish and Skykomish Rivers core area (North Fork Skykomish River, Salmon Creek, and South Fork Skykomish River). The lack of connectivity with the Troublesome Creek local population is a natural condition. The connectivity between the other three local populations reduces the risk of extirpation from habitat isolation and fragmentation. However, connectivity with the South Fork Skykomish River local population is dependent upon the WDFW trap-and-haul facility at Sunset Falls.

Changes in Environmental Conditions

Since the bull trout listing, federal actions occurring in the Snohomish and Skykomish Rivers core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Snohomish and Skykomish Rivers core area.

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

Climate change is expected to negatively affect the Snohomish and Skykomish Rivers core area (USFWS 2008a, p. 14). Climate change is expected to result in higher water temperatures, lower spawning flows, and increased magnitude of winter peak flows (Battin et al. 2007; Mauger et al. 2015, and references therein). Higher peak flows may increase redd scour and mortality to eggs, incubating embryos, and pre-emergent juveniles. Bull trout spawning and rearing areas are particularly vulnerable to future climate change impacts, especially due to the narrow distribution of spawning sites within this system (USFWS 2008a, p. 14). See the Climate Change subsection below for additional information on anticipated effects of climate change on aquatic habitats.

Threats

There are four primary threats to bull trout in the Snohomish and Skykomish Rivers core area (USFWS 2015b, p. A-14):

Instream Impacts: Flood Control. Flood and erosion control associated with agricultural practices, residential development, and urbanization continues to result in poor structural complexity within lower river FMO habitats key to the persistence of the anadromous life history form.

Instream Impacts: Recreational Mining. Recreational mining activities impact spawning and rearing tributary habitats.

Water Quality: Residential Development and Urbanization. Associated impacts increase seasonal high water temperature in lower mainstem rivers, migration corridors that are key to the persistence of the anadromous life history form.

Connectivity Impairment: Fish Passage Issues. Persistence of the South Fork Skykomish River local population is reliant upon continued funding and ongoing operation of the trap-and-haul facility at Sunset Falls.

Additional threats to the Snohomish and Skykomish core area bull trout population include the following:

- Effects of climate change on freshwater and marine ecosystems will exacerbate effects of habitat loss and degradation, and will negatively affect bull trout and bull trout forage resources. Primary negative effects will occur as a result of warmer stream and sea surface temperatures, lower summer flows, higher peak winter flows, sea level rise, and ocean acidification.
- Below-historical and depressed abundances of naturally-reproducing salmon and steelhead trout populations in the watershed limits forage resources in some areas during some times of the year.
- Depressed forage fish abundances in the Puget Sound nearshore limits forage resources available to anadromous bull trout during their marine residency.
- Degraded habitat conditions from effects associated with timber harvests, logging roads, and timber land fertilization, especially in the upper watershed, where spawning occurs.

- Blocked fish passage, altered stream morphology, and degraded water quality in the lower watershed resulting from agricultural and livestock management practices.
- Injury and/or mortality from illegal harvest or incidental hooking/netting, which may occur where recreational fishing is allowed by the WDFW.
- Degraded water quality from municipal and industrial effluent discharges and development.
- Degradation of riparian areas due to residential development and urbanization, and associated loss of foraging habitat and prey.

<u>Factors Responsible for the Condition of the Species</u>

The habitat conditions and threats detailed above are responsible for the condition of bull trout in the Snohomish and Skykomish Rivers core area.

Current Condition of Bull Trout Critical Habitat in the Action Area

The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The 2010 designation of critical habitat for bull trout uses the term PCE. However, recent critical habitat regulations (81 FR 7214 [February 11, 2016]) replace this term with physical or biological features (PBFs). This shift in terminology does not change the approach used in conducting our analysis, whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this Biological Opinion, the term PCE is synonymous with PBF or essential features of critical habitat.

Central Puget Sound

Critical habitat in Puget Sound marine waters extends offshore to the depth of minus 33 feet relative to the mean low low-water line, which is the photic zone and is considered to be the habitat most consistently used by bull trout in marine waters. The action area includes broad areas of Port Gardner Bay and Tulalip Bay. Most of this area is included in the action area only because hatchery salmon smolts and returning adults seasonally occupy this general area at approximately the same time as foraging adult, subadult, and large juvenile bull trout. Although three of the marine facilities are located in the marine nearshore, only the Everett net pen is within designated bull trout critical habitat. Tulalip Bay is considered essential excluded habitat, but is not designated critical habitat (75 FR 63898-63979 [October 18, 2010]).

The nearshore areas of central Puget Sound provide marine foraging, migration, and overwintering habitat for adult, subadult, and large juvenile bull trout originating from several core areas (e.g., Skagit, Stillaguamish, and Snohomish and Skykomish Rivers bull trout core areas), and numerous local populations. These bull trout core areas support large and moderately sized local bull trout populations, including the largest anadromous bull trout populations found anywhere in Washington State (Skagit River).

The action area includes shoreline areas of Puget Sound from Everett to Port Gardner Bay. Shoreline areas around Everett have continuously developed for residential, commercial, industrial, and municipal purposes. Different indicators of Puget Sound ecosystem health have been described and evaluated by the Puget Sound Partnership in the 2015 State of the Sound report (Hamel et al. 2015). The authors concluded that development pressures continue to negatively impact marine and freshwater habitats in the Puget Sound region, and emphasize the following trends and concerns:

- Declining Pacific herring (*Clupea pallasii*) stocks.
- Continuing loss of non-federal forested land cover to development.
- Shoreline armoring was stable from 2011 to 2014, as restoration actions have recently started offsetting increases in private shoreline armoring.
- Conversion and loss of vegetation cover on ecologically important lands is accelerating and is currently more than double the 2020 target.
- Marine water quality trends have been getting worse with closures of beaches and shellfish harvest in some bays. Although there has been some increase between 2011 and 2014 in the amount of shellfish beds open to harvest, about 19 percent are still closed and PCB levels in fish are still high.
- Native eelgrass (*Zostera marina*) abundance appears stable, but is still thousands of acres short of the 2020 target.
- Continued increases in the human population in Puget Sound will result in continued impacts to shoreline areas and degradation of water and habitat quality.

The current condition of PCEs of critical habitat present within the action area and are as follow:

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.

Critical habitat in the marine action area is part of a heavily developed commercial shoreline where the Snohomish River drains into Puget Sound. Impairments typically associated with such areas include the following: noise from boats, water quality degradation from pollution and elevated turbidity, and over- and in-water structures associated with piers. These impairments may present partial, temporary and/or intermittent barriers to migration. There are no permanent physical obstructions within the migratory corridor.

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

In general, forage resources (forage fish species and juvenile salmonids) have declined across Puget Sound. This decline is likely more severe around industrial and commercial waterfronts such as the shorelines of Everett, which are degraded and do not provide suitable spawning habitat for marine forage fish.

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 substrates, to provide a variety of depths, gradients, velocities, and structure.

The part of the action area associated with the Everett net pen is located in a highly modified and disturbed area. It is a heavily developed commercial shoreline and is adjacent to a large marina. Bank armoring and overwater structures predominate along the nearshore, effectively eliminating most, if not all, natural nearshore habitat functions. Armoring often results in increased beach erosion waterward of the armoring, which, in turn, leads to beach lowering, coarsening of substrates, increases in sediment temperature, and reductions in invertebrate density (Dethier et al. 2016). Riparian areas consist exclusively of roads, parking lots, and commercial facilities. Riparian vegetation, aquatic vegetation, and forage fish spawning habitat are absent.

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

Critical habitat in the marine portion of the action area consists largely of heavily developed commercial shorelines and industrial waterfront facilities. Impairments typically associated with such areas include water quality degradation from pollution and elevated turbidity.

Snohomish and Skykomish Rivers Core Area

Anadromous-accessible portions of the Snohomish River watershed are either designated critical habitat or are considered essential excluded habitat (75 FR 63898-63979 [October 18, 2010]). Upper watershed areas in the Skykomish and Snoqualmie subwatersheds lie in the Mt. Baker-Snoqualmie National Forest. Middle and lower reaches are mostly State or privately owned. The mainstem of the Snohomish River is almost exclusively in private ownership. Nearly all of the essential excluded habitat (areas excluded from critical habitat designation) are waters adjacent to nonfederal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Act, including the Washington State Department of Natural Resources HCP and the Washington Forest Practices HCP. The PCEs of critical habitat present within the action area and their baselines are as follows:

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

The action area contains springs, seeps, groundwater sources, and/or subsurface water in the hyporheic zone that provides cold water to the river. Springs and seeps occur in the basin as well as groundwater fed off-channel habitats. The effect of groundwater and surface water withdrawal in the lower watershed for residential, municipal, and agricultural purposes is not well understood, but most likely has a negative impact on this PCE (Golder 1999). In the

Wallace River, Haring (2002, p. 239) reported that the Snohomish County Public Utility District operates several wells adjacent to May Creek, but that there was no information on whether the groundwater withdrawals impact flows in the river.

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

The general condition of this PCE in the Snohomish River watershed is as described in the Connectivity subsection in the Environmental Baseline: Current Condition of Bull Trout in the Action Area section above. Operation of the trap and haul facility at Sunset Falls, which was a natural fish passage barrier, provides seasonal upstream passage for adult salmonids, including bull trout. At the scale of the core area, this PCE is minimally impaired.

In the Wallace River, the weir at the WDFW hatchery currently inhibits volitional upstream and downstream movement of adult salmonids, including bull trout. There are approximately 4.5 miles of designated critical habitat upstream of the weir site. This is foraging, migration, and overwintering habitat only; there is no spawning and rearing habitat upstream from the weir site. During the time of weir operation (June through September), volitional passage is only available opportunistically during occasional high flow events when the WDFW removes weir panels to prevent damage. This typically only occurs in September. Thus, this PCE in the Wallace River is significantly impaired from June through September.

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

Anadromous salmon and steelhead trout provide critical direct and indirect forage resources to bull trout in coastal streams and rivers. Compared to other Puget Sound watersheds, the Snohomish River watershed supports large populations of some anadromous salmonid species, particularly coho salmon. However, compared to historical abundances, anadromous salmon and steelhead trout populations in the Snohomish River watershed, including coho salmon, are substantially reduced. This is largely due to the extensive habitat loss and degradation throughout the watershed and marine nearshore, as described throughout this Environmental Baseline section. Abundance of Chinook salmon and steelhead trout are particularly low. Reduced abundance of naturally-spawning salmonids both limits direct forage resources available to bull trout (i.e., salmonid eggs and juveniles), and suppresses general ecosystem productivity, which further reduces the forage base. That is, abundance of resident fishes and aquatic invertebrates are also negatively affected by the diminished abundance of naturally-reproducing anadromous salmon and steelhead trout. The extent to which the current diminished abundance of salmon and steelhead trout populations limits the bull trout forage base in this watershed is not known. In the lower watershed, the construction and continued presence of levees and other shoreline armoring has decreased the contribution of terrestrial prey organisms to the river by reducing the amount of functioning riparian vegetation, large wood, and through other impacts to stream habitat such as reduced wetlands and floodplain connectivity. For these reasons, we expect that this PCE is moderately impaired.

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 substrates, to provide a variety of depths, gradients, velocities, and structure.

This PCE is severely impaired in the Snohomish River, and moderately to severely impaired within the mainstems of the Skykomish and Snoqualmie Rivers, depending on location. In the Snohomish River, historical channel straightening (channelization), levee and dike construction, large wood removal, and riparian deforestation have greatly reduced and simplified aquatic habitats and continue to constrain the processes that create and maintain complex environments (Haring 2002). Similar impacts affect the Skykomish and Snoqualmie Rivers, although to a lesser extent. Sedimentation from historical logging practices has also contributed to simplification of the aquatic environment.

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

Water temperature data (Solomon and Boles 2002, pp. 52-57; Kardouni and Cristea 2006; WDOE 2011; 2013; 2017a; 2017b) suggests that mainstem reaches of the Snohomish, Skykomish, and Snoqualmie Rivers regularly exceed 15 °C during summer months (June into September), including at the bottom of deep pools. Limited data from the Wallace River suggests that similar conditions exist in this subwatershed. This PCE appears to be unimpaired or minimally impaired in higher-elevation reaches and tributaries of the Skykomish and Snoqualmie Rivers. Some lower elevation tributaries, such as the Sultan River, also appear minimally impaired. Deep water withdrawal at the Culmback Dam on the Sultan River provides cold water during warm summer periods that appears to benefit salmonid populations. The combined effects of riparian vegetation removal, wetland loss, and sedimentation (mostly from historical logging activities) contribute to water temperature problems throughout the basin. Surface and groundwater withdrawals also contribute to temperature impairments and loss of cold water refugia, especially in the lower watershed. As a result, this PCE is moderately degraded in the lower watershed and functional in upper watershed areas.

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.

Based on the information presented in Haring (2002), this PCE appears to be unimpaired or minimally impaired in the North Fork Skykomish River sub-basin spawning and rearing areas, and in the South Fork Skykomish River sub-basin's Foss River. Other spawning and rearing areas in the South Fork Skykomish River sub-basin, including the Beckler River, are moderately to severely impaired. Historical logging and logging road practices, as well as large wood removal in some areas, are the primary factors contributing to impairment.

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

Haring (2002, pp. 19-20) evaluated factors contributing to hydrologic conditions throughout the Snohomish River watershed. The primary factors affecting hydrology were found to be instream water withdrawals, altered hydrology associated with increased impervious surfaces (primarily in the lower watershed), and altered hydrology from increased rain-on-snow runoff. The major water withdrawals in the watershed are the City of Snohomish withdrawal from the Pilchuck River, the City of Everett withdrawals from the upper end of Ebey Slough and the Sultan River, and the Seattle City Light withdrawal from the South Fork Tolt River. Negative impacts have also been identified for several streams (e.g., Beckler River) in upper forested areas, where forest harvest has resulted in increased runoff during rain-on-snow events. Based on this information, this PCE appears to be impaired in some areas of the upper watershed, but not others. Downstream of these areas, this PCE becomes more impaired. Channelization, ground and surface water withdrawals, extensive loss of wetlands and mature forests, and impervious surfaces contribute to increased peak flows in middle and lower parts of the watershed.

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

Haring (2002) evaluated factors contributing to water quality (Haring 2002, pp. 19) and water quantity (Haring 2002, pp. 19-20) conditions throughout the Snohomish River watershed. The primary water quality concern throughout the basin is temperature, as described above for PCE 5. In addition, low dissolved oxygen may occur in some estuarine sloughs and tributaries, particularly upstream of drainage district pump plants such as those in lower French Creek, Marshland, and Swan Trail Slough, and in areas with high nutrient input (often associated with unrestricted livestock access). In some areas, elevated levels of nitrogen (including ammonia and nitrate), phosphorus, turbidity, suspended solids, and metals are present. Water withdrawals from the Pilchuck and Sultan Rivers diminish summer low flows in these rivers. For these reasons, we conclude that this PCE is moderately impaired in the lower and middle watershed reaches, and, depending on location, minimally to unimpaired in upper watershed areas.

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 (*Salvelinus fontinalis*) are known to occur in the Snohomish River watershed outside of designated bull trout critical habitat (in lakes and in the Snoqualmie River upstream of Snoqualmie Falls). Surveys in other areas of the watershed are lacking. Therefore, brook trout presence is likely in at least some bull trout critical habitat areas, but abundance and distribution is not known.

<u>Factors Responsible for the Condition of Critical Habitat</u>

The factors responsible for the condition of critical habitat are as described above.

Conservation Role of the Action Area

The action area completely overlaps the Snohomish and Skykomish Rivers core area. Maintaining and recovering bull trout at the core area level is considered essential to re-establishing a viable range-wide population (USFWS 2004; USFWS 2015a). Threats that need to be addressed in the action area to ensure recovery are as described above.

Marine waters of Puget Sound are critical in supporting the bull trout anadromous life history form due to their complex migratory patterns associated with foraging and overwintering (USFWS 2015b, p. A-1, A-4). Bull trout from three nearby core areas are expected to use marine portions of the action area year round. The marine environment provides important foraging habitat including eelgrass and kelp for prey species such as Pacific herring, surf smelt, sand lance, and juvenile salmonids. Marine nearshore and estuarine habitats are highly productive due to the complexity of habitats and nutrient inputs (USFWS 2004, p. 43). Tulalip Bay is a known Pacific herring spawning area, and bull trout have been documented using this area. In addition, marine areas provide migratory corridors for bull trout from their natal streams to other locations within Puget Sound or nearby watersheds to forage and overwinter. Thus, the conservation role of the action area is to provide foraging, migration, and overwintering habitat necessary for bull trout recovery (USFWS 2015a; 2015b). The primary threats to the Puget Sound marine area include development, urbanization, and effects of climate change that degrade or eliminate nearshore marine and estuarine habitats and processes critical to the persistence of the anadromous life history form and their marine prey base.

Climate Change

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. These effects may be positive, neutral, or negative, and they may change over time. The nature of the effect depends on the species, 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.

As in other areas around the world, climate in the Puget Sound region has been changing for several decades. As a result, climate-related elements of freshwater and marine aquatic habitats have also been changing (Mauger et al. 2015, and references therein). Climate change is expected to continue for many decades into the future, with substantial negative implications to freshwater and marine habitats and the species that currently inhabit these waters. Higher summer water temperatures, lower spawning flows, and increased magnitude of winter peak flows are expected to have considerably negative effects to bull trout and other salmonid populations in rivers and streams across the region, including the Snohomish River watershed (USFWS 2008a, p. 14; Battin et al. 2007; Mauger et al. 2015, and references therein). In marine waters, anadromous bull trout may experience lower survival due to thermal stress from increased water temperatures, and slower growth caused by ocean acidification. Largely due to widespread diking and bank armoring, sea level rise is expected to result in a decrease in both estuary habitat important for juvenile salmon, and forage fish spawning habitat. Juvenile salmonids and marine forage fish are important components of bull trout diet. Thus, climate-related declines in abundance of these species may result in further negative effects to bull trout. Existing and ongoing habitat degradation in Puget Sound and the Snohomish River watershed (described throughout the Environmental Baseline section) is expected to exacerbate effects of climate change and diminish resilience of aquatic species to climate change effects.

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

The effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

Direct effects are those effects from the project that immediately affect bull trout. Indirect effects are those impacts from the projects that are later in time and may occur outside of the areas directly affected by the actions. Indirect effects must be reasonably certain to occur before they can be considered as an effect of the actions. Indirect effects may occur from changes in habitat that affect bull trout ability to use habitat or through other changes such as decreased prey abundance and availability. 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. First we examine the elements of the action to which bull trout will be exposed. Then we assess which actions will result in beneficial effects to bull trout, followed by those aspects with insignificant and/or discountable effects. Lastly, we consider both the direct and indirect effects of actions which will result in adverse effects to bull trout.

Exposure Analysis

Bull trout are found throughout the Snohomish River watershed including the nearshore marine environment. Information on adult movement and distribution is known primarily through data and observations documented in several USFWS documents (USFWS 2004; 2008a; 2010), as well as more recent acoustic telemetry study (Goetz et al. 2012). Spawning and early juvenile rearing is limited to the mainstems and tributaries of the North Fork and South Fork Skykomish Rivers: in the North Fork above RM 9 (mouth of Salmon Creek, including Salmon Creek); in the South Fork above RM 7.5 (mouth of Index Creek, excluding Index Creek). In reference to the hatchery facilities, the nearest hatchery facility (Wallace River Hatchery) is more than 21 miles downstream from spawning and early juvenile rearing habitat. Limited empirical data suggest that bull trout in the North Fork Skykomish River and tributaries spawn primarily from late

September through mid-November (Fowler, in litt. 2017). Spawn timing is presumably similar in the South Fork Skykomish River tributaries, although there are no empirical data to confirm this. Post-spawning fluvial and anadromous bull trout in other Puget Sound rivers move to lower sections of the river system (e.g., Ogg et al. 2008; Peters, in litt. 2016), and possibly marine habitats (Beamer and Henderson 2004; Goetz et al. 2004; Hayes et al. 2011), to overwinter. We assume similar behaviors in Skykomish River bull trout.

Incubation time and fry emergence time in the Snohomish River watershed are not known, although fry likely emerge during the spring and early summer. It is generally believed that bull trout fry and subyearlings remain relatively near spawning areas to rear, and that downstream movement of migratory life history forms does not begin until fish are yearlings or older (McPhail and Baxter 1996, p. 16; USFWS 2004, p. 3). Some downstream movement of young juveniles may occur due to density-dependent displacement and/or displacement from high flow events (Goetz 1989, p. 24-25; McPhail and Baxter 1996, p. 16; Bellerud et al. 1997, p. 36-49; Downs et al. 2006, p. 198). The possible existence of intentional downstream fry or subyearling outmigrations is unknown (e.g., Mesa et al. 2008, p. 71), but does not appear likely in Puget Sound rivers such as the Skykomish River. In general, physical habitat conditions and summertime water temperatures in Puget Sound rivers, including the Skykomish River, become less favorable to bull trout fry and subyearlings downstream of the lowest documented spawning areas. We are not aware of any observations of bull trout fry or subyearlings in mainstem Puget Sound rivers outside of known headwater spawning and early juvenile rearing areas. Thus, any early juvenile rearing downstream of these areas is expected to be extremely minor or non-existent.

There are limited data on migration timings of Snohomish and Skykomish Rivers core area bull trout smolts, subadults, and adults. Fluvial and anadromous bull trout juveniles outmigrate from early juvenile rearing areas to lower watershed and marine foraging habitats from mid-March through July based on limited smolt trapping efforts in the Skykomish River and more extensive data from the nearby Skagit River (Zimmerman and Kinsel 2010). Adult anadromous bull trout that overwinter in freshwater outmigrate to marine habitats during March, April, and May (Hayes et al. 2011; Goetz et al. 2012). Anadromous bull trout re-enter freshwater from May through August and migrate upstream to spawning areas.

Bull trout have been observed in the Wallace River, Tulalip Bay, and Port Gardner Bay near the hatchery facility and operations (USFWS 2004; 2008a; 2010). These areas are also designated critical habitat (Wallace River, Port Gardner Bay) or essential excluded habitat (Tulalip Bay). The Wallace River is noted as a productive salmon stream important for seasonal foraging by migratory bull trout (USFWS 2010, p. 159). Bull trout are presumed to use May Creek and Eagle Creek, including areas upstream of the hatchery facilities (WDFW 2017b), although surveys in these creeks are lacking. Both creeks provide spawning and rearing habitat for other salmonids (USFWS 2010), which contribute to the bull trout forage base. Tulalip Bay is a documented spawning area for Pacific herring, an important forage resource for anadromous bull trout.

This exposure analysis is based on information provided above and in the following sections: Status of the Species; Status of the Species in the Core Area and Foraging, Migration, and Overwintering Area; and, Environmental Baseline.

Beneficial Effects

The hatchery programs may provide a limited direct forage benefit to bull trout. In freshwater, only large bull trout (over 500 mm FL) are likely to consume fish released as yearlings from these programs due to the relatively large body size of the hatchery fish (Keeley and Grant 2001, p. 1126; Lowery 2009, p. 48, 57). Chinook salmon released as subyearlings are smaller and would be available to smaller size classes of bull trout. In addition, the hatchery programs are designed to ensure that released smolts rapidly outmigrate to marine waters. Most hatchery-released fish likely outmigrate to marine waters within a few days of release, depending on the location of the hatchery in the watershed, and few are expected to remain in freshwater for more than one week. Therefore, their temporal availability as bull trout prey in the river is very limited. In nearshore marine habitats, bull trout appear to rely primarily on surf smelt, Pacific herring, and sand lance for forage, although some salmonids, including coho, chum, and Chinook salmon, may also be consumed (Goetz et al. 2004, p. 101-114).

Returning hatchery-origin adults that spawn naturally in the watershed may provide some benefits to bull trout, as their offspring provide a prey resource. Abundance of spawning anadromous salmonids has been found to influence abundance, growth rates, and size of bull trout (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30; Copeland and Meyer 2011, pp. 937-938), as well as other species (Bentley et al. 2012; Nelson and Reynolds 2014). Anadromous salmonids provide a forage resource in the form of eggs and freshwater-rearing juveniles, which can make up a substantial proportion of the bull trout diet in freshwater habitats (Lowery and Beauchamp 2015). Spawning fish and carcasses also increase ecosystem productivity, thereby increasing the abundance of aquatic invertebrates and resident fishes (e.g., Cederholm et al. 1999; Moore et al. 2008; Copeland and Meyer 2011; Rinella et al. 2012), which may also provide important components of the bull trout diet (Lowery and Beauchamp 2015).

Hatchery-origin fish appear to be a relatively small component of naturally-spawning salmon in the Snohomish River watershed. Based on very limited data, hatchery-origin coho salmon appear to make up 1 percent (Tulalip Tribes 2013a; WDFW 2013b, pp. 23-25; WDFW 2016c, pp. 39-40) to 12 percent (NMFS 2017, p. 51) of the 50,000 to 180,000 natural spawners in the watershed. Naturally-spawning hatchery-origin Chinook salmon have numbered from 500 to 2,500 individuals in recent years, comprising 10 to 30 percent of all naturally-spawning Chinook salmon (Tulalip Tribes 2012, pp. 18-31; WDFW 2013a, pp. 47-49). Hatchery-origin chum salmon do not appear to stray into or spawn in the Snohomish River watershed or any nearby streams, except for Quilceda Creek (Tulalip Tribes 2013b, p. 19). For these reasons, hatchery-origin adult salmon that spawn naturally are expected to provide a relatively minor benefit to bull trout.

Hatchery operators may dispose of carcasses of spawned fish, mortalities, or other excess fish by distributing them in the watershed for nutrient enhancement. Watersheds across western Washington, including the Snohomish, experience returns of naturally-spawning salmonids that are far below historical estimates. Historically, returns of naturally-spawning salmonids delivered large quantities of nutrients to otherwise nutrient-limited aquatic ecosystems. These nutrients, in tandem with other ecological services provided by the spawning fish (e.g., streambed disturbance, nutrient release and retention, release of aquatic invertebrates and salmon eggs from the substrate), stimulated aquatic ecosystem productivity and supported large populations of resident and freshwater-rearing anadromous salmonids. These services are being provided at reduced levels currently due to the lower abundances of naturally-spawning salmon and steelhead trout in the Snohomish River watershed. Distribution of hatchery-origin salmon carcasses in the watershed will help provide some of the functions, albeit likely at relatively minor levels.

Insignificant and/or Discountable Effects

The following effects are anticipated to be insignificant and/or discountable for the reasons described.

Genetic and Ecological Effects to Naturally-reproducing Salmonid Populations

This section pertains only to interactions between hatchery-origin fish and naturally-reproducing salmon and steelhead populations, and the effects of these interactions on bull trout. Analyses of direct ecological effects to bull trout populations from hatchery-origin fish are included in the Inter-specific Competition and Predation subsection below.

It is generally recognized that hatchery programs and practices may, in some circumstances, suppress the abundance of naturally-reproducing salmon and steelhead trout populations via genetic and ecological effects (e.g., Araki 2008; Naish et al. 2008; Kostow 2009; HSRG 2014, p. 1). This is of concern to bull trout because, as discussed in the preceding section, naturally-reproducing populations of salmon and steelhead trout often provide critical forage resources and ecological services that directly benefit bull trout. Persistent genetic and ecological hatchery influences that suppress naturally-reproducing salmon and steelhead trout populations may also suppress growth rates, survival, and abundance of bull trout.

The naturally-reproducing populations of Chinook salmon and steelhead trout in the Snohomish River watershed are both listed entities. The Chinook salmon population belongs to the Puget Sound Chinook salmon Evolutionarily Significant Unit, which was listed as threatened in 1999. The steelhead trout population belongs to the Puget Sound steelhead trout Distinct Population Segment, which was listed as threatened in 2007. As listed entities under NMFS jurisdiction, the NMFS evaluated effects of the hatchery programs on these populations (NMFS 2017b). The NMFS concluded that the hatchery programs will not appreciably reduce the likelihood of survival and recovery in the wild of either listed entity. Further, each consultation imposes mandatory Reasonable and Prudent Measures and Terms and Conditions that ensure the hatchery programs minimize the amount and extent of take of listed, naturally-reproducing Chinook salmon and steelhead trout in the Snohomish River watershed. In addition, the NMFS will monitor these activities, and data collected, to ensure that the activities viewed as having potentially negative effects on Chinook salmon and steelhead trout are reduced in effect or adjusted to further reduce effects. The NMFS will also monitor emerging science and information related to interactions between hatchery fish and fish from natural populations and will consider that re-initiation of consultation with the WDFW and/or Tulalip Tribes is required in the event that new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in the existing consultations. For these reasons, we conclude that any effects of the hatchery programs on limiting or suppressing the abundance of naturally-reproducing populations of Chinook salmon and steelhead trout, and by extension the bull trout forage base, are insignificant.

The HSRG provides guidelines, based on best available current science, for managing hatchery programs to minimize deleterious genetic effects to naturally-reproducing populations (HSRG 2014; 2015). There are two primary metrics used by the HSRG for integrated hatchery programs, such as the coho salmon programs under consideration in this consultation. The first is pHOS, or the proportion of hatchery-origin spawners relative to all natural spawners[2] in the watershed. The second is PNI, or proportionate natural influence, which is a measure of the degree to which natural-origin fish influence both natural and hatchery production. For highly-valued natural populations, such as the Snohomish River basin coho salmon populations, current HSRG guidelines are pHOS < 0.30 and PNI > 0.67 (HSRG 2015, pp. 16-17). There are insufficient data to accurately determine pHOS and PNI for coho salmon in the Snohomish River watershed. However, based on various factors, the NMFS (2017, p. 51) believes that pHOS is likely at or below 0.12 and PNI is approximately 0.77, supporting their conclusion that genetic effects from hatchery coho salmon on the natural population are negligible. Limited data presented in the HGMPs (Tulalip Tribes 2013a; WDFW 2013b, pp. 23-25; WDFW 2016c, pp. 39-40) support these assumptions and conclusions.

In freshwater habitats, Chinook and coho salmon released from the Wallace River and Eagle Creek facilities may interact with naturally-rearing salmon. However, several factors minimize such interactions. First, the hatchery programs are designed to produce seawater-ready smolts to ensure that released smolts rapidly outmigrate to marine waters. Most hatchery-released fish likely outmigrate to marine waters within days of release. Therefore, direct competitive interactions would only occur for a short period of time. In addition, time, location, and size at release would also minimize interactions with naturally-rearing coho salmon, and other species such as chum salmon and pink salmon (*O. gorbuscha*) (NMFS 2017a, pp. 51-53). Currently, there is no information to suggest that any deleterious ecological interactions in freshwater habitats between fish currently or potentially released from the hatchery programs considered in this consultation and naturally-reproducing salmonid populations would be significant enough to affect the survival or abundance of bull trout. For these reasons, we conclude that any effects of the hatchery programs on limiting or suppressing the abundance of naturally-reproducing salmonid populations, and by extension the bull trout forage base, are insignificant.

In the marine environment, very little is known about extent of ecological interactions between hatchery- and naturally-produced salmonids, and implications to survival and abundance of natural populations. Although ecological interactions are expected to occur in marine waters (e.g., Pearsons 2008, p. 280; Reese et al. 2009; Beamish et al. 2010), these are complex and not well understood. Currently, there is no information to suggest that any deleterious ecological interactions in marine waters between fish currently or potentially released from the hatchery programs considered in this consultation and bull trout or naturally-reproducing salmonid populations would be significant enough to affect survival or abundance of bull trout.

[2] Natural spawners include hatchery-origin fish that do not return to the hatchery, but instead spawn in the watershed's rivers and streams.

Effects to Bull Trout Forage Base and Foraging Opportunities

The subsection applies only to direct effects of hatchery infrastructure on bull trout forage base and foraging opportunities. As discussed above in the Beneficial Effects subsection, salmon and steelhead often provide critical forage resources to bull trout. Hatchery weirs on the Wallace River and May Creek prohibit or present partial obstructions to adult salmon and steelhead migrating upstream to spawn, and may thus affect salmon and steelhead abundance. Salmon and steelhead that are delayed or inhibited from accessing spawning habitat may, as a result, spawn in suboptimal locations or die prior to spawning. They may also seek out alternative spawning grounds in use by other fish, thereby increasing the risk of redd superimposition. Each of these may result in death of eggs and embryos, and thus diminish abundance of rearing juveniles available for bull trout forage. Hatchery water withdrawals, which reduce flows in source streams between the withdrawal and discharge points, may also reduce the quantity of rearing habitat and thus juvenile abundance in these partially dewatered reaches. Hatchery surface water intake screening meets 1995 and 1996 guidelines (NMFS 1995; NMFS 1996), but do not meet current guidelines (NMFS 2011a) and may therefore not adequately protect juvenile salmonids. These limitations to abundance and productivity of juvenile salmonids are expected to represent a small proportion of the overall abundance and productivity of salmonids within the Snohomish River watersheds for the following reasons: 1) the proportion of spawning and rearing habitat above the weirs is small relative to all spawning and rearing habitat in the watershed; 2) the spawning and rearing habitat above the weirs is degraded, especially in May Creek; 3) natural-origin salmonids are passed above both weirs, except that Chinook salmon are not passed above the May Creek weir due to disease concerns at the hatchery; 4) screening at the water intakes will be in compliance with current guidelines by 2020 (NMFS 2017b); 5) very short reaches of the Wallace River and May Creek are affected by water withdrawals, therefore having an insignificant effect on spawning and rearing habitat and juvenile salmonid abundance.

Artificial lighting at night is known to attract and concentrate juvenile salmonids and expose them to increased rates of predation. There is outdoor lighting at the Wallace River Hatchery, and some light reaches the water surface near the water intakes on the Wallace River and May Creek. The extent to which these lights increase predation on juvenile salmonids in these areas is not known. However, these are small, localized areas. Therefore, any effects of increased predation to juvenile salmonids in these areas would be minor, and are not expected to measurably affect bull trout. For these reasons, effects to bull trout from artificial lighting at night are considered insignificant.

The presence and operating protocols of the weirs and traps on the Wallace River and May Creek prevent bull trout from accessing foraging habitat in the upper Wallace River and May Creek during parts of the year. Access is prohibited from early June through September in the Wallace River, and from June through mid-March to mid-April in May Creek. We expect few bull trout to be in the Wallace River or attempt to enter the upper Wallace River or May Creek from June through September. Adult bull trout migrate to spawning habitats during June, July, and August, and there is no bull trout spawning habitat in the Wallace River or May Creek. In addition, no bull trout have been captured at either the Wallace River or May Creek broodstock collection traps through decades of operation. Although this may be due in part to a reluctance of bull trout to enter such traps, it is strongly suggestive that few if any bull trout are attempting to migrate upstream through these areas during these times. Any bull trout that may be prevented from foraging upstream of the facilities during June, July, August, and September have uninhibited access to abundant and equivalent or greater quality foraging habitat in nearby areas of the Wallace River and Skykomish River watershed.

May Creek weir operation from October through mid-March to mid-April allows limited access to May Creek because weir panels are frequently removed to prevent damage during high flow events and/or high flows overtop the weir. Bull trout may therefore move into May Creek to forage during such events. However, few if any bull trout are believed to use May Creek for foraging during the period of weir operation for the reasons described in the preceding paragraph (i.e., no bull trout captured at the May Creek weir through decades of operation). Any bull trout that may be prevented from foraging in May Creek while panels are in place have uninhibited access to abundant and equivalent or greater quality foraging habitat in nearby areas of the Wallace River and Skykomish River watershed.

Because few if any bull trout attempt to forage in the upper Wallace River or May Creek during the periods of weir operations, and because the overall reduction in the Snohomish River watershed forage base is small, effects to bull trout associated with restricted access to foraging habitat and reductions in their forage base associated with hatchery infrastructure and water withdrawals are considered insignificant.

Pathogen Risk

Naish et al. (2008, p. 141-149) identify several mechanisms by which salmonid hatchery operations may affect pathogen risk to and disease status of naturally-reproducing or wild fish. Although these risks exist in theory, the authors note that:

> …there are but a few well-documented cases in which hatchery fish have been shown to affect directly the health or infectious disease status of wild stocks. Nevertheless, this remains a considerable area of debate and a major source of scientific uncertainty requiring additional research. (Naish et al. 2008, p. 143)

Many of these risks, including the most severe, are precluded when hatcheries follow good fish health protocols and do not transfer fish to or from distant watersheds (Naish et al. 2008, p. 141-149). The WDFW and Tulalip Tribes programs implement such measures. The hatchery programs are operated in compliance with "The Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" protocols (WSTIT and WDFW 2006). These are science-based protocols for pathogen prevention, diagnosis, treatment, and control, and corresponding BMPs for hatchery operations and sanitation practices. When implemented, these protocols help contain any pathogen outbreaks at hatchery facilities, minimize release of infected fish from hatcheries, and reduce the risk of fish pathogen transfer and amplification to natural-origin fish (NMFS 2011b).

Disease and pathogen dynamics between hatcheries and naturally-reproducing fish is not well studied or understood (Naish et al. 2008, pp. 141-149, 166-167). However, the current balance of evidence suggests that hatchery operations managed in accordance with current science-based protocols (e.g., WSTIT and WDFW 2006) do not result in an increased risk of disease and pathogens to bull trout. For these reasons, we conclude that fish pathogen transmission and amplification risks are insignificant.

Discharge of Hatchery Effluent

Assumptions

The following assumptions apply to our analysis of hatchery effluent discharge:

- Hatchery effluent discharge is implemented consistent with applicable NPDES permits.
- Chemotherapeutic agents are used in accordance with Food and Drug Administration and American Fisheries Society guidelines.
- Cleaning agents are used at lowest effective concentrations.

Factors considered, species response, and risk of harm or mortality

Hatchery operations require the use and discharge of surface and/or well water into streams adjacent to the operating facilities. Hatchery water discharge may affect several water-quality parameters in the aquatic system. Hatchery facility waste products may include uneaten food, fish waste products (i.e., fecal matter, mucus excretions, proteins, soluble metabolites such as ammonia), chemotherapeutic agents (e.g., Formalin), cleaning agents (e.g., chlorine), drugs and antibiotics, nutrients (e.g., various forms of nitrogen and phosphorus), bacterial, viral, or parasitic microorganisms, and algae. Some of these waste products are in the form of suspended solids and settleable solids, while others are dissolved in the water. Water temperature may increase and dissolved oxygen decrease as water flows through hatchery raceways and holding ponds. Maintenance activities, such as vacuuming and removal of accumulated sediment on the bottoms of hatchery ponds and raceways, may temporarily elevate the concentration of some contaminants in the hatchery water system.

Under its NPDES permit, the Wallace River Hatchery operates a pollution abatement pond to remove suspended solids and settleable solids from discharge water. However, the pond is undersized, which led to three exceedances of TSS from 2008 through 2012. These exceedances occurred during high flow events, were short in duration, and likely had minimal effects to bull trout. A new abatement pond will be constructed by fall 2020 (see above) to reduce the risk of TSS limit exceedance in the future. The new pond is expected to be effective at minimizing the release of uneaten food, fecal matter, and associated nutrients.

The Eagle Creek Pond facility does not meet the thresholds set by WDOE for requiring an NPDES permit (20,000 pounds of fish per year and 5,000 pounds of fish feed per month). The number of fish reared at the facility is relatively small (54,000 fish at 15 fish per pound); therefore, the quantity of feces, uneaten food, and other pollutants in the effluent is correspondingly small. Flows in Eagle Creek are generally high relative to discharge volume. Thus, the effluent would be diluted rapidly near the point of discharge. For these reasons, we do not expect suspended solids or settleable solids to measurably degrade or diminish habitat functions such as water quality or prey resources used by individual bull trout.

The Everett Marina Net Pen does not meet the thresholds set by WDOE for requiring an NPDES permit (20,000 pounds of fish per year and 5,000 pounds of fish feed per month). The number of fish reared at the facility is relatively small (20,000 fish at 15 fish per pound); therefore, the quantity of feces, uneaten food, and other pollutants is correspondingly small. Operation of the net pen may affect water quality, native substrates, and benthos in the immediate vicinity of the operation. The net pen is operated from January through May or June of each year. Due the small quantity of fish reared and partial-year operation, any effects are likely to be small in scale, localized near the facility, and will not have any measurable effect on bull trout.

The existing NPDES permits do not specify discharge levels or monitoring requirements for dissolved oxygen. Dissolved oxygen must be maintained within the facilities at levels sufficient to support rearing salmonids. Thus, dissolved oxygen is not depleted to levels detrimental to juvenile salmonids. Furthermore, any decrease in dissolved oxygen is expected to be restored near the point of discharge because the discharge water volumes are relatively small compared to the volume of water in the receiving waterbodies where bull trout may occur.

Most of the water used at the hatcheries flows through outdoor raceways and/or ponds, which typically are not shaded. The water flow pathways through hatchery facilities may be a greater distance - up to approximately 0.5 mile - relative to water not diverted into the hatcheries. These factors (lack of shading and increased distance traveled) increase the opportunity for warming by solar radiation and atmospheric conduction. This would be most pronounced and have the greatest potential to affect bull trout during summer months. However, water temperatures must be maintained within the hatchery facilities at cold enough levels to support rearing juvenile salmon. Thus, temperatures in the hatchery facilities do not rise to levels that are detrimental to juvenile salmonids. In addition, the discharge volume is relatively small compared to the volume of the receiving waters. For these reasons, warming is expected to be minor and the effect of any warming is expected to be ameliorated very near the point of discharge.

Most, if not all, chemicals used at hatcheries are used sporadically and in relatively low volumes. This is particularly true for chemotherapeutic agents, which must be used at levels that will not appreciably affect the fitness or survival of juvenile salmonids rearing at the hatchery. Although potentially more harmful, cleaning agents may be used sporadically, but are diluted prior to being discharged. Hatchery effluent is anticipated to be rapidly diluted near the point of discharge to the receiving waterbody, but bull trout may detect and be attracted to the effluent. The likelihood of injury to bull trout from exposure to effluent is related to the frequency of occurrence, length of time they are exposed (e.g., how long bull trout remain in the immediate vicinity of the effluent discharge points), and concentration of substances within the effluent water. Due to the sporadic nature of chemical and chemotherapeutic use, and the low concentrations that are commonly achieved at or very near the point of discharge, we do not expect any deleterious effects to bull trout.

Bull trout are opportunistic predators that feed on the eggs and juveniles of anadromous salmon and resident fish. They likely locate profitable feeding areas using chemical cues left in the water by their prey. Effluent from the hatchery likely contains relatively high concentrations of these cues, and could serve as a feeding attractant to bull trout, which is rewarded during the time when smolts are released, but may not be rewarded at other times. This "attractive nuisance" effect may keep bull trout from feeding as efficiently as they might if they were responding to feeding cues from natural food resources. Bull trout are regularly documented below other hatchery facilities during the time of year when hatchery fish are released. However, beyond these anecdotal observations, there are no data or evaluations documenting the scope and magnitude of these effects, or the extent to which this phenomenon may be detrimental to bull trout.

Bull trout may be attracted to or deterred from hatchery effluent at various times depending on the exact physical and chemical properties of the effluent, which is determined by numerous factors including, but not limited to, chemicals in use at the hatchery, usage patterns, and volume of rearing fish present. These behavioral responses and the effects of exposure are not well studied, but appear to be minor. Therefore, we conclude that effects to bull trout growth, reproduction, and survival from discharge of hatchery effluent are insignificant.

Surface Water Withdrawals and Diversions

Water usage at all hatchery facilities is non-consumptive and is returned to surface waters near withdrawal points. At the Wallace River hatchery, surface water withdrawn from the Wallace River is returned to the river within 10 feet of withdrawal. Therefore, water withdrawal is not expected to affect water level, passage conditions, or habitat conditions in the Wallace River. Surface water withdrawn from May Creek is returned to May Creek 25 to 150 feet downstream of withdrawal. Water withdrawal from May Creek may affect water level, passage conditions, and habitat conditions in the short reach between withdrawal and discharge, particularly during the late summer and early fall annual low flow period. However, there are no documented occurrences of bull trout in May Creek. Bull trout are not likely to use May Creek during the annual low flow period due to elevated water temperatures and degraded habitat conditions throughout the creek. For these reasons, effects to bull trout associated with water withdrawal at the Wallace River hatchery are considered discountable.

The Eagle Creek facility withdraws up to 3 cfs of water from Eagle Creek. Eagle Creek water withdrawals do not inhibit fish passage through the affected reach of Eagle Creek, as evidenced by successful passage of adult salmon. Visual observation also suggests that the discharge of Eagle Creek is much greater than the water withdrawal, even during annual low flow periods, although this has not been quantified. In addition, the total length and quantity of habitat in the affected reach is small compared to other available nearby habitat. Therefore, any effects to water level, passage conditions, and habitat conditions appear very minor. For these reasons, effects of Eagle Creek water withdrawals are considered insignificant.

Surface water intake screening on the Wallace River and May Creek is not in compliance with current NMFS (2011a) standards, but meets superseded standards (NMFS 1995; NMFS 1996). The intake screening will be in compliance with current standards by 2020. The current and improved intake screening prevents entrainment and impingement of bull trout of the size classes expected in the Wallace River (large juveniles though adult). Intake screening at the Eagle Creek facility is not required to comply with NMFS (2011a) standards because NMFS-jurisdictional listed species do not inhabit Eagle Creek. The intake screening at this facility is designed and configured in a manner that poses minimal if any risk of impingement or entrainment to the size classes of bull trout that may be present (adults, subadults, large juveniles). The risk of bull trout entrainment and impingement on intake screens is therefore considered discountable.

Water intakes and uses at the Tulalip Tribes facilities occur in waters not inhabited by bull trout. Therefore, there are no effects to bull trout from these activities.

Maintenance Activities

Maintenance of hatchery equipment and infrastructure (e.g., weirs, fish ladders, holding ponds, raceways) occurs intermittently and during short time periods. Such maintenance may generate some disturbance from noise (equipment operation) and resuspension of fine sediments localized near the operation. The life history stages of bull trout exposed to these project effects are adults, subadults, and larger juveniles. These fish are highly mobile and able to detect and avoid areas of disturbance. Any bull trout that may be in the vicinity can easily move around or pass through the sediment plume. Individuals that pass through the sediment plume will only be exposed to elevated levels of turbidity for a brief period (less than 1 hour), and are not expected to be measurably affected. Noise from heavy equipment is not expected to reach levels that would be harmful to bull trout. Therefore, direct effects to bull trout associated with short-term exposure to elevated levels of turbidity and/or noise from maintenance activities are considered insignificant.

Herbicides (primarily glyphosate-based chemicals) are used at many hatchery facilities to maintain landscaping and lawns. Herbicides are used in accordance with the manufacturer's label guidelines, and are applied during dry weather conditions (i.e., not raining) to prevent runoff into surface waters. Rodeo and/or Roundup are used around buildings and landscaped areas, and are not applied near water. A backpack sprayer is used for all applications. Approximately 2.5 gallons of Rodeo may be applied during summer months at the Wallace River Hatchery. At the Tulalip Tribe facilities, no herbicides or chemicals are used during grounds maintenance or applied near water. Because herbicide use is relatively low and conservation measures are implemented to prevent chemicals from entering the water, effects to bull trout associated with the use of herbicides is considered insignificant.

Other maintenance activities (e.g., building and grounds maintenance, painting, minor building repairs, lighting and fence repair, weeding and mowing) do not occur near water and are not expected to have any adverse effects to bull trout. Maintenance activities that may affect water quality of effluent (e.g., vacuuming and removal of accumulated sediment on the bottoms of hatchery ponds and raceways) are included in the subsection entitled *Discharge of Hatchery Effluent* above.

Adverse Effects

The following effects are likely to adversely affect bull trout for the reasons described below.

Broodstock Collection Infrastructure

Description of Specific Factors Considered

This section pertains only to the presence and operation of the Wallace River Hatchery weirs and the hatchery-related infrastructure at the mouths of Tulalip Creek and Battle (Mission) Creek as they affect bull trout. Effects of capture and handling at the collection ponds and traps associated with these facilities, and with off-site broodstock collection activities (i.e., seining), are discussed in the section Adverse Effects: Incidental Capture and Handling below.

Impacts to bull trout can occur as a result of hatchery broodstock collection activities. Of these collection methods, full river-spanning weirs/traps located in the mainstem river or tributary migration areas may have the greatest impact on fish. Weirs effectively block or impeded upstream and downstream migration depending on the season, type and configuration of the weir, and operational protocols. Upstream migrating fish may be directed into a trap and holding area.

The Wallace River is noted as a productive salmon stream important for seasonal foraging by migratory bull trout (USFWS 2010, p. 159). There is no bull trout spawning or spawning habitat in the Wallace River or May Creek. However, the Wallace River and May Creek each provide several miles of salmon and steelhead trout spawning and rearing habitat above the weir sites. Migratory adult, subadult, and large juvenile bull trout forage in the Wallace River. We are not aware of any biological surveys for bull trout in the Wallace River or May Creek. Anecdotal observations of bull trout in the Wallace River have been sporadic and few. No bull trout have been captured in the Wallace River Hatchery adult collection pond. No bull trout have been observed in May Creek or captured at the hatchery's in-stream trap on May Creek. Any bull trout that may have encountered the Wallace River or May Creek traps have refused to enter them. Elevated water temperatures from June through September likely discourage and limit bull trout use of the Wallace River and May Creek during this time, although WDFW staff observed four bull trout near the hatchery in early July 2015 during a time period of particularly high water temperatures. These fish were observed in a pool with returning adult Chinook salmon. Bull trout may follow or hold near returning adult salmon and steelhead trout in order to forage on eggs.

The Wallace River weir blocks fish movement from June through October 1, and the May Creek weir blocks fish movement from June through mid-March to mid-April. During these times, blocked fish attempting to move up the Wallace River may volitionally enter a fish ladder and off-channel adult collection pond. Bull trout attempting to move upstream into May Creek may volitionally enter an in-stream fish trap. There are no provisions for downstream fish passage at either weir, except during occasional high flow events which typically do not occur until September. Therefore, operational protocols agreed to by WDFW and USFWS dictate that any bull trout captured at either weir will be placed back into the river on the downstream side of the weirs. Any bull trout that are upstream of the weir sites when the weirs are put into operation in early June would be unable to migrate back downstream past the weirs until September or October.

Bull trout likely use Tulalip Bay, but are not known to attempt to enter Tulalip Creek or Battle (Mission) Creek. There is no bull trout spawning habitat in either creek. These are small streams that flow directly into Puget Sound. Bull trout have been observed using similar streams along the Washington coast (Brenkman and Corbett 2005; USFWS 2010, pp. 71-75) and the Strait of Juan de Fuca (Ogg et al. 2008, p. 29; USFWS 2010, pp. 65-66). However, bull trout use of such streams in Puget Sound has not been documented or reported, and thus does not appear common or widespread at this time. No bull trout have been captured at either of the Tulalip Tribes broodstock collection facilities over approximately 30 years of operation. No bull trout have ever been captured in Tulalip Bay during juvenile salmonid monitoring surveys. Any bull trout that may have encountered the traps at these facilities have refused to enter them. During the time of broodstock collection activities, most anadromous adult bull trout are likely in freshwater for spawning or overwintering. In addition, bull trout distribute and roam broadly throughout the marine environment. For these reasons, bull trout presence in Tulalip Bay during broodstock collection is expected to be sporadic and in in very low abundance.

Broodstock collection infrastructure and activities are not in or near areas where bull trout spawn or small juveniles rear. Therefore, these life history stages will not be exposed to effects of broodstock collection infrastructure and activities.

Species Response

The physical presence of a weir in migratory corridors that lead into or out from foraging habitat, such as the Wallace River, can affect salmonids by:

- Contributing to impingement, injury, or mortality as fish attempt to pass through or over the weir;
- Injuring or killing fish that attempt to jump over the weir;
- Increasing fish vulnerability to predation through corralling effects and fish holding behaviors at the weir.
- Delaying spawning activities of fish that cannot move downstream past the weir.
- Prolonged exposure to elevated water temperatures for fish that cannot move downstream past the weir.

Risk of Injury or Mortality

Risks associated with bull trout entering off-channel ponds or in-stream traps, and capture and handling to remove them from these areas are addressed separately. Though the effects described below may not occur in each year, the extended term of this consultation makes it reasonably certain that such effects will occur. Weirs can interfere with and disrupt normal behaviors such as feeding and sheltering. They can also cause stress and could injure or kill adult or subadult fish, or cause fish to be concentrated or confined. Concentration, confinement, and injury may subject bull trout to potential predation from mammalian and avian predators. Prolonged exposure to elevated water temperatures can cause stress and could injure or kill adult or subadult fish.

Bull trout are expected to encounter the Wallace River and May Creek weirs while attempting to migrate into the upper Wallace River watershed or into May Creek. Based on known behaviors of salmonids at weirs, some bull trout that encounter the weirs are expected to hold in areas below the weirs for some period of time prior to moving back downriver to alternative foraging areas or entering the collection pond or in-stream trap. Some of these fish may be subject to injury or mortality while seeking alternative pathways past the weirs, or from encounters with predators. Based on the limited observations of bull trout near the hatchery facility, we estimate that, over the 20-year period of this consultation, up to 2 bull trout will be exposed to the weir and will be directly injured or killed while attempting to avoid the weir structure, or as a result of predation caused by delays or injury at the weir. There are no data quantifying the degree to which these types of effects occur at the Wallace River Hatchery weirs, nor at any other similar type of infrastructure. Therefore, the estimate is our best professional judgment based, in part, on the number of bull trout that are expected to enter the hatchery collection pond (Wallace River) and/or in-stream trap (May Creek), as described in the Adverse Effects: Incidental Capture and Handling section below. We expect that the number of bull trout encountering the weir and subject to effects of the weir in this area is proportional to the number of bull trout that enter the pond and/or trap.

Any bull trout that may be present on the upstream side of weirs in June when the weirs are installed will be exposed to similar effects as described above for upstream migrating fish. In addition, because these fish will essentially be trapped in the upper Wallace River watershed or May Creek until September or October, they will experience additional effects associated with seasonally low flows, elevated surface water temperatures, and diminished forage resources. Specifically, low river flows will reduce pool depths and expose fish to elevated risk of predation. In addition, cold water refugia will contract or disappear, and fish will experience prolonged exposure to elevated water temperatures. Low summer flows are generally associated with lowest abundance of rearing juvenile salmonids, an important forage resource for bull trout. These effects may result in physiological stress and/or death. Any spawning-age female bull trout trapped above the weir would experience effects of delayed spawning. Bull trout typically migrate upstream to spawning habitats in June, July, and August. By not being able to begin their spawning migration until September or October, these fish may spawn in suboptimal locations, or may not spawn at all. Redds in suboptimal locations may be subject to scour, destroying some or all of the incubating embryos or pre-emergent alevins present. For any females that do not spawn as a result of delayed migration, all potential offspring for that year would be lost.

Over the entire 20-year term of the consultation, we estimate that up to four adult or subadult bull trout will be upstream of the Wallace River and/or May Creek weirs when the weirs are put into operation at the beginning of the broodstock collection season. These fish will be unable to move back downstream of the weirs until September or October when some weir panels will occasionally be removed during high flow events. We estimate that up to 2 of these fish will be injured or lethally harmed from prolonged exposure to elevated surface water temperatures, diminished forage resources, and/or predation. In addition, the offspring of up to 2 adult female bull trout will be lost or lethally harmed due to effects of delayed spawning migration, including spawning in suboptimal locations subject to redd scour and/or not spawning.

The probability that a bull trout will experience effects from the Tulalip Tribes broodstock collection infrastructure during the term of this consultation is extremely small, and therefore discountable. This is based on the low numbers of bull trout expected to be in the marine environment during broodstock collection activities, the broad dispersal of bull trout in the marine environment, and the general lack of use of small streams that flow directly into Puget Sound. If any bull trout enter the area between the pinniped barrier and the trap at either creek, the pinniped barrier will provide protection from some predators, and therefore may provide some beneficial effects.

Incidental Capture and Handling

Incidental capture and handling of bull trout may result from implementation of broodstock collection actions. Bull trout may be incidentally captured, handled, and released during broodstock collection activities at the Wallace River hatchery, including the following: the Wallace River weir off-channel collection pond; the May Creek weir in-stream trap; and seining in the Wallace River below the hatchery.

<u>Assumptions</u>

The following assumptions apply to our analysis of incidental capture and handling:

- Capture and handling can result from broodstock collection and fish rescue efforts (e.g., at the off-channel adult collection pond).
- Bull trout captured in traps and holding ponds will be released within 24 hours of capture.
- Prior to conducting activities that may involve handling of fish, personnel ensure that hands are free of harmful and/or deleterious products, including but not limited to sunscreen, lotion, and insect repellent.
- Effects to bull trout from incidental capture in seines and removal from traps and holding ponds will be minimized by maintaining fish in water as much as possible between capture and release, releasing incidentally captured fish as soon as practicable after capture, and holding fish in areas and using equipment that maintains their health and safety (e.g., cold, well-aerated water).

<u>Description of Specific Factors Considered</u>

Incidental capture and handling is associated with broodstock collection activities. Therefore, the specific factors considered in the section Adverse Effects: Broodstock Collection Infrastructure above apply here, in addition to the factors discussed below.

Although bull trout are known to occur in the Wallace River during the time of broodstock collection activities, no bull trout have been captured to date as part of these activities. This may be due to one or more of the following: 1) low bull trout abundance in the Snohomish River watershed; 2) sporadic, infrequent use of the Wallace River by bull trout; 3) avoidance of or refusal to enter the collection pond (Wallace River) and in-stream trap (May Creek); and 4) relatively recent and infrequent use of beach seining in the Wallace River.

During weir operation (Wallace River, May Creek) collection ponds and in-stream traps are checked daily for presence of fish, and are monitored for debris and/or flow issues. Non-target, natural-origin species are manually removed by hatchery staff. Natural-origin adult salmonids that enter the traps and holding ponds are placed back in their river or stream of origin on the upstream side of the weirs, with two exceptions: 1) natural-origin Chinook salmon are not passed above the May Creek weir due to disease concerns at the hatchery, warm water temperatures, and limited habitat; and, 2) per agreement with the USFWS, any captured bull trout would be placed on the downstream side of the weirs, although no bull trout have been captured at either trap to date. Bull trout that enter the collection pond or in-stream trap would be removed using a seine or soft-mesh dip net.

Bull trout are known to occur in Tulalip Bay. However, no bull trout have been captured at either of the Tulalip Tribes broodstock collection facilities over approximately 30 years of operation, and no bull trout have ever been captured in nearby marine waters during juvenile salmonid monitoring surveys. This may be due to one or more of the following: 1) low bull trout abundance in Tulalip Bay during broodstock collection; 2) sporadic, infrequent use of Tulalip Bay by bull trout during broodstock collection; 3) avoidance of or refusal to enter the traps. For these reasons, we do not expect that any bull trout will be captured during broodstock collection in Tulalip Bay.

<u>Species Response</u>

All weir and adult trapping and collection actions can stress, injure, or kill fish if improperly designed and implemented. Measures can be implemented to minimize these types of impacts. Collection ponds can be checked frequently to minimize effects of crowding and to ensure that predator exclusion systems are functioning and in good repair. The netting or capturing, handling, and releasing of 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 increase susceptibility to disease (and predators and competitors when released) and potential for direct injury. Death can result if fish are handled roughly or kept out of water for extended periods of time. Standard practices employed by fisheries professionals that minimize harm associated with handling fish, including bull trout, include minimizing handling time, using clean hands free of sunscreen, insect repellent, and other contaminants, and using appropriate types of containers for transferring bull trout.

Handling of fish has some potential to result in injury or death. Mortality may be immediate or delayed. Handling of fish increases their stress levels and can reduce disease resistance, increase osmotic-regulatory problems, decrease growth, decrease reproductive capacity, increase vulnerability to predation, and increase chances of mortality (Kelsch and Shields

1996). Fish may suffer from thermal stress during handling, or may receive subtle injuries such as de-scaling and loss of their protective slime layer. Handling can contribute directly or indirectly to disease transmission and susceptibility, or increased post-release predation. Fish that have been stressed are more vulnerable to predation (Mesa et al. 1994; Mesa and Schreck 1989).

In most cases, handling time required to release captured bull trout will be short, minimizing stress. However, some injury or deaths may occur during the handling and/or transfer process.

Risk of Injury or Mortality

Impacts that may be associated with capture:

- Injuring or killing fish during confinement in collection ponds and in-stream traps due to stress or predation;
- Physically harming the fish during their capture and retention;
- Harming fish by holding them improperly or for long durations;
- Physically harming fish during handling;
- Increasing fish susceptibility to displacement downstream following release;
- Increasing fish susceptibility to predation following release; and
- Latent effects associated with stress.

Bull trout that enter the Wallace River collection pond or May Creek in-stream trap are expected to be adult, subadult, and larger juveniles seeking foraging opportunities (both structures) and overwintering habitat (May Creek trap only). Routine hatchery operations suggest that bull trout that enter the pond or trap will likely be removed and placed back in the river within 24 hours of entrance. Bull trout are believed to forage and overwinter in nearby areas of the Wallace and Skykomish Rivers. Therefore, bull trout removed from the pond are expected to locate other suitable foraging and overwintering habitat nearby fairly quickly. Although we expect significant disruptions to the normal behavior for fish that enter the pond or trap, we do not expect significant impairment of essential behaviors.

Based on historical observations of bull trout in the Wallace River, we anticipate that up to four adult, subadult, or large juvenile bull trout may enter the Wallace River off-channel collection pond or May Creek in-stream trap during the 20-year period of this consultation. These fish will be removed using nets. There are no studies of immediate or post-release (delayed) mortality of bull trout associated with capture in hatchery ponds and traps, and net removal. Captured bull trout are released with very minimal handling. The fish are not anesthetized, marked or tagged, or tissue sampled. Immediate mortality of adult salmonids captured in various types of nets is usually low, often less than 5 percent (e.g., Donaldson et al. 2011, p. 138; Donaldson et al. 2012, p. 733; Raby et al. 2014, p. 1810). For post-release mortality, Raby et al.'s (2014) results for adult coho salmon captured in lower Fraser River beach seine fisheries most closely approximate the conditions that bull trout captured in the hatchery collection pond or trap experience (freshwater capture, short time spent in net, immediate release with no tagging). After accounting for natural mortality and effects of tagging, Raby et al. (2014, p. 1813) estimated that post-release mortality associated with capture in beach seines was approximately 17 percent. Applying these estimates to bull trout captured at the Wallace River Hatchery facilities, we anticipate that one individual will suffer immediate or delayed mortality during the 20-year period of this consultation.

We anticipate that up to four bull trout may be captured during the 20-year consultation period by seining in the Wallace River for broodstock collection, and that one of these fish will suffer immediate or delayed mortality as a result of this capture. While no bull trout have been captured to date using these techniques, there is a possibility of capture due to the nature of the techniques, their time and place of deployment, and known use by bull trout of the same habitat used by returning adult Chinook salmon (i.e., deep pools). In addition, these techniques have only recently been implemented, and may be used more frequently in the future increasing the probability of bull trout capture. Our estimate is based on best professional judgment given these facts and assumptions.

Inter-specific Competition and Predation

Although bull trout evolved with and continue to coexist with anadromous salmonids (Ratliff and Howell 1992), hatchery releases of anadromous salmonids may impose predation, competition, and other pressures on bull trout above currently-existing baseline levels. The expected size and rapid outmigration of hatchery-released smolts minimizes the potential for predation and competitive interactions with bull trout. Some hatchery-released fish may not be captured in fisheries or return to the hatchery facility. Instead, these fish may seek out spawning habitat and mates, and may spawn in the wild (a phenomenon known as straying). This presents the possibility of disturbance to or destruction of bull trout redds, and predation on bull trout by progeny of naturally-spawning hatchery-origin fish. The degree to which hatchery-origin salmonids and their progeny interact with bull trout depends upon relative characteristics of each species, including: 1) size; 2) behavior; 3) habitat use; 4) abundance; and 4) movement patterns. Interaction potential between salmon and bull trout can also depend on habitat structure and system productivity. System productivity determines the degree to which fish populations may be food-limited, and thus negatively impacted by limited resources. The type and level of interaction between these fish involve complex mechanisms.

<u>Predation</u>

Releasing hatchery fish may result in predation to bull trout by the following pathways: 1) direct predation, whereby the hatchery fish themselves consume small bull trout; 2) indirect predation, whereby large concentrations of released hatchery fish attract predators that also prey on bull trout that may be in the same area; and, 3) predation on small bull trout by progeny of hatchery-origin adult fish that spawn naturally in the watershed. With hatchery-released fish, predation on naturally-produced juvenile salmonids and other fishes is a potential concern when the hatchery fish are large enough to be piscivorous, and when there is spatial and temporal overlap of predator and prey (Naman and Sharpe 2012). The magnitude and vulnerability to predation from hatchery releases result from a combination of prey and predator abundance, size of bull trout in relation to the size of the hatchery fish, feeding habits of hatchery-origin fish, among other factors.

Direct predation on bull trout from hatchery-released fish is not likely for several reasons. Any bull trout in the areas occupied by hatchery-released smolts are expected to be adults, subadults, or large juveniles. Juvenile outmigrant trapping from other Puget Sound watersheds (e.g., Zimmerman and Kinsel 2010; Topping, in litt. 2014) indicate that outmigrating bull trout smolts are 120 mm FL and greater, too large to be preyed upon by hatchery-released Chinook salmon (160 mm FL) and coho salmon (131 mm FL) smolts. Smaller-size bull trout (young juveniles) are expected to occur only in the upper watershed many miles upstream from the hatchery release points. There are no data to suggest that hatchery-released juvenile Chinook or coho salmon would move upstream into areas where young bull trout rear. Returning adult salmon are not known to prey on fish upon entering freshwater habitats. Therefore, returning adult hatchery-origin fish are not expected to consume any bull trout.

Large concentrations of released hatchery juvenile salmon may attract predators (e.g., birds, fish, mammals), which may also prey on natural-origin fish in the same area (Hillman and Mullan 1989; Steward and Bjornn 1990; USFWS 1994; Kostow 2009). Conversely, hatchery-released juvenile salmonids exhibit riskier behaviors which make them more susceptible to predation than natural-origin fish (Olla and Davis 1989; Olla et al. 1998). This may negate any effects of the larger predator aggregations, as the predators would be more likely to forage on prey that is easier and more efficient to capture. These relationships are complex and not well understood. For these reasons, ascribing any predation on bull trout from predator aggregations induced by hatchery releases is speculative at best.

In a typical watershed, most Chinook and coho salmon spawning and rearing occurs in lower areas of the watershed relative to bull trout. This is true in the Snohomish River watershed. However, some small proportion of adult hatchery-origin Chinook and coho salmon may spawn naturally in the same areas of the watershed (e.g. the Skykomish River) as bull trout. Therefore, progeny of naturally-spawning hatchery-origin salmon may rear in close proximity to small juvenile bull trout, potentially exposing bull trout to predation. There are very few studies of predation on juvenile bull trout by piscivorous fishes. In a study focused on lake trout and northern pikeminnow (*Ptychocheilus oregonenesis*), Zollweg (1998, p.41) did not observe any juvenile bull trout in the stomachs of seven rainbow trout (*O. mykiss*) sampled in the Flathead River, Montana. We are not aware of any other studies that have evaluated predation on juvenile bull trout by the species released from the hatcheries. Bull trout fry are the most susceptible life stage to predation due to their small size. However, they tend to be cryptic and hide in the substrate during the day, which helps them avoid predation. Juvenile bull trout typically occupy different habitats than other, larger salmonids, which likely reduces the predation risk from these other species (Saffel and Scarnecchia 1995, pp. 312-313, and references therein). Bull trout fry typically remain in close proximity to and within the interstitial spaces of gravel and cobble substrates to a much greater extent than other salmonids (Pratt 1992; Rieman and McIntyre 1993), where the potential for predation by salmon and trout would be limited.

Most juvenile Chinook and coho salmon emigrate to the marine environment before becoming large enough to prey on fish. While rearing in freshwater, their diets are comprised primarily of invertebrates. In general, salmonids become primarily piscivorous at lengths of 310 mm (Keeley and Grant 2001, p. 1126). At lengths of 198 to 210 mm, about 30 percent of salmonids would be expected to have some fish in their stomachs, but fish would not be a primary component of their diet (Keeley and Grant 2001, p. 1125). Most Chinook salmon emigrate as subyearlings at sizes likely less than 100 mm FL, and most coho salmon emigrate as yearlings at sizes likely less than 150 mm FL. Some relatively small proportion of Chinook and coho salmon rear in freshwater for an extra year prior to outmigrating, and may become large enough to consume small fish.

Juvenile bull trout behavior and habitat use is likely to limit their exposure to predation, and most naturally-rearing salmonids outmigrate to marine habitat before becoming large enough to prey on fish. However, we cannot rule out the possibility that a small number of bull trout may be eaten by progeny of hatchery-origin fish. Our anticipation that some bull trout may be eaten by progeny of hatchery-origin Chinook and coho salmon is theoretical, and is based on their relative sizes, known behaviors and piscivory, and partial temporal and spatial overlap at the reach-scale. Based on these factors, our best professional judgment leads us to conclude that no more than 400 bull trout fry or small juveniles may be consumed during the 20-year consultation period by progeny of hatchery-origin Chinook and coho salmon.

Competition

Competition for food and space between anadromous salmonids and bull trout may occur in spawning and/or rearing areas, the migration corridor, and in the marine habitat. Competition may result from direct interactions, in which salmon interfere with bull trout for access to limited resources, or indirect interactions, in which utilization of a limited resource reduces the amount available for bull trout.

In marine habitats, hatchery salmon smolts and returning adults seasonally occupy marine waters at approximately the same time of year as foraging adults, subadult, and larger juvenile bull trout. Competitive interactions for rearing space and forage resources over broad spatial and temporal scales may ensue. However, such effects are extremely unlikely to be measurable due to the broad expanse of marine habitat available to these species in the nearshore areas of central Puget Sound relative to the abundance of the bull trout and salmonid populations in this area. There are no data to suggest that there are negative competitive interactions between bull trout and hatchery- or natural-origin salmon in the central Puget Sound marine nearshore, or any other marine nearshore habitat that bull trout occupy across their range. There is no evidence to suggest that hatchery-origin fish in Puget Sound generally or the action area specifically deplete forage resources to the detriment of bull trout. For these reasons, effects of the action on competition for forage resources in marine waters are considered insignificant.

Competition for rearing space and forage resources between bull trout and hatchery-released salmon is expected to be limited due to the following: 1) the short residence time of hatchery-released salmon in freshwater; and, 2) differences in habitat selection, foraging behavior, and prey selection between bull trout and hatchery-released smolts. The hatchery programs are designed to ensure that released smolts rapidly outmigrate to marine waters. Most hatchery-released fish likely outmigrate to marine waters within days of release. Therefore, any direct competitive interactions would occur during a short time period. Differences in habitat selection and foraging behavior would further minimize competitive interactions. Bull trout generally prefer colder water and are more-closely associated with deeper portions of rivers, whereas hatchery-reared fish are typically surface-oriented (Flagg et al. 2000, p. 8, and references therein; Reinhardt 2001; Robison and Rowland 2005). In addition, fish are expected to be the primary prey of bull trout in areas of the Snohomish River watershed where bull trout co-occur with hatchery-released fish (Lowery and Beauchamp 2015). In contrast, evidence suggests that newly-released hatchery-raised smolts are inefficient foragers and are most likely to feed non-selectively on invertebrates and items other than fish (Flagg et al. 2000, pp. 5-6, and references therein; Jackson et al. 2013). There is no evidence to suggest that hatchery-origin fish in the Snohomish River watershed deplete forage resources to the detriment of bull trout. For these reasons, we do not expect competitive interactions between hatchery-released smolts and bull trout to be significant enough to affect the survival or abundance of bull trout or measurably affect their normal behaviors.

Progeny of adult hatchery-origin fish that stray and spawn naturally in bull trout spawning and rearing areas may compete with young juvenile bull trout for rearing space and forage resources. The extent to which this occurs and potential effects to bull trout is not known. However, increasing evidence suggests that in areas where bull trout co-occur with naturally-reproducing salmon and steelhead trout, bull trout abundance is dependent upon abundant naturally-reproducing salmon and steelhead (e.g., Ratliff and Howell 1992, p. 16; Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30; Copeland and Meyer 2011, pp. 937-938; Lowery and Beauchamp 2015) (also see discussion in Beneficial Effects subsection above). This suggests that benefits of abundant naturally-spawning salmon and steelhead are greater than any deleterious competitive interactions. In addition, most returning adult hatchery-origin fish that stray and spawn naturally in the watershed likely do so in close proximity to their release points (Quinn 1993; Mackey et al. 2001; Hoffnagle et al. 2008; Dittman et al. 2010; Williamson et al. 2010), which in the Snohomish River watershed are well downstream of bull trout spawning and rearing areas. Finally, abundances of naturally-reproducing salmon and steelhead trout in the Snohomish River watershed are well below historical levels; therefore, any deleterious competitive interactions with bull trout are expected to be relatively minor. For these reasons, we do not anticipate any measurable competitive interactions between progeny of hatchery-origin strays and bull trout.

Adult hatchery-origin Chinook and coho salmon may stray and spawn naturally in bull trout spawning areas. As discussed above, most adult stray hatchery-origin Chinook and coho salmon likely spawn in lower areas of the watershed relative to bull trout for the following reasons: 1) lower-watershed spawning is more typical of Chinook and coho salmon; 2) hatchery practices, such as rearing and releasing from the same location, minimize straying; 3) the hatchery release points are many miles downstream from bull trout spawning reaches. Therefore, relatively few hatchery-origin salmon are expected in bull trout spawning areas. In addition, bull trout typically select different water depths and velocities to spawn in than other salmonids, although the range of depths and velocities that these species have been observed spawning in overlap (Keeley and Slaney 1996, p. 12). In the Snohomish River watershed, Chinook abundance is generally low in bull trout spawning areas (SBSRF 2005, p. 4-2). Chinook salmon are also substantially larger than bull trout, and are thus expected to spawn in larger substrates than bull trout. Coho salmon spawn at approximately the same time as bull trout. Although coho and bull trout may spawn in the same reaches, there has been little overlap reported in spawning microhabitat selection between these two species (Keeley and Slaney 1996, p. 12). However, coho salmon were reported superimposing on a small number of bull trout redds in a tributary of the upper Lewis River (USGS 2016).

Because there is overlap in reach-scale spawning habitat selection between bull trout and hatchery-reared species (Chinook and coho salmon), and superimposition of redds has been documented in other watersheds, it is reasonable to assume that there will be some competition for spawning habitats, destruction of bull trout redds via superimposition, and loss of deposited eggs. However, we expect these losses to be small, affecting no more than eight redds during the 20-year consultation period, based on our best professional judgment considering the following: much broader spawner distribution of the hatchery-reared species; hatchery-origin fish are imprinted on and released into lower watershed reaches; and minor degree of overlap in documented spawner microhabitat selection.

Effects to Bull Trout Critical Habitat

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

Surface water withdrawals for all hatchery facilities and programs are non-consumptive, and all water is returned near the points of withdrawal. Because all of the water is returned to the streams of origin close to where it is withdrawn, water use from these streams will have no measurable effect on groundwater recharge. Hatchery water used in rearing ponds may contribute to minor warming of the receiving water body at the point of discharge. However, given the relatively small area of the mixing zone, effects to thermal refugia are not expected to be measurable. Because hatchery operations will not measurably affect groundwater sources, springs, or thermal refugia, effects to this PCE are considered insignificant.

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

The Wallace River Hatchery weir is located within designated bull trout foraging, migration, and overwintering habitat. It currently obstructs upstream and downstream bull trout movement seasonally from June through October 1. When the weir is in place and operating, bull trout access to approximately 4.5 miles of designated critical habitat upstream of the weir is precluded, except during occasional high flow events when weir panels are removed to prevent damage. This typically only occurs in September. There is no bull trout spawning habitat upstream from the weir. Therefore, migration to spawning habitat is largely unaffected, except for any fish that are upstream of the weir when the weir is installed in June. These fish would not be able to move downstream past the weir until September (during high flow events) or October (weir removal), because there are no available pathways for downstream fish passage when the weir is operating. The migratory function of this PCE is impaired because bull trout cannot volitionally access upstream foraging habitat from June through September, and because downstream movement for access to spawning habitat or other foraging habitat is prevented from June to September or October. Therefore, the effects to this PCE from the presence and operation of the weir are considered adverse.

Surface water withdrawn from the Wallace River is returned to the river within 10 feet of the withdrawal point. Therefore, water withdrawals are not expected to impact migratory conditions in the river. Effects to this PCE associated with water withdrawals for the Wallace River Hatchery are considered insignificant.

The Everett net pen facility is located near the shoreline in marine habitat. It is a small structure located within a highly altered and disturbed area. The facility spans a small proportion of the width of the migratory corridor. Impact to water quality from net pen operation may extend a short distance from the perimeter of the structure, but these are expected to be minor and not preclude bull trout movement through the area. Effects to this PCE from the net pen facility are therefore considered insignificant.

PCE3: An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

Effects to this PCE are as described in the following sections and subsections above: Beneficial Effects; Genetic and Ecological Effects to Naturally-reproducing Salmonid Populations; and Effects to Bull Trout Forage Base and Foraging Opportunities. For the reasons described in these sections, effects to this PCE are considered insignificant.

Operation of net pens can simplify and alter substrate habitats due to accumulation of feces and uneaten food, and alteration of water chemistry (Nash 2001). These effects are minimized by having a fallow period each year in which the net pen is not in operation. The Everett net pen facility is small and does not operate from June through December. However, there may be some small, localized effects to substrate aquatic communities that diminish bull trout forage resources. The facility is located in a highly altered and disturbed area and there is no suitable forage fish spawning habitat nearby. Any effects from net pen operation are expected to be indistinguishable from current baseline conditions. For these reasons, effects to forage fish or prey resources from net pen operation are considered insignificant.

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.

Maintenance of bank armoring or construction activities that impact aquatic environments, shorelines, substrates or riparian vegetation are not routine hatchery operation and maintenance activities and are not proposed under this action. None of the normal operation and maintenance activities conducted at the hatchery facilities will alter or affect this PCE over baseline conditions.

Although the Wallace River Hatchery weir is seasonally installed, supporting infrastructure and bank armoring associated with the weir are permanent alterations that have diminished habitat complexity and impaired processes that establish and maintain natural habitat features and complexity. Other bank armoring and alterations are associated with the water intake structure. Bank armoring simplifies the shoreline and prevents large wood recruitment, undercut bank formation, formation of side channels and pools, and growth of natural riparian vegetation. The weir's concrete apron locally simplifies the hydraulic environment. Effects to this PCE from the weir and water intake infrastructure are therefore considered adverse, although their effects are relatively small and localized.

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

Water temperatures at the Wallace River Hatchery must be cold enough to support rearing juvenile salmonids. Thus, temperatures in the hatchery facilities do not rise to levels that are detrimental to juvenile salmonids. Minor warming may occur in rearing ponds prior to the water being discharged into the receiving waterbody. However, the volume of water discharged from the hatchery facilities is relatively small compared to the volume of the receiving waters and any incremental increase in temperature is not expected to be measurable beyond the mixing zones at the point of discharge. For these reasons, warming is expected to be very minor and will not impair or significantly affect this PCE. Other facilities (Eagle Creek; Tulalip Tribes facilities) are not in or near critical habitat, and are not expected to affect this PCE.

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.

None of the facilities are in or near spawning and rearing habitat. All facilities are several miles or more downstream from spawning and rearing habitat. Therefore, there will be no effects to this PCE associated with operations of these facilities.

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

Surface water withdrawn from the Wallace River is returned to the river within 10 feet of the withdrawal point. There are no data or anecdotal accounts to suggest that this influences the hydrograph within this small area to the extent that this PCE would be measurably affected. Surface water withdrawn from May Creek and Eagle Creek are returned to the respective creeks prior to these creeks entering critical habitat. Therefore, effects to this PCE from surface water withdrawals are considered insignificant.

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

An insignificant decrease in water quality may result from the discharge of hatchery effluent into surface waterbodies. The area affected by discharges is relatively small and will not measurably impair water quality in the receiving water body. Chemicals and other hatchery-related pollutants in the effluent, slightly reduced dissolved oxygen levels, and minor increases in temperature (see PCE 5) will not alter water quality downstream of the facilities to a degree that would inhibit or measurably affect reproduction, growth or survival of bull trout or other salmonids downstream of any of the facilities. In addition, the discharge volumes are relatively small compared to the volumes of the receiving waterbodies in critical habitat. Surface water used for hatchery programs are expected to have insignificant effects to water quantity in critical habitat for the reasons described in PCE 7. For these reasons, effects to this PCE from the hatchery programs are considered insignificant.

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

The proposed actions are not expected to cause any increase or decrease in the presence of non-native predators or competitors. Therefore, the proposed actions will have no effect to this PCE.

Summary of the Effects of the Action

Summary of Effects to bull trout

<u>Effects to Individuals</u>

The hatchery programs and facilities will have effects that are both positive and negative to the bull trout forage base and bull trout access to foraging habitat. These include the following: 1) hatchery-origin juveniles provide prey for larger bull trout (positive); 2) carcasses, eggs, and juveniles from naturally-spawning hatchery-origin strays provide forage resources and nutrients for bull trout and other aquatic organisms (positive); and 3) operation of the weir and traps presents a passage obstruction to Wallace River salmonid spawning and rearing habitat and bull trout foraging habitat (negative). However, these effects, both positive and negative, are expected to be relatively small. Bull trout that are obstructed from accessing prey resources have access to other forage resources nearby. In addition, hatchery operations only affect juvenile Chinook salmon (i.e., bull trout forage) production from May Creek, which has only a limited production capacity due to the small amount of degraded spawning and rearing habitat available. Therefore, effects to forage resources and access to the habitat and resources that are blocked by weirs are considered insignificant. Because of the large size of juvenile coho and Chinook salmon released from the hatcheries, and the short duration they spend in freshwater before entering marine areas, beneficial effects to bull trout prey resources in the Snohomish River watershed are relatively minor.

Bull trout that enter the adult collection pond (Wallace River) or in-stream trap (May Creek) will experience a significant disruption of their normal behaviors. These fish will be captured and handled for removal from the off-channel collection pond. In addition, bull trout are likely to be captured and handled during seining for broodstock collection. Based on capture and handling data, immediate or delayed mortality or injury to a small number of bull trout is reasonably certain to occur as a result of impairment to normal behaviors at the weir, during confinement in the collection pond or trap, during or after collection and removal from the pond or trap, or from capture during seining in the Wallace River. For most bull trout captured in traps and seines, disruptions to normal behaviors will be short in duration (less than 24 hours), and effects are not expected to result in direct mortality or have long-term effects on those individuals.

Some bull trout will experience a significant disruption of their normal behaviors if they are upstream of the Wallace River or May Creek weir sites in June when the weirs are installed. These fish will be unable to migrate downstream past the weir sites until September or October. The number of fish affected is expected to be small. These fish may be subject to stress or mortality from seasonally low water levels, elevated surface water temperatures and limited cold water refugia, low forage base, and predation. In addition, fish may be subject to delayed spawning or induced to not spawn. Females that are delayed may spawn in sub-optimal locations, subjecting redds to scour and embryo or alevin loss. Females that do not spawn will not produce offspring that year.

Some adult returning hatchery-origin fish are expected to stray and spawn in areas where bull trout spawned, and disturb or destroy bull trout redds as a result. Hatchery practices are expected to minimize the distance that strays spawn from the Wallace River Hatchery and the Eagle Creek Hatchery. Few hatchery-origin fish are expected to stray and spawn in bull trout spawning areas because these areas are not near any of the hatchery facilities. Stray hatchery fish that spawn in the same reaches as bull trout may not necessarily spawn on top of existing bull trout redds due to variability in microhabitat selection. Thus, few bull trout redds are expected to be disturbed or destroyed.

Some mortality to small juveniles (e.g., fry) is expected as a result of predation. However, the release timing, location, and behavior of hatchery-origin smolts in relation to bull trout rearing areas, fry emergence timing, and fry behavior suggests that relatively few bull trout fry will be consumed.

Quantification of Affected Bull Trout

Table 2 provides a summary of the number of bull trout expected to be negatively affected. We anticipate that normal behaviors of up to four adult or subadult bull trout may be disrupted during the 20-year consultation period as a result of entering the Wallace River adult collection pond or the May Creek in-stream trap. In addition, we anticipate that up to four adult or subadult bull trout will be captured during the 20-year consultation period while seining in the Wallace River for broodstock collection. Therefore, we anticipate that up to eight adult or subadult bull trout will be captured during the 20-year consultation period due to all broodstock collection activities combined.

We further anticipate that up to four adult or subadult bull trout will be subject to prolonged involuntary residency above the Wallace River or May Creek weirs as a result of being above the weir sites when the weirs are installed in early June. We anticipate that up to two of these fish will be females, both of which will be subject to delayed spawning or skipped spawning by being prevented from exiting the upper Wallace River during the normal spawning migration period.

The following three sources of mortality were each considered: 1) capture and handling associated with the off-channel pond and in-stream; 2) capture and handling associated with seining; 3) predation or other effects from weirs that are not associated with capture in the off-channel pond or in-stream trap. We anticipate the immediate or delayed mortality of one adult or subadult bull trout during the 20-year consultation period due to capture and handling associated with the off-channel pond and in-stream. In addition, we anticipate the immediate or delayed mortality of one adult or subadult bull trout during the 20-year consultation period due to capture and handling associated with seining. We also anticipate mortality associated with the weir but not due to capture and handling from the following: 1) two adult or subadult bull trout injured or killed as a result of attempting to avoid the weir structure, or as a result of predation caused by delays or injury at the weir; 2) two adult or subadult bull trout injured or killed as a result of stress, injury, or predation from prolonged involuntary residence in the upper Wallace River or May Creek. Therefore, we anticipate that all sources of mortality combined will result in the immediate or delayed mortality of up to six adult or subadult bull trout during the 20-year consultation period.

We anticipate that eggs and fry of up to eight adult female bull trout will be injured or killed during the 20-year consultation period as a result of redd destruction by hatchery-origin strays spawning in bull trout spawning areas. In addition, we anticipate that up to 400 bull trout fry will be killed during the 20-year consultation period as a result of predation from progeny of hatchery-origin fish that stray and spawn naturally in the watershed.

Table 2. Summary of estimates for adverse effects to bull trout as a result of the Snohomish River watershed hatchery salmon programs during the 20-year consultation period.

Action / Stressor	Non-lethal Disruption [1]	Indirect Effects / Impairment[2]	Non-lethal Capture [1]	Injury / Death [1]
Broodstock Collection Infrastructure				
Weir	4	2		4
Incidental Capture and Handling				
Ponds and traps			4	1
Seine			4	1
Inter-species competition and predation				
Predation				400 fry
Redd destruction		8		
Total[3]	4	10	8	6 400 fry

[1] Estimates provided are individual adult and subadult fish, unless indicated otherwise.

[2] Estimates provided are number of adult spawning females for which effects would occur to their eggs and/or fry. This may include 1,000 to 10,000 eggs or fry per spawning female.

[3] The total number of bull trout adversely affected is not equal to the sum of all columns. This is because, in some cases, the same individual fish would be affected. For example, four bull trout are expected to be captured in ponds and traps, and one of these is expected to experience injury or death. Thus, the total number of bull trout adversely affected in this example is four. See text for the sum total of all individual bull trout adversely affected.

Effects to Bull Trout Local Populations in the Snohomish and Skykomish Rivers Core Area

The effects to individuals are not expected to have measureable effects on local populations of bull trout in the Snohomish and Skykomish Rivers core area because a small number of individuals are expected to be affected and the anticipated beneficial effects of the proposed action are expected to at least partially offset these negative effects. Over the 20-year term of the consultation, we anticipate the potential loss of up to 6 individual adult or subadult bull trout, 400 bull trout fry, eggs and fry from 10 redds, and one brood each from 2 adult female bull trout that skip spawning. The release of hatchery juveniles are expected to enhance the bull trout forage base thereby increasing growth, survival, and abundance of bull trout. One of the four local populations (Troublesome Creek) will not be affected by the proposed actions because this is mainly a resident population upstream of a natural migration barrier. We anticipate that the other three local populations will be affected in proportion to their size (relative abundance) due to their locations and proximity to the proposed actions and their effects. For these reasons, we do not anticipate any measurable decline in the abundance, reproduction, survival, or distribution of bull trout at the scale of the local populations as a result of the overall net effects of the hatchery facilities and operations. Furthermore, we do not anticipate any long-term changes in habitat or function as a result of this proposed action that would affect the numbers, reproduction, survival, or distribution of individual bull trout at the scale of the local population.

Summary of Effects to Bull Trout Critical Habitat

Adverse effects are anticipated for PCEs 2 and 4. The Wallace River weir obstructs volitional movement into and out from 4.5 miles of designated bull trout foraging critical habitat. The weir and affiliated structures and bank armoring are permanent alterations that have diminished habitat complexity and impaired processes that establish and maintain complexity within a relatively small and localized area.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Climate change is, by definition, not a cumulative effect. Because climate change is expected to alter baseline conditions, its effects are appropriately considered in the Integration and Synthesis section below.

With the exception of some inholdings, much of the upper watershed where bull trout spawning and rearing occurs is in federal ownership (Mt. Baker - Snoqualmie National Forest). Therefore, most bull trout spawning and early rearing habitat in the watershed will not be subject to cumulative effects.

Entities such as the Tulalip Tribes and local conservation organizations have been and are expected to continue to seek and implement restoration projects for the specific benefit of fish and aquatic habitat in the Snohomish River watershed. These actions are expected to be targeted specifically to anadromous Pacific salmon and steelhead trout rather than bull trout. However, these actions will benefit bull trout because their habitat needs are similar to Pacific salmon and steelhead trout. In addition, State and local governments are expected to modify or implement new conservation programs and practices as new data and scientific findings emerge. By themselves, restoration actions and conservation programs are expected to make minor to moderate improvements in habitat quality and quantity for foraging, migrating, and overwintering bull trout. In addition, by benefitting anadromous Pacific salmon and steelhead, these actions will benefit bull trout by increasing the forage base represented by these species.

Human population growth is projected for the Snohomish River watershed and is likely to result in increasing habitat degradation, particularly to riparian areas and water quality, and diminished opportunities for substantial restoration. Despite some local permitting requirements and regulations, our observations are that these activities tend to remove riparian vegetation, interrupt groundwater-surface water interactions, reduce stream shade (and increase stream temperature), reduce the opportunity for large wood recruitment, and increase water pollution. These effects may further degrade in-stream conditions for bull trout foraging in and migrating through the lower watershed. Each action by itself may have only a small incremental effect, but taken together they may substantively degrade the watershed's environmental baseline and undermine the improvements in habitat conditions necessary for listed species to survive and recover. Watershed assessments and other education programs may reduce these adverse effects by continuing to raise public awareness about the potentially detrimental effects of residential development on salmonid habitats and by presenting ways in which a growing human population and healthy fish populations can co-exist.

We expect that negative effects from future habitat degradation and increased demand for surface and groundwater will be partially, but not wholly, offset by beneficial effects from restoration and conservation efforts. Therefore, during the term of this consultation, we anticipate that baseline conditions will become further degraded from cumulative effects.

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 the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated critical habitat for the conservation of the species.

Bull Trout

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alteration, and climate change. Six segments of the coterminous United States population of the bull trout are essential to the survival and recovery of this species and are identified as Recovery Units. The WDFW hatchery activities are located in the Coastal Recovery Unit's Snohomish and Skykomish Rivers core area, which supports four local populations of bull trout. As described in the summary of effects to bull trout, effects of the hatchery actions will affect three of the four local populations. The core area and the local populations are at increased risk of extirpation from natural, randomly occurring events because of the small number of local populations, low adult abundance of three local populations, persistence of critical threats, and uncertainties associated with watershed restoration and recovery. Some of the activities considered in this consultation marginally contribute to or increase this risk.

Bull trout spawn, rear, forage, migrate, and complete other aspects of their life history in the Snohomish River basin. The conservation role of the Snohomish River basin is to maintain the genetic components of the species and maintain the geographic range of the species. Snohomish River bull trout represent an important component of the Coastal Recovery Unit's geographic range. The Snohomish and Skykomish Rivers core area is one of only 10 core areas that currently exhibit the anadromous life history form. In addition, it is one of only 5 core areas connected to the Puget Sound. There are no cumulative effects in large areas of the upper watershed because much of it is in federal ownership. Ongoing issues in the middle and lower watershed due to water withdrawals, low instream flow, and elevated water temperature during late summer and early fall will continue to present challenges to bull trout migration and survival. Baseline conditions are moderately to severely degraded, primarily as a result of historical land and river management practices. This baseline is somewhat dynamic due to climate change, increasing urbanization, and habitat restoration and salmon recovery efforts. Anticipated effects of climate change are expected to have substantial direct and indirect negative effects to bull trout in the Snohomish River watershed.

Since the time of the coterminous United States bull trout listing in 1999, the hatchery infrastructure and operations have not been identified as a primary cause of the "potential risk" for extirpation status of Snohomish River watershed bull trout. Hatchery programs and infrastructure, including those included in this consultation, have existed for many years or decades in the Snohomish River watershed. Some aspects have changed over the years (e.g., species and numbers released have changed), but most if not all of the changes have benefitted bull trout. For example, the Hatchery Scientific Review Group and the NMFS 4(d) authorization process have identified ways that hatchery operations can minimize deleterious effects to aquatic habitats and naturally-reproducing fish species. Snohomish River watershed hatcheries have been included in these efforts, and have been implementing improvement measures. Other improvements in recent decades have included installing water intake screening to prevent fish entrainment and impingement, and meeting NPDES permit requirements for reducing discharge of pollutants into the surface waters. To the extent that the hatchery infrastructure and operations have exacerbated existing threats and/or presented additional pressures inhibiting bull trout recovery, these have been reduced in recent years due to these modifications.

Some hatchery activities will adversely affect bull trout, including the following: 1) blocked access to bull trout forging habitat presented by the Wallace River weir; 2) blocked or restricted access to bull trout forging and overwintering habitat presented by the May Creek weir; 3) blocked egress from the upper Wallace River and May Creek watersheds; 4) broodstock collection activities resulting in incidental capture of bull trout; and 5) release of hatchery fish resulting in inter-specific competition with and predation on bull trout. As many as 14 adult or subadult bull trout may be affected during the 20-year consultation period, and these effects are likely to result in the death of up to six of these fish. Temporally distributed across the 20-year consultation period, these figures represent a very small proportion of the current Snohomish and Skykomish Rivers core area population. In addition, we anticipate that up to 400 juvenile bull trout, and eggs and fry of up to 10 adult female bull trout will be killed during the 20-year consultation period as a result of the project. Up to two females will experience skipped spawning (fish do not spawn due to prolonged delay in spawning migration) during the 20-year consultation period. It is possible, but very unlikely, that the affected bull trout will all be from the same local population for the following reasons: 1) three of the four local populations of bull trout in the core area express migratory life history strategies (i.e., bull trout from any of the three local populations could enter the Wallace River and be exposed to effects of the weirs, traps, and seining); and, 2) returning adult hatchery-origin fish may stray into the spawning and rearing habitat of any of these three local populations. Therefore, the relatively minor effects of the hatchery operations are most likely to be distributed across multiple local populations, affecting relatively few bull trout within each. For these reasons, we conclude that the combined effects of the action will have no net effect on the reproduction, abundance, or distribution of bull trout at the scale of the local populations or the core area.

Drawing from the above discussion, we conclude that the effects of the determinations by NMFS and associated actions relative to salmon hatchery activities by the WDFW and the Tulalip Tribes in the Snohomish River basin, considered with cumulative effects, and in the context of the degraded and changing baseline conditions, will not affect bull trout reproduction, abundance, or distribution within the Snohomish and Skykomish Rivers core area. Therefore, the action also will not affect reproduction, survival, or distribution, or the survival and recovery potential of bull trout, at the scale of the Coastal Recovery Unit or the coterminous listed range.

Bull Trout Critical Habitat

The range-wide status of designated critical habitat for bull trout is variable among and within Critical Habitat Units, which were designated in five states in a combination of reservoirs/lakes and streams/shoreline. Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing; and, 2) foraging, migration, and overwintering. The conservation role of bull trout critical habitat is to support viable core area populations. The core areas reflect the meta-population structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. Thirty-two Critical Habitat Units and 78 associated subunits are designated as critical habitat under the 2010 final rule.

The status of habitat conditions and the PCEs of designated critical habitat in the action area vary throughout the watershed. Most upper watershed areas where spawning and rearing critical habitat is located, are in fair to good condition. In contrast, 7 of the 8 PCEs that exist in lower watershed foraging, migration, and overwintering critical habitat are moderately to severely impaired. These include the following: PCE 1 (groundwater), PCE 2 (connectivity), PCE 3 (food base), PCE 4 (complex habitat), PCE 5 (water temperature), PCE 7 (hydrograph), and PCE 8 (water quality and quantity). The degradation of these PCEs in the lower watershed is primarily caused by surface water and groundwater withdrawals, historical land and river management practices (channelization, levee and dike construction, large wood removal, riparian and upland deforestation, and historical timber extraction activities in the upper watershed), and road crossings. Impairment is expected to become worse due to persistence of these alterations, population growth, and climate change.

None of the hatchery structures or activities are a primary cause of the most significant impairments to critical habitat in the watershed. However, the proposed action does, to varying degrees, exacerbate the degraded conditions. The Wallace River weir seasonally obstructs movement into and out from 4.5 miles of foraging habitat in the Wallace River (PCE 2). This PCE currently does not and will not function in the Wallace River during seasonal operation of the weir (June through September or October) unless provisions for downstream passage are provided or the weir is not installed. The upper Wallace River represents a relatively small proportion of foraging habitat within the Snohomish River watershed. Other accessible foraging habitat of equal or greater quality is located nearby and throughout the watershed. There is no bull trout spawning and rearing habitat in the Wallace River. Therefore, at the scale of the watershed or core area, the effects to this PCE are minor and not expected to affect the overall functioning of this PCE. The weir and water intake infrastructure and affiliated structures and bank armoring diminish habitat complexity (PCE 4). However, their effects are relatively small and localized, and are not expected to affect the functioning of this PCE at the scale of the watershed or core area. All other effects to critical habitat from hatchery facilities and operations are considered insignificant.

Historical habitat degradation, combined with surface and groundwater water withdrawals, are the dominant and primary factors contributing to degraded habitat conditions and PCEs throughout the watershed. Further degradation is likely due to the persistence of these factors, population growth, and climate change. The effects of the action exacerbate these, but represent only incremental declines at small spatial scales, and do not preclude bull trout from foraging, migrating, or overwintering within the action area. Within the action area, the proposed action will not preclude bull trout critical habitat from establishing and maintaining functioning PCEs. The proposed action will not impair or prohibit critical habitat within the action area from serving the intended conservation role for the species at the scale of the core area, Coastal Recovery Unit, and coterminous range.

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 hatchery activities and the cumulative effects, it is the USFWS' Opinion that the hatchery operations, as proposed, are not likely to jeopardize the continued existence of the bull trout and is not likely to destroy or adversely modify designated critical habitat.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. *Harm* is defined by the USFWS as an act which actually kills or injures wildlife. Such 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 NMFS so that they become binding conditions of any grant or permit issued to the WDFW, as appropriate, for the exemption in section 7(o)(2) to apply. None of the Tulalip Tribes hatchery activities[3] were determined to result in adverse effects to or take of bull trout. Therefore, this Incidental Take Statement does not apply to the Tulalip Tribes' activities. The NMFS has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the NMFS 1) fails to assume and implement the terms and conditions or 2) fails to require the WDFW to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the NMFS and the WDFW 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)].

AMOUNT OR EXTENT OF TAKE

The USFWS anticipates that incidental take of up to 14 adult or subadult bull trout, offspring of up to 10 adult female bull trout, and 400 juvenile bull trout during the 20-year consultation period is reasonably certain to occur as a result of this proposed action. The incidental take is expected to be in the form of harm and harass as detailed below and summarized in Table 2.

Some forms of incidental take will be difficult to detect or quantify for the following reasons: the species is wide-ranging in habitats that are difficult to access; eggs, fry, and juveniles are small and exhibit cryptic behaviors; and some effects will result in delayed injury or mortality.

Pursuant to the authority of section 402.14(i)(1)(i) of the implementing regulations for section 7 of the Act, a surrogate can be used to express the amount or extent of anticipated take if the following criteria are met: the causal link between the surrogate and take is described; an explanation is provided as to why it is not practical to express the amount or extent of take or to monitor take-related impacts in terms of individuals of the listed species; and a clear standard is set for determining when the level of anticipated take has been exceeded. When it is not practical to monitor take impacts in terms of individual bull trout due to the extremely low likelihood of 1) finding dead or injured individuals in the aquatic environment or 2) detecting significant behavior changes, we use operational criteria or capture rates as a clear standard for take exceedance. Therefore, where appropriate, we have identified surrogates for monitoring and reporting the incidental take of bull trout.

[3] Seining activities in the Wallace River for Chinook salmon broodstock collection are WDFW-led activities, as described in the HGMPs (Tulalip Tribes 2012, p. 11; WDFW 2013a, pp. 44-45) and the Biological Assessment (WDFW 2016a, p. 8 and Appendix 1, p. 6). The Tulalip Tribes may participate in and assist with such seining. However, for the purposes of this consultation, such participation by Tulalip Tribes personnel in these Wallace River seining activities is not considered a Tulalip Tribes hatchery activity. All seining activities conducted in the Wallace River, including those with participation by Tulalip Tribes personnel, are conducted under the purview of the WDFW. Therefore, the WDFW is responsible for related take of bull trout and reporting requirements described in this section.

The following incidental take is anticipated due to the proposed action:

1. Incidental take of bull trout in the form of *harm* resulting from the Wallace River and May Creek weirs and associated blockage of upstream access to foraging and overwintering habitat. This does not include bull trout that are prevented from exiting the upper Wallace River or May Creek by the weirs, or bull trout that enter the Wallace River off-channel pond or May Creek in-stream trap. These are included in numbers 2, 3, and 4 below. We estimate that up to two adult or subadult bull trout will be harmed during the 20-year consultation period as a result of these activities. It is not feasible to monitor the actual number of bull trout that will be affected by the weir because carcasses of fish killed at or near the weirs are likely to get washed downstream with the current and/or be carried away by predators, and therefore go undetected. However, the incidental take that was evaluated was based on the number of bull trout expected to enter the off-channel adult collection pond or in-stream trap, which serve as an indicator of the relative number of bull trout encountering the weirs. That is, larger numbers of bull trout that enter the off-channel pond or in-stream trap would suggest that larger numbers of bull trout are holding below the weirs and being exposed to effects of the weirs. Therefore, detecting and monitoring the number of bull trout that are captured in the off-channel pond and in-stream trap provides some estimate of the number of individuals that are not detected, but still adversely affected by the weirs.

2. Incidental take of bull trout in the form of *harassment* and *harm* resulting from the Wallace River and May Creek weirs and associated blockage of downstream egress from areas upstream of the weirs. We estimate that up to four adult or subadult bull trout will be harassed during the 20-year consultation period by being unable to exit the upper Wallace River or May Creek for a prolonged period from June through September or October. Up to two of these fish will be harmed (killed). The offspring or potential offspring of up to two others may experience indirect effects due to delayed spawning, spawning in suboptimal locations, or skipped spawning. It is not feasible to monitor the actual number of bull trout that will be killed because dead or dying fish will likely be carried away by predators, and therefore go undetected. Also, attempting to correlate bull trout spawning site selection and reproductive success with delays caused by the weir is not be possible due to low bull trout abundance and scientific uncertainties. However, the incidental take that was evaluated was based on a total of four adult or subadult bull trout estimated to be upstream of the Wallace River and/or May Creek weirs when the weirs are put into operation in June. It is possible to determine the number of bull trout above the weirs with methodologies such as snorkel surveys. Therefore, the number of adult or subadult bull trout observed above the weirs during post-weir installation surveys will serve as our surrogate for detecting and monitoring take.

3. Incidental take of bull trout in the form of *harassment* resulting from capture in the off-channel pond, in-stream trap, or during seining. We estimate that up to eight adult or subadult bull trout will be captured during the 20-year consultation period: four bull trout captured in the pond or trap, and four bull trout during seining for adult broodstock collection.

4. Incidental take of bull trout in the form of *harm* resulting from capture, handling, captivity, and confinement related to broodstock collection infrastructure and activities. We anticipate that capture, captivity, confinement, and handling from all broodstock collection activities combined will result in immediate or delayed mortality of up to two adult or subadult bull trout during the 20-year consultation period. It is not feasible to monitor delayed mortality. Therefore, capture rates identified in number 3 above, and immediate mortality, will serve as surrogates for monitoring and reporting immediate and delayed mortality. Exceedances of either the capture rates identified in number 3 or immediate mortality will be considered an exceedance of take from immediate and delayed mortality.

5. Incidental take of bull trout in the form of *harm* resulting from interspecies interactions, including predation and redd destruction. We estimate that up to 400 juvenile bull trout and the offspring of up to eight adult female bull trout will be harmed as a result of these activities during the 20-year consultation period. It is not feasible to monitor the actual number of bull trout that will be affected because attempting to monitor redd destruction by hatchery-origin fish, and predation on juvenile bull trout is not practical. However, the incidental take anticipated is based on hatchery production goals (number of fish released per year), fish size at release, and specific time and place of fish release. Therefore, these operational criteria serve as our surrogate for establishing limits on the take of the number of bull trout described above.

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.

REASONABLE AND PRUDENT MEASURES

Bull Trout

The USFWS believes the following reasonable and prudent measure(s) (RPM) are necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of bull trout:

1. Minimize and monitor adverse effects to bull trout associated with hatchery broodstock collection activities, including incidental capture and handling.

2. Monitor effects of adverse inter-species interactions of hatchery-released fish on Snohomish River watershed bull trout.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the NMFS and the WDFW 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.

Bull Trout

Terms and Conditions associated with RPM 1:

1. Individuals engaged in broodstock collection activities and/or that may handle bull trout shall be trained and knowledgeable in bull trout identification and safe fish handling procedures.

2. All bull trout shall be released as soon as possible and as close as possible to the point of capture. All captured bull trout shall be released with the minimum handling necessary to liberate the fish from the capture gear and safely return it to the river.

3. Ensure that any bull trout that enter the Wallace River adult collection pond or May Creek in-stream trap are released downstream of the weirs as soon as practicable, preferably within 24 hours.

4. All captured bull trout shall be reported to the USFWS. Reports shall include the following: date and location of capture, capture method, approximate size of the fish, condition of the fish at release (including any obvious injuries or descaling, and whether injuries were the result of WDFW's incidental capture and handling associated with broodstock collection), and whether the fish was released alive or died. See Term and Condition 10 below for manner and timeline for reporting.

5. Bull trout mortalities shall be kept whole and put on ice or frozen. Frozen specimens shall be wrapped directly in aluminum foil to preserve the specimen in a manner that allows for future analysis. Alternative arrangements regarding the preservation or use of mortalities are allowed if coordinated with the USFWS. The USFWS office listed below must approve of the request in writing prior to implementing any alternative:

   Jeff Chan, Bull Trout Lead
   Listing and Recovery Division
   U.S. Fish and Wildlife Service
   510 Desmond Dr. SE, Suite 102
   Lacey, Washington 98503
   360-753-9440

6. All incidental visual observations of bull trout shall be reported to the USFWS. Reports shall include the following: date and location of each fish observed, and approximate size and condition of each fish observed, including any obvious signs of injury. See Term and Condition 10 below for manner and timeline for reporting.

7. The WDFW shall develop and implement a plan in coordination with and subject to USFWS approval to annually determine the number of bull trout in the Wallace River and May Creek above the weir sites when the weirs are put into operation at the beginning of the broodstock collection season. A draft plan shall be submitted to the USFWS by (December 15, 2017), and a final plan shall be submitted by (April 1, 2018). These timelines may be extended with USFWS approval.

8. The WDFW shall annually report to the USFWS the beginning and ending dates of annual weir operations on the Wallace River and May Creek. For the purposes of this Term and Condition, annual weir operation occurs when all weir panels are in-place and the weir obstructs volitional upstream and downstream fish movement. In addition, the WDFW shall report dates when weir panels are temporarily removed to prevent damage in anticipation of high flow events. See Term and Condition 10 below for manner and timeline for reporting.

Terms and Conditions associated with RPM 2:

9. The WDFW shall annually report to the USFWS the following information regarding releases of hatchery fish from the Snohomish River watershed hatchery facilities: location(s) of fish releases, number of fish released at each location, average size of released fish (in mm FL), and date(s) of release at each location. See Term and Condition 10 below for manner and timeline for reporting.

Terms and Conditions associated with RPMs 1 and 2:

10. The WDFW shall annually report to the USFWS all information described in Terms and Conditions 4, 6, 7, 8, and 9. Reporting requirements may be included in the WDFW annual bull trout observation reports that are provided to the USFWS under Section 6 of the Act, provided that: a) the reports clearly differentiate between observations associated with Snohomish River watershed hatchery operations and those associated with Section 6 or other activities (restoration and recovery actions that benefit bull trout); and b) the report transmittal to the USFWS indicates that reporting requirements pertaining to USFWS Consultation Reference Number 01EWFW00-2015-F-0120, Snohomish River Watershed Salmon Hatchery Operations are included in the report. A copy of the report shall be provided to:

    Mark Celedonia
    Division of Consultation and Conservation Planning
    U.S. Fish and Wildlife Service
    510 Desmond Dr. SE, Suite 102
    Lacey, Washington 98503
    360-753-9440

Any reporting requirements that are provided separately from the Section 6 report shall reference the same consultation number and be sent to the same address above. All reporting requirements shall be provided by June 30 for the previous calendar year. This timeline may be adjusted with USFWS approval.

The USFWS believes that no more than 14 adult or subadult bull trout, offspring of up to 10 adult female bull trout, and 400 juvenile bull trout will be incidentally taken during the 20-year consultation period 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 the 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' Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

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

1. The hatchery programs produces fish that support fisheries which overlap in space and time with bull trout presence. Bull trout are known to be highly susceptible to incidental capture in some fisheries[4]. However, by-catch of bull trout in Snohomish River fisheries is not currently monitored. Therefore, we recommend that the NMFS, the WDFW, and the Tulalip Tribes monitor and evaluate the scope and magnitude of incidental and illegal take of bull trout associated with these fisheries, including:

[4] The bull trout 4(d) rule, implemented at the time of bull trout listing in 1999, exempts take associated with fisheries operated in accordance with applicable State, National Park Service, and Native American Tribal laws and regulations. The USFWS considers fisheries supported by the WDFW's and Tulalip Tribes' Snohomish River watershed hatchery programs as meeting requirements for exemption under the 4(d) rule.

a) Instituting reporting requirements for incidental capture of bull trout in commercial and Tribal fisheries, when these fisheries overlap in space and time with bull trout presence.

b) Conducting periodic creel surveys to monitor and evaluate bull trout capture in recreational fisheries, and modifying timing and locations of open fisheries as necessary to reduce impacts.

c) Increasing law enforcement presence in the Snohomish River watershed during open recreational fisheries at times and places when bull trout fisheries are closed.

d) Increasing angler education and outreach on the following subjects: 1) proper identification and handling of bull trout; 2) the listed status of bull trout and illegality of intentionally killing or injuring bull trout when bull trout fisheries are closed; 3) ecological importance of bull trout, particularly in helping to maintain abundance and vitality of naturally-reproducing salmonid populations, including steelhead trout.

2. We recommend that hatchery operators evaluate extent to which artificial light used at the hatchery facilities at night reaches water surfaces where juvenile salmonids may be present. We encourage hatchery operators to explore opportunities for reducing spill light on water surfaces during the night. These may include shielding lights, using lighting only when and where needed for safety and security, removing or disabling lights that are not needed, and putting lights on timers

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

REINITIATION NOTICE

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

LITERATURE CITED

Araki, H., B.A. Berejikian, M.J., Ford, and M.S. Blouin. 2008. Fitness of hatchery-reared salmonids in the wild. Evolutionary Applications 1:342–355.

Arlinghaus, R., S.J. Cooke, J. Lyman, D. Policansky, A. Schwab, C.D. Suski, S.G. Sutton, and E.B. Thorstad. 2007. Understanding the complexity of catch-and-release in recreational fishing: an integrative synthesis of global knowledge from historical, ethical, social, and biological perspectives. Reviews in Fisheries Science 15:75–167.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104:6720-6725.

Beamer, E. M. and R. Henderson. 2004. Distribution, abundance, timing, size of anadromous bull trout in the Skagit River Delta and Skagit Bay. Skagit River Systems Cooperative. LaConner, WA.

Beamish, R.J., R.M. Sweeting, C.M. Neville, and K.L. Lange. 2010. Competitive interactions between pink salmon and other juvenile Pacific salmon in the Strait of Georgia. North Pacific Anadromous Fish Commission , Document 1284. 26 pp.

Bellerud, B.L., S. Gunkel, A.R. Hemmingsen, D.V., Buchanan, and P.J. Howell. 1997. Bull trout life history, genetics, habitat needs, and limiting factors in central and northeast Oregon. 1996 Annual Report for Bonneville Power Administration, Project No. 95-54 and Contract No. 94BI34342.

Bentley, K.T., D.E. Schindler, J.B. Armstrong, R. Zhang, C.P. Ruff, and P.J. Lisi. 2012. Foraging and growth responses of stream-dwelling fishes to inter-annual variation in a pulsed resource subsidy. Ecosphere 3(12):1-17. http://dx.doi.org/10.1890/ES12-00231.1

Brenkman, S.J., and S.C. Corbett. 2005. Extent of anadromy in bull trout and implications for conservation of a threatened species. North American Journal of Fisheries Management 25:1073-1081.

Brenkman, S.J., and S.C. Corbett. 2007. Use of otolith chemistry and radiotelemetry to determine age-specific migratory patterns of anadromous bull trout in the Hoh River, Washington. Transactions of the American Fisheries Society 136:1-11.

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24:6-15.

Copeland, T., and K.A. Meyer. 2011. Interspecies synchrony in salmonid densities associated with large-scale bioclimatic conditions in central Idaho. Transactions of the American Fisheries Society 140:928-942.

Dethier, M.N., W. Raymond, A. McBride, J. Toft, J. Cordell, A. Ogston, S. Heerhartz, and H. Berry. 2016. Multiscale Impacts of Armoring on Salish Sea Shorelines: Evidence For Cumulative and Threshold Effects. Estuarine, Coastal and Shelf Science 175:106-117.

Dittman, A.H., D. May, D.A. Larsen, M.L. Moser, M. Johnston, and D. Fast. 2010. Homing and spawning site selection by supplemented hatchery- and natural-origin Yakima River spring Chinook salmon. Transactions of the American Fisheries Society 139:1014-1028.

Donaldson, M.R., S.G. Hinch, D.A. Patterson, J. Hills, J.O. Thomas, S.J. Cooke, G.D. Raby, L.A. Thompson, D. Robichaud, K.K. English, and A.P. Farrell. 2011. The consequences of angling, beach seining, and confinement on the physiology, post-release behaviour and survival of adult sockeye salmon during upriver migration. Fisheries Research 108:133–141.

Donaldson, M.R., S.G. Hinch, G.D. Raby, D.A. Patterson, A.P. Farrell, and S.J. Cooke. 2012. Population-Specific Consequences of Fisheries-Related Stressors on Adult Sockeye Salmon. Physiological and Biochemical Zoology 85:729-739.

Downs, C.C., D. Horan, E. Morgan-Harris, and R. Jakubowski. 2006. Spawning Demographics and Juvenile Dispersal of an Adfluvial bull trout Population in Trestle Creek, Idaho. North American Journal of Fisheries Management 26:190–200.

Dunham, J., and B.E. Rieman. 1999. Metapopulation structure of bull trout: influence of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9(2):642-655.

Flagg, T.A., B.A. Berejikian, J.E. Colt, W.W. Dickhoff, L.W. Harrell, D.J. Maynard, C.E. Nash, M.S. Strom, R.N. Iwamoto, and C.V.W. Mahnken. 2000. Ecological and Behavioral Impacts of Artificial Production Strategies on the Abundance of Wild Salmon Populations. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC- XX, 98 p.

Fowler, A. 2017. Washington Department of Fish and Wildlife, Mill Creek, Washington. Email to: Mark Celedonia, Fish Biologist, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. Topic: January 4, 2017 email regarding bull trout spawn timing in the Skykomish River.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead lake and river system, Montana. Northwest Science 63(4):133-143.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. Willamette National Forest, Eugene, Oregon, February 1989. 53 pp.

Goetz, F., E. Connor, E. Jeanes, and M. Hayes. 2012. Migratory patterns and habitat use of bull trout in Puget Sound. Presentation given at the 2012 Salvelinus Confluentus Curiosity Society Meeting. August 15-17, Lake Crescent, Washington. Available at http://www.ybfwrb.org/Assets/Documents/Calendar/ScCS2012/6_Goetz_Bull%20Trout%20Habitat%20and%20Migration%20SCCS%202012.GOETZ.pdf.

Goetz, F.A., E. Jeanes, and E. Beamer. 2004. Bull trout in the Nearshore. Preliminary Draft Report, U.S. Army Corps of Engineers, Seattle, Washington.

Goetz, F., E.D. Jeanes, and C.M. Morello. 2007. Puget Sound bull trout migration and habitat use study: Nooksack River and estuary and northeast Puget Sound nearshore. USFWS Interagency Agreement # 13410-6-H001. September 2007. 28 pp.

Golder (Golder Associates Incorporated). 1999. Snohomish County Ground Water Management Plan. Redmond, WA.

Hamel, N., J. Joyce, M. Fohn, A. James, J. Toft, A. Lawver, S. Redman and M. Naughton. 2015. 2015 State of the Sound: Report on the Puget Sound Vital Signs. November 2015. 86 pp. www.psp.wa.gov/sos.

Haring, D. 2002. Salmon Habitat Limiting Factors Analysis: Water Resource Inventory Area 7. Washington State Conservation Commission.

Hayes, M.C., S.P. Rubin , R.R. Reisenbichler , F.A. Goetz , E. Jeanes, and A. McBride. 2011. Marine Habitat Use by Anadromous bull trout from the Skagit River, Washington. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 3:394-410.

Hillman, T. W., and J. W. Mullan, editors. 1989. Effect of hatchery releases on the abundance of wild juvenile salmonids. Report to Chelan County PUD by D.W. Chapman Consultants, Inc., Boise, ID.

Hoffnagle, T.L., R.W. Carmichael, K.A. Frenyea, and P.J. Keniry. 2008. Run timing, spawn timing, and spawning distribution of hatchery- and natural-origin spring Chinook salmon in the Imnaha River, Oregon. North American Journal of Fisheries Management 28:148-164.

HSRG (Hatchery Scientific Review Group). 2004. Hatchery Reform: Principles and Recommendations of the HSRG. Long Live the Kings, Seattle, WA. Available at http://www.hatcheryreform.us/hrp/reports/puget/welcome_show.action.

______. 2014. On the science of hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. A. Appleby, H.L. Blankenship, D. Campton, K. Currens, T. Evelyn, D. Fast, T. Flagg, J. Gislason, P. Kline, C. Mahnken, B. Missildine, L. Mobrand, G. Nandor, P. Paquet, S. Patterson, L. Seeb, S. Smith, and K. Warheit.

______. 2015. Annual Report to Congress on the Science of Hatcheries, 2015: A report on the application of up-to-date science in the management of salmon and steelhead hatcheries in the Pacific Northwest. Pacific Northwest Hatchery Reform Project.

IPCC (Intergovernmental Panel on Climate Change). 2014a. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

______. 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

Jackson, L.A., C.F. Rakocinski, and R.B. Blaylock. 2013. Feeding performance of juvenile hatchery-reared spotted seatrout *Cynoscion nebulosus*. Journal of Fish Biology 82:1032-1046.

Kardouni, J., and N. Cristea. 2006. Snoqualmie River Temperature Total Maximum Daily Load Study. Washington Department of Ecology. Publication Number 06-03-106. Olympia, WA.

Keeley, E.R., and J.W.A. Grant. 2001. Prey size of salmonid fishes in streams, lakes, and oceans. Canadian Journal of Fisheries and Aquatic Sciences 58:1122-1132.

Keeley, E.R., and P.A. Slaney. 1996. Quantitative Measures of Rearing and Spawning Habitat Characteristics For Stream-Dwelling Salmonids: Guidelines For Habitat Restoration. Watershed Restoration Project Report No. 4. Province of British Columbia, Ministry of Environment, Lands and Parks, and Ministry of Forests.

Kelsch, S.W., and B. Shields. 1996. Care and handling of sampled organisms. Pages 121-155 (Chapter 5) in Murphy, B., and D. Willis (eds.). Fisheries Techniques, 2nd Edition. American Fisheries Society, Bethesda, Maryland.

Kostow, K. 2009. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries 19(1): 9-31.

Kraemer, C. 1994. Some observations on the life history and behavior of the native char, dolly varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) of the north Puget Sound region. Washington Department of Fish and Wildlife, Olympia, WA.

Kraemer, C. 2003. Lower Skagit bull trout: Age and Growth Information Developed From Scales Collected From Anadromous and Fluvial Char. Management Brief, Washington Department of Fish and Wildlife. Olympia, Washington.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology 7(4):856-865.

Lowery, E.D. 2009. Trophic relations and seasonal effects of predation on Pacific salmon by fluvial bull trout in riverine food webs. Master of Science Thesis, University of Washington.

Lowery, E.D., and D.A. Beauchamp. 2015. Trophic Ontogeny of Fluvial bull trout and Seasonal Predation on Pacific Salmon in a Riverine Food Web. Transactions of the American Fisheries Society 144:724-741, DOI:10.1080/00028487.2015.1035452.

Luce, C.H., and Holden, Z.A. 2009. Declining annual streamflow distributions in the Pacific Northwest United States, 1948–2006. Geophysical Research Letters, 36(16), L16401, doi:10.1029/2009GL039407.

Mackey, G., J.E. McLean, and T.P. Quinn. 2001. Comparisons of Run Timing, Spatial Distribution, and Length of Wild and Newly Established Hatchery Populations of Steelhead in Forks Creek, Washington. North American Journal of Fisheries management 21:717-724.

Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

MBTSG (The Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Montana Fish, Wildlife, and Parks, Helena, MT, May 1998. 77 pp.

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries management report no. 104. University of British Columbia. Vancouver, British Columbia. 31 pp.

Mesa, M.G., P.J. Connolly, N.A. Zorich, L.K. Weiland, H.K. Barnett, and D.K. Paige. 2008. Juvenile bull trout and rainbow trout movements and growth in selected tributaries of the Chester Morse Lake basin, Cedar River Municipal Watershed, Washington. Final Report of Research, August 2005-December 2007. Prepared for Seattle Public Utilities, North Bend, WA by U.S. Geological Survey, Cook, WA.

Mesa, M.G., T.P. Poe, D.M. Gadomski, and J.H. Petersen. 1994. Are all prey created equal? A review and synthesis of differential predation on prey in substandard condition. Journal of Fish Biology 45 (Suppl. A):81-96.

Mesa, M.G., and C.B. Schreck. 1989. Electrofishing mark-recapture and depletion methodologies evoke behavioral and physiological changes in cutthroat trout. Transaction of the American Fisheries Society 118:644-658.

Moore, J.W., D.E. Schindler, and C.P. Ruff. 2008. Habitat Saturation Drives Thresholds in Stream Subsidies. Ecology, 89:306–312.

Naish, K.A., J.E. Taylor, III, P.S. Levin, T.P. Quinn, J.R. Winton, D. Huppert, and R. Hilborn. 2008. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in Marine Biology 53:61-194.

Naman, S.W., and C.S. Sharpe. 2012. Predation by hatchery yearling salmonids on wild subyearling salmonids in the freshwater environment: A review of studies, two case histories, and implications for management. Environmental Biology of Fishes 94:21-28.

Nash, C.E. 2001. The net-pen salmon farming Industry in the Pacific Northwest. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-49. 125 pp.

Nelson, M.C., and J.D. Reynolds. 2014. Time-Delayed Subsidies: Interspecies Population Effects in Salmon. PLoS ONE 9(6): e98951. doi:10.1371/journal.pone.0098951.

NMFS (National Marine Fisheries Service). 1995. Juvenile fish screen criteria for pump intakes. Available from: http://www.nwr.noaa.gov/1hydrop/nmfscrit1.htm.

______. 1996. Juvenile fish screen criteria for pump intakes. Available from: http://www.nwr.noaa.gov/1hydrop/pumpcrit1.htm.

______. 2011a. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

______. 2011b. Effects of Hatchery Programs on Salmon and Steelhead Populations: Reference Document for NMFS ESA Hatchery Consultations. Craig Busack, Editor. March 7, 2011. NMFS Northwest Region Office, Salmon Management Division. Portland, Oregon.

______. 2011c. Pacific Coastal Salmon Recovery Fund, FY 2000-2010: 2011 Report to Congress. Portland, Oregon.

______. 2017a. Environmental Assessment to Analyze Impacts of NOAA’s National Marine Fisheries Service Determination that Six Hatchery Programs for Snohomish River Basin Salmon as Described in Joint State-Tribal Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule. Lacey, WA.

______. 2017b. National Marine Fisheries Service (NMFS) Evaluation of Six Hatchery and Genetic Management Plans for Snohomish River basin Salmon under Limit 6 of the Endangered Species Act Section 4(d) Rule. Consultation Number NWR-2012-00841. Lacey, WA.

Ogg, L., S. Spalding, and M. McHenry. 2008. Dungeness River Basin bull trout Study, 2003 – 2006. United States Forest Service, Olympic National Forest.

Olla, B.L. and M.W. Davis. 1989. The role of learning and stress in predator avoidance of hatchery-reared coho salmon (*Oncorhynchus kisutch*) juveniles. Aquaculture, 76:209-214.

Olla, B.L., M. W. Davis, and C.H. Ryer. 1998. Understanding how the hatchery environment represses or promotes the development of behavioral survival skills. Bulletin of Marine Science 62:531-550.

Pearsons, T.N. 2008. Misconception, reality, and uncertainty about ecological interactions and risks between hatchery and wild salmonids. Fisheries 33:278-290.

Peters, R. 2016. U.S. Fish and Wildlife Service, Lacey, Washington. Email to: Mark Celedonia, Fish Biologist, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. Topic: June 29, 2016 email regarding bull trout movement timing in the Puyallup River watershed.

Pratt, K.L., 1992. A review of bull trout life history. *In:* P.J. Howell and D.V. Buchanan (eds.). Pp. 5-9. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Quinn, T.P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research 18:29-44.

Raby, G.D., M.R. Donaldson, V.M. Nguyen, M.K. Taylor, N.M. Sopinka, K.V. Cook, D.A. Patterson, D. Robichaud, S.G. Hinch, and S.J. Cooke. 2014. Bycatch mortality of endangered coho salmon: impacts, solutions, and aboriginal perspectives. Ecological Applications 24:1803-1819

Raphael, M.G., G.A. Falxa, D. Lynch, S.K. Nelson, S.F. Pearson, A.J. Shirk, and R.D. Young. 2016. Status and trend of nesting habitat for the marbled murrelet under the Northwest Forest Plan. Pages 37-94 *in* G.A. Falxa and M.G. Raphael, editors. Northwest Forest Plan—The first 20 years (1994-2013): status and trend of marbled murrelet populations and nesting habitat. General Technical Report PNW-GTR-933. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 132 pp.

Ratliff, D.E. and P.J. Howell. 1992. The status of bull trout populations in Oregon. *In:* P.J. Howell and D.V. Buchanan (eds.). Pp. 10-17. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Reese, C., N. Hillgruber, M. Sturdevant, A. Wertheimer, W. Smoker, and R. Focht. 2009. Spatial and temporal distribution and the potential for estuarine interactions between wild and hatchery chum salmon (*Oncorhynchus keta*) in Taku Inlet, Alaska. Fishery Bulletin, 107:433-450.

Reinhardt, U.G. 2001. Selection for surface feeding in farmed and sea-ranched masu salmon juveniles. Transactions of the American Fisheries Society 130:155-158.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. General Technical Report INT-302. United States Forest Service, Intermountain Research Station. Ogden, Utah.

Rieman, B.E., J.T. Peterson, and D.E. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fish and Aquatic Sciences 63:63-78.

Rinella, D.J., M.S. Wipfli, C.A. Stricker, R.A. Heintz, and M.J. Rinella. 2012. Pacific Salmon (Oncorhynchus Spp.) Runs and Consumer Fitness: Growth and Energy Storage in Stream-Dwelling Salmonids Increase with Salmon Spawner Density. Canadian Journal of Fisheries and Aquatic Sciences 69: 73–84.

Robison, B.D., and W. Rowland. 2005. A potential model system for studying the genetics of domestication: behavioral variation among wild and domesticated strains of zebra danio (*Danio rerio*). Canadian Journal of Fisheries and Aquatic Sciences 62:2046-2054.

Saffel, P.D., and D.L. Scarnecchia. 1995. Habitat use by juvenile bull trout in belt-series geology watersheds of northern Idaho. Northwest Science 69:304-3 17.

SBSRF (Snohomish Basin Salmon Recovery Forum). 2005. Snohomish River Basin Salmon Conservation Plan. Snohomish County Department of Public Works, Surface Water Management Division. Everett, WA.

Solomon, F., and M. Boles. 2002. Snoqualmie Watershed Aquatic Habitat Conditions Report: Summary of 1999-2001 Data. King County Department of Natural Resources and Parks. Seattle, WA.

Steward, C. R., and T. C. Bjornn, editors. 1990. Supplementation of Salmon and Steelhead Stocks with Hatchery Fish: A Synthesis of Published Literature. . Report to Bonneville Power Administration (BPA), Project No. 88-100. 126p, Portland, Oregon.

Topping, P.C. 2014. Puget Sound Juvenile Operations Lead. Washington Department of Fish and Wildlife, Olympia, Washington. Emails to: Mark Celedonia, Fish Biologist, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, Washington. Topic: Two emails dated March 18, 2015 and one attachment included information and data regarding number and size of bull trout in the Dungeness River smolt trap from 2005 to 2014.

Tulalip Tribes. 2012. Hatchery and Genetic Management Plan: Bernie Kai-Kai Gobin Salmon Hatchery "Tulalip Hatchery" Subyearling Summer Chinook Program. December 20, 2012. Olympia, WA.

______. 2013a. Hatchery and Genetic Management Plan: Tulalip Coho. March 29, 2013. Olympia, WA.

______. 2013b. Hatchery and Genetic Management Plan: Tulalip Hatchery Chum. April 10, 2013. Olympia, WA.

USFWS (U.S. Fish and Wildlife Service). 1994. Programmatic Biological Assessment of the Proposed 1995-99 LSRCP Program. USFWS, LSRCP Office, Boise, Idaho.

______. 2003. Biological Opinion and letter of concurrence for effects to bald eagles, marbled murrelets, northern spotted owls, bull trout, and designated critical habitat for marbled murrelets and northern spotted owls from Olympic National Forest program of activities for August 5, 2003, to December 31, 2008. USFWS Reference 1-3-03-F-0833. U.S. Fish and Wildlife Service, Lacey, Washington.

______. 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of bull trout (*Salvelinus confluentus*): Volume 1 of 2, Puget Sound Management Unit. Portland, Oregon.

______. 2008a. Bull trout core area templates - an unpublished compilation of updated bull trout core area analysis to support the five-year review. U.S. Fish and Wildlife Service, Portland, OR, August 24, 2008. 1895 pp.

______. 2008b. Bull trout (*Salvelinus confluentus*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Portland, OR. 53 pp.

______. 2010. Bull trout final critical habitat justification: Rationale for why habitat is essential, and documentation of occupancy. U.S. Fish and Wildlife Service, Portland, Oregon. 979 pp.

______. 2013. Biological Opinion for Effects to Northern Spotted Owls, Critical Habitat for Northern Spotted Owls, Marbled Murrelets, Critical Habitat for Marbled Murrelets, Bull Trout, and Critical Habitat for Bull Trout from Selected Programmatic Forest Management Activities March 25,2013 to December 31,2023 on the Olympic National Forest Washington. USFWS Reference 13410-2009-F-0388. U.S. Fish and Wildlife Service, Lacey, Washington.

______. 2015a. Recovery plan for the coterminus United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, OR, September 28, 2015. xii + 179 pp.

______. 2015b. Coastal Recovery Unit Implementation Plan for bull trout. Lacey, WA and Portland, OR. 143 pp.

______. 2015c. Bull trout (*Salvelinus confluentus*) 5-Year Review. U.S. Fish and Wildlife Service, Portland, OR.

______. 2017. Biological opinion: 2017 - 2036 Puget Sound Treaty and Non-Treaty (All-Citizen) Salmon Fisheries. Consultation No. 0lEWFW00-2016-F-1181. Lacey, WA.

USGS (United States Geological Survey). 2008. Migration timing and habitat characteristics of anadromous bull trout in Skagit Bay, Washington.

______. 2009. Letter from Richard Wagner, water quality specialist, U.S. Geological Survey, to Shawn Yannity, Stillaguamish Tribe Natural Resources Department, regarding summaries of field data and chemical analyses of water samples collected by the U.S. Geological Survey and Stillaguamish Tribe of Indians from surface waters within the Stillaguamish watershed in September 2008, June 2, 2009.

______. 2016. Information and Studies to Anadromous Fish Reintroduction into Merwin and Yale Reservoirs. Prepared for PacifiCorp, Portland, OR.

Walters, A.W., T. Copeland, and D.A. Venditti. 2013. The density dilemma: limitations on juvenile production in threatened salmon populations. Ecology of Freshwater Fish 22: 508–519.

WDOE (Washington Department of Ecology). 2011. Snoqualmie River Basin Temperature Total Maximum Daily Load: Water Quality Improvement Report and Implementation Plan. Publication No. 11-10-041. Bellevue, WA.

______. 2013. Skykomish River Temperature Total Maximum Daily Load Development. Publication No. 13-03-104. Lacey, WA.

______. 2017a. River and Stream Water Quality Monitoring: 07C070 - Skykomish R @ Monroe. https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear=&tab=temperature&scrolly=483.2&wria=07&sta=07C070#tempdatadownload. Accessed February 3, 2017.

______. 2017b. River and Stream Water Quality Monitoring: 07D050 - Snoqualmie R nr Monroe. https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear=&tab=temperature&scrolly=500&wria=07&sta=07D050. Accessed February 3, 2017.

WDFW (Washington Department of Fish and Wildlife). 2013a. Hatchery and Genetic Management Plan: Wallace River Summer Chinook Hatchery Program (Integrated). February 11, 2013. Olympia, WA.

______. 2013b. Hatchery and Genetic Management Plan: Everett Net Pen Coho Program (Integrated). June 27, 2013. Olympia, WA.

______. 2016a. Snohomish River Basin Hatchery Activities' Potential Impacts on Bull Trout (*Salvelinus confluentus*) Biological Assessment. March 3, 2016. Olympia, WA.

______. 2016b. Fishing in Washington: 2016-2017 Sportfishing Rules Pamphlet. June 2016. Olympia, WA.

______. 2016c. Hatchery and Genetic Management Plan: Wallace River Coho Hatchery Program (Integrated). September 16, 2016. Olympia, WA.

______. 2017a. Salmon Conservation Reporting Engine. Olympia, WA. https://fortress.wa.gov/dfw/score/score/species/species.jsp. Accessed March 10, 2017.

______. 2017b. SalmonScape. Olympia, WA. http://apps.wdfw.wa.gov/salmonscape/map.html. Accessed February 7, 2017.

WDFW (Washington Department of Fish and Wildlife) and WWTIT (Western Washington Treaty Indian Tribes). 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. http://access.nwifc.org/enhance/documents/FinalDiseasePolicy-July2006_Ver3.pdf.

Williamson, K.S., A.R. Murdoch, T.N. Pearsons, E.J. Ward, and M.J. Ford. 2010. Factors influencing the relative fitness of hatchery and wild spring Chinook salmon (Oncorhynchus tshawytscha) in the Wenatchee River, Washington, USA. Canadian Journal of Fsiheries and Aquatic Sciences 67:1840-1851.

WSTIT (Washington State Treaty Indian Tribes) and WDFW (Washington Department of Fish and Wildlife). 2006. The salmonid disease control policy of the fisheries co-managers of Washington State (revised July 2006). Fish Health Division, Fish Program. Washington Department Fish and Wildlife, Olympia, Washington. 38p.

Zimmerman, M., and C. Kinsel. 2010. Migration of Anadromous Juvenile bull trout in the Skagit River, 1990-2009. Report FPT 11-01. Washington Department of Fish and Wildlife, Olympia, WA.

Zollweg, E.C. 1998. Piscine predation on bull trout in the Flathead River, Montana. M.S. Thesis. Montana State University.

Appendix A
Status of the Species: Bull Trout

(This page intentionally left blank)

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 Dymanics

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).

[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 resident[2] 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 resident

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

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.

Upper Clark Fork Geographic Region

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).

Lower Clark Fork Geographic Region

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.

Flathead Geographic Region

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).

Kootenai Geographic Region

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).

Coeur d'Alene Geographic Region

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 7 geographic regions or major watersheds: Salmon River (10 core areas, 123 local populations), Boise River (2 core areas, 29 local populations), Payette River (5 core areas, 25 local populations), Little Lost River (1 core area, 10 local populations), Malheur River (2 core areas, 8 local populations), Jarbidge River (1 core area, 6 local populations), and Weiser River (1 core area, 5 local populations). The Upper Snake Recovery Unit includes a total of 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 7 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 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).

---

[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.

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 2 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 5 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 3 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

Conservation Needs

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 Service 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, culver 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).

LITERATURE CITED

[ACA] Alberta Sustainable Resource Development and Alberta Conservation Association. 2009. Status of the bull trout (*Salvelinus confluentus*) in Alberta: Update 2009. Alberta Sustainable Resource Development. Wildlife Status Report No. 39 (Update 2009). Edmonton, Alberta.

Ardren, W. R., P. W. DeHaan, C. T. Smith, E. B. Taylor, R. Leary, C. C. Kozfkay, L. Godfrey, M. Diggs, W. Fredenberg, and J. Chan. 2011. Genetic structure, evolutionary history, and conservation units of bull trout in the coterminous United States. Transactions of the American Fisheries Society 140:506-525. 22 pp.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104(16):6720-6725. 6 pp.

Baxter, C.V. 2002. Fish movement and assemblage dynamics in a Pacific Northwest riverscape. Doctoral dissertation. Oregon State University, Corvallis, OR. 174 pp.

Baxter, J. S. 1997. Aspects of the reproductive ecology of bull trout in the Chowade River, British Columbia. Master's thesis. University of British Columbia, Vancouver. 110 pp.

Beauchamp, D.A., and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-216. 13 pp.

Behnke, R.J. 2002. Trout and Salmon of North America; Chapter: Bull Trout. Free Press, Simon and Shuster, Inc. N.Y., N.Y. Pp. 293-299.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 in E.D. Salo and T.W. Cundy (eds). Streamside Management Forestry and Fisheries Interactions. Institute of Forest Resources, University of Washington, Seattle, Washington, Contribution No. 57. 46 pp.

Bisson, P.A., B.E. Rieman, C. Luce, P.F. Hessburg, D.C. Lee, J.L. Kershner, G.H. Reeves, and R.E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: Current knowledge and key questions. Forest Ecology and Management. 178 (2003) 213-229. 17 pp.

Boag, T.D. 1987. Food habits of bull char, *Salvelinus confluentus*, and rainbow trout, Salmo gairdneri, coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1): 56-62. 6 pp.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 in Howell, P.J. and D.V. 4 pp.

Bonneau, J.L. and D.L. Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125: 628-630. 3 pp.

Brenkman, S.J. and S.C. Corbett. 2005. Extent of Anadromy in Bull Trout and Implications for Conservation of a Threatened Species. North American Journal of Fisheries Management. 25:1073–1081. 9 pp.

Brewin, P.A. and M. K. Brewin. 1997. Distribution Maps for Bull Trout in Alberta. Pages 206-216 in Mackay, W.C., M.K. Brewin and M. Monita. Friends of the bull Trout Conference Proceedings. 10 pp.

Buchanan, D.V., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Mackay, W.C., Pp. 119-126

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife. 168 pp.

Buktenica, M. W., D. K. Hering, S. F. Girdner, B. D. Mahoney, and B. D. Rosenlund. 2013. Eradication of nonnative brook trout with electrofishing and antimycin-A and the response of a remnant bull trout population. North American Journal of Fisheries Management 33:117-129.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55:75-81. 7 pp.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541. 16 pp.

Cavender, T. M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckley), from the American Northwest. California Fish and Game 64: 139-174. 19 pp.

Chamberlain, T. W., R. D. Harr, and F. H. Everest. 1991. Timber harvesting, silviculture and watershed processes. Pages 181-205 in W. R. Meehan (ed). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. 26 pp.

Combes, S. 2003. Protecting freshwater ecosystems in the face of global climate change. In: Hansen LJ et al. (eds) Buying time: a user's manual for building resistance and resilience to climate change in natural systems. WWF, Washington, UDA. Pp. 175-214. 44 pp.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, *Salvelinus confluentus* (Pisces: Salmonidae). Evolution. 57(2):328-344. 17 pp.

Craig, S.D., and R.C. Wissmar. 1993. Habitat conditions influencing a remnant bull trout spawning population, Gold Creek, Washington (draft report). Fisheries Research Institute, University of Washington. Seattle, Washington. 47 pp.

Dambacher, J. M., M. W. Buktenica, and G. L. Larson. 1992. Distribution, abundance, and habitat utilization of bull trout and brook trout in Sun Creek, Crater Lake National Park, Oregon. Proceedings of the Gearhart Mountain Bull Trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

DeHaan, P., M. Diggs, and J. VonBargen. 2011. Genetic analysis of bull trout in the Saint Mary River System. U.S. Fish and Wildlife Service. Abernathy Fish Technology Center, Longview, Washington.

Donald, D.B. and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71: 238-247. 10 pp.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655. 15 pp.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-905. 11 pp.

Dunham, J., C. Baxter, K. Fausch, W. Fredenberg, S. Kitano, I. Koizumi, K. Morita, T. Nakamura, B. Rieman, K. Savvaitova, J. Stanford, E. Taylor, and S. Yamamoto. 2008. Evolution, ecology, and conservation of Dolly Varden, white-spotted char, and bull trout. Fisheries 33:537–550.

Fishbase 2015. http://www.fishbase.org/Summary/SpeciesSummary.php?ID=2690&AT=bull+trout 2pp.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Open File Report Number 156-99. Flathead Lake Biological Station, University of Montana, Polson, MT, 46 pp.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. American Fisheries Society Special Publication 19:297-323. 14 pp.

Gilbert C. H. 1897. The fishes of the Klamath Basin. Bulletin of the U.S. Fish Commission 17:1-13.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. Willamette National Forest. Eugene, Oregon. 60 pp.

Goetz, F. 1994. Distribution and juvenile ecology of bull trout (*Salvelinus confluentus*) in the Cascade Mountains. M.S. thesis. Oregon State University, Corvallis. 190 pp.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, Washington, June, 2004, 396 pp.

Haas, G. R., and J. D. McPhail. 1991. Systematics and distributions of Dolly Varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*) in North America. Can. J. Fish. Aquat. Sci. 48: 2191-2211. 21 pp.

Hartill, T. and S. Jacobs. 2007. Distribution and abundance of bull trout in the Sprague River (Upper Klamath Basin), 2006. Oregon Department of Fish and Wildlife. Corvallis, Oregon.

Hari, R. E., D. M. Livingstone, R. Siber, P. Burkhardt-Holm, and H. Guttinger. 2006. Consequences of climatic change for water temperature and brown trout populations in alpine rivers and streams. Global Change Biology 12:10–26. 17 pp.

Henjum, M.G., J.R. Karr, D.L. Bottom, D.A. Perry, J.C. Bednarz, S.G. Wright, S.A. Beckwitt, and E. Beckwitt. 1994. Interim protection for late-successional forests, fisheries, and watersheds. National forests east of the Cascade Crest, Oregon, and Washington. A report to the Congress and President of the United States Eastside Forests Scientific Society Panel. American Fisheries Society, American Ornithologists Union Incorporated, The Ecological Society of America, Society for Conservation Biology, The Wildlife Society. The Wildlife Society Technical Review 94-2. 112 pp.

Hoelscher, B. and T.C. Bjornn. 1989. Habitat, density and potential production of trout and char in Pend O'reille Lake tributaries. Project F-71`-R-10, Subproject III, Job No. 8. Idaho Department of Fish and Game, Boise, ID. 72 pp.

Howell, P.J. and D.V. Buchanan, eds. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR. 72 pp.

Howell, P. J., J. B. Dunham, and P. M. Sankovich. 2009. Relationships between water temperatures and upstream migration, cold water refuge use, and spawning of adult bull trout from the Lostine River, Oregon, USA. Published in 2009: Ecology of Freshwater Fish 2010:19: 96-106. Malaysia. 11 pp.

Hudson, J. M., R. Koch, J. Johnson, J. Harris, M. L. Koski, B. Galloway, and J. D. Williamson. 2015. Clackamas River Bull Trout Reintroduction Project, 2014 Annual Report. Oregon Department of Fish and Wildlife and U.S. Fish and Wildlife Service, 33 pp.

[IDFG] High, B, Meyer, K., Schill, D., and E. Mamer. 2005. Bull trout status review and assessment in the State of Idaho. Grant #F-73-R-27. Idaho Department of Fish and Game. 57pp.

[IDFG] High, B, Meyer, K., Schill, D., and E. Mamer. 2008. Distribution, abundance, and population trends of bull trout in Idaho. North American Journal of Fisheries Management 28:1687-1701.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate change 2007: the physical science basis. Available: www.ipcc.ch. (February 2007). 1007 pp.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB 2007-2. Portland, Oregon. 2007. 146 pp.

Johnson, L. 1990. State of Nevada, Department of Wildlife, Bull trout management plan. State of Nevada statewide Fisheries Program, project number F-20-26, Job number 2017.4. 17 pp.

Leary, R.F. and F.W. Allendorf. 1997. Genetic confirmation of sympatric bull trout and Dolly Varden in western Washington. Transactions of the American Fisheries Society 126:715-720. 6 pp.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] 7:856-865.

Leathe, S.A. and P. Graham. 1982. Flathead Lake Fish Food Habits Study. Environmental Protection Agency, through Steering Committee for the Flathead River Basin Environmental Impact Study. 208 pp.

Light, J., L. Herger, and M. Robinson. 1996. Upper Klamath basin bull trout conservation strategy, a conceptual framework for recovery. Part one. The Klamath Basin Bull Trout Working Group. 88 pp.

Magnuson, J.J., Robertson, D.M., Benson, B.J., Wynne, R.H., Livingstone, D.M., Arai, T., Assel, R.A., Barry, R.G., Card, V., Kuusisto, E., Granin, N.G., Prowse, T.D., Stewart, K.M., and Vuglinski, V.S. 2000. Historical trends in lake and river cover in the Northern Hemisphere. Science 289:1743-1746. 5 pp.

Martinez, P. J., P. E. Bigelow, M. A. Deleray, W. A. Fredenberg, B. S. Hansen, N. J. Horner, S. K. Lehr, R. W. Schneidervin, S. A. Tolentino, and A. E. Viola. 2009. Western lake trout woes. Fisheries 34:424-442.

MBTSG (Montana Bull Trout Scientific Group). 1995a. Upper Clark Fork River drainage bull trout status report (including Rock Creek). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 46 pp.

______. 1995b. Bitterroot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 34 pp.

______. 1995c. Blackfoot River drainage bull trout status report. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 43 pp.

______. 1995d. Flathead River drainage bull trout status report (including Flathead Lake, the North and Middle forks of the Flathead River and the Stillwater and Whitefish River). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 52 pp.

______. 1995e. South Fork Flathead River drainage bull trout status report (upstream of Hungry Horse Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 43 pp.

______. 1996a. Swan River drainage bull trout status report (including Swan Lake). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 48 pp.

______. 1996b. Lower Clark Fork River drainage bull trout status report (Cabinet Gorge Dam to Thompson Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 43 pp.

______. 1996c. Middle Clark Fork River drainage bull trout status report (from Thompson Falls to Milltown, including the lower Flathead River to Kerr Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 31 pp.

______. 1996d. Lower Kootenai River drainage bull trout status report (below Kootenai Falls). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 39 pp.

______. 1996e. Middle Kootenai River drainage bull trout status report (between Kootenai Falls and Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 27 pp.

______. 1996f. Upper Kootenai River drainage bull trout status report (including Lake Koocanusa, upstream of Libby Dam). Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 31 pp.

______. 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 86 pp.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Management history of eastside ecosystems: Changes in fish habitat over 50 years, 1935 to 1992. U.S. Forest Service, Pacific Northwest Research Station, General Technical Report. PNW-GTR 321. 62 pp.

Meeuwig, M., C. S. Guy, S. T. Kalinowski, and W. Fredenberg. 2010. Landscape influences on genetic differentiation among bull trout populations in a stream-lake network. Molecular Ecology 19:3620-3633.

Minckley, W. L., D. A. Henrickson, and C. E. Bond. 1986. Geography of western North American freshwater fishes: description and relationships to intracontinental tectonism. Pages 519-613 *in* C. H. Hocutt and E. O. Wiley, editors. The zoogeography of North American freshwater fishes. Wiley and Sons, New York.

McPhail, J.D., and J.S. Baxter. 1996. A Review of Bull Trout (*Salvelinus confluentus*) Life-history and Habitat Use in Relation to Compensation and Improvement Opportunities. University of British Columbia. Fisheries Management Report #104. 37 pp.

Meehan, W.R. 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. 12 pp.

Meffe, G.K., and C.R. Carroll. 1994. Principles of conservation biology. Sinauer Associates, Inc. Sunderland, Massachusetts. 8 pp.

Mogen, J. 2013. Bull trout investigations in the Saint Mary River Drainage, Montana – 2010-2012 summary report. U.S. Fish and Wildlife Service Northern Rockies FWCO, Bozeman, Montana.

Mogen, J. T., and L. R. Kaeding. 2001. Population biology of bull trout (*Salvelinus confluentus*) in the Saint Mary River drainage, progress report 1997-2001. U.S. Fish and Wildlife Service, Bozeman, Montana.

Mogen, J. T., and L. R. Kaeding. 2005a. Identification and characterization of migratory and nonmigratory bull trout populations in the St. Mary River drainage, Montana. Transactions of the American Fisheries Society 134:841-852.

Mogen, J. T., and L.R. Kaeding. 2005b. Large-scale, seasonal movements of radiotagged, adult bull trout in the St. Mary River drainage, Montana and Alberta. Northwest Science 79(4):246-253.

Moore, T. 2006. Distribution and abundance of bull trout and redband trout in Leonard and Deming Creeks, July and August, 2005. Oregon Department of Fish and Wildlife. Corvallis, Oregon.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G.R. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds:peer review summary. USFWS, Lacey, Washington, September 19, 2002. 14 pp

NPS (National Park Service). 1992. Value Analysis, Glacier National Park, Divide Creek. West Glacier, Montana.

Nehlsen, W., J. Williams, and J. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(02):4-21. 20 pp.

Newton, J.A., and S. Pribyl. 1994. Bull trout population summary: Lower Deschutes River subbasin. Oregon Department of Fish and Wildlife, The Dalles, Oregon. Oregon administrative rules, proposed amendments to OAR 340-41-685 and OAR 340-41-026. January 11, 1996. 18 pp.

ODEQ (Oregon Department of Environmental Quality). 1995. National pollution discharge elimination system permit evaluation report. Facility Bourne Mining Corporation. December 11, 2003. File number 11355. 8pp.

ODFW (Oregon Department of Fish and Wildlife). 2012. Klamath watershed fish district stock status report, September 2012. ODFW, Klamath Falls, Oregon.

Porter, M. and M. Nelitz. 2009. A future outlook on the effects of climate change on bull trout (*Salvelinus confluentus*) habitats in the Cariboo-Chilcotin. Prepared by ESSA Technologies Ltd.for Fraser Salmon and Watersheds Program, B.C. Ministry of Environment, and Pacific Fisheries Resource Conservation Council. 10 pp.

Pratt, K.L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game, Boise, Idaho. 74 pp.

Pratt, K.L. 1992. A Review of bull trout life history. 00. 5-9. In Proceedings of the Gearhart Mountain Bull Trout Workshop, ed. Howell, P.J. and D.V. Buchanan. Gearhart Mountain, OR. Corvallis, OR: Oregon Chapter of the American Fisheries Society. August 1992. 8 pp.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in Lake Pend Oreille and the lower Clark Fork River: (draft report) Prepared for the WWPC, Spokane, WA. 200 pp.

Quinn, T. P. 2005. The behavior and ecology of pacific salmon and trout. 2005. University of Washington Press. 1st edition. 9 pp.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis. 8 pp.

Redenbach, Z., and E. B. Taylor. 2002. Evidence for historical introgression along a contact zone between two species of char (Pisces: Salmonidae) in northwestern North America. Evolution 56:1021-1035.

Rich, C.F., Jr. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. MS thesis, Montana State University, Bozeman, MT. 60 pp.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements of bull trout *Salvelinus confluentus*. General Technical Report INT-GTR- 302. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah. 42 pp.

Rieman, B.E., and J.D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124:285-296. 12 pp.

Rieman, B.E. and J.D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American J. of Fisheries Manage. 16: 132-146. 10pp.

Rieman, B., and J. Clayton. 1997. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14. 10 pp.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64. 14 pp.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society. 136:1552-1565. 16 pp.

Rode, M. 1990. Bull trout, *Salvelinus confluentus suckley*, in the McCloud River: status and recovery recommendations. Administrative Report Number 90-15. California Department of Fish and Game, Sacramento, California. 44 pp.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conservation Biology 5:18-32. 15 pp.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho. 66 pp.

Sedell, J.R. and F.H. Everest. 1991. Historic changes in poll habitat for Columbia River Basin salmon under study for TES listing. Draft USDA Report. Pacific Northwest Research Station. Corvallis, OR. 6 pp.

Sexauer, H.M., and P.W. James. 1997. Microhabitat Use by Juvenile Trout in Four Streams Located in the Eastern Cascades, Washington. Pages 361-370 in W.C. Mackay, M.K. Brown and M. Monita (eds.). Friends of the Bull Trout Conference Proceedings. Bull Trout Task Force (Alberta), c/o Trout Unlimited Calgary, Canada. 10 pp.

Shively, D., C. Allen, T. Alsbury, B. Bergamini, B. Goehring, T. Horning and B. Strobel. 2007.

Clackamas River bull trout reintroduction feasibility assessment. Sandy, Oregon, Published by USDA Forest ervice, Mt. Hood National Forest for the Clackamas River Bull Trout Working Group.

Shuter, B.J., and Meisner, J.D. 1992. Tools for assessing the impact of climate change on freshwater fish populations. GeoJournal 28(1):7-20. 22 pp.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University Press of Idaho. Moscow, ID. 5 pp.

Smillie, G. M., and D. Ellerbroek. 1991. Flood hazard evaluation for Divide and Wild creeks, Glacier National Park. Technical Report NPS/NRWRD/NRTR-91/02. Water Resources Division, National Park Service, Fort Collins, Colorado.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of Bull trout populations. Ecology of Freshwater Fish 8:114-121. 8 pp.

Spruell P., A.R. Hemmingsen, P.J. Howell, N. Kandal and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4: 17–29. 14 pp.

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (*Salvelinus confluentus*). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801. Department of Fisheries and Oceans, Winnipeg, MB, Canada, 2007, 54 pp.

Taylor, B.E., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (*Salvelinus confluentus*) from northwestern North America: implications for zoogeography and conservation. Molecular Ecology 8:1155-1170. 16 pp.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana. 108 pp.

USDA (U.S. Department of Agriculture), and USDI (U.S. Department of the Interior). 1995. Decision Notice/Decision Record Finding of No Significant Impact, Environmental Assessment for the Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon, and Washington, Idaho, and portions of California (PACFISH). 211 pp.

USFWS (U.S. Fish and Wildlife Service). 1996. Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act. Federal Register Vol. 61 4722-4725.

______. 1998. Determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout. Federal Register Vol. 63 31647-31674. 28 pp.

______. 1999. Determination of threatened status for bull trout in the coterminous United States; Final Rule. Federal Register Vol. 64 58190-58933. 25 pp.

______. 2002a. Bull trout (*Salvelinus confluentus*) draft recovery plan - Chapter 1: Introduction. U.S. Fish and Wildlife Service, Portland, Oregon, October, 2002, 137 pp.

______. 2002b. Bull trout (*Salvelinus confluentus*) draft recovery plan - chapter 2 Klamath River. U.S. Fish and Wildlife Service, Portland, Oregon. 93 pp.

______. 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 297 pp.

______. 2008a. Bull trout (*Salvelinus confluentus*) 5-year review: summary and evaluation. Portland, Oregon. 55 pp.

______. 2008b. Bull trout draft core area templates - complete core area by core area analysis. W. Fredenberg and J. Chan, editors. U. S. Fish and Wildlife Service. Portland, Oregon. 1,895 pages.

______. 2010. Revised designation of critical habitat for bull trout in the coterminous United States. Federal Register Vol 75, No. 200. 63898-64070.

______. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

______. 2015a. Coastal recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Lacey, Washington, and Portland, Oregon. 155 pp.

______. 2015b. Klamath recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Klamath Falls, Oregon. 35 pp.

______. 2015c. Mid-Columbia recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 345 pp.

______. 2015d. Columbia headwaters recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana, and Spokane, Washington. 179 pp.

______. 2015e. Upper Snake recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Boise, Idaho. 113 pp.

______. 2015f. St. Mary recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana. 30 pp.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: and investigation at hierarchical scales. North American Journal of Fisheries Management 17:237-252. 16 pp.

WDFW (Washington Department of Fish and Wildlife), FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. March 1997. Olympia,Washington

WDFW. 1998. Washington State Salmonid Stock Inventory - Bull Trout/Dolly Vardin. 444 pp.

WDOE (Washington Department of Ecology). 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oyxgen: Draft discussion paper and literature summary. Publication Number 00-10-071. Washington Department of Ecology, Olympia, WA, 90 pp.

Whiteley, A.R., P. Spruell, F.W. Allendorf. 2003. Population Genetics of Boise Basin Bull Trout (*Salvelinus confluentus*). University of Montana, Division of Biological Sciences. Report to the U.S. Forest Service, Rocky Mountain Research Station, Boise, ID. 37 pp.

Whitesel, T. A., J. Brostrom, T. Cummings, J. Delavergne, W. Fredenberg, H. Schaller, P. Wilson, and G. Zydlewski. 2004. Bull trout recovery planning: a review of the science associated with population structure and size. Science team report #2004-01, U.S. Fish and Wildlife Service, Portland, Oregon. 68 pp.

Wissmar, R., J. Smith, B. McIntosh, H. Li, G. Reeves, and J. Sedell. 1994. A history of resource use and disturbance in riverine basins of eastern Oregon and Washington (early 1800s-1990s). Northwest Science 68:1-35. 18 pp.

Ziller, J.S. 1992. Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon. Pages 18-29 in Howell, P.J. and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR. 12 pp.

Appendix B
Status of the Designated Critical Habitat: Bull Trout

(This page intentionally left blank)

Appendix B
Status of Designated Critical Habitat: Bull Trout

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 (Service) 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.

LITERATURE CITED

Buchanan, D.V., M.L. Hanson, and R.M. Hooton. 1997. Status of Oregon's bull trout. Oregon Department of Fish and Wildlife. 168 pp.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications 9:642-655. 15 pp.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143.

Hard, J. 1995. A quantitative genetic perspective on the conservation of intraspecific diversity. American Fisheries Society Symposium 17: 304-326. 22 pp.

Healey, M.C. and A. Prince. 1995. Scales of variation in life history tactics of Pacific salmon and the conservation of phenotype and genotype. American Fisheries Society Symposium 17:176-84. 10 pp.

Leary, R.F., F.W. Allendorf, and S.H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River drainages. Conservation Biology [CONSERV. BIOL.] 7:856-865.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout. Prepared for Montana Bull Trout Restoration Team. Helena, Montana. 86 pp.

Quigley, T.M., and S.J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: volume III. Gen. Tech. Rep. PNW-GTR-405. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 4 vol. 13 pp.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in: P.J. Howell and D.V. Buchanan (eds). Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis. 8 pp.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements of bull trout *Salvelinus confluentus*. General Technical Report INT-GTR- 302. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, Utah. 42 pp.

Rieman, B.E., and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764. American Fisheries Society, Bethesda, Maryland. 10 pp.

Rieman, B.E., D.C. Lee and R.F. Thurow. 1997. Distribution, status and likely future trends of Bull trout within the Columbia River and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125. 48 pp.

Rieman, B.E., J.T. Peterson and D.L. Myers. 2006. Have brook trout (*Salvelinus fontinalis*) displaced bull trout (*Salvelinus confluentus*) along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences. Vol. 63, No. 1, pp. 63–78. 16 pp.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho. 66 pp.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana. 108 pp.

USFWS (U.S. Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Consultation handbook: procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. 315pp.

USFWS (U.S. Fish and Wildlife Service). 1998. Determination of threatened status for the Klamath River and Columbia River distinct population segments of bull trout. Federal Register Vol. 63 31647-31674. 28 pp.

______. 1999. Determination of threatened status for bull trout for the Jarbidge River population segment of bull trout. Federal Register Vol. 64 17110-17125. 16 pp.

______. 2004a. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 297 pp.

______. 2004b. Draft Recovery Plan for the Jarbidge Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 148 pp.

______. 2010. Revised designation of critical habitat for bull trout in the coterminous United States. Federal Register Vol 75, No. 200. 63898-64070.

Appendix C
Stillaguamish Core Area

(This page intentionally left blank)

Appendix C
Stillaguamish Core Area

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

Bull trout in the Stillaguamish core area primarily consist of the anadromous and fluvial life-history forms (USFWS 2004, p. 96). Resident bull trout occur in the upper South Fork Stillaguamish River (USFWS 2004, p. 98; USFWS 2008a, p. 1) and possibly also upstream of the anadromous barrier on Higgins Creek (USFWS 2008a, p. 3). There are no known populations in the North Fork Stillaguamish River above a natural anadromous barrier at river mile 37.5 (Kraemer, in litt. 1999).

The South Fork Stillaguamish River upstream of Granite Falls has supported anadromous bull trout since the construction of a fishway in the 1950s (USFWS 2004, pp. 97-98). Previously, the falls were impassable to anadromous fish. Anecdotal information from fish surveys in the 1920s and 1930ssuggest that native char likely were present above Granite Falls prior to construction of the fishway (USFWS 2004, pp. 97-98).

Spawning habitat is generally limited in the Stillaguamish core area due to two primary factors: 1) there is a relatively small amount of high elevation areas, which often provide the best thermal regimes for spawning, egg incubation, and early juvenile rearing; and, 2) historical land management practices, particularly related to timber harvesting, have degraded much of the available spawning and rearing habitat. In the North Fork Stillaguamish River basin, migratory bull trout spawn in the upper reaches of the Deer Creek subbasin, including Upper Deer, Little Deer, and Higgins Creeks. There is also a spawning population of resident char (bull trout or Dolly Varden) above the anadromous barrier on Higgins Creek (USFWS 2008a, p. 3). In the Boulder River subbasin, bull trout spawn below the impassible falls at river mile 3. Adult bull trout have been observed in the North Fork Stillaguamish River above the Boulder River confluence, including in the Squire Creek subbasin (USFWS 2004, p. 97). However, these fish are suspected to be strays, colonizers (USFWS 2015, p. A-149), and/or fish foraging from other core areas (USFWS 2004, pp. 3-4), although there has been no extensive juvenile sampling or evaluation of spawning success.

In the South Fork Stillaguamish River basin, bull trout are known to spawn and rear in Canyon, Palmer, Perry, and Buck Creeks and the upper South Fork mainstem above Palmer Creek (USFWS 2004, pp. 94-99). Primary spawning grounds have been identified in the South Fork Stillaguamish River above the Palmer Creek confluence. Spawning and early rearing habitat in the South Fork Stillaguamish River is considered to be in fair condition. Although bull trout spawn in the upper South Fork Stillaguamish River and other tributaries, available habitat is partially limited by gradient and competition with coho (*Oncorhynchus kisutch*) salmon. Migratory and resident fish coexist on the spawning grounds.

In Canyon Creek, bull trout use the upper south fork of the creek for spawning and rearing (USFWS 2004, p. 98). Although there have been isolated and incidental observations of spawning by migratory-size bull trout, electrofishing surveys in the early 2000s were unable to locate any juvenile or resident fish. Spawning and early rearing habitat is believed to be in poor condition due to the relatively low elevation and persistent effects of historical land management activities, including logging.

The Stillaguamish core area population was considered "at risk" for extirpation in 2008 (USFWS 2008b, p. 35). Extirpation risk may be greater now due to lower abundance and declining productivity. 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, and 4) connectivity (USFWS 2004, p. 215).

Number and Distribution of Local Populations

Three local populations are recognized within the Stillaguamish core area: 1) Upper Deer Creek, 2) South Fork Stillaguamish River, and 3) Canyon Creek. These local populations are relatively well-distributed throughout the core area. The Upper Deer Creek local population may be extirpated (USFWS 2015, p. A-13), based on the paucity of historical observations of bull trout and more recent failures to detect bull trout. Core areas with fewer than 5 interconnected local populations are at increased risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218).

A fourth local population - North Fork Stillaguamish River - was recognized from the early 2000s (USFWS 2004, p. 94-99) until 2015, when it was no longer considered a local population (USFWS 2015, p. A-149). Numerous adult bull trout have been observed in this part of the Stillaguamish River system during staging and spawning periods. However, these are now thought to have been anadromous individuals from outside the basin (USFWS 2015, p. A-149). Bull trout redds, possibly from colonizing individuals from outside the basin, were observed in the 1980s (USFWS 2015, p. A-149). No bull trout redds have been detected since then, though redd surveys have been limited. Because of the past adult detections in this area, the North Fork Stillaguamish River is considered a potential local population only.

Adult Abundance

The Stillaguamish core area likely contains fewer than 250 adults, however survey data is limited and origin of fish observed in the former North Fork Stillaguamish River local population is uncertain. This core area is at risk from genetic drift because it contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 218-224).

The South Fork Stillaguamish River local population may be the only functional population in the core area (USFWS 2008a, p. 2). Average adult abundance in this local population, estimated from redd counts, was approximately 40 fish from 2009 to 2011, a decline from approximately 125 fish from 2005 to 2008 (Fowler 2012).

The Upper Deer Creek and Canyon Creek local populations are believed to be very low, although systematic surveys are not performed here. Past observations of redds and adults suggest that each of these populations number well below 100 adults (USFWS 2004, p. 96). Surveys in 2002 and 2003 did not detect any native char in either area (USFWS 2008a, p. 3). The Upper Deer Creek local population may be extirpated (USFWS 2015, p. A-13).

The North Fork Stillaguamish River is not currently believed to support a spawning local population, although there is insufficient information to rule out the possibility of one in existence (USFWS 2015, p. A-149). It is believed that upwards of 100 adult bull trout utilize this area (USFWS 2004, pp. 96-97), presumably as strays, colonizers (USFWS 2015, p. A-149), and/or fish foraging from other core areas (USFWS 2004, pp. 3-4).

All Stillaguamish core area local populations are at risk from inbreeding depression because they appear to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 218-224).

Productivity

Productivity of the Stillaguamish River core area may be in decline based on trends in redd counts observed in the South Fork Stillaguamish River, the primary local population. Average adult abundance estimated from redd counts was approximately 40 fish from 2009 to 2011, a decline from approximately 125 fish from 2005 to 2008 (Fowler 2012). In addition, the three-year running average of redd counts declined every year from 2007 (53 redds per year) to 2011 (18 redds per year). More recent survey data is needed to confirm whether this apparent trend is continuing. Declining productivity places the core area at increased risk of extirpation (USFWS 2004, p. 224-225).

Connectivity

The presence of migratory bull trout in the primary local population (South Fork Stillaguamish River) and likely other local populations diminishes the risk of local extirpation from connectivity issues. However, persistence of migratory life history forms in the South Fork Stillaguamish River depends upon continued operation of the Granite Fall fishway, which may not be fully functional (USFWS 2008a, p. 5). In addition, a weir on Cook Slough impedes upstream fish passage and/or traps migratory spawners (USFWS 2015, p. A-13).

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

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Snohomish-Skykomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, restoration of fish passage at barriers, and habitat-improvement projects. In addition, federally funded transportation projects involving repair and protection of roads and bridges have been completed. Finally, section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans that address bull trout in this core area. For example, in 2000, State forest practice regulations were significantly revised following the Forest and Fish agreement. These regulations increased riparian protection, unstable slope protection, recruitment of large wood, and improved road standards significantly. Because there is biological uncertainty associated with some of the prescriptions, the Forest and Fish agreement relies on an adaptive management program for assurance that the new rules will meet the conservation needs of bull trout. The updated regulations are expected to significantly reduce the level of future timber harvest impacts to bull trout streams on private lands, however, most legacy threats from past forest practices will likely continue to be a threat for decades.

The number of non-federal actions occurring in the Stillaguamish core area since the bull trout listing is unknown. Beneficial actions include Snohomish County revised Critical Area Regulations, effective October 1, 2007. The revised regulations included consideration for anadromous fish intended to preserve the critical area functions beneficial to these species. In addition, recent salmon recovery efforts are improving conditions for bull trout. Although directed toward salmonids other than bull trout, the regional salmon recovery plan under the Shared Strategy for Puget Sound and watershed-scale implementation under the Puget Sound Partnership have resulted in general aquatic habitat improvements that benefit many target and non-target species, including bull trout. Other non-federal activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout.

Climate change is expected to negatively affect the Stillaguamish core area (USFWS 2008a, pp. 14-15). Climate change projections for the Puget Sound region suggest the following impacts to occur in river systems across the region, including the Stillaguamish (Battin et al. 2007; Beechie et al. 2013; Hall et al. 2014; Tohver et al. 2014): greater proportion of rain during the winter and less snowpack in the late spring and early summer; higher water temperatures, especially during the summer; lower flows during the summer and early fall; and, increased magnitude of winter peak flows Snowpack reduction, increased peak flows, and associated bluff erosion and landslides may result in increased rates of sediment aggradation downstream (Lee and Hamlet 2011, p. 128-131). Higher peak flows and increased aggradation may increase redd scour and smothering, resulting in mortality to eggs, incubating embryos, and pre-emergent juveniles. In addition, the Stillaguamish River basin already suffers from temperature exceedances within its mainstem and two forks (WDOE 2007), making it particularly vulnerable to climate change impacts. There are no glaciers or protected areas in the Stillaguamish River basin that could help to buffer the impacts of climate change (USFWS 2008a, p. 14-15).

Threats

There are six primary threats to bull trout in the Stillaguamish core area (USFWS 2015, p. A-13):

Upland/Riparian Land Management: Forest Management. Legacy and ongoing impacts have exacerbated landslide activity in the watershed degrading salmonid habitat and water quality.

Instream Impacts: Recreational Mining. Activities impact spawning and rearing tributary habitats.

Water Quality: Forest Management, Residential Development and Urbanization. Legacy impacts result in seasonal high water temperatures in mainstem river, North and South Forks, and some local population tributaries; anticipated to be further exacerbated by climate change.

Connectivity Impairment: Fish Passage Issues. Stillaguamish weir on Cook Slough impedes upstream fish passage and/or traps migratory spawners.

Connectivity Impairment: Fish Passage Issues. Persistence of the migratory life history in the South Fork Stillaguamish River local population is reliant upon continued functionality of the fishway at Granite Falls.

Small Population Size: Genetic and Demographic Stochasticity. Available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in the South Fork Stillaguamish and Upper Deer Creek local populations, in fact, the Upper Deer Creek local population may be extirpated.

Additional threats to the Stillaguamish core area bull trout population include the following:

- Estuarine nearshore foraging habitats have been severely diminished in quantity and quality (USFWS 2008a, pp. 8, 13). In addition, declines in forage fish species, particularly surf smelt and Pacific herring, in the marine nearshore areas of the Salish Sea (Therriault et al. 2009; Greene et al. 2015) have resulted in part from degradation of habitats including natural beaches and eel-grass beds, and from water pollution impacts. Anadromous bull trout feed heavily on these species in nearshore areas (Goetz et al. 2004, pp. 109-112). Declines in marine nearshore habitat quality and prey resources may limit the abundance of the anadromous life history form.

- The abundance of many species of anadromous salmonids in the Stillaguamish core area has been in decline for many years (WDFW 2015). Bull trout abundance and growth rates are positively correlated with abundance of live-spawning anadromous salmonids in the nearby Lower Skagit core area (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30) and elsewhere (Copeland and Meyer 2011, pp. 937-938). Such correlations have been observed for other species as well (Bentley et al. 2012; Nelson and Reynolds 2014). Anadromous salmonids provide a direct forage resource via eggs and juveniles, which can make up a substantial proportion of the bull trout diet (e.g., Lowery and Beauchamp 2015). Live spawners and carcasses also stimulate ecosystem productivity, thereby increasing abundance of aquatic invertebrates and resident fishes (e.g., Cederholm et al. 1999; Moore et al. 2008; Copeland and Meyer 2011; Rinella et al. 2012), which bull trout forage on (Lowery and Beauchamp 2015). The long-term decline in abundance of live-spawning anadromous salmonids and the related decline in the forage base may limit the long-term abundance and productivity of the core area's bull trout populations.

- Climate change is expected to negatively affect spawning and rearing bull trout via elevated water tempertures during migration, spawning, and rearing periods; redd scour due to increased peak flows; decreased habitat quantity as a result of lower summer flows.

- Historical planting of Westslope cutthroat trout in the North and South Forks of the Stillaguamish River in areas overlapping bull trout spawning and rearing is a concern (USFWS 2004; USFWS 2008a, p. 7).

LITERATURE CITED

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104(16):6720-6725.

Bentley, K.T., D.E. Schindler, J.B. Armstrong, R. Zhang, C.P. Ruff, and P.J. Lisi. 2012. Foraging and growth responses of stream-dwelling fishes to inter-annual variation in a pulsed resource subsidy. Ecosphere 3(12):1-17. http://dx.doi.org/10.1890/ES12-00231.1

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, P. Kiffney, and N. Mantua. 2013. Restoring salmon habitat for a changing climate. River Research and Applications, 29(8), 939-960.

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24:6-15.

Copeland, T., and K.A. Meyer. 2011. Interspecies synchrony in salmonid densities associated with large-scale bioclimatic conditions in central Idaho. Transactions of the American Fisheries Society 140:928-942.

Fowler, A. 2012. 2011 Skagit, Stillaguamish, and North Fork Skykomish Rivers bull trout monitoring report. Washington Department of Fish and Wildlife, La Connor, Washington. 13 pp.

Goetz, F.A., E. Jeanes, and E. Beamer. 2004. Bull trout in the nearshore. Preliminary draft. U.S. Army Corps of Engineers, Seattle, WA.

Greene, C., L. Kuehne, C. Rice, K. Fresh, and D. Penttila. 2015. Forty years of change in forage fish and jellyfish abundance across greater Puget Sound, Washington (USA): anthropogenic and climate associations. Marine Ecology Progress Series 525:153-170.

Hall, J.E., T.J. Beechie, and G.R. Pess. 2014. Influence of climate and land cover on river discharge in the North Fork Stillagaumish River. Final Contract Report to the Stillaguamish Tribe of Indians. NOAA Fisheries, Seattle, WA.

Kraemer, C. 1999. Document from Curtis Kraemer, WDFW, re Bull trout in the Stillaguamish River system. July 1999.

Kraemer, C. 2003. Lower skagit bull trout age and growth information developed from scales collected from anadromous and fluvial char. Management Brief. Washington Department of Fish and Wildlife, Olympia, WA.

Lee, S., and A.F. Hamlet. 2011. Skagit River Basin Climate Science Report. Summary report prepared for Skagit County and the Envision Skagit Project by the Department of Civil and Environmental Engineering and The Climate Impacts Group, University of Washington.

Lowery, E.D., and D.A. Beauchamp. 2015. Trophic Ontogeny of Fluvial Bull Trout and Seasonal Predation on Pacific Salmon in a Riverine Food Web. Transactions of the American Fisheries Society 144:724-741, DOI:10.1080/00028487.2015.1035452.

Moore, J.W., D.E. Schindler, C.P. Ruff. 2008. Habitat saturation drives thresholds in stream subsidies. Ebcology 89:306-312.

Nelson, M.C., and J.D. Reynolds. 2014. Time-Delayed Subsidies: Interspecies Population Effects in Salmon. PLoS ONE 9(6): e98951. doi:10.1371/journal.pone.0098951.

Rinella, D.J., M.S. Wipfli, C.A. Stricker, R.A. Heintz, and M.J. Rinella. 2012. Pacific salmon (Oncorhynchus spp.) runs and consumer fitmess: growth and energy storage in stream-dwelling salmonids increase with salmon spawner density. Canadian Journal of Fsiheries and Aquatic Sciences 69:73-84.

Therriault, T.W., D.E. Hay, and J.F. Schweigert. 2009. Biologic overview and trends in pelagic forage fish abundance in the Salish Sea (Strait of Georgia, British Columbia). Marine Ornithology 37: 3-8.

Tohver, I.M., A.F. Hamlet, and S. Lee. 2014. Impacts of 21st-Century Climate Change on Hydrologic Extremes in the Pacific Northwest Region of North America. Journal of the American Water Resources Association 50(6): 1461-1476. DOI: 10.1111/jawr.12199.

USFWS. 2004. Draft Recovery Plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*). Volume I: Puget Sound Management Unit, 389+xvii pp. Portland, Oregon.

USFWS. 2008a. Bull trout core area templates - an unpublished compilation of updated bull trout core area analysis to support the five-year review. Stillaguamish River Core Area Chapter. U.S. Fish and Wildlife Service, Portland, OR, August 24, 2008.

USFWS. 2008b. Bull Trout (Salvelinus confluentus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Portland, OR. 53 pp.

USFWS. 2015. Coastal Recovery Unit Implementation Plan for Bull Trout (*Salvelinus confluentus*). Lacey, WA and Portland, OR.

WDOE (Washington Department of Ecology). 2007. Stillaguamish River Fecal Coliform, Dissolved Oxygen, pH, Mercury, and Temperature Total maximum Daily Load: Water Quality Implementation Plan. Publication No. 07-10-033. Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 2015. Salmon Conservation Reporting Engine, Skykomish Bull Trout. Olympia, WA. https://fortress.wa.gov/dfw/score/score/species/species.jsp. Accessed October 1, 2015.

Zimmerman, M., and C. Kinsel. 2010, Migration of Anadromous Juvenile Bull Trout in the Skagit River, 1990-2009. Report FPT 11-01. Washington Department of Fish and Wildlife, Olympia, WA.

Appendix D
Lower Skagit Core Area

(This page intentionally left blank)

Appendix D
Lower Skagit Core Area

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

Bull trout occur throughout the Lower Skagit core and express fluvial, adfluvial, resident, and anadromous life history forms. Adfluvial bull trout occur in Baker Lake and Lake Shannon. Fluvial bull trout forage and overwinter in the larger pools of the upper portion of the mainstem Skagit River and, to a lesser degree, in the Sauk River (Kraemer 2001, p. 2). Populations expressing the resident life history form are found throughout the basin and often co-occur with migratory life history forms. Life history expression of bull trout is highly plastic. Individual fish may change life histories during their lifetime (USFWS 2008a, p. 2). Also, life history of progeny may vary from that of the parents (Brenkman et al. 2007, pp. 8-9; Rieman and McIntyre 1993, pp. 2-3).

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

The Lower Skagit core area population is considered at "low risk" for extirpation (USFWS 2008b, p. 35). This core area is one of four population strongholds in the Coastal Recovery Unit (USFWS 2015a, p. 79). 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).

Number and Distribution of Local Populations

Twenty local populations are recognized within the Lower Skagit core area (USFWS 2004, p. 76; USFWS 2015b, p. A-148): 1) Bacon Creek, 2) Baker Lake, 3) Buck Creek, 4) Cascade River, 5) Downey Creek, 6) Forks of Sauk River, 7) Goodell Creek, 8) Illabot Creek, 9) Lime Creek, 10) Lower White Chuck River, 11) Milk Creek, 12) Newhalem Creek, 13) South Fork Cascade River, 14) Straight Creek, 15) Sulphur Creek, 16) Sulphur Creek (Lake Shannon), 17) Tenas Creek, 18) Upper South Fork Sauk River, 19) Upper Suiattle River, and 20) Upper White Chuck River. Core areas with more than 10 interconnected local populations are at a diminished risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218). Eighteen local populations within the Lower Skagit core area are interconnected. Connectivity of two local populations with the rest of the core area is partially obstructed (see Connectivity section below).

Adult Abundance

The Lower Skagit core area is believed to contain the largest spawning population of bull trout in Washington. Adult abundance is estimated to be between 5,000 and 10,000 individuals based on partial spawner survey data from less than half of the core area (USFWS 2008a, p. 3). This core area is not considered at risk from genetic drift because it supports more than 1,000 adults (USFWS 2004, pp. 218-224). However, some local populations may be at risk from inbreeding depression because they appear to contain fewer than 100 adults (USFWS 2004, pp. 218-224). At least half of the local populations are believed to have 100 or more adults, and thus are not at risk from inbreeding depression. Abundance data for most local populations are limited and/or outdated. These data are described below. More recent and/or higher quality survey data for most local populations are needed to reach more confident conclusions.

The WDFW conducted surveys in index reaches of six local populations from 2001 to 2011 (Downen 2009; Fowler 2012), although not every local population was surveyed in every year. It is uncertain what proportion of available habitat was represented by the surveyed index reaches. Therefore, survey results represent minimum abundances. Unless otherwise noted, the following adult abundances are based on redd survey results. Survey years are noted in parentheses.

Bacon Creek: 42 to 134 adults (2009 to 2011); 118 to 300 adults (2001 to 2008).

Cascade River: 182 to 414 adults (2009 to 2011); 666 to 868 adults (2006 to 2008).

Downey Creek: 190 to 282 adults (2009 to 2011); 316 to 394 adults (2005 to 2008).

Forks of Sauk River: 154 to 416 adults (2005 to 2011); 350 to 740 adults (2001 to 2004); 10 to 104 adults (1988 to 1996).

Goodell Creek: 25 to 63 adults (2004 to 2008); 150 to 175 adults (2002 to 2003). Abundances are peak live counts of individual fish.

Illabot Creek: 100 to 260 adults (2005 to 2008); 600 to 660 adults (2002 to 2004).

Puget Sound Energy has performed limited bull trout surveys annually in the Baker Lake and Sulphur Creek (Lake Shannon) local populations since 2009. Similar surveys were performed by the National Park Service and/or R2 Consulting from 2000 to 2006. Surveys have been intended to provide indicators of relative, not absolute, abundance. Nonetheless, surveys suggest the following:

Baker Lake: May contain at least 100 adults, but likely fewer than 500.

Sulphur Creek (Lake Shannon): Less than 100 adults.

For all other local populations, there are no recent adult abundance data. In 2001, the WDFW provided abundance estimates for many core areas (Kraemer 2001). However, the methods and assumptions used to derive these estimates were not described; therefore, the quality and accuracy of these estimates is uncertain.

Buck Creek: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Lime Creek: Less than 100 migratory adults. "Abundant" residents.

Lower White Chuck River: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Newhalem Creek: Unknown abundance.

Milk Creek: Limited migratory use presumably due to natural factors. "Abundant" residents believed to be near historical numbers.

South Fork Cascade River: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Straight Creek: Less than 100 migratory adults. "Unknown" resident component.

Sulphur Creek: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Tenas Creek: Less than 100 migratory adults. "Limited" resident component.

Upper South Fork Sauk River: Less than 500 migratory adults. "Abundant" residents believed to be near historical numbers.

Upper Suiattle River: "Unknown" abundance of migratory and resident forms.

Upper White Chuck River: "Unknown" abundance of migratory and resident forms, but believed to be one of the larger local populations, presumably due to the quantity and quality of habitat.

<u>Productivity</u>

Most local populations are not consistently monitored; therefore, trends in abundance are unknown. Data from the six local populations monitored by the WDFW (Downen 2009; Fowler 2012) suggest that a basin-wide decline in productivity occurred in the mid-2000's (see Adult Abundance section above). Unusually low summer flows and record flood events in the mid-2000 may have been primary contributors to this decline. It is unknown if productivity is continuing to decline or has stabilized. This uncertainty is due to the following: 1) the relatively recent timing of the decline; 2) lack of any abundance data more recent than 2011; and, 3) inherent inter-annual variability in bull trout abundance surveys. Any persistent and widespread decline in productivity across the core area would increase the risk of extirpation (USFWS 2004, pp. 224-225). More recent and/or higher quality survey data for most local populations are needed to reach more confident conclusions.

Long-term monitoring data from the Forks of Sauk River local population suggests that this local population remains at abundances greater than pre-listing levels despite the apparent recent decline in productivity. The extent to which this is true for other local populations is unknown.

Monitoring data from 2009 to 2014 for the Baker Lake and Sulphur Creek (Lake Shannon) local populations suggest stable or increasing trends in productivity, likely due to recent intensive sockeye salmon hatchery production and fry releases into the lakes.

Connectivity

There are no connectivity barriers between 18 of the 20 local populations, and most, if not all, of these local populations contain migratory life history forms. Thus, there are no extirpation risks associated with connectivity among these local populations. Connectivity within the Baker River system, and between the Baker River system and other local populations, is partially obstructed by two hydropower dams owned and operated by Puget Sound Energy. Bull trout passage across the dams has improved with the construction of new passage infrastructure (floating surface collectors for downstream migrants; adult trap-and-haul facility for upstream migrants) and implementation of improved passage protocols. These were negotiated as part of the 2004 Settlement Agreement and 2008 Federal Energy Regulatory Commission license renewal. The overarching bull trout passage strategy is the most effective one that can be achieved with the dams in place. However, there are limitations that prevent the passage measures from being fully effective, which places the two local populations above the dams - Baker Lake and Sulphur Creek (Lake Shannon) - at increased risk of extirpation. The Service works closely with Puget Sound Energy to monitor passage effectiveness and make improvements where possible.

Currently, bull trout in the Lower Skagit core area can migrate upstream only as far as Gorge Dam. Historically, bull trout may have been able to migrate as far as the current site of Diablo Dam (USFWS 2004, p. 77), approximately 4 miles upstream from Gorge Dam.

Changes in Environmental Conditions

Since the bull trout listing, federal actions occurring in the Lower Skagit core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; federally authorized repair and maintenance of levees and emergency bank protection actions; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have negatively directly affected bull trout in the Lower Skagit core area.

Carpenter, Turner, Otter Pond, Red, Fisher, Hansen, Lake, Nookachamps, and East Fork Nookachamps Creeks are all temperature-impaired tributaries to the Skagit River within the Lower Skagit core area. These creeks are addressed in a TMDL study of the lower Skagit basin (WDOE 2008, p. 18).

The number of non-federal actions occurring in the Lower Skagit core area since the bull trout listing is unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably have negatively affected bull trout and parts of their forage base. State fishing regulations allow a daily limit of two fish within the Lower Skagit core area. Emergency regulations were implemented in 2007 within sections of the Skagit River to prohibit the retention of bull trout to address the decline in bull trout spawners that had been observed. These declines may have been the result of drought and flood events. Changes in fishing regulations were implemented in 2008 by WDFW within portions of the Skagit, Sauk, and Cascade Rivers, including new selective gear rules and catch and release requirements (USFWS 2008a, p. 12)

A number of major restoration and conservation land protection projects have been completed in the Skagit River watershed that improve and protect bull trout habitat. Many of these projects were implemented as the result of project prioritization processes and state and federal funding coordinated by the Skagit Watershed Council (E. Connor, Seattle City Light, pers. comm. 2008 in USFWS 2008a, p. 12). Major restoration projects that have been implemented or completed since 2004 include the Milltown Island and Wiley Slough Estuary Restoration Project sponsored by the Skagit River System Cooperative (SRSC) and WDFW, and the sediment reduction projects in the middle Skagit and Suiattle River watersheds sponsored by the U.S. Forest Service. Over 1,100 acres of habitat in the Cascade River was put into permanent conservation protection through the partnership of Seattle City Light, Washington Department of Natural Resources, and USFWS (USFWS 2008a, p. 12). Several miles of foraging, migration, and overwintering habitat along the middle Skagit River have been protected since 2004 by the Skagit Land Trust and The Nature Conservancy, and major areas along the middle Skagit are being restored by the Skagit Fisheries Enhancement Group and SRSC. The SRSC has been reducing the impacts of bank armoring on foraging, migration, and overwintering habitats in the Sauk River by acquiring lands and subsequently removing riprap (USFWS 2008a, p. 12). Additionally, the severity of downstream fish passage impacts at Upper Baker Dam have been reduced (USFWS 2008a, p. 9) and work to upgrade the upstream adult trap and haul facility at the Lower Baker Dam has been completed.

Climate change is expected to negatively affect the Lower Skagit core area (USFWS 2008a, p. 19). Climate change is expected to result in higher water temperatures, lower spawning flows, and increased magnitude of winter peak flows (Battin et al. 2007 in USFWS 2008a, p. 19; Lee and Hamlet 2011). Glacial retreat, snowpack reduction, bluff erosion, landslides, and increased peak flows, are expected to result in increased rates of aggradation downstream (Lee and Hamlet 2011, p. 128-131). Higher peak flows and increased aggradation may increase redd scour and smothering, resulting in mortality to eggs, incubating embryos, and pre-emergent juveniles. The unusually low summer flows and record flood events in the mid-2000's, which are believed to be a primary contributor to basin-wide declines in bull trout abundance, may be an indicator of how climate change may affect bull trout in the Lower Skagit core area (USFWS 2008a, p. 19).

<u>Threats</u>

There are five primary threats to bull trout in the Lower Skagit core area (USFWS 2015b, pp. A-11 to A-12):

Upland/Riparian Land Management: Legacy Forest Management. Associated sediment impacts, particularly from forest roads, have led to habitat degradation within key spawning and rearing basins (i.e., Sauk and Suiattle Rivers) in the core area.

Instream Impacts: Flood Control. Flood and erosion control associated with agricultural practices, transportation corridors, residential development and urbanization continues to result in poor structural complexity within lower river FMO habitats (e.g., Skagit and lower Sauk Rivers) key to the persistence of the anadromous life history form.

*Water Quality: Agriculture Practices and Residential Development and Urbaniza*tion. Related activities have resulted in sediment and temperature impairment in major tributaries to the lower Skagit River and possibly upper Sauk River

Water Quality: Climate Change. Increasing variability in flows (higher peak and lower base flows) are anticipated to significantly impact both spatial and life history diversity of bull trout within the core area.

Connectivity Impairment: Fish Passage Issues. Upstream and downstream connectivity at hydropower facilities (i.e., Baker River hydropower project) is directly tied to active fish passage measures under the 2004 Settlement Agreement and 2008 Federal Energy Regulatory Commission license renewal.

Additional threats to the Lower Skagit core area bull trout population include the following:

- Operations of the Lower Baker Dam occasionally have significantly affected water quantity in the lower Baker and Skagit Rivers.

- Estuarine nearshore foraging habitats have been, and continue to be, negatively affected by agricultural practices and development activities. In addition, declines in forage fish species, particularly surf smelt and Pacific herring, in the marine nearshore areas of the Salish Sea (Therriault et al. 2009; Greene et al. 2015) have resulted in part from degradation of habitats including natural beaches and eel-grass beds, and from water pollution impacts. Anadromous bull trout feed heavily on these species in nearshore areas (Goetz et al. 2004, pp. 109-112). Declines in marine nearshore habitat quality and prey resources may limit the abundance of the anadromous life history form.

- Declines in abundance of anadromous salmonids have reduced the bull trout forage base and may limit the abundance and productivity of the core area's bull trout populations (USFWS 2008a, p. 15). Anadromous salmonids are vital to Lower Skagit core area bull trout because they provide an abundant forage resource. However, the abundance of many species of anadromous salmonids in the Lower Skagit core area has been in decline for a decade (chum salmon, *Oncorhynchus keta*) or more (Chinook salmon, *O. tshawytscha*, and steelhead trout, *O. mykiss*) (WDFW 2015). Bull trout abundance and growth rates are positively correlated with abundance of spawning anadromous salmonids in the Lower Skagit core area (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30) and elsewhere (Copeland and Meyer 2011, pp. 937-938). Such correlations have been observed for other species as well (Bentley et al. 2012; Nelson and Reynolds 2014). Anadromous salmonids provide a direct forage resource via eggs and juveniles, which make up a substantial proportion of the bull trout diet (Lowery and Beauchamp 2015). Spawning fish and carcasses also stimulate ecosystem productivity, thereby increasing abundance of aquatic invertebrates and resident fishes (e.g., Cederholm et al. 1999; Moore et al. 2008; Copeland and Meyer 2011; Rinella et al. 2012). Aquatic invertebrates and resident fishes are also important components of the Lower Skagit core area bull trout diet (Lowery and Beauchamp 2015).

LITERATURE CITED

Bentley, K.T., D.E. Schindler, J.B. Armstrong, R. Zhang, C.P. Ruff, and P.J. Lisi. 2012. Foraging and growth responses of stream-dwelling fishes to inter-annual variation in a pulsed resource subsidy. Ecosphere 3(12):1-17. http://dx.doi.org/10.1890/ES12-00231.1

Brenkman, S.J., S.C. Corbett, and E.C. Volk. 2007. Use of otolith chemistry and radiotelemetry to determine age-specific migratory patterns of anadromous bull trout in the Hoh River, Washington. Transactions of the American Fisheries Society 136:1-11.

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: Essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24:6-15.

Copeland, T., and K.A. Meyer. 2011. Interspecies synchrony in salmonid densities associated with large-scale bioclimatic conditions in central Idaho. Transactions of the American Fisheries Society 140:928-942.

Downen, M.R. 2009. 2008 Skagit bull trout monitoring program annual report. Washington Department of Fish and Wildlife, 2009. 4 pp.

Fowler, A. 2012. 2011 Skagit, Stillaguamish, and North Fork Skykomish Rivers bull trout monitoring report. Washington Department of Fish and Wildlife, La Connor, Washington. 13 pp.

Goetz, F.A., E. Jeanes, and E. Beamer. 2004. Bull Trout in the Nearshore. Preliminary Draft Report. U.S. Army Corps of Engineers, Seattle, WA.

Greene, C., L. Kuehne, C. Rice, K. Fresh, and D. Penttila. 2015. Forty years of change in forage fish and jellyfish abundance across greater Puget Sound, Washington (USA): anthropogenic and climate associations. Marine Ecology Progress Series 525:153-170.

Kraemer, C. 2001. Draft: Puget Sound bull trout core areas - lower Skagit core area. Washington Department of Fish and Wildlife, Olympia, WA, July 31, 2001. 8 pp.

Kraemer, C. 2003. Lower skagit bull trout age and growth information developed from scales collected from anadromous and fluvial char. Management Brief. Washington Department of Fish and Wildlife, Olympia, WA.

Lee, S., and A.F. Hamlet. 2011. Skagit River Basin Climate Science Report. Summary report prepared for Skagit County and the Envision Skagit Project by the Department of Civil and Environmental Engineering and The Climate Impacts Group, University of Washington.

Lowery, E.D., and D.A. Beauchamp. 2015. Trophic Ontogeny of Fluvial Bull Trout and Seasonal Predation on Pacific Salmon in a Riverine Food Web. Transactions of the American Fisheries Society 144:724-741, DOI:10.1080/00028487.2015.1035452.

Moore, J.W., D.E. Schindler, C.P. Ruff. 2008. Habitat saturation drives thresholds in stream subsidies. Ebcology 89:306-312.

Nelson, M.C., and J.D. Reynolds. 2014. Time-Delayed Subsidies: Interspecies Population Effects in Salmon. PLoS ONE 9(6): e98951. doi:10.1371/journal.pone.0098951.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-302, Ogden, Utah, September 1993. 38 pp.

Rinella, D.J., M.S. Wipfli, C.A. Stricker, R.A. Heintz, and M.J. Rinella. 2012. Pacific salmon (Oncorhynchus spp.) runs and consumer fitmess: growth and energy storage in stream-dwelling salmonids increase with salmon spawner density. Canadian Journal of Fsiheries and Aquatic Sciences 69:73-84.

Therriault, T.W., D.E. Hay, and J.F. Schweigert. 2009. Biologic overview and trends in pelagic forage fish abundance in the Salish Sea (Strait of Georgia, British Columbia). Marine Ornithology 37: 3-8.

USFWS. 2004. Draft Recovery Plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*). Volume I: Puget Sound Management Unit, 389+xvii pp and Volume II: Olympic Peninsula Management Unit, 277+xvi pp, Portland, Oregon.

USFWS. 2008a. Bull trout core area templates - an unpublished compilation of updated bull trout core area analysis to support the five-year review. Lower Skagit River Core Area Chapter. U.S. Fish and Wildlife Service, Portland, OR, August 24, 2008..

USFWS. 2008b. Bull Trout (Salvelinus confluentus) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Portland, OR. 53 pp.

USFWS. 2015a. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*). Portland, OR. xii + 179 pp.

USFWS. 2015b. Coastal Recovery Unit Implementation Plan for Bull Trout (*Salvelinus confluentus*). Lacey, WA and Portland, OR.

WDFW (Washington Department of Fish and Wildlife). 2015. Salmon Conservation Reporting Engine, Skykomish Bull Trout. Olympia, WA. https://fortress.wa.gov/dfw/score/score/species/species.jsp. Accessed October 1, 2015.

WDOE. 2008. Lower Skagit River tributaries temperature total maximum daily load. Water quality improvement report. Water Quality Program, WDOE, Publication No. 08-10-020, Bellevue, Washington, July 2008. 252 pp.

Zimmerman, M., and C. Kinsel. 2010, Migration of Anadromous Juvenile Bull Trout in the Skagit River, 1990-2009. Report FPT 11-01. Washington Department of Fish and Wildlife, Olympia, WA.