United States Department of the Interior
FISH AND WILDLIFE SERVICE
Washington Fish and Wildlife Office
510 Desmond Dr. S.E., Suite 102
Lacey, Washington 98503

In Reply Refer To:
01EWFW00-2020-F-1607

Allyson Purcell
National Marine Fisheries Service
Sustainable Fisheries Division
1201 NE Lloyd Blvd, Suite 1100
Portland, Oregon 97232

Dear Ms. Purcell:

Subject: Operation and Maintenance of the Sunset Falls Trap-and-Haul Facility and Integrated Skykomish River Summer Steelhead Program

This letter transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) addressing the proposed Operation and Maintenance of the Sunset Falls Trap-and-Haul Facility, and Integrated Skykomish River Summer Steelhead (*Oncorhynchus mykiss*) Program, located in Snohomish County, Washington, and its effects on bull trout (*Salvelinus confluentus*) and designated bull trout critical habitat. 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 August 25, 2020, request for formal consultation was received on August 28, 2020.

The enclosed Opinion is based on information provided in the August 25, 2020, Biological Assessment, email messages, video conversations, and other sources of information cited in the Opinion. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington. An electronic copy of this Opinion will be available to the public approximately 14 days after it is finalized and signed. A list of Opinions completed by the Service since October 1, 2017, can be found on the Environmental Conservation Online System (ECOS) website at https://ecos.fws.gov/ecp/report/biological-opinion.html.

The Biological Assessment also included a request for Service concurrence with a "not likely to adversely affect" determination for certain listed resources. The enclosed document includes a section separate from the Opinion that addresses your concurrence request. We included a concurrence for marbled murrelet (*Brachyramphus marmoratus*). The rationale for this concurrence is included in the concurrence section.

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 Ryan McReynolds (ryan_mcreynolds@fws.gov) or Curtis Tanner (curtis_tanner@fws.gov).

Sincerely,

CURTIS TANNER

Digitally signed by CURTIS TANNER
Date: 2021.04.12 13:34:03 -07'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Enclosure(s)

cc:
NMFS, Lacey, WA, (S. Sebring)
NMFS, Lacey, WA, (M. Celedonia)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2020-F-1607

Sunset Falls Trap-and-Haul Facility and Integrated Skykomish River Summer Steelhead Program

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

CURTIS TANNER

Digitally signed by CURTIS TANNER
Date: 2021.04.12 13:34:25 -07'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Date

TABLE OF CONTENTS

TABLE OF CONTENTS

Appendices

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
Act	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
FHS	Fish Health Specialist
FMO	Foraging, Migration and Overwintering
FR	Federal Register
GPS	Global Positioning System
km	kilometer
mm	millimeter
NF	North Fork
NMFS	National Marine Fisheries Service
no.	number
Opinion	Biological Opinion
PBF	Physical and Biological Feature
PCE	Primary Constituent Element
RM	river mile
RPM	Reasonable and Prudent Measures
Service	U.S. Fish and Wildlife Service
SF	South Fork
SFF	Sunset Falls Trap-and-Haul Fishway Facility
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife

(This page intentionally left blank)

1 INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) and concurrence based on our review of the proposed Operation and Maintenance of the Sunset Falls Trap-and-Haul Fishway Facility (SFF), and Integrated Skykomish River Summer Steelhead (*Oncorhynchus mykiss*) Program, located in Snohomish County, Washington. The Opinion addresses effects to bull trout (*Salvelinus confluentus*) and designated bull trout critical habitat in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). A separate concurrence section addresses effects to marbled murrelet (*Brachyramphus marmoratus*). Your August 25, 2020, request for formal consultation was received on August 28, 2020.

This Opinion is based on information provided in the August 25, 2020, Biological Assessment, email messages, video conversations, and other sources of information as detailed below. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

2 CONSULTATION HISTORY

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

- The Biological Assessment was received on August 28, 2020.
- Additional information necessary to initiate consultation was received on October 9, 2020, and January 6, 2021.
- Formal consultation was initiated on January 6, 2021.
- A copy of the draft Opinion was provided to the National Marine Fisheries Service (NMFS) on March 26, 2021.
- Comments were received from the NMFS and Washington State Department of Fish and Wildlife (WDFW) on April 2, 2021.

3 CONCURRENCE

3.1 Marbled Murrelet

The marbled murrelet was listed as a threatened species in Washington, Oregon, and California in 1992 under the Act. The primary reasons for listing included extensive loss and fragmentation of the old-growth forests which serve as nesting habitat for marbled murrelets, and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992]). Although some threats such as gillnet mortality and loss of nesting habitat on federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (USFWS 2019, p. 65).

The action area for this proposed federal action is based on the geographic extent of the Snohomish River basin, including the Skykomish River and its tributaries, and the mainstem Snohomish River. Specifically, the action area includes the SFF on the South Fork (SF) Skykomish River, facilities on the mainstem Skykomish River where summer steelhead will be reared and released (i.e., Reiter Ponds and Wallace River Hatchery), the North Fork (NF) Skykomish River where summer steelhead will be outplanted, and locations throughout the larger Snohomish River basin where hatchery-origin, native summer steelhead are likely to become established.

The SFF and two hatchery facilities are surrounded by open fields, residential developments, roads, and second-growth forest. The NF Skykomish River basin is predominantly second-growth forest with mature forest stands on steep hillslopes (typically at least 0.20 mile from the valley floor), and large portions of the valley held in private ownership and used for timber harvesting. Based on habitat suitability modeling (Raphael et al. 2016), there may be areas of "moderately high quality" nesting habitat within the NF and SF Skykomish River basins, where WDFW proposes (respectively) to outplant summer steelhead from the integrated program and truck transport native species upriver around the series of impassable falls.

Operations at the two hatchery facilities generally occur between the hours of 8 am and 5 pm. Noise-generating activities may include grounds maintenance (e.g., lawn mowing and trimming), operation of personal motor vehicles, chainsaws, generators, heavy equipment, and other machinery. Such activities, when conducted greater than 110 yards (330 ft) from suitable habitat where marbled murrelets may be nesting, are not expected to result in adverse effects (USFWS 2015a). Marbled murrelets that nest at distances greater than 110 yards (330 ft) from these noise-generating activities are expected to exhibit only mild behavioral responses, such as head-turning or increased vigilance for short periods (USFWS 2015a). These minor behavioral responses are considered to have insignificant effects to nesting marbled murrelets.

Sound levels from routine hatchery activities, trap-and-haul operations, and vehicular traffic (i.e., during fish transport and release) are very similar to the surrounding background levels and will not substantially exceed background levels in the adjacent forest stands. We do not expect sound levels generated from the proposed action to measurably exceed background levels in suitable marbled murrelet nesting habitat. And, the proposed action will not remove or alter suitable marbled murrelet nesting habitat. Temporary exposures and effects are not expected to measurably disrupt normal marbled murrelet behaviors (i.e., the ability to successfully feed, move, and/or shelter), and the foreseeable effects of the proposed action are therefore considered insignificant.

4 BIOLOGICAL OPINION

5 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).

There are three distinct but inter-related elements to this proposed action and consultation: (1) Operation and maintenance of the SFF, (2) a new, integrated Skykomish River summer steelhead hatchery program, and (3) the NF Skykomish River steelhead outplant program. The SFF, in operation on the SF Skykomish River since 1958, transports fish (including bull trout) via tank truck a distance of 11 miles upriver around a series of three large, impassable cascades (i.e., Sunset Falls, Canyon Falls, and Eagle Falls) to access upriver habitat. The NMFS proposes to reissue WDFW's expiring Section 10(a)(1)(A) incidental take permit for enhancement purposes, and operations of the SFF require take coverage for trapping and relocating bull trout from the SFF upriver on the SF Skykomish River. The WDFW also proposes, and NMFS will authorize WDFW, (1) to trap and transport native summer steelhead for purposes of Skykomish River hatchery facility broodstock, and (2) to transport and outplant native summer steelhead in the NF Skykomish River. This Opinion addresses all three elements of the proposed action in the subsequent sections.

5.1 Sunset Falls Trap-and-Haul Fishway Facility

The SFF is a combination vertical slot fishway and trap-and-haul complex located at the base of Sunset Falls on the SF Skykomish River, approximately 1.8 miles (3 km) upriver of the confluence of the NF and SF Skykomish Rivers near the town of Index, Washington. Since 2000, incidental take coverage for bull trout was provided for activities under Section 6(c) of the Act, including SFF operations, through a Section 6 Cooperative Agreement between the Service and WDFW. On February 24, 2020, a new Section 6 Cooperative Agreement was issued, which no longer provides incidental take coverage for Section 6(c) activities. Therefore, the NMFS and WDFW seek take coverage for bull trout and SFF operations by way of this Opinion.

WDFW proposes to operate the SFF five days per week from approximately July 1 to January 1, depending on when fish begin arriving at the facility and when river conditions allow access to the SFF and release location(s). Fish voluntarily enter the SFF, are captured, transported by tank truck, and released 3.6 miles (6 km) upriver of three large, impassable cascades (i.e., Sunset Falls, Canyon Falls, and Eagle Falls), providing an additional 87 linear miles (145 kilometers) of habitat. Chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), pink (*O. gorbuscha*), chum (*O. keta*), and sockeye salmon (*O. nerka*); steelhead; mountain whitefish (*Prosopium williamsoni*); and bull trout are transported upriver (Table 1).

Fish enter through a series of stepped pools into a holding tank and are held there until they can be sorted by species. After sorting, fish either volitionally swim or are moved via dip net from the holding area to the brail (method depending upon species composition within the holding area). From the brail, they are transferred (via water-to-water transfer) to a tank truck fitted with water recirculation and oxygenation equipment. No more than 25 adult salmonids are transported at a time to reduce stress. Fish are transported upriver at least once daily; more frequently depending upon fish numbers. The total drive time is approximately 20 minutes. Upon release, fish are monitored for signs of stress.

Table 1. Numbers of salmonids collected annually at the SFF, 1994-2020. Annual sums exclude early-returning ‘jack’ salmon.

Year	Bull trout	Chinook salmon	Chum salmon	Coho salmon	Cutthroat trout	Pink salmon	Sockeye salmon	Steelhead
1994	18	531	42	32,607	13	0	12	1,647
1995	40	892	52	18,925	3	12,690	8	745
1996	45	754	261	17,395	0	0	10	1,232
1997	42	699	22	15,152	3	1,988	14	883
1998	47	550	29	21,695	0	0	19	1,145
1999	45	530	45	12,839	0	962	4	716
2000	51	712	52	23,726	1	1	9	2,052
2001	63	1,119	345	50,434	1	12,475	22	2,072
2002	90	765	387	44,152	1	0	21	1,491
2003	92	889	133	31,443	0	18,857	13	1,176
2004	128	675	599	40,704	4	0	51	1,158
2005	103	523	62	23,208	1	17,596	18	578
2006	99	603	11	8,521	0	0	20	701
2007	53	588	126	28,581	3	41,172	17	364
2008	68	707	141	8,982	2	1	16	398
2009	52	250	19	25,038	1	98,195	21	506
2010	97	399	25	8,889	0	2	53	483
2011	60	318	10	27,916	1	23,645	37	430
2012	55	414	27	20,724	1	1	35	717
2013	46	157	45	20,887	2	54,657	14	833
2014	67	344	21	11,278	1	4	41	613
2015	23	498	1	6,507	1	17,297	8	734
2016	34	280	43	12,947	1	1	29	677
2017	9	269	0	4,231	0	1,205	94	431
2018	10	97	0	10,734	0	0	51	348
2019[a]	13	294	0	10,005	0	734	8	274
2020[a]	16	400	0	8,206	0	0	33	133
Mean (2011-2020)	**33**	**307**	**15**	**13,344**	**1**	**19,508[b]**	**35**	**519**

[a] Preliminary
[b] Only odd years used in calculation

Steelhead will be utilized in the following ways: (1) released into the upper SF Skykomish River basin (discussed above), (2) included as adult broodstock for the hatcheries (see Section 5.2), and (3) outplanted into the NF Skykomish River (see Section 5.3). Outplanted native, summer steelhead will either originate from the SFF or a Skykomish River hatchery. WDFW will sort steelhead depending upon their destination, with individuals targeted for broodstock or outplanting moved first. From 2007 through 2018, natural origin summer-run steelhead returns at the SFF have averaged 306 adults annually (Table 2).

Table 2. Numbers of unmarked, natural origin summer steelhead collected annually at the SFF.

Year	Number of summer steelhead
2007	235
2008	282
2009	311
2010	369
2011	307
2012	592
2013	407
2014	284
2015	235
2016	261
2017	164
2018	221
Mean	**306**

5.2 Integrated Skykomish River Summer Steelhead Hatchery Program

Most aspects of the proposed summer steelhead hatchery program have recently been consulted on by the Service in two related Section 7 consultations with NMFS:

> *Snohomish River Early Winter Steelhead Hatchery Program*; consultation completed in 2016 (FWS Ref. 01EWFW00-2016-I-0500 and 01EWFW00-2016-I-0511); and,
>
> *NMFS 4(d) Rule Determination for WDFW and Tulalip Tribes Salmon Hatchery Operations in the Snohomish River Watershed*; consultation completed in 2017 (FWS Ref. 01EWFW00-2015-F-0120).

The 2016 and 2017 consultations addressed hatchery facility operations where summer steelhead broodstock will be collected (Sunset Falls excepted) and where juveniles will be reared (discussed in more detail below). Aspects of the proposed integrated summer steelhead hatchery program not included in the 2016 and 2017 consultations are:

1. Additional water withdrawals at Reiter Ponds, specifically for the summer steelhead program.

2. Ecological effects resulting from the release of juvenile summer steelhead into the Skykomish River. And,

3. Ecological effects resulting from outplant of adult hatchery-origin, native summer steelhead into the NF Skykomish River (discussed further in Section 5.3).

The 2016 and 2017 consultations addressed effects to listed species and designated critical habitat under Service jurisdiction resulting from operations at the Wallace River Hatchery and Reiter Ponds, including broodstock collection (i.e., weirs, traps, and collection ponds); hatchery water withdrawals and associated water diversion and intake structures; and effluent discharges. The integrated summer steelhead hatchery program will operate with these same facilities, and proposed operations for the integrated summer steelhead hatchery program are consistent with those that were described and evaluated in the 2016 and 2017 consultations (other than water withdrawals at Reiter Ponds). The final rearing and release of hatchery, native summer-run steelhead will be conducted at Reiter Ponds. New hatchery actions will use the same weirs, traps, and collection ponds over the same time periods evaluated in the 2016 and 2017 consultations; therefore, no additional effects are expected.

The co-managers (WDFW and Tulalip Tribes) and the NMFS (federal action agency) propose a new integrated summer-run steelhead broodstock using locally adapted summer steelhead to replace out-of-basin, legacy Skamania River broodstock. New individuals will be integrated into the hatchery broodstock in subsequent years to maintain diversity and prevent genetic drift into an isolated broodstock. During the initial four years of the program, the co-managers will establish the new broodstock by gathering no more than 30 percent of the total natural-origin recruits returning to the SFF (Table 3). Once hatchery returns are established and sufficient numbers of adult steelhead return to the SFF, the co-managers propose to integrate this broodstock with hatchery-origin fish that return to Reiter Ponds, SFF, or Wallace River Hatchery. The following sections summarize information from the proposed Hatchery Genetic Management Plan (WDFW 2019a).

Table 3. Planned native summer-run steelhead releases, broodstock collection, and outplants by WDFW in the Skykomish River (Snohomish County, WA).

Year	Juvenile Steelhead Hatchery Releases	Adult Steelhead Broodstock	Adult Steelhead Outplanted to NF Skykomish River[a]
2021	56,000	120 or maximum of 30%	0
2022	76,000	120 or maximum of 30%	0
2023	116,000	120 or maximum of 30%	0
2024	116,000	120 or maximum of 30%	0
2025	116,000	As needed	maximum of 250
2026	116,000	As needed	maximum of 250
2027	116,000	As needed	maximum of 250
2028	116,000	As needed	maximum of 250
2029	116,000	As needed	maximum of 250
2030	116,000	As needed	maximum of 250
2031	116,000	As needed	maximum of 250
2032	116,000	As needed	maximum of 250
2033	116,000 (in perpetuity)	As needed (in perpetuity)	0

[a] Steelhead outplant will occur over an eight-year duration and is currently scheduled for 2025 through 2032.

Broodstock Collection and Spawning – The co-managers propose to establish broodstock for this new integrated summer steelhead hatchery program by collecting unmarked natural-origin summer steelhead over the realized run timing returns to the SFF. During the first four years of the program (2021 through 2024), the co-managers will collect natural-origin summer steelhead for broodstock, to a maximum of 30 percent of the individuals (or 120 adults) returning to Sunset Falls (Table 3). The co-managers anticipate that this number of steelhead will be sufficient to achieve its full broodstock collection, egg take, and release goals while also ensuring no significant impact to the steelhead populations of the SF Skykomish River. Over an eight-year duration (currently scheduled for 2025 through 2032), the co-managers will collect up to 250 native summer-run steelhead adults returning to Sunset Falls annually, and will outplant these steelhead to the NF Skykomish River (Table 3; discussed further in Section 5.3).

Rearing and Release – The co-managers will begin the program in 2021 by releasing 56,000 juveniles in the first year, 76,000 juveniles in 2022, and 116,000 juveniles in 2023 and annually thereafter (Table 3). Fish will be reared and released from Reiter Ponds with the Wallace River Hatchery as an alternate location. One-year old smolts (approximately 165-180 millimeters in length) will be volitionally released from April 15 to May 21 annually. Fish that do not outmigrate during the first year may be retained and released from the hatchery the subsequent year as two-year old smolts (approximately 190-220 mm upon release). If these individuals do not leave the hatchery ponds during the second year, the co-managers will consider these fish non-migratory freshwater residents and will release them into landlocked lakes.

The co-managers propose to rear and release fish at the hatchery facilities according to practices and operations described in the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006) (hereafter referred to as Disease Control Policy). This will be done to maintain the overall health of the broodstock and to minimize the chance introduction and/or spread of any diseases at the hatchery facilities.

5.3 NF Skykomish River Steelhead Outplant

The co-managers propose to improve native steelhead conservation efforts by outplanting adult, summer steelhead into the NF Skykomish River annually over an eight-year duration (currently scheduled for 2025 through 2032). No more than 250 steelhead adults would be outplanted annually, to approximate an equal ratio of bull trout to steelhead. These numbers are based upon 20 years of redd survey data from the NF Skykomish River (WDFW 2020). The exact location and timing of the adult steelhead outplants is yet to be determined but will be based upon road access. Regardless of outplant location and timing, the outplanted native summer steelhead will have access to most of the watershed available to bull trout.

The outplant program will include research, monitoring, and evaluation to document native steelhead supplementation program effects upon bull trout recovery in the NF Skykomish River. To document impacts, redd surveys will be conducted annually, when flow and weather conditions allow, for bull trout spawning activity in the NF Skykomish River (from RM 13.1 to 19.0) and Goblin Creek. Further monitoring activities may be conducted to assess integrated summer steelhead program effectiveness and the effects of the program upon bull trout.

5.4 Conservation Measures

The co-managers (WDFW and Tulalip Tribes) and the NMFS (federal action agency) propose the following practices to minimize the intensity, duration, or magnitude of the effects to bull trout:

- Biologists will use a soft mesh sanctuary net to minimize handling stress when manual transfer of fish is necessary.
- The co-managers will increase genetic diversity by collecting broodstock summer steelhead throughout the return or spawning period in proportions approximating the timing and age distribution of the population.
- The co-managers have agreed to return no less than 70 percent of natural-origin adult steelhead to the Skykomish River, to retain the wild origin characteristics.
- To minimize likelihood of harm to natural-origin fish, the co-managers will operate hatcheries in accordance with water rights and 'Upland Fin-Fish Hatching and Rearing' permits (permits WAG13-3005 and WAG13-3006) administered by the Washington Department of Ecology.
- Natural-origin fish will be used to found and integrate broodstock; fish health best management practices will follow the Disease Control Policy.
- Fish health is monitored daily by hatchery staff and at least monthly by a State Fish Health Specialist (FHS). Hatchery personnel will carry out treatments prescribed by the FHS consistent with the Disease Control Policy.
- WDFW Fish Health Section pathologists will monitor fish health monthly. Hatchery technicians will examine fish at each life stage, may conduct tests for infectious viruses, bacteria, and parasites, and will examine gross pathology or signs of clinical disease. The program is operated consistent with the Disease Control Policy.
- The co-managers will distribute surplus carcasses for nutrient supplementation according to Disease Control Policy guidelines. WDFW will monitor for specific fish pathogens through eggs/fish movements in accordance with the Disease Control Policy.

5.5 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 the Snohomish River basin, including the Skykomish River and its tributaries, and the mainstem Snohomish River, where hatchery summer steelhead and bull trout may interact. The action area includes the SFF (Figure 1), facilities where native summer steelhead will be reared and released (i.e., Reiter Ponds and Wallace River Hatchery) (Figures 2 and 3), and locations throughout the larger Snohomish River basin where hatchery-origin, native summer steelhead are likely to become better established (including the NF and SF Skykomish Rivers).

Figure 1. The SFF is located on the SF Skykomish River about 1.8 miles upriver of the confluence with the NF Skykomish River.

Figure 2. The Reiter Ponds facility is located at river mile (RM) 46 on the north side of the mainstem Skykomish River, near Big Bend, WA.

NMFS considered whether the marine areas of Puget Sound and the ocean should be included in the action area. The potential concern is a relationship between hatchery production and density-dependent interactions affecting salmon growth and survival. NMFS determined, that based on the ongoing nature of the hatchery programs, and lack of additional effects associated with transition to native summer steelhead broodstock, we can be reasonably certain that effects resulting from the integrated summer steelhead hatchery program in the Snohomish River watershed may extend into and include brackish tidal habitats of Puget Sound.

The proposed action and its three primary elements are located in the Snohomish/Skykomish River bull trout core area and Coastal Recovery Unit. Sunset Falls is located on the SF Skykomish River about 1.8 miles upriver of the confluence with the NF Skykomish River. The mainstem Skykomish River continues for about 30 miles to its confluence with the Snoqualmie River, which then becomes the Snohomish River for 15 miles before entering Puget Sound near the city of Everett (Figure 3). Reiter Ponds is located about six miles downstream from Sunset Falls on the mainstem Skykomish River at RM 46. The Wallace River Hatchery enters the mainstem Skykomish River at RM 36 (Figure 3).

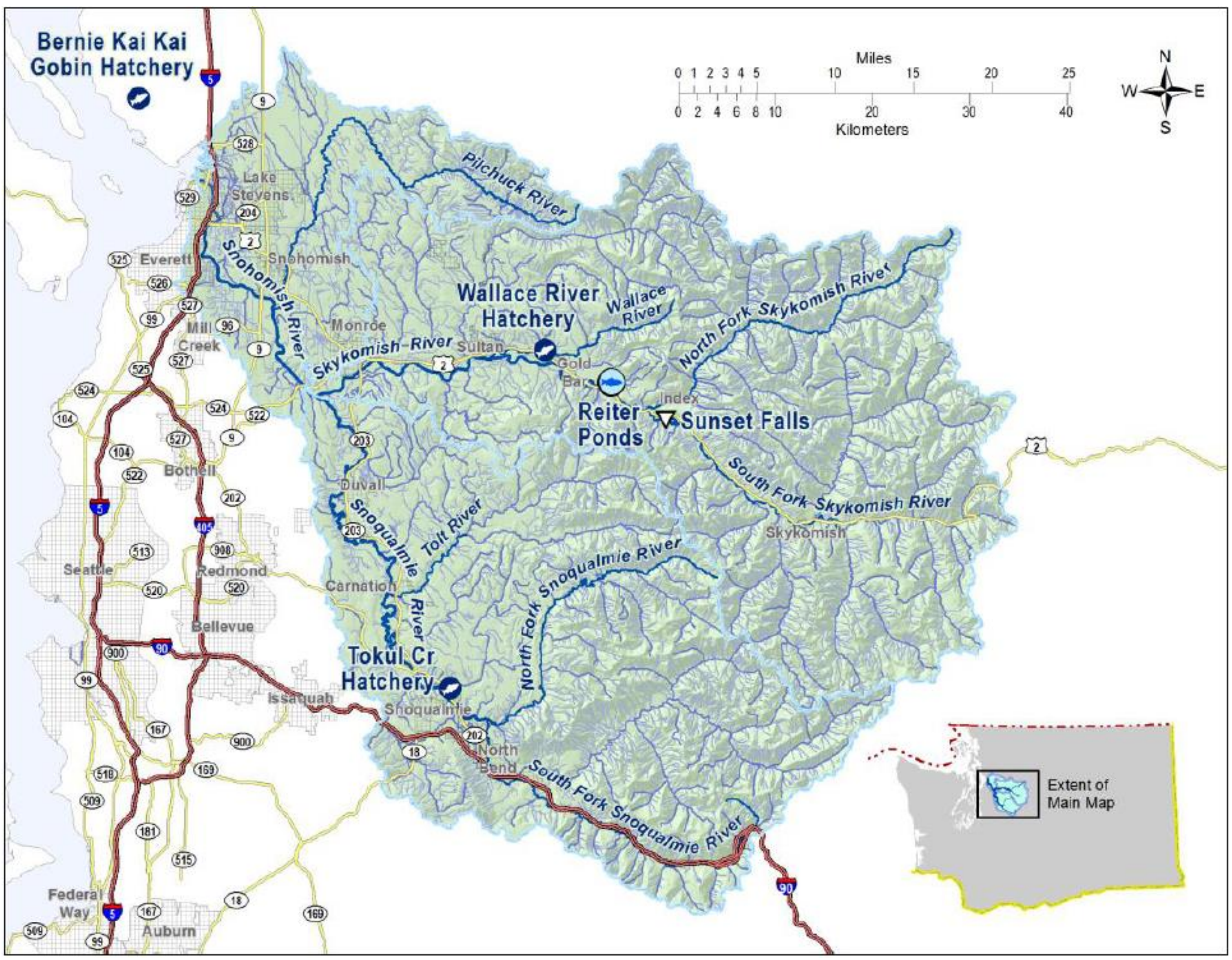

Figure 3. Action area, the Snohomish River watershed.

6 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

6.1 Jeopardy Determination

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

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

2. The *Environmental Baseline*, which evaluates the condition of the species in the action area relative to its reproduction, numbers, and distribution without the consequences of the proposed action, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species;

3. The *Effects of the Action*, which evaluates all future consequences to the species that are reasonably certain to be caused by the proposed action, including the consequences of other activities that are caused by the proposed action, and how those impacts are likely to influence the conservation role of the action area for the species; and

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

In accordance with policy and regulation, the jeopardy determination is made by evaluating the consequences of the proposed federal action in the context of the species' current range-wide status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild. The key to making this finding is clearly establishing the role of the action area in the conservation of the species as a whole, and how the effects of the proposed action, taken together with cumulative effects, are likely to alter that role and the continued existence (i.e., survival) of the species.

6.2 Adverse Modification Determination

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

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

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

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

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

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

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

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

7 STATUS OF THE SPECIES: Bull Trout

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.

8 STATUS OF CRITICAL HABITAT: Bull Trout

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

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

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action.

The environmental baseline includes the past and present impacts of all federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

9.1 Current Condition of the Species and Critical Habitat in the Action Area

The action area completely overlaps the Coastal Recovery Unit's Snohomish/Skykomish River bull trout core area, which supports four local populations of bull trout. The local populations are: 1) NF Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (tributary to the NF Skykomish River; resident form only), 3) Salmon Creek (tributary to the NF Skykomish River), and 4) SF Skykomish River. The Troublesome Creek local bull trout population is isolated upstream of an anadromous barrier. Anadromous, fluvial, and likely resident bull trout from these local populations are present in the action area.

The Snohomish/Skykomish River bull trout 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 upriver of Snoqualmie Falls, upriver of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the NF Skykomish River, or above Alpine Falls on the Tye River. Bull trout did not occur above Sunset Falls on the SF Skykomish River prior to 1958, when the Washington Department of Fisheries (now WDFW) implemented a trap-and-haul program for anadromous salmonids.

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. Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish/Skykomish River core area. 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).

The Snohomish Basin provides important foraging, migrating, and overwintering (FMO) habitat for adult, subadult, and large juvenile bull trout. The topography of the basin limits the amount of spawning and early rearing habitat in comparison with many other bull trout core areas. Bull trout rear throughout most accessible reaches within the basin and extensively use the lower estuary, nearshore marine areas, and Puget Sound for extended rearing.

Local bull trout populations from the Snohomish/Skykomish River core area are considered at "potential risk" for extirpation (USFWS 2008; USFWS 2015b). Since 2008, some of the key status indicators have declined. The status of a bull trout core area 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).

9.1.1 Number and Distribution of Local Bull Trout Populations

Four local populations are recognized within the Snohomish/Skykomish River bull trout core area (USFWS 2004; USFWS 2015b) (Figure 4). Core areas with fewer than five interconnected local populations are at increased risk of local extirpation and adverse effects from random naturally occurring events (USFWS 2004). Three of the four Snohomish/Skykomish River local bull trout populations are interconnected (see Connectivity section below).

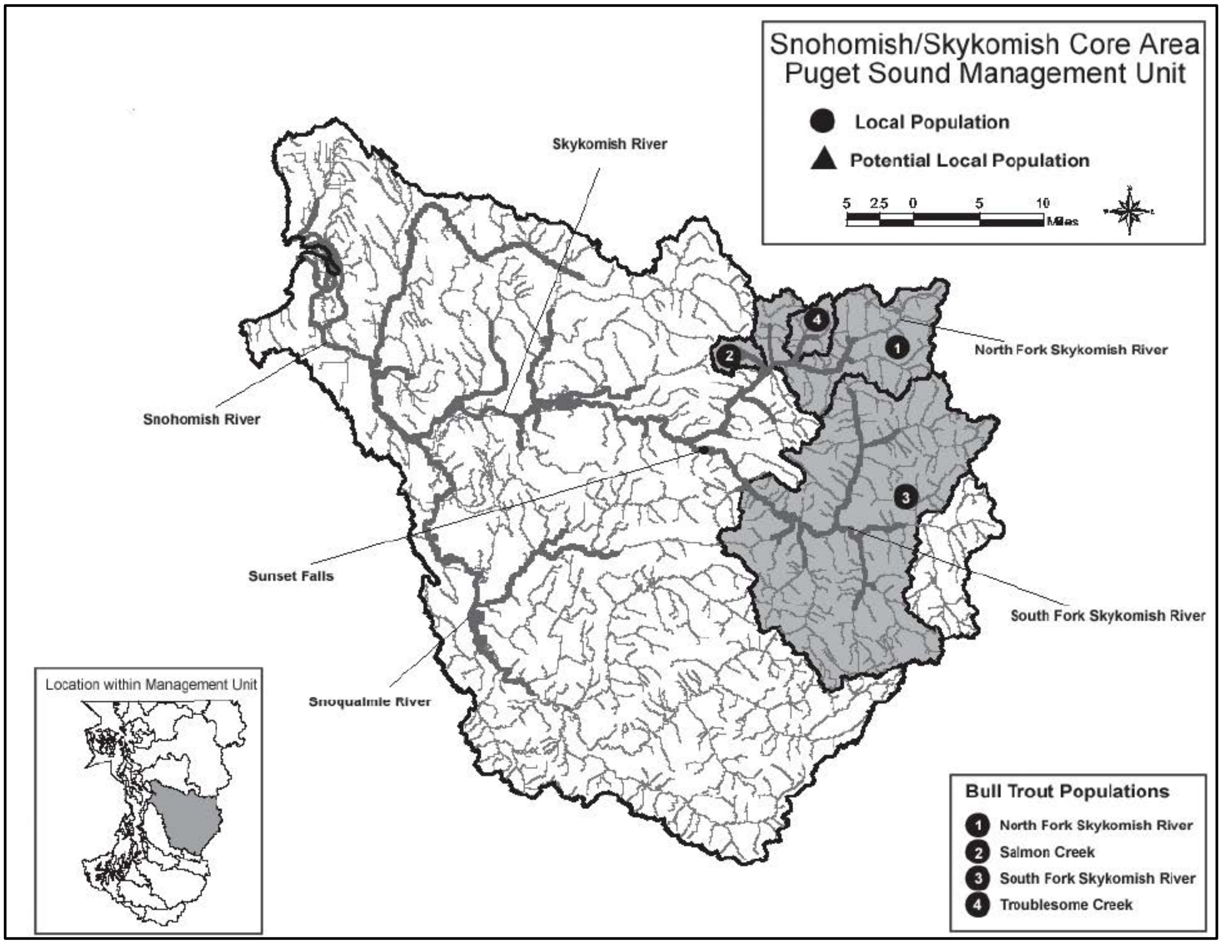

Figure 4. Local bull trout populations in the Snohomish/Skykomish River basin and core area.

9.1.2 Adult Abundance

In 2008, it was believed that the Snohomish/Skykomish River bull trout core area supported approximately 1,000 adults (USFWS 2008). Since then, abundance indices in the two primary local populations (NF Skykomish River and SF Skykomish River) are thought to have substantially declined (WDFW 2019b, Figure 8). From 2008 to 2019, five-year mean counts steadily declined by 80 percent and 56 percent for the SF (adult trap counts) and NF (redd counts) indices, respectively (Figure 5). SF trap counts from 2015 through 2019 are five of the six lowest ever recorded; counts from 2017 through 2019 are the lowest.

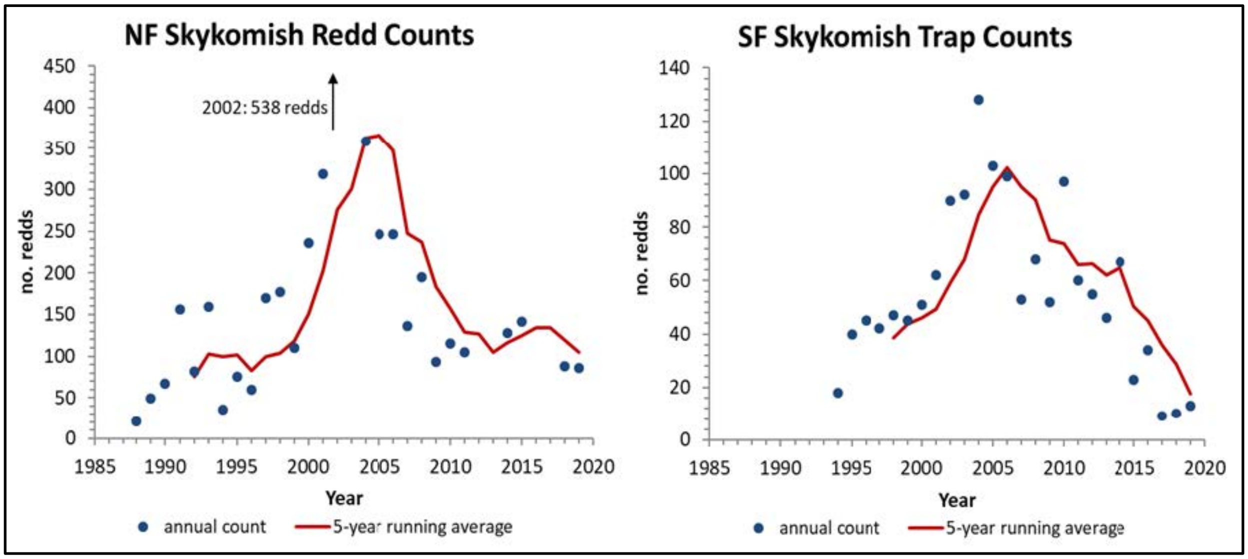

Figure 5. Annual counts and 5-year running averages for bull trout redds in the NF Skykomish River (left), and adult bull trout captured at the SFF on the SF Skykomish River (right).

Recent NF Skykomish River redd counts are not as low as some counts from 1988 through 1996, though it is uncertain how comparable survey effort was for these early years relative to more recent years. SF trap counts and NF redd counts are statistically correlated[1] (Pearson correlation coefficient = 0.64; $r^2 = 0.42$, $p = 0.002$) (Figure 6), suggesting that one or more common factors have likely been affecting each abundance index.

Snorkel survey counts of bull trout in the NF Skykomish River collected by WDFW biologists during 2019 suggest that the number of bull trout utilizing the primary spawning reach upriver of Bear Creek Falls is at minimum between 90 and 109 fish (WDFW 2020). These results are similar to redd surveys of this local population conducted by WDFW in the watershed. The Troublesome Creek local population consists of individuals residing upstream of a natural migration barrier. Adult abundance is unknown for this local population. The Salmon Creek local population is thought to have fewer than 100 adults.

The Snohomish/Skykomish River bull trout core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004). Two local populations (SF Skykomish River and Salmon Creek) are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004). The NF Skykomish River local population is not at risk from inbreeding depression. Risk from inbreeding depression to the Troublesome Creek local population is unknown.

[1] Statistical correlation was evaluated for years 1994–2019. The following years were excluded because survey effort for NF redd counts was not comparable to other years: 2012, 2013, 2016, 2017.

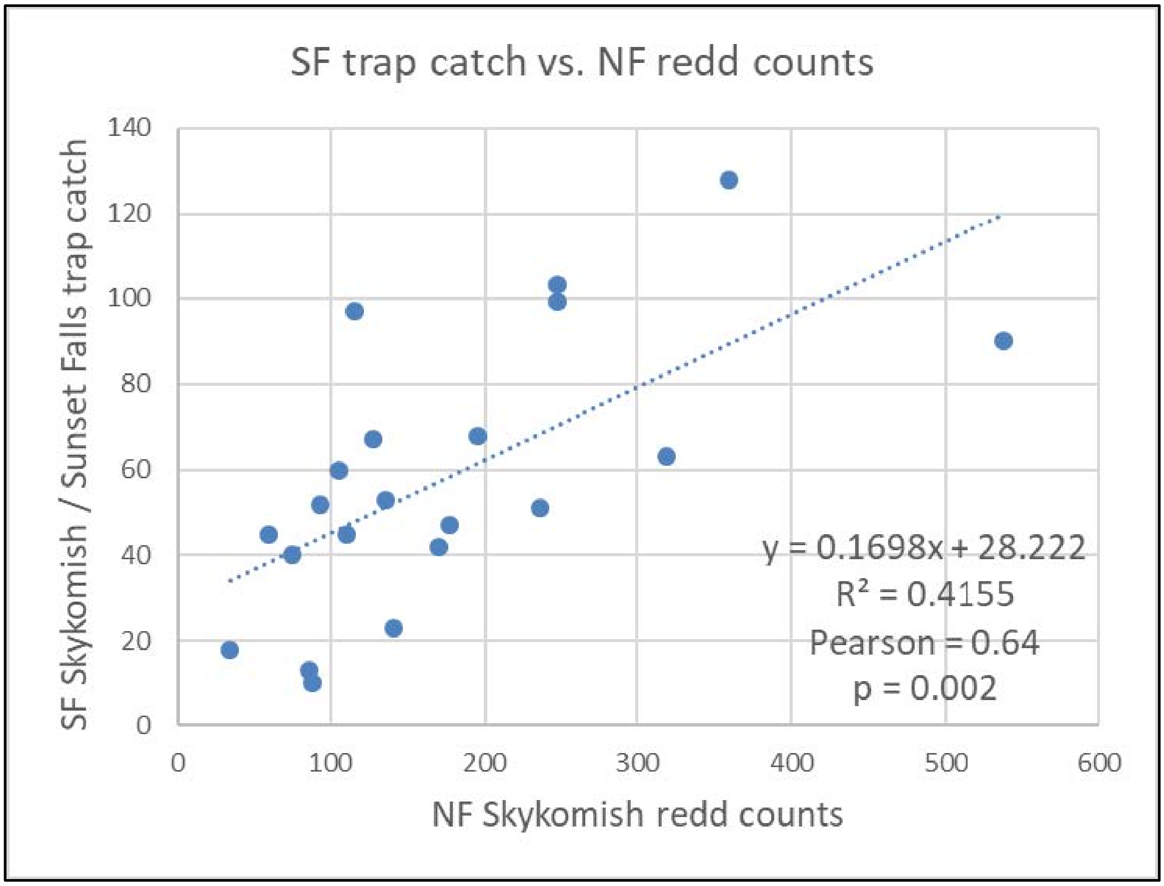

Figure 6. Linear regression estimate of annual catch at the SFF (SF Skykomish River) and annual redd counts in the NF Skykomish River, 1994–2019.

9.1.3 Productivity

Population trends for the two primary local populations (NF Skykomish River and SF Skykomish River) have indicated decline since peaking in the early- to mid-2000's (Figure 5). Long-term redd counts for the NF Skykomish River local population peaked between 2001 and 2004, declined through about 2013, and have been approximately stable since. Recent five-year running averages (104 to 135 redds) have been equivalent to or slightly higher than 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 SF Skykomish River SFF, although counts from 2017 through 2019 are the lowest ever recorded and counts from 2015 through 2019 are five of the six lowest. It is thought that the SF Skykomish River local population was continuing to colonize new spawning and rearing habitat. However, it is uncertain if this remains the case given the very low adult counts in recent years.

Productivity of the Troublesome Creek and Salmon Creek local populations is unknown. Available spawning and early rearing habitats for these local populations are considered to be in good to excellent condition. However, broad basin-wide effects, such as those from climate change, may be having a negative effect on productivity. The Snohomish/Skykomish River bull trout core area is at increased risk of extirpation due to declining productivity (USFWS 2004).

9.1.4 Connectivity

Migratory bull trout occur in three of the four local populations in the Snohomish/Skykomish River bull trout core area (NF Skykomish River, Salmon Creek, and SF 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 SF Skykomish River local population is dependent upon the SFF.

9.1.5 Changes in Environmental Conditions

Since the bull trout listing, federal actions occurring in the Snohomish/Skykomish River bull trout 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/Skykomish River bull trout core area.

The number of non-federal actions occurring in the Snohomish/Skykomish River 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/Skykomish River core area (USFWS 2008). 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). 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 2008). See the Climate Change subsection below for additional information on anticipated effects of climate change on aquatic habitats.

9.1.6 Threats

There are four primary threats to bull trout in the Snohomish/Skykomish River bull trout core area (USFWS 2015b):

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 SF Skykomish River local population is reliant upon continued funding and ongoing operation of the SFF.

Additional threats to the Snohomish/Skykomish River bull trout core area local populations include the following:

- Effects of climate change on freshwater and marine ecosystems will (1) exacerbate effects of habitat loss and degradation and (2) 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.

9.1.7 Factors Responsible for the Condition of Critical Habitat

The Skykomish River mainstem and its tributaries (below the confluence of two major forks near Index) drain 325 square miles, approximately 75 percent of which are forested hills and mountains. The most common land use outside the forests is residential, with extensive agriculture uses in floodplain areas. The NF and SF Skykomish River drain an additional 507 square miles, 98 percent of which are forested. Approximately 29 percent of the watershed is within ownership of the U.S. Forest Service, Mount Baker-Snoqualmie National Forest (Figure 7). More than 150,000 acres of the forested hills and mountains surrounding the NF and SF Skykomish rivers are conserved within the Wild Sky Wilderness Area, although private landownership remains in the valleys and timber harvest occurs within these areas. Residential development along the valley floors constitutes the remainder of land use in this portion of the watershed.

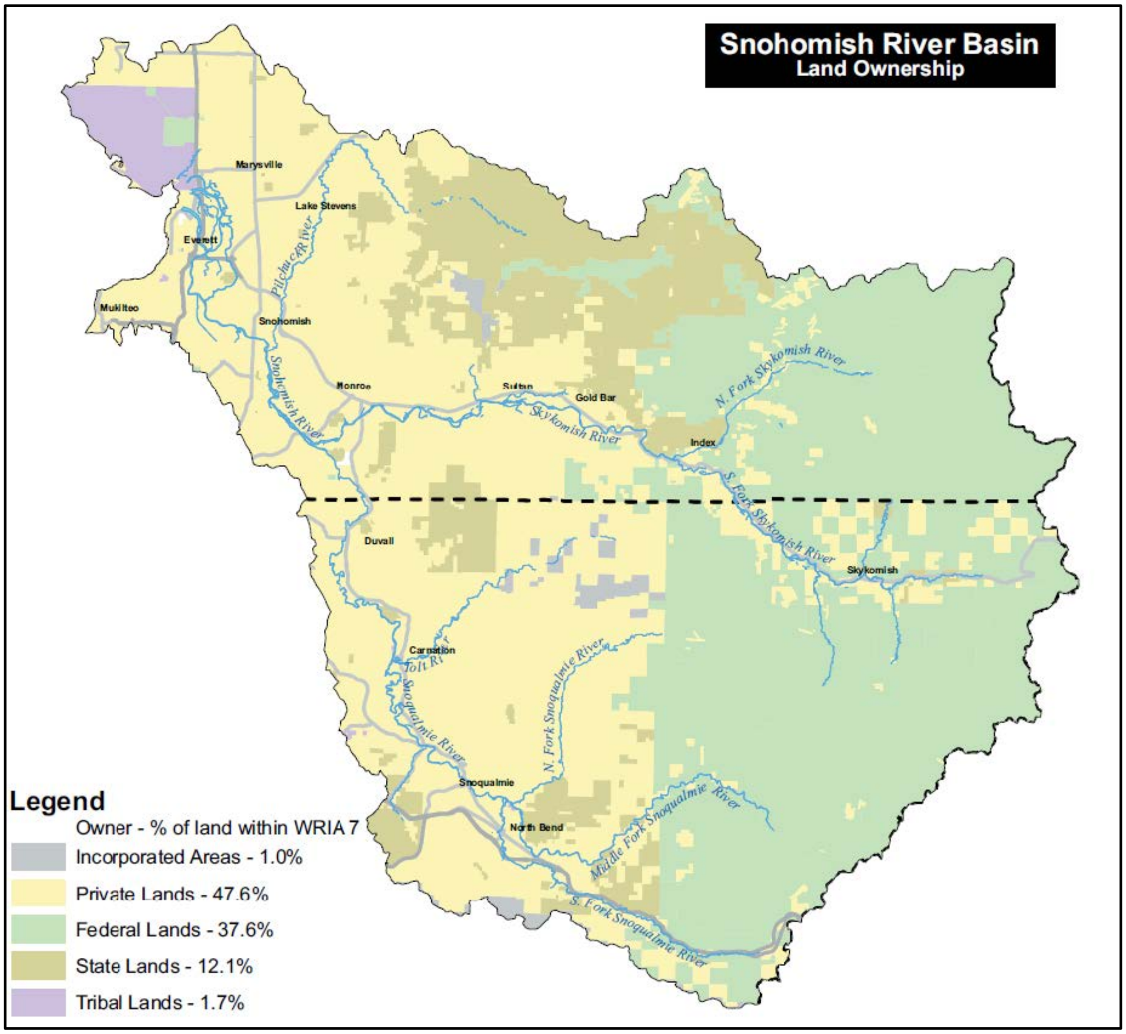

Figure 7. Land ownership in the Snohomish River and NF/SF Skykomish River basins.

Within the Snohomish River basin, the nearshore, estuary, mainstem river, and key tributary salmon habitats have been adversely affected by numerous activities (Snohomish Basin Salmon Recovery Forum 2005). Approximately 70 percent of the Snohomish River basin shoreline has experienced modification and subsequent population declines in plant and animal species important for various salmon life stages.

Sediment delivery and transport, riparian conditions, and intertidal habitat conditions have been extensively modified along the Snohomish nearshore, most notably due to construction of the Burlington Northern/Santa Fe railroad in the 1890s, construction of bulkheads, riprap, and piers in the industrial waterfront, and dredging of berths and the federal navigation channel. The largest habitat impacts in the nearshore result from the railroad and from shoreline armoring needed to protect numerous homes and structures that likely will not be removed. The largest threat to habitat facing the estuary is urbanization near the Interstate-5 highway corridor.

Permanent habitat losses have already occurred and few sites remain undeveloped. Recent infrastructure development has included the expansion of Interstate-5 to include high occupancy vehicle lanes in both directions and larger rights-of-way. There are also dikes and water control structures throughout the estuary that limit the aquatic habitat that is accessible by fish. Dikes, bank armoring, roads, railroads, and bridges confine the mainstem throughout the watershed that disconnects off-channel habitat, reduces edge habitat complexity, and increases peak flows downstream. Riparian forest cover has been substantially degraded within these areas, reducing large woody debris recruitment and further simplifying the habitat.

Other habitat problems on mainstem sections of rivers within the Snohomish watershed include excessive erosion of stream banks, blocking culverts on small streams, and degraded water quality (i.e., high temperature, low dissolved oxygen, high fecal coliform counts, and high levels of toxic metals). Forestry comprises 50 percent of the land base in the mainstem Skykomish River basin (Shared Strategy for Puget Sound 2007). Forestry is most dominant in the highest elevation areas of the Skykomish watershed. Residential land uses are, for the most part, located away from the river shorelines, which are zoned primarily for agricultural production. However, pockets of rural residential development are present adjacent to mainstem reaches near several small cities. Significant portions of the NF Skykomish River basin are second-growth forest, and old-growth forest in the upper portions of the basin are protected within designated wilderness areas. This portion of the Snohomish watershed has the lowest road density and will remain so given the designated wilderness conservation status.

9.1.8 Previously Consulted on Federal Actions

Hatchery and SFF operations have been consulted upon previously. Most aspects of the proposed, integrated Skykomish River summer steelhead hatchery program have recently been consulted on by the Service in two related Section 7 consultations with NMFS: (1) *Snohomish River Early Winter Steelhead Hatchery Program* (FWS Ref. 01EWFW00-2016-I-0500 and 01EWFW00-2016-I-0511), and (2) *NMFS 4(d) Rule Determination for WDFW and Tulalip Tribes Salmon Hatchery Operations in the Snohomish River Watershed* (FWS Ref. 01EWFW00-2015-F-0120). For SFF operations, a maintenance operation (sediment removal) was consulted upon in 2010 (01EWFW00-2010-I-0329).

Since 2000, incidental take coverage for bull trout was provided for activities under Section 6(c) of the Act, including SFF operations, through a Section 6 Cooperative Agreement between the Service and WDFW. On February 24, 2020, a new Section 6 Cooperative Agreement was issued, which no longer provides incidental take coverage for Section 6(c) activities. The NMFS proposes to reissue WDFW's expiring Section 10(a)(1)(A) incidental take permit for enhancement purposes. Operations of the SFF require, and the WDFW seeks, take coverage for trapping and relocating bull trout from the SFF upriver on the SF Skykomish River.

There are no previously consulted upon federal actions that included and addressed the summer steelhead NF Skykomish River outplant.

9.2 Climate Change

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

Climate change is expected to decrease flows and increase water temperature in rivers across the Puget Sound, including in the Snohomish River. In the Puget Sound region, Battin et al. (2007) used climate, land cover, hydrology, and salmon population dynamics models to analyze climate change impacts on Chinook salmon habitats within the Snohomish River basin. Their model results project adverse impacts from climate change in relatively pristine, high-elevation streams similar to the Skykomish River watershed. These impacts include higher water temperatures, lower spawning flows, and, most importantly, increased magnitude of winter peak flows within the Snohomish River basin and other hydrologically similar watersheds throughout the region (Battin et al. 2007). Although potential climate change impacts to bull trout in the Puget Sound region remain uncertain, these results indicate that bull trout spawning and early rearing habitats are particularly vulnerable to future climate change impacts, especially due to the narrow spawning site distribution within this and other similar systems.

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

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

10.1 Sunset Falls Trap-and-Haul Fishway Facility

Sunset Falls is a natural anadromous barrier. Bull trout would not be present above the falls without operation of the trap-and-haul facility/SFF. The SF Skykomish River local bull trout population is entirely dependent on continued passage provided by the trap-and-haul (USFWS 2015b), excepting that there may now be a resident local population above Sunset Falls. The

Service noted that maintaining connectivity to the upper SF Skykomish River watershed by continuing operation of the SFF is important for bull trout recovery (USFWS 2015b). The Service identified upriver passage at Sunset Falls as a Tier 2 recovery priority (USFWS 2015b), described as "An action that must be taken to prevent a significant decline in species population or habitat quality." There are adverse effects to individual bull trout that result from capture and transport above the falls.

The effects of the action on bull trout include exposures and effects to individuals, and those effects experienced as a result of habitat changes or alterations. SFF operations include the exposures and effects resulting from collecting, handling, transporting, and releasing bull trout into the SF Skykomish River upriver of Sunset Falls. Bull trout comprise a small fraction of the fish captured at the SFF; and effects to individual bull trout are directly related to or result from the capture, holding, and release procedures of the trap-and-haul program. The long-term beneficial effects of increased habitat availability to the SF Skykomish River local bull trout population outweigh the potential adverse effects to some individuals resulting from the trap-and-haul operations.

NMFS has completed several previous consultations in which hatchery programs, or aspects of these programs, adversely affect bull trout. In the context of this consultation, the effects from operating the SFF include:

- Capture, handling, and transport at the trap-and-haul facility.
- Post-release interactions among hatchery-reared steelhead and bull trout.

Furthermore, proposed operations at the SFF may limit upriver access to early-arriving bull trout. Bull trout in north Puget Sound tributaries, including the Skykomish River, start arriving near spawning grounds in early June (Kraemer 1994). However, WDFW proposes July 1 as the annual trap-and-haul start date due to constraints associated with staffing, maintenance, and weather. From 2000 through 2015, start dates ranged between July 12 and 28 (median, July 17) for all years except one. On average, nearly half (48 percent) of the annual bull trout catch occurred during the first week of trap operations (Figure 8). The full extent of this limitation is not well understood, as early arriving fish may migrate elsewhere in the Skykomish River watershed when their upriver progress is impeded.

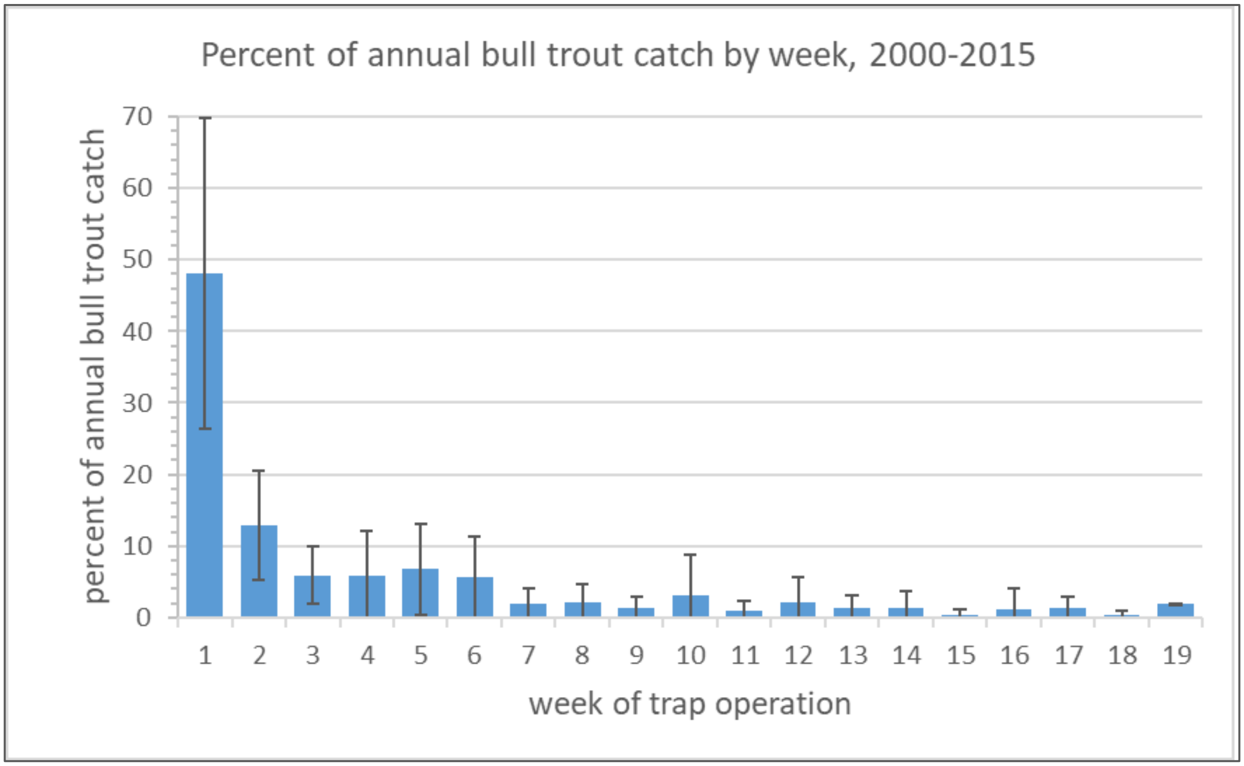

Figure 8. Mean percent of annual bull trout catch by week at the SFF, 2000–2015. Start of trapping was July 12–28 (median, July 17) for all years except one (July 1, 2015). Error bars are one standard deviation.

During the first week of trap operations, bull trout catch can be as high as 60 to 80 percent of the annual total (7 of 16 years). This, combined with bull trout migratory timing in north Puget Sound tributaries, suggests that many adult bull trout were holding at or near the base of Sunset Falls prior to the annual opening of the trap. Based on this evidence, a considerable proportion of adult bull trout will be delayed by several days to greater than a month before the trap opens in July.

Because SFF operations and upriver bull trout migration is somewhat out of sync, there may be impacts to individuals (McLaughlin et al. 2013; van Leeuwen et al. 2016). Fish may delay migration and hold at or near Sunset Falls until the trap opens or migrate to the NF Skykomish River (or further locations) in search of thermal refugia, thereby incurring greater metabolic costs. Alternatively, individuals may hold downstream of the SFF and be exposed to elevated water temperatures. For example, seven-day average daily maximum temperatures at Sunset Falls from late June through July were 68 to 72°F and 64°F in 2015 and 2014, respectively (Figure 9). Bull trout do tolerate similar temperatures during spawning migrations (e.g., Swanberg 1997; Howell et al. 2010). However, the effects of prolonged warm temperature exposures may include sublethal effects such as decreased growth rate, increased susceptibility to stress (e.g., from capture and handling) or disease, and reduced reproductive and survival rates.

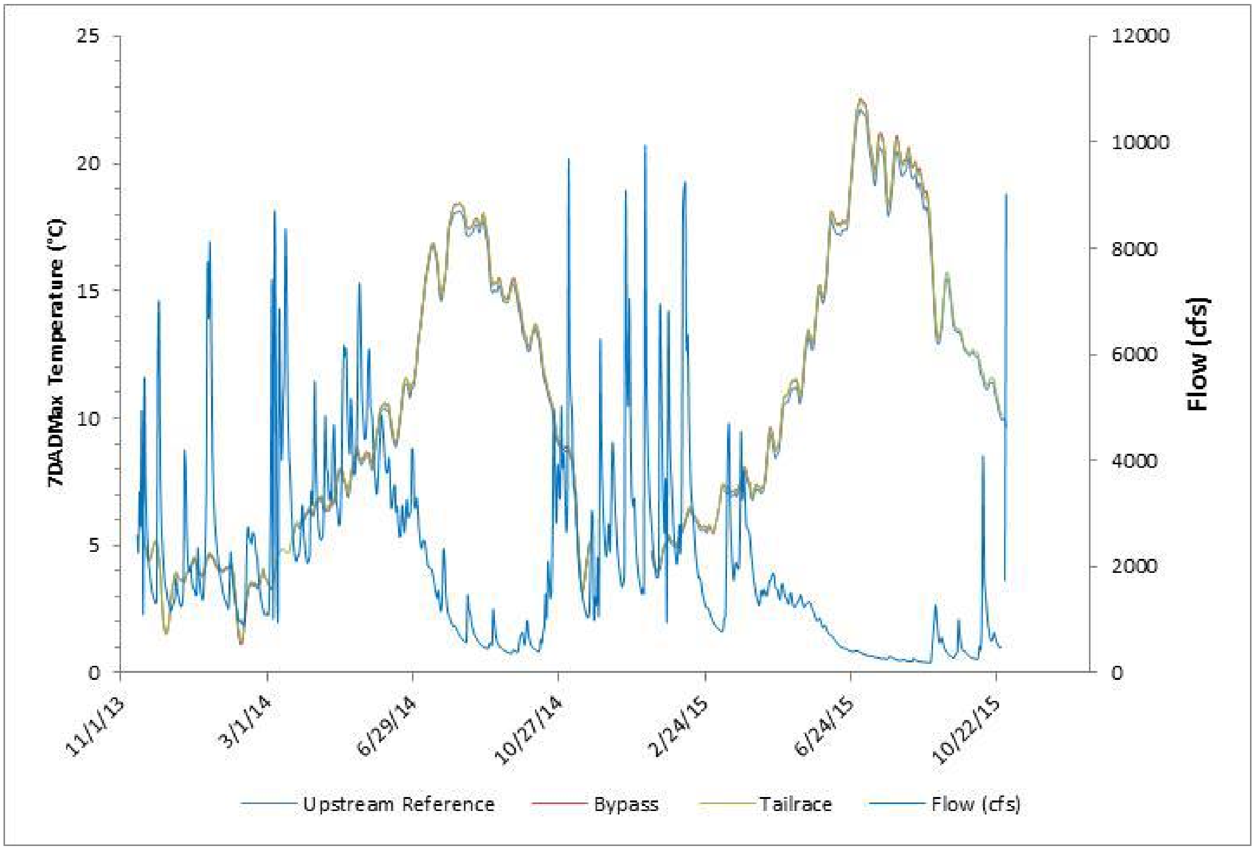

Figure 9. SF Skykomish River water temperature (green line; 7-day average daily maximum) and flow at Sunset Falls, 2014–2015.
Source: Snohomish County Public Utility District (SCPUD 2015)

U.S. Geological Survey (USGS) data show increasing river temperature (Figure 9) and decreasing river flow from early June into July (Figure 10). Thus, fish delayed at Sunset Falls prior to trap opening do likely experience higher water temperatures and reduced river flow while waiting to complete their upriver migration. These exposures and effects may be partially offset by the 3.6 mile distance that fish are transported upriver from Sunset Falls. After transport and release, migration distance remaining to reach the lower limits of known bull trout spawning grounds are 6.8 miles (Beckler River) and 11.8 miles (East Fork Foss River).

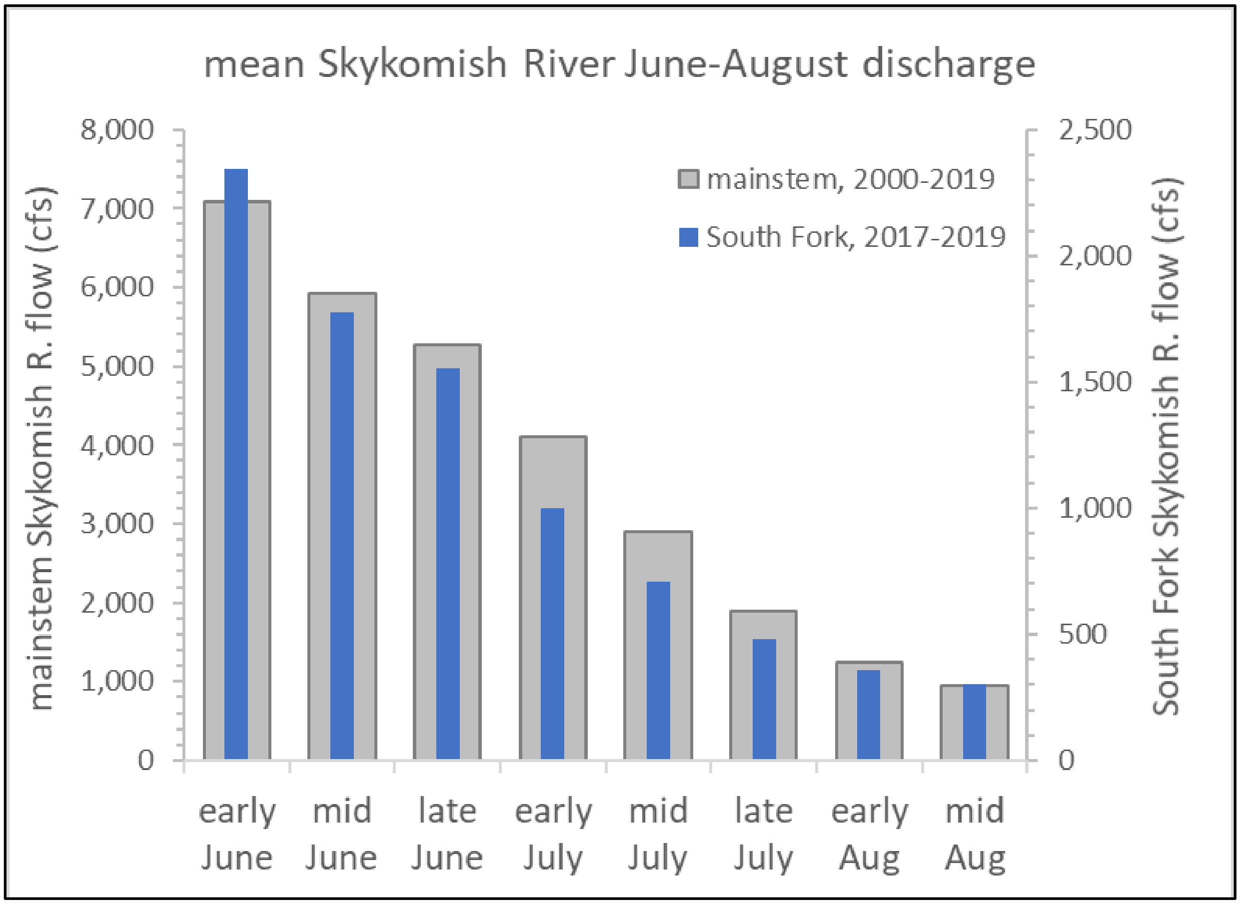

Figure 10. Mean discharge in the mainstem Skykomish River (near Gold Bar, WA), 2000-2019, and the SF Skykomish River (near Skykomish, WA), 2017-2019. Discharge is shown in cubic feet per second (cfs). The SF Skykomish River was not gaged prior to 2017.
Source: USGS gage data: 12131500 (SF Skykomish River), 12134500 (mainstem Skykomish River).

10.1.1 <u>Fish Capture, Handling, and Transport</u>

Previous to the listings of Puget Sound salmonids under the Act, WDFW collected thousands of fish for hatchery broodstock while transporting thousands more into the upper portion of the SF Skykomish River watershed (Table 1). While bull trout have always comprised a small proportion of those fish collected at the SFF, those numbers have declined through time.

WDFW has not collected any tissue samples or biometric information from any bull trout and does not propose to do so in this consultation. This limits the duration and intensity of effects (i.e., handling stress and mortality) associated with transferring bull trout upriver of Sunset Falls. WDFW's proposed water-to-water transfer of fish into the transport tank will minimize descaling and handling stress. WDFW may hold fish in a common transport tank until they are released back into the river. The distance from the trap-and-haul facility to the upriver release point is 11 miles via road, requiring about 20 minutes of travel time. The time required for biologists to capture and transfer all fish for a single load will vary from minutes to hours.

Researchers have broadly grouped fish physiological responses associated with handling and other stressors as primary, secondary, and tertiary. Primary responses, which involve the initial neuroendocrine responses, include the release of catecholamines from chromaffin tissue (Randall and Perry 1992; Reid et al. 1998), and hypothalamic-pituitary-interrenal axis stimulation culminating in the release of corticosteroid hormones (Donaldson 1981; Wendelaar Bonga 1997; Mommsen et al. 1999). Secondary responses include changes in plasma and tissue ion and metabolite levels, hematological features, and heatshock or stress proteins, all of which relate to physiological adjustments such as in metabolism, respiration, acid-base status, hydromineral balance, immune function, and cellular responses (Pickering 1981; Iwama et al. 1992, 1997; Mommsen et al. 1999). Tertiary responses may also occur such as changes in growth, condition, overall resistance to disease, metabolic scope for activity, behavior, and ultimately survival (Wedemeyer and McLeay 1981; Wedemeyer et al. 1990). The number, duration, and intensity of stressors are factors determining whether the fish's homeostatic response mechanisms are restored, or exceeded, which may cause a sustained reduction in fitness or death (Schreck 1981; 2000).

The physiological effects resulting from handling stress depend on the time, duration, and frequency of the handling events. In this case, adult bull trout migrate to Sunset Falls during the late spring and early summer in preparation for spawning and to seek thermal refugia. WDFW monitors the collection trap for fish numbers to reduce fish crowding and duration within the trap between upriver releases. When adult bull trout enter the SFF, they are of sufficient size to minimize their own predation risk prior to their release into the upper SF Skykomish River. Although there is evidence of river otter predation in the Reiter Ponds hatchery facility, there are no observations or evidence of any bull trout, river otter interactions in the SFF.

Capturing and handling bull trout results in the primary and secondary responses discussed above. But, exposures to stress from capture, handling, and transportation will be limited to two to three hours. Individuals are likely to recuperate to normal activity patterns within 24 hours, and overall effects may generally be short-lived (NMFS 2002).

Bull trout will experience an increase in blood cortisol levels during the process of collection, transport, and post-release. Fish typically respond to handling and transport with elevated blood cortisol levels that dissipate within hours to days after release. During this time, bull trout may likely reduce or cease normal foraging behavior and seek cover. These behaviors will temporarily decrease growth rate but are unlikely to decrease fitness. Due to the brevity of handling time, fish survival is not likely to be affected.

Overall, the short-term effects of the trap-and-haul program are considered relatively minor. We expect and conclude that SFF operations will result in measurable forms of physiological stress, and create a likelihood of injury with consequences for growth and long-term survival, but only for a few bull trout individuals per year at most. The affected individuals are from the SF Skykomish River local bull trout population. The trap-and-haul program will continue to have the significant benefit of providing migratory access for bull trout individuals and the whole of the SF Skykomish River local bull trout population. Continued SFF operations and access to the upper SF Skykomish River provide bull trout with much additional foraging, spawning, and early rearing habitat.

Hydrological impacts associated with climate change are related to shifts in timing, magnitude, and distribution of peak flows which are most pronounced in high elevation streams (Battin et al. 2007). Over time, hydrologic conditions are likely to shift the timing of SFF fish passage operations as climate change intensifies. Increased water temperature, altered hydrology timing and intensity, and earlier snow melt may affect bull trout migration timing at the SFF with greater numbers arriving earlier than during previous years.

10.2 Integrated Skykomish River Summer Steelhead Hatchery Program

Effects to bull trout from the proposed summer steelhead hatchery program in the Skykomish River include water withdrawals and juvenile steelhead hatchery fish releases.

10.2.1 Water Withdrawals

The Service analyzed effects associated with water withdrawals, quantity, and quality in its 2016 consultation with NMFS (USFWS References 01EWFW00-2016-I-0500 and 01EWFW00-2016-I-0511). WDFW withdraws approximately 4.9 cfs of water each from Austin and Hogarty Creeks, which affects approximately 3,900 linear feet of the Skykomish River (mouth of Austin Creek to Reiter Ponds discharge). The Service previously determined that these water withdrawals result in insignificant effects to bull trout for the following reasons:

1. Bull trout are not known to use either Austin or Hogarty Creeks.

2. Total habitat length and quantity affected by water withdrawals in these creeks is small compared to the other nearby available habitat.

3. Austin Creek withdrawal volume is a small percentage of Skykomish River flow – 0.6 percent during median low flow and 1.6 percent during periodic extreme low flow conditions – resulting in no measurable effects to bull trout in the Skykomish River.

WDFW proposes to increase water withdrawals, from 4.9 cfs, to 10 cfs from each creek, upon initiation of the new integrated summer steelhead program. Despite withdrawing slightly more than double the amount of water, the rationale for insignificant effects (i.e., from the 2016 consultation) remains valid. The Service has determined and agrees that the effects of water withdrawals from Austin and Hogarty Creeks are insignificant for bull trout.

10.2.2 Steelhead Smolt Releases

NMFS anticipates that summer steelhead smolts released from Reiter Ponds and Wallace River Hatchery will have similar competition and predation interactions with bull trout as the early winter steelhead smolts currently released from these facilities. As described in the 2016 consultation, potential ecological interactions between hatchery-origin early winter steelhead and vulnerable size classes of bull trout are considered discountable. Since the locations, life stages, and timing of early winter steelhead smolt releases rarely temporally and spatially overlap with juvenile bull trout, significant competition and predation are considered extremely unlikely. Similarly, the locations, life stages, and proposed timing of releases of summer steelhead smolts will rarely temporally and spatially overlap with juvenile bull trout, and significant competition and predation are considered extremely unlikely.

The co-managers propose to release juvenile summer steelhead from Reiter Ponds, which is one of the release sites analyzed for the early winter steelhead program. The co-managers propose volitional releases of summer steelhead smolts at approximately 170–180 mm length, which is smaller than the current 200 mm early winter steelhead program releasees. As a result, summer steelhead smolts should have less potential for adverse interactions with bull trout. WDFW will release juvenile summer steelhead at a similar timing as the early winter steelhead program, between mid-April and May.

The new integrated summer steelhead hatchery program will provide a direct, albeit small and temporally limited, forage resource to bull trout in freshwater habitats. Hatchery released juvenile steelhead trout are large (approximately 170–180 mm in length) in comparison to sub-yearling migrants. Thus, only larger adult bull trout would be able to consume the summer steelhead hatchery releasees (Keeley and Grant 2001; Lowery 2009). The relatively rapid out-migration of hatchery-released juvenile steelhead to the marine environment restricts their temporal availability to bull trout as a prey resource.

10.3 NF Skykomish River Steelhead Outplant

The proposed outplanting of 250 adult, native summer steelhead annually over an eight year duration, into the NF Skykomish River, will increase the potential for interactions between steelhead and bull trout. These interactions may be beneficial or adverse for bull trout, and will vary by life stage for individual bull trout. In general, the potential for adverse interactions among bull trout and steelhead are greatest if the species occur together at the same place and time. And, the frequency of interactions will increase in proportion to the number of steelhead outplanted.

Summer steelhead are an early migratory life-history form; adults migrate into natal streams from the ocean during the late spring and summer. This early migration timing allows them to travel higher into watersheds through canyons and other confined channel areas that block access to winter-run steelhead later in the year (Busby et al. 1996). They commonly hold in habitats with deep pools, high quality instream cover, and cool water before spawning in late-winter/early spring of the following year (Hard et al. 2007) and are known to spawn in similar reaches as bull trout (Hard et al. 2015).

Bull trout spawn and rear in the coldest streams in a given watershed, which are generally high-gradient areas with cold-water springs and groundwater infiltration (Rieman et al. 1997; Baxter and McPhail 1999, Baxter et al. 1999; Goetz 1989; Pratt 1992; Rieman and McIntyre 1993). Temperature in these areas is moderated by groundwater sources, which appears to be important during the overwinter incubation period. Goetz (1989) suggested optimum water temperatures for juvenile rearing of about 44 °F to 46 °F and optimum water temperatures for egg incubation of 35 °F to 39 °F. Water temperatures during spawning vary but generally range from 39 °F to 51 °F (Howell et al. 2010).

10.3.1 Insignificant and Discountable Exposures and Effects

Some of the proposed action's potential effects to the bull trout are insignificant or discountable. Effects to bull trout resulting from the following project elements are considered extremely unlikely to occur (discountable), or will not be measurable or detectable (insignificant):

- Juvenile life stage interactions
- Pathogens from hatchery facilities

Juvenile life stage interactions – In addition to interactions during and shortly after spawning, bull trout and steelhead progeny will co-occur throughout the NF Skykomish River basin. Kraemer (1994) reported that juvenile bull trout cope with larger salmonid presence by burying themselves in the substrate and emerging to feed during the night. This behavioral adaptation is commonly exhibited by individuals in the NF Skykomish River and appears to reduce competitive interactions for rearing space and forage. As a result, juvenile bull trout are likely to compensate for the presence of adult steelhead by exhibiting more nocturnal activity.

Underwood et al. (1995) studied the effects of hatchery steelhead smolt supplementation on bull trout in three southeast Washington streams and found no adverse interactions between the species. They reported that bull trout and steelhead were present in the same watersheds but exhibited microhabitat preference differences that decreased competitive interaction potential. These species appear to partition habitat suggesting an adaptive mechanism for minimizing competitive interaction between these co-evolved species (Underwood et al. 1995). This may be due in part to the opportunistic feeding habits of bull trout. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, and small fish (Goetz 1989; Donald and Alger 1993). Adult bull trout exhibiting a migratory life history feed primarily on a wide variety of resident and anadromous fish species (Fraley and Shepard 1989; Brown 1992; Donald and Alger 1993; Guy et al. 2011).

Pathogens from hatchery facilities – Whenever fish are transported directly from hatchery facilities, there is the potential for those fish to be vectors for bacteria, fungus, parasites, or other pathogens. Due to higher fish densities, hatchery fish often experience greater stress and exhibit lower immune responses resulting in an increased risk of contracting pathogens. Even holding adult steelhead for brief periods at hatchery facilities may increase the likelihood of pathogen transfer into the NF Skykomish River. Interactions between hatchery-reared and wild fish may also be a source of pathogen and disease transmission although there is little evidence showing that diseases are transmitted from hatchery-origin to natural-origin fish (Steward and Bjornn 1990). By following the proposed protocols described in Section 5.2 (i.e., Disease Control Policy), the co-managers will minimize disease transmission potential to natural-origin fishes, regardless of species. As such, the transmission of pathogens from adult steelhead to bull trout as a result of the proposed action is considered extremely unlikely.

10.3.2 Temporal Overlap

Summer steelhead enter the NF Skykomish River during mid-June through mid-October, hold for several months, and spawn from March to June (WDFW 2002). Steelhead do not feed prior to spawning, but instead conserve energy while their gametes mature. Steelhead fry normally emerge from early April through May, depending on water temperatures and flows (Pratt 1992; Ratliff and Howell 1992; McPhail and Baxter 1996). Juvenile steelhead rear in freshwater throughout the summer and migrate to saltwater the following spring as yearlings. Therefore, interactions among adults and juveniles of both species may occur throughout the year.

Bull trout are present throughout the Snohomish/Skykomish River basin year-round, with parts of the NF and SF Skykomish River used for spawning from mid-September through November (Figure 11). 'Redd superimposition' probably presents the greatest potential for interactions resulting in adverse effects to bull trout. Bull trout eggs and/or larvae (alevin) may remain buried in the substrate when summer steelhead begin to build redds. These summer steelhead will likely in some cases superimpose redds atop bull trout redds and will excavate and redistribute sediment from the substrate surface. Steelhead may partially to completely superimpose redds on top of bull trout redds, resulting in a range of potential effects, from a low percentage of injury and mortality for eggs and/or alevin, to a high percentage of injury and mortality. Redd superimposition is considered a major cause of density-dependent egg and alevin mortality for salmonids (Parenskiy 1990; Chebanov 1991; Fukushima et al. 1998).

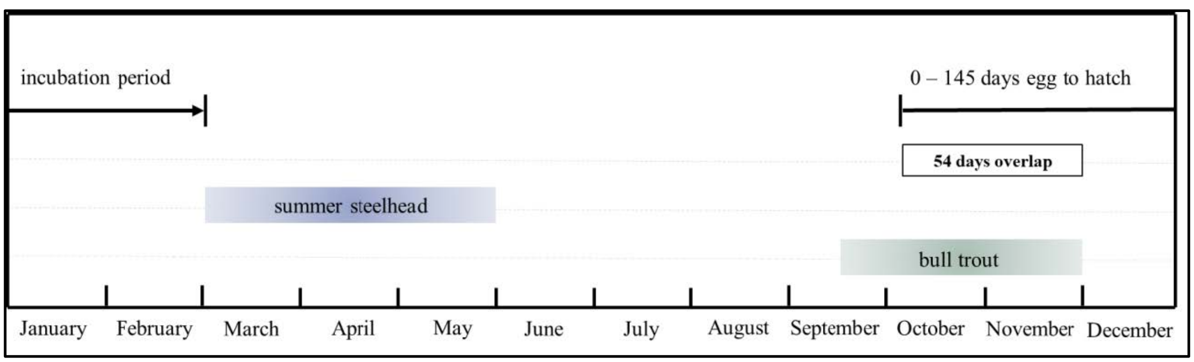

Figure 11. Temporal overlap of bull trout and summer steelhead spawn timing and bull trout egg incubation in the Skykomish River.

Two factors related to spawn timing are critical to identifying the magnitude of potential effects to bull trout egg and alevin life stages from redd superimposition: 1) the difference in timing of spawning activity; and 2) the length of time required for bull trout fry to become mobile. The normal incubation time for bull trout eggs varies from 100 to 145 days, depending on water temperature (Pratt 1992), and fry remain in the substrate after hatching for several weeks, with the time from egg deposition to fry emergence often surpassing 200 days. If bull trout eggs are deposited within the final 54 days of the typical spawning season, those eggs and alevin may be vulnerable to displacement when the first summer steelhead begin excavating redds.

Bull trout eggs and alevin that are dislodged from the substrate due to redd superimposition will exhibit decreased survival rate. As such, we anticipate that most of the adverse effects and bull trout mortality that result from redd superimposition will be in the form of unhatched eggs or alevin.

10.3.3 Spatial Overlap

Bull trout spawn in the lower reaches of larger tributaries to the NF Skykomish River, including Goblin, Salmon, Troublesome, and West Cady Creeks (Figure 13). As previously noted, one of these local populations (i.e., Troublesome Creek) is resident and located above natural barriers to anadromy. Bull trout also spawn in a 3.5-mile reach (RM 15.0–18.5) of the mainstem NF Skykomish River, between San Juan Creek and Goblin Creek, which is surveyed annually by WDFW (Kraemer 1994; USFWS 2004).

Summer steelhead spawn in a 5.6-mile section of the mainstem NF Skykomish River between Bear Creek Falls and Goblin Creek (Hard et al. 2015), which overlaps entirely the above-mentioned 3.5-mile reach of the mainstem used by spawning bull trout. Three local bull trout populations occupy and use the upper NF Skykomish River basin – Salmon Creek, Troublesome Creek, and NF Skykomish River (Figures 12 and 13; Hard et al. 2015). The Troublesome Creek population is inaccessible to anadromous species due to natural barriers. This local bull trout population is isolated and should not be affected by the NF Skykomish River summer steelhead outplants.

Spawning grounds for the Salmon Creek local bull trout population slightly overlap with steelhead spawning grounds in the lower reach of Salmon Creek (Figure 12). For the most part, this overlap is slight, and the effects of NF Skykomish River summer steelhead outplants should be insignificant for this local bull trout population.

Spawning grounds for the NF Skykomish River local bull trout population substantially overlap with steelhead spawning grounds (Figure 13). WDFW assesses this local bull trout population with redd surveys, conducted annually in the 3.5-mile reach (RM 15.0–18.5) of the mainstem NF Skykomish River between San Juan Creek and Goblin Creek, (Kraemer 1994; USFWS 2004). Due to the substantial overlap of their primary spawning grounds, the effects of NF Skykomish River summer steelhead outplants are expected to be most significant for the NF Skykomish River local bull trout population.

In addition to temporal and spatial overlap, the effects of potential redd superimposition on local bull trout populations will depend on factors such as microhabitat selection and egg deposition depth. With their assessment of summer steelhead and bull trout interactions in the NF Skykomish River, current and former WDFW bull trout specialists have characterized bull trout spawning habitats as follows (WDFW 2020):

> *The spring spawning steelhead generally create redds in the mainstem of the river or in braids that have a substantial proportion of the overall streamflow. The fall spawning bull trout prefer off-channel and protected habitat and are rarely observed spawning at sites that would be considered likely summer steelhead spawning habitat. Bull trout redds are often observed at the terminus of ephemeral streams, where interstitial flow and spring water provide reliable cold oxygenated water to eggs in redds. These locations, while typical for bull trout redd site selection, are not commonly used by steelhead. The difference in preferred spawning habitat areas [or sites] may reflect in part that spawning of bull trout and summer steelhead occurs at different points within the hydrologic*

cycle. In order to produce progeny, bull trout redds must be [established] in a location and manner to withstand the high flow events during winter months that can cause significant bed scour.

Previous studies suggest that the frequency, extent, and potential consequences of redd superimposition can be variable. Weeber et al. (2010) analyzed superimposition of kokanee salmon (*O. nerka*) redds onto bull trout redds and found no significant differences in the number or timing of emerging fry between superimposed and undisturbed redds. The researchers noted that the spawning kokanee salmon did not scour the stream bed deeply enough to reach the bull trout eggs (Weeber et al. 2010). Summer steelhead, however, are generally larger-bodied fish and are known to deposit eggs to a depth of 10-30 centimeters (cm), which is comparable to bull trout (Weeber et al. 2010; DeVries 1997). Taniguchi et al. (2000) found that 13 percent of Dolly Varden (*S. malma*) redds were superimposed by rainbow trout (*O. mykiss*) redds. Hayes (1987) documented a high frequency of redd superimposition (94 percent) between brown trout (*Salmo trutta*) and rainbow trout. The frequency, extent, and potential consequences of redd superimposition are influenced by several factors, including species and relative size, timing, temporal and spatial overlap, spawning ground characteristics, and microhabitat selection.

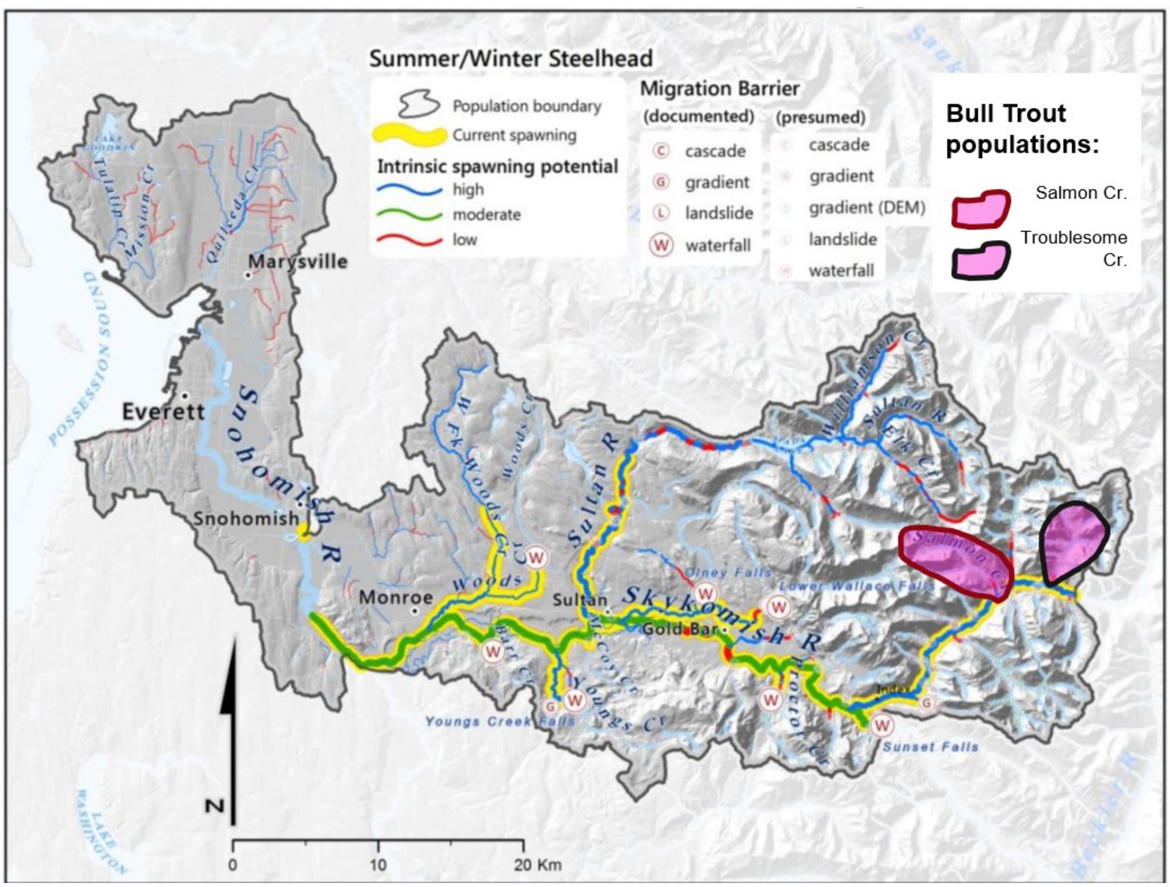

Figure 12. Spawning habitat for the Salmon Creek and Troublesome Creek local bull trout populations and steelhead in the NF Skykomish River basin
(adapted from Hard et al. 2015)

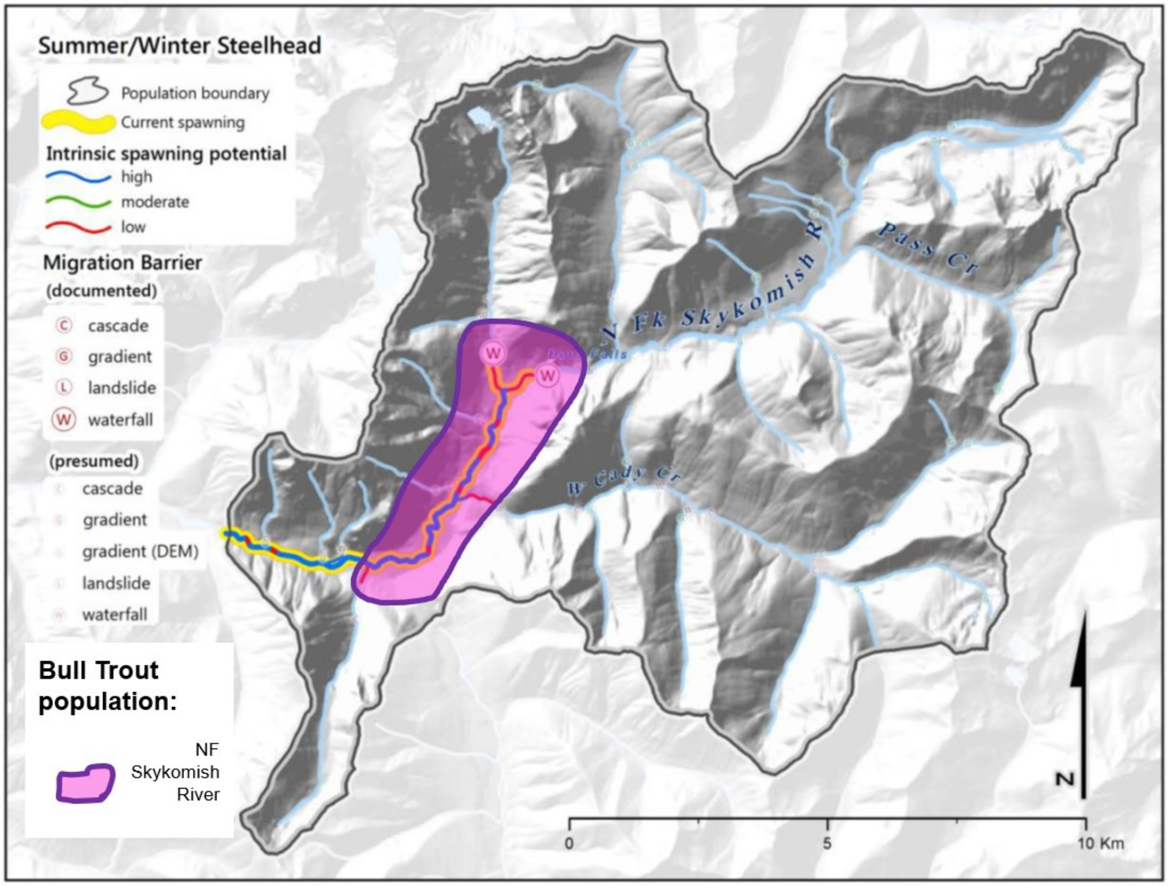

Figure 13. Spawning habitat for the NF Skykomish River local bull trout population and steelhead in the NF Skykomish River basin
(adapted from Hard et al. 2015)

10.3.4 Population Estimates and Effects

Redd surveys are typically the most common method used to estimate adult salmonid populations, especially if they are completed repeatedly and by well-trained staff. However, this population assessment method can yield highly variable and imprecise results, due to considerable inter-annual variation in site selection and difficulty identifying redds of both large (anadromous) and small (resident) bull trout life history forms (Dunham et al. 2001; Al-Chokhachy et al. 2005; Howell and Sankovich 2012). Howell and Sankovich (2012) determined that minimum declines of 44 to 56 percent, or increases of 78 to 118 percent over 10 to 15 years, are necessary to detect with traditional statistical criteria. For these reasons, the co-managers rely on highly trained personnel with years of experience conducting bull trout redd surveys throughout North Puget Sound.

National Forest Road-65 is the only reliable access route to the upper NF Skykomish River basin, and its use is limited from late spring to mid-fall. These conditions limit the ability to conduct summer steelhead surveys in the NF Skykomish River, except during low snowfall years (e.g., those that occurred in 2010 and 2015).

Spawning surveys conducted by WDFW during 2010 and 2015 yielded a total of 46 and 39 summer steelhead redds, respectively. These figures suggest that the numbers of summer steelhead spawning in the NF Skykomish River during those years were at least 92 individuals and 78 individuals, respectively. An independent 2010 escapement estimate of 82 natural-origin summer steelhead adults for this demographically independent population (Mike Haggerty, pers. comm. 2019) is similar to the aforementioned estimates. As a result, NMFS uses 82 fish as the current best estimate of natural-origin summer steelhead in the NF Skykomish River. Previous estimates generated using a species-specific habitat-based assessment for steelhead (Hard et al. 2015) suggest a historical carrying capacity for the NF Skykomish River between 663 and 1,325 fish (summer and winter steelhead combined). NMFS used these and other data to determine their recovery threshold for summer steelhead, and their goal of outplanting 250 native summer steelhead to the NF Skykomish River annually (NMFS 2019).

The proposed outplanting of native summer steelhead, redd superimposition along the NF Skykomish River, and resulting adverse effects to and mortality of bull trout eggs and alevin can be evaluated by comparing the timing, density, and spatial overlap of spawning between the two populations. To complete these estimates, we assumed:

1. A 1:1 male to female spawner ratio.

2. Fish are uniformly distributed within spawning habitats.

3. Fish spawn only within reaches so designated. And,

4. Spawning effort is uniformly distributed throughout the typical spawning season.

The most recent ten-year average, 108 bull trout redds (Table 4; 2009 through 2019; years with incomplete surveys were excluded), yields a current estimate of 216 bull trout individuals in the NF Skykomish River. Based upon these figures, current bull trout spawning density in the NF Skykomish River, between RM 15.0 and RM 18.5, is approximately 60 fish per mile.

Despite significant declines in average redd counts (e.g., an average of 305 redds were observed over the period 2002 through 2007; WDFW 2015), the NF Skykomish River local bull trout population appears to remain the largest current local population in the Snohomish/Skykomish River bull trout core area. Adult returns at the SFF over the past decade (Table 1) have averaged 33 individuals, the resident Troublesome Creek local bull trout population is considered small (but ‘unknown’ or uncertain), and the Salmon Creek local bull trout population was previously estimated to be fewer than 100 individuals (USFWS 2004).

Table 4. Bull trout redd counts; NF Skykomish River

Year	Total Redds
2009	96
2010	115
2011	105
2012[a]	6
2013[a]	0
2014	128
2015	141
2016[a]	12
2017[a]	20
2018	88
2019	86
Mean	**108**

[a] Incomplete surveys – not included in the mean.
(WDFW 2020)

NMFS used the 82 natural-origin summer steelhead escapement estimate for the NF Skykomish River, and the current bull trout spawning density in the NF Skykomish River between RM 15.0 and RM 18.5 (approximately 60 fish per mile), to model and estimate what number of annual NF Skykomish River native summer steelhead outplants would achieve or approximate an equal ratio of bull trout and summer steelhead spawners (Figure 14) on this important, primary spawning reach for both species. The co-managers (WDFW and Tulalip Tribes) and the NMFS (federal action agency) have determined that no more than 250 steelhead adults should be outplanted annually, to approximate an equal ratio of bull trout to steelhead spawners.

We expect that the effects of NF Skykomish River summer steelhead outplants will be most significant for the NF Skykomish River local bull trout population, and that most of the adverse effects and bull trout mortality that result from redd superimposition will be in the form of unhatched eggs or alevin. We acknowledge, that greater summer steelhead densities may increase adverse interactions between the two species, although little information suggests a threshold at which adverse effects would occur, or whether these relationships are linear.

Furthermore, in addition to adverse interactions in the form of redd superimposition, bull trout and steelhead progeny may increasingly co-occur throughout the NF Skykomish River basin. And, with time and increasing success of the program (i.e., wider and better establishment of the native summer steelhead population), co-occurrence may be broader and more extensive.

Research findings indicate, when hatchery-origin fish spawn naturally they often do so in close proximity to their release point or the facility where they were acclimated and imprinted (Quinn 1993; Mackey et al. 2001; Hoffnagle et al. 2008; Dittman et al. 2010; Williamson et al. 2010). Mackey et al. (2001) observed that 75 percent of hatchery-origin steelhead that strayed in the Willapa River did so within one mile of their release location. NF Skykomish River summer steelhead outplants may stray and return to the SFF or to the Reiter Ponds, and there is a degree of uncertainty as to how completely they will remain in and spawn in the NF Skykomish River.

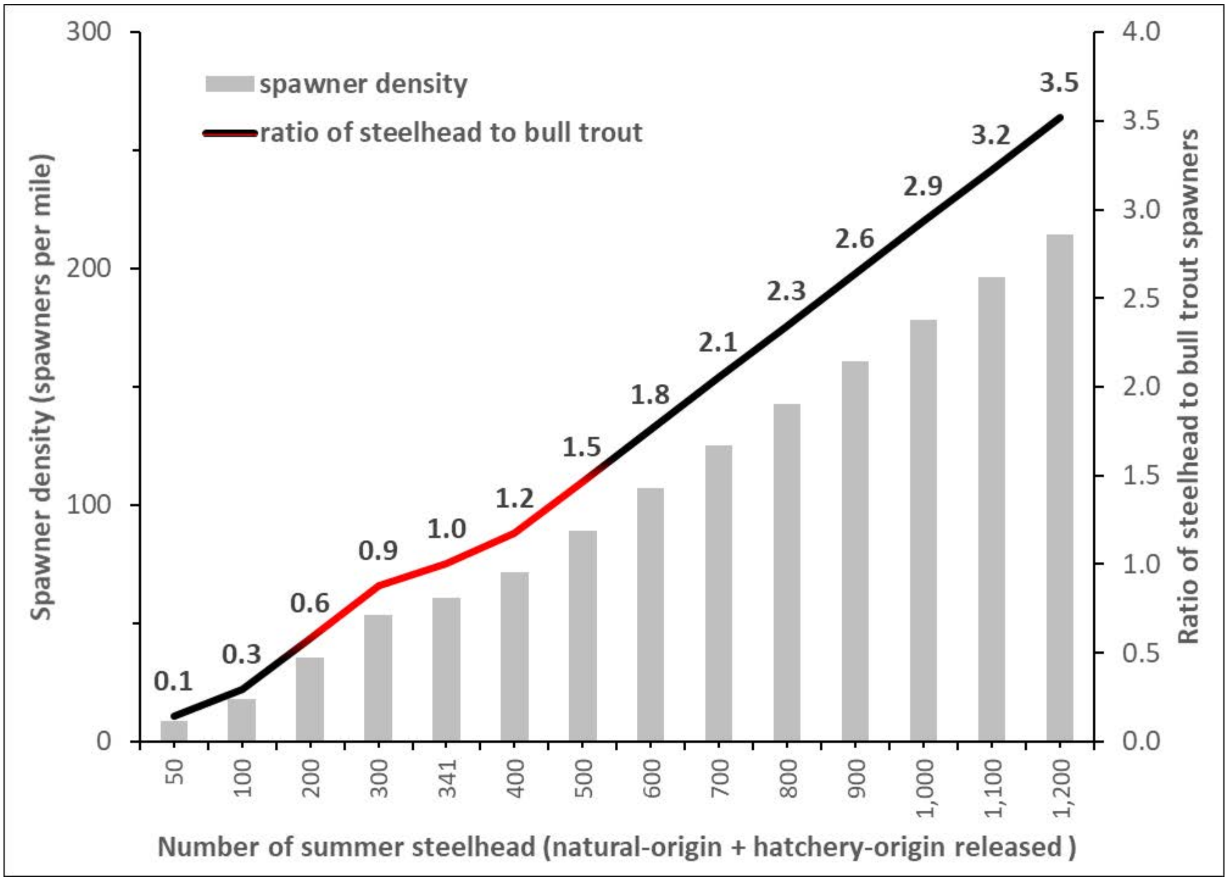

Figure 14. Density and ratio of summer steelhead and bull trout spawners in the NF Skykomish River as a function of summer steelhead abundance. Spawner ratios are denoted above each modeled estimate of steelhead. The red section of the spawner ratio line indicates abundances identified by NMFS as meeting the recovery threshold for summer steelhead in the NF Skykomish River (i.e., 200-500 fish).

Although the numbers of summer steelhead outplanted to the NF Skykomish River would be a substantial increase over current escapement numbers, and bull trout and summer steelhead are likely to compete to some extent for space and forage resources (perhaps implying a reduced growth rate for either or both), larger bull trout are capable of consuming young steelhead and may thereby benefit from the additional forage base, grow faster, and produce more offspring.

Marine-derived nutrients are identified as lacking in the upper NF Skykomish River basin (Snohomish Basin Recovery Forum 2005). An increase to the number of summer steelhead returning to the NF Skykomish River may add marine-derived nutrients, result in greater abundance and productivity of aquatic invertebrates, and improve foraging conditions for juvenile life stages of both species. Lowery and Beauchamp (2015) reported that nearly half of forage in mainstem habitats of the Skagit River system was obtained through salmon eggs and salmon carcasses. And, significant portions of the bull trout diet came from predation on juvenile salmonids, especially juvenile steelhead. Accordingly, even a modest increase in nutrients may benefit bull trout and potentially compensate for competitive interactions among the species.

10.3.5 Conclusion

The native NF Skykomish River summer steelhead population and the NF Skykomish River local bull trout population both currently exhibit historically low numbers and productivity. Their combined numbers are far below the system carrying capacity, as indicated by the amounts of available spawning and early rearing habitat.

The co-managers (WDFW and Tulalip Tribes) and the NMFS (federal action agency) have established outplant goals (i.e., 250 steelhead adults outplanted annually) and recovery goals for the NF Skykomish River summer steelhead population that may unavoidably increase some forms of competition, and most tangibly and significantly for bull trout in the form of a greater incidence and frequency of redd superimposition. These adverse effects will be most significant for the NF Skykomish River local bull trout population.

With consideration for the temporal and spatial overlap of these populations within and along the primary spawning reach, in light of the evidence to indicate that spawning microhabitat preferences substantially differ between the two species, and acknowledging a number of related and significant uncertainties and unknowns, the Service can only provide an approximate lower bound ('best case scenario') and an approximate upper bound ('worst case scenario') for the range of possible annual losses of bull trout productivity. We expect that annual losses of bull trout productivity, resulting over eight years of native NF Skykomish River summer steelhead outplanting (currently scheduled for 2025 through 2032) are likely to fall in the range of 15 to 25 percent.

The most recent ten-year average (2009-2019), for the numbers of bull trout redds in the NF Skykomish River, is approximately 108 redds. However, survey effort is sometimes uneven, and these numbers fluctuate widely. Accordingly, we expect and conclude that redd superimposition, mortality, and reduced survival of unhatched eggs and alevin, will most likely affect between 10 and 30 bull trout redds per year, resulting in a variable year-to-year loss of productivity (approximately 15 to 25 percent) for the NF Skykomish River local bull trout population. We consider this level or amount of take to be a cautious and conservative estimate; one that may overstate losses in some years. We conclude, it is extremely unlikely, that losses in any year would exceed these conservative estimates.

10.4 Designated Bull Trout Critical Habitat

Appendix B provides a detailed account of the status of the designated bull trout critical habitat. Prior to February 11, 2016, designations of critical habitat variously 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 2016 critical habitat regulations (81 FR 7414) 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 our analyses, which are the same regardless of whether the original designation identified PCEs, PBFs, or essential features. For those reasons, in this Opinion, references to PCEs or essential features should be viewed as synonymous with PBFs. All of these terms characterize the key components of critical habitat that provide for the conservation of the listed species.

The foreseeable effects to designated bull trout critical habitat are analyzed below for each of the three distinct elements described and analyzed earlier – Sunset Falls trap-and-haul (SFF), Skykomish summer steelhead hatchery activities (Hatchery), and NF Skykomish River summer steelhead outplant (Outplant).

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

   SFF – No effect.

   Hatchery – Because hatchery operations will not measurably affect groundwater sources, springs, or thermal refugia, effects to this PCE from the summer steelhead hatchery program are considered insignificant.

   Outplant – No effect.

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.*

   SFF – Trap-and-haul operations maintain migratory access to more than 60 miles of high-quality habitat in the upper SF Skykomish River. WDFW operates the SFF for approximately six months each year, from July 1 through January 1, mostly overlapping bull trout migration timing to the upper watershed for spawning. The proposed operation plan maintains the migratory corridor to the upper SF Skykomish River on the same timeline as outlined in the recovery plan (USFWS 2015b). The proposed action will have beneficial effects to the current function of this PCE.

   Hatchery – WDFW will operate hatchery facilities to minimize effluent releases and will monitor effluent levels. By adhering to permit conditions, the potential for water temperature alterations resulting from hatchery operations should be minimal. The proposed action will have insignificant effects, and no adverse effects, to the current function of this PCE.

   Outplant – No effect.

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

   SFF – SFF operations provide upriver passage for salmon and steelhead, which contribute substantially to the bull trout forage base within the Skykomish River watershed. Greater than 20,000 fish are transported annually into the upper SF Skykomish River, depositing more than 100,000 pounds of marine-derived nutrients from post-spawned salmon carcasses. The continued operation of the trap-and-haul program significantly improves the abundance of aquatic invertebrates and forage items in the upper watershed (Zhang et al. 2003). The proposed action will have beneficial effects to the current function of this PCE.

Hatchery – Possible beneficial effects. Hatchery released steelhead provide a food source for larger bull trout.

Outplant – Steelhead do not feed while holding prior to spawning, but instead conserve energy while their gametes mature. An increase to the number of summer steelhead returning to the NF Skykomish River may add marine-derived nutrients, result in greater abundance and productivity of aquatic invertebrates, and improve foraging conditions for juvenile life stages. Bull trout and steelhead exhibit microhabitat preferences that decrease competitive interaction. These species appear to partition habitat, suggesting an adaptive mechanism for minimizing competitive interactions between co-evolved species (Underwood et al. 1995). This may be due in part to the opportunistic feeding habits of bull trout. With time and success of the program (i.e., wider and better establishment of the native summer steelhead population), the proposed action will have beneficial effects to the current function of this 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.*

   SFF – The SFF is an existing structure. The SFF provides access to more than 60 miles of habitat for bull trout, but has no effect on the condition and function of habitats located upriver of the falls. The proposed action will have no effect on this PCE.

   Hatchery – None of the normal operation and maintenance activities will alter or affect this PCE.

   Outplant – No effect.

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.*

   SFF – No effect.

   Hatchery – At the hatchery facilities, water temperatures must be cold enough to support rearing juvenile salmonids. Minor warming may occur in rearing ponds prior to the water being discharged into the receiving waterbody. However, discharge volumes from the hatchery facilities are small compared to the volume of the receiving waters, and any incremental temperature increase is not expected to be measurable beyond the discharge mixing zones. For these reasons, warming will not impair or significantly affect this PCE. The proposed action will have insignificant effects, and no adverse effects, to the current function of this PCE.

   Outplant – No effect.

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.*

   SFF – No effect.

   Hatchery – No effect.

   Outplant – Outplanted native summer steelhead will increase the likelihood and incidence of redd superimposition. During redd construction, steelhead can disturb substrates used by bull trout as spawning (eggs) and rearing areas (young fry). Steelhead and bull trout redds are constructed at a similar depth, but often with differing microsite preferences, suggesting some potential for impacts and adverse effects to this 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.*

   SFF – WDFW seeks to withdraw a maximum quantity of 180 cfs from the SF Skykomish River to fill the SFF. Water use at the SFF is non-consumptive, and water is returned to the river within seconds to minutes. Effects to this PCE are insignificant.

   Hatchery – Water use at Reiter Ponds is non-consumptive, is a small proportion of river flow, and is returned near the point of withdrawal. Water withdrawn from Austin Creek affects 3,900 feet of the Skykomish River (mouth of Austin Creek to Reiter Ponds discharge), which is designated bull trout critical habitat. Water withdrawal from Austin Creek remains a small proportion of Skykomish River flow at median low flow (1.2 percent) and periodic extreme low flow (3.3 percent) conditions, resulting in no measurable effects to habitat in the Skykomish River. Therefore, any effects to this PCE from water use at the Wallace River Hatchery and Reiter Ponds are insignificant.

   Outplant – No effect.

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

   SFF – SFF operations include non-consumptive water use for approximately six months every year. SFF operations will not change water temperature and will require a minimal amount of water diversion from the SF Skykomish River to fill the fishway. The proposed action will have no effect to the current function of this PCE.

   Hatchery – Areas affected by effluent discharges are small and localized. There will be no measurable effects to water quality in the receiving waterbodies beyond the discharge mixing zones. The discharge volumes are small compared to the volumes of the receiving waterbodies. Hatchery programs are expected to have insignificant effects to water quantity for the reasons described above (PCE 7). For these reasons, effects to this PCE are considered insignificant.

   Outplant – No effect.

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.*

   SFF – SFF operations transport only native species of salmon and trout to the upper SF Skykomish River for conservation purposes. Therefore, the proposed action will have no effect on this PCE.

   Hatchery – No effect.

   Outplant – No effect.

11 CUMULATIVE EFFECTS

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

11.1 Bull Trout

Most bull trout spawning and early rearing occurs in the upper watershed on lands under 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.

Parties, such as the Tulalip Tribes and local conservation organizations, have in the past and will continue to implement restoration projects for fish habitat in the Snohomish River watershed. These actions specifically target benefits for anadromous salmon and steelhead, but also benefit bull trout. In addition, we expect that State and local governments will adjust existing programs and implement new conservation programs and practices as new data and scientific findings emerge. These restoration actions and conservation programs should continue to make minor to moderate improvements in habitat quality and quantity for foraging, migrating, and overwintering bull trout. In addition, by benefitting anadromous salmon and steelhead, these actions will increase the forage base and thereby provide additional indirect benefits to bull trout.

11.2 Designated Bull Trout Critical Habitat

Human population growth is projected for the Snohomish River watershed and is likely to result in increasing habitat degradation (particularly for riparian areas and water quality) and diminished opportunities for restoration. Despite State and local permitting requirements and regulations, our observations are that development tends 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 sources of 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 substantially degrade the watershed's environmental baseline and undermine the improvements in habitat conditions that are 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 detrimental effects of development on salmonid habitats, and by presenting ways in which a growing human population and healthy fish populations may co-exist.

We expect that adverse effects from future development, habitat degradation, and increased demand for sources of surface and groundwater, will be partially but not wholly offset by beneficial effects from restoration and conservation efforts. Therefore, we expect some decline in baseline conditions as a result of these cumulative effects.

12 INTEGRATION AND SYNTHESIS OF EFFECTS

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

12.1 Bull Trout

Throughout their range, bull trout are threatened by the combined effects of habitat degradation or alteration, fragmentation, and climate change. Six portions of the coterminous United States bull trout range are essential to the survival and recovery of the species, and are identified as Recovery Units. The proposed action, consisting of three inter-related elements (i.e., operation and maintenance of the SFF; a new, integrated Skykomish River summer steelhead hatchery program; and, the NF Skykomish River steelhead outplant program), is located in the Coastal Recovery Unit's Snohomish/Skykomish River bull trout core area.

The Snohomish/Skykomish River bull trout core area supports four local populations of bull trout; one located in the SF Skykomish River basin, and three located in the NF Skykomish River basin. The core area and these local bull trout populations are at an increased risk of extirpation from natural, randomly occurring events, in part because there are relatively few local populations (including one that is isolated), adult abundance is low or moderately low, threats persist through large parts of the watershed, and climate change and other uncertainties are possibly of growing importance.

Bull trout spawn, rear, forage, migrate, and complete other aspects of their life history throughout the Snohomish River, SF Skykomish River, and NF Skykomish River. All of the available bull trout spawning and early rearing habitats are located in the upper portions of the SF and NF Skykomish Rivers and their tributaries. To the best of our knowledge, bull trout expressing an anadromous life history are found in three of the four local bull trout populations (i.e., not in the isolated resident Troublesome Creek local population).

The Snohomish/Skykomish River bull trout core area is an important component of the Coastal Recovery Unit's geographic range. The Snohomish/Skykomish River bull trout core area is one of five that interconnect by way of the Puget Sound's nearshore marine habitats; others include the Puyallup, Stillaguamish, Lower Skagit, and Nooksack River bull trout core areas. The Snohomish/Skykomish River bull trout core area is one of only 10 that currently support bull trout expressing an anadromous life history; those other bull trout core areas, in addition to those listed above, are located on the Olympic Peninsula and north Washington Coast. The Snohomish/Skykomish River bull trout core area represents a significant portion of the bull trout range, and contributes to both genetic diversity and life history diversity; these represent the conservation roles of the Snohomish/Skykomish River bull trout core area.

There are three distinct but inter-related elements to this proposed action and consultation: (1) Operation and maintenance of the SFF, (2) a new, integrated Skykomish River summer steelhead hatchery program, and (3) the NF Skykomish River steelhead outplant program. Hatchery and SFF operations have been consulted upon previously. Most aspects of the proposed, integrated Skykomish River summer steelhead hatchery program have recently been consulted on by the Service in two related Section 7 consultations with NMFS: (1) *Snohomish River Early Winter Steelhead Hatchery Program* (FWS Ref. 01EWFW00-2016-I-0500 and 01EWFW00-2016-I-0511), and (2) *NMFS 4(d) Rule Determination for WDFW and Tulalip Tribes Salmon Hatchery Operations in the Snohomish River Watershed* (FWS Ref. 01EWFW00-2015-F-0120).

The SFF, in operation on the SF Skykomish River since 1958, provides an additional 87 linear miles (145 kilometers) of habitat for Chinook, coho, pink, chum, and sockeye salmon, steelhead, and bull trout. Bull trout would not be present above the falls without operation of the trap-and-haul facility/SFF and the SF Skykomish River local bull trout population is entirely dependent on continued passage provided by the trap-and-haul, excepting that there may now be a resident local population above the falls.

SFF operations include the exposures and effects resulting from collecting, handling, transporting, and releasing bull trout. However, overall, the short-term effects of the trap-and-haul program are considered relatively minor. We expect and conclude that SFF operations will result in measurable forms of physiological stress, and create a likelihood of injury with consequences for growth and long-term survival, but only for a few bull trout individuals per year at most. The affected individuals are from the SF Skykomish River local bull trout population. The trap-and-haul program will continue to have the significant benefit of providing migratory access for bull trout individuals and the whole of the SF Skykomish River local bull trout population. Continued SFF operations and access to the upper SF Skykomish River provide bull trout with much additional foraging, spawning, and early rearing habitat. The long-term beneficial effects of increased habitat availability to the SF Skykomish River local bull trout population outweigh the potential adverse effects to some individuals resulting from the trap-and-haul operations.

Hatchery programs and infrastructure, including those addressed with 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.

The only hatchery operations and programs analyzed in this Opinion are 1) production of native, summer run steelhead, and, 2) a doubling of the water withdrawals in Austin and Hogarty Creeks (tributaries to the Skykomish River). Resulting effects to bull trout are considered insignificant.

All other hatchery operations and programs were analyzed in the 2015 and 2016 consultations, were determined by the Service to not significantly affect reproduction, survival, or distribution, and do not appreciably reduce the likelihood of survival and recovery of bull trout, at the scales of the Snohomish/ Skykomish River bull trout core area, Coastal Recovery Unit, or conterminous range.

The NF Skykomish River steelhead outplant program, i.e., the outplanting of native adult summer steelhead into the NF Skykomish River, is a new element that has not been consulted upon previously. The NF Skykomish River steelhead population is lower than desired for population perseverance and well below carrying capacity. The program will outplant up to 250 adult summer steelhead annually over an eight year duration (currently scheduled for 2025 through 2032) to improve native summer steelhead numbers.

The co-managers (WDFW and Tulalip Tribes) and the NMFS (federal action agency) have established outplant goals (i.e., 250 steelhead adults outplanted annually) that may unavoidably increase some forms of competition, and most tangibly and significantly for bull trout in the form of a greater incidence and frequency of redd superimposition. Due to the substantial overlap of their primary spawning grounds (i.e., the 3.5-mile reach of the mainstem NF Skykomish River between San Juan Creek and Goblin Creek), the effects of the outplant program are expected to be most significant for the NF Skykomish River local bull trout population.

Bull trout eggs and/or alevin may remain buried in the substrate when summer steelhead begin to build redds. These summer steelhead will likely in some cases superimpose redds atop bull trout redds, and will excavate and redistribute sediment from the substrate surface. Bull trout eggs that are dislodged from the substrate due to redd superimposition will exhibit decreased survival rate. As such, we anticipate that most of the adverse effects and bull trout mortality that result from redd superimposition will be in the form of unhatched eggs or alevin.

The proposed outplanting of native summer steelhead, redd superimposition along the NF Skykomish River, and resulting adverse effects to and mortality of bull trout eggs and alevin can be evaluated by comparing the timing, density, and spatial overlap of spawning between the two populations. With consideration for the temporal and spatial overlap of these populations within and along the primary spawning reach, in light of the evidence to indicate that spawning microhabitat preferences substantially differ between the two species, and acknowledging a number of related and significant uncertainties and unknowns, the Service can only provide an approximate lower bound ('best case scenario') and an approximate upper bound ('worst case scenario') for the range of possible annual losses of bull trout productivity. We expect that annual losses of bull trout productivity, resulting over eight years of native NF Skykomish River summer steelhead outplanting are likely to fall in the range of 15 to 25 percent. We expect and conclude that redd superimposition, mortality, and reduced survival of unhatched eggs and alevin, will most likely affect between 10 and 30 bull trout redds per year, resulting in a variable year-to-year loss of productivity (approximately 15 to 25 percent) for the NF Skykomish River local bull trout population. We consider this level or amount of take to be a cautious and conservative estimate; one that may overstate losses in some years. We conclude, it is extremely unlikely, that losses in any year would exceeded these conservative estimates.

The NF Skykomish River local bull trout population remains the largest local population in the Snohomish/Skykomish River bull trout core area, but trends have indicated a decline since peaking in the early- to mid-2000's. Long-term redd counts peaked between 2001 and 2004, declined through 2013, and have been approximately stable since. Recent five-year running averages (104 to 135 redds) have been equivalent to or slightly higher than pre-listing levels (75 to 118 redds). The most recent ten-year average, 108 bull trout redds, yields a current estimate of 216 bull trout individuals in the NF Skykomish River. Recent (2019) snorkel survey counts suggest that a minimum of 90 to 109 bull trout utilize the primary spawning reach.

The expected variable year-to-year loss of productivity, estimated at between 10 and 30 bull trout redds per year (or approximately 15 to 25 percent), will not be insignificant for the NF Skykomish River local bull trout population. Furthermore, with time and increasing success of the program (i.e., wider and better establishment of the native summer steelhead population), co-occurrence could be broader and more extensive. However, bull trout and native summer steelhead appear to select habitats differently and/or partition habitat, suggesting an adaptive mechanism for minimizing competitive interaction between these co-evolved species. Although the numbers of summer steelhead outplanted to the NF Skykomish River would be a substantial increase over current escapement numbers, and bull trout and summer steelhead are likely to compete to some extent for space and forage resources (perhaps implying a reduced growth rate for either or both), larger bull trout are capable of consuming young steelhead and may thereby benefit from the additional forage base, grow faster, and produce more offspring.

The Service concludes that the proposed action, and its foreseeable direct and indirect effects, will not appreciably reduce or diminish the current, known distribution of bull trout in the action area. The Service concludes that the proposed action may appreciably reduce or diminish reproduction (productivity) of the NF Skykomish River local bull trout population, but will not appreciably reduce or diminish numbers (abundance) or reproduction (productivity) for the other three local bull trout populations.

The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, Tribal, local, and private actions will not appreciably reduce the likelihood of survival and recovery of the species. The anticipated direct and indirect effects of the action will not appreciably reduce numbers or distribution at the scale of the Snohomish/Skykomish River bull trout core area, Coastal Recovery Unit, or coterminous range. The anticipated direct and indirect effects of the action will not alter the status of the bull trout at the scale of the recovery unit or coterminous range.

12.2 Designated Bull Trout Critical Habitat

The Service concludes that the proposed action will have limited and mostly insignificant effects to the current function of the PCEs. Effects to PCE #2 (migratory habitat) and to PCE #3 (an abundant food base) will be significant and beneficial. Effects to PCE #6 (spawning substrates, conditions for egg and embryo survival) will be adverse, but limited in temporal and spatial extent.

Outplanted native summer steelhead will increase the likelihood and incidence of redd superimposition. During redd construction, steelhead can disturb substrates used by bull trout as spawning (eggs) and rearing areas (young fry). Steelhead and bull trout redds are constructed at a similar depth, but often with differing microsite preferences, suggesting some potential for impacts and adverse effects to the current function of this PCE.

The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, Tribal, local, and private actions will not prevent the PCEs of designated bull trout critical habitat from being maintained, and will not measurably degrade the current ability to establish functioning PCEs at the scale of the action area. Within the action area, critical habitat will continue to serve the intended conservation role for the species, at the scale of the Snohomish/Skykomish River bull trout core area, Coastal Recovery Unit, and coterminous range.

13 CONCLUSION: Bull Trout and Designated Bull Trout Critical Habitat

After reviewing the current status of bull trout, the environmental baseline for the action area, the effects of the proposed action (trap-and-haul operations, hatchery operations, and summer steelhead outplanting), and the cumulative effects, it is the Service's biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout and is not likely to destroy or adversely modify designated bull trout critical habitat.

14 INCIDENTAL TAKE STATEMENT

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

The measures described below are non-discretionary, and must be undertaken by the 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. 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 or WDFW must report the progress of the action and its impact on the species to the Service as specified in this Incidental Take Statement [50 CFR 402.14(i)(3)].

15 AMOUNT OR EXTENT OF TAKE

The Service expects that incidental take will be difficult to detect for the following reason(s): Incidental take of individuals, and the actual numbers of affected individuals, may be difficult to detect or determine when the species is wide-ranging; has small body size; when finding a dead or impaired specimen is unlikely; because losses may be masked by seasonal fluctuations in numbers or other causes; or the when the species occurs in habitats that make detection difficult.

However, pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an Incidental Take Statement, provided three criteria are met: (1) measuring take impacts to a listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded.

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

The Service acknowledges that in many cases the science related to the habitat requirements and behavior of the listed species informs the analytical basis for establishing a causal link between the effects of the proposed federal action to habitat and take of the listed species. A habitat-based approach to evaluating the effects of proposed federal actions on listed species is a customary practice of the Service in Biological Opinions. For these reasons, quantifying and monitoring take via project effects to the habitat of the listed species, not a surrogate species, is a scientifically credible and practical approach for expressing and monitoring the anticipated level of take for situations where use of a surrogate is warranted. In the accompanying Opinion we provided an analysis of how the anticipated effects occurring within suitable habitat are reasonably certain to significantly disrupt essential behaviors to the extent that it results in direct injury or mortality and/or a significant impairment of their normal behaviors.

The Service anticipates that bull trout will be taken as a result of this proposed action. The following incidental take of bull trout can be anticipated:

1. Incidental take of bull trout in the form of *harassment* (a likelihood of injury), resulting from operations of the Sunset Falls Trap-and-Haul Fishway Facility (SFF), and associated physiological stress during capture, handling, and transportation.

   - A minimum of three (3) bull trout individuals per year, and a maximum of 15 bull trout individuals per year, from the SF Skykomish River local bull trout population, will be harassed for the duration of SFF operations.

2. Incidental take of bull trout in the form of *harm* (physical injury or mortality), resulting from outplants of native summer steelhead, redd superimposition along the NF Skykomish River, and resulting mortality of bull trout eggs and alevin.

   - Some, less commonly all, eggs and alevin (10 to 100 percent), associated with a maximum of 30 bull trout redds per year, from the NF Skykomish River local bull trout population, will be harmed (injured or killed) over the eight-year duration of the NF Skykomish River native steelhead outplant program (2025 through 2032; or, Year 1 through Year 8 of the outplanting).

16 EFFECT OF THE TAKE

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

17 REASONABLE AND PRUDENT MEASURES

The Service finds that the following Reasonable and Prudent Measures (RPMs) are necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of bull trout:

1. RPM 1 – When environmental conditions permit, conduct Sunset Falls Trap-and-Haul Fishway Facility (SFF) operations annually from July 1st through January 1st.

2. RPM 2 – Limit NF Skykomish River native summer steelhead outplants to 250 adults per year, and from 2025 through 2032 only (or, Year 1 through Year 8 of the outplanting).

3. RPM 3 – When environmental conditions permit, conduct annual bull trout spawning redd counts for the NF Skykomish River local bull trout population.

18 TERMS AND CONDITIONS

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

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

1. The NMFS and WDFW shall provide an annual report to the Service (Washington Fish and Wildlife Office; Lacey, Washington) within 60 days of completion of the last upriver transportation from the Sunset Falls Trap-and-Haul Fishway Facility (SFF) each season. The report shall include:

    a. Weekly tabulations of fish transported by destination, species, age, origin (hatchery/natural origin, when determined), and final disposition (uninjured, visible stress or trauma, mortality).

    b. Start and end date of operations.

2. In the event of any bull trout mortality, NMFS and WDFW shall provide notification to the Service (Washington Fish and Wildlife Office; Lacey, Washington) within 14 days.

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

1. The NMFS and WDFW shall provide an annual report to the Service (Washington Fish and Wildlife Office; Lacey, Washington) within 60 days of completion of the last steelhead outplants each year. The report shall include:

    a. Locations and dates of releases.

    b. Origin of outplants (SFF, Wallace River Hatchery, Reiter Ponds).

    c. Individual identifying marks of outplants (adipose fin-clip, implanted blank wire tag, implanted passive integrated transponder tag).

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

1. The NMFS and WDFW shall provide an annual report to the Service (Washington Fish and Wildlife Office; Lacey, Washington) within 60 days of completion of bull trout spawning redd counts/surveys each year. The report shall include:

    a. Redd counts for the NF Skykomish River local bull trout population.

    b. Redd locations by GPS (when available) or by topographical interpolation (when GPS is not available).

    c. Dates when bull trout spawning redd counts/surveys were conducted.

The Service has determined that no more than 15 individual bull trout per year will be incidentally taken as a result of operations of the Sunset Falls Trap-and-Haul Fishway Facility (SFF). The Service has determined that a maximum of 30 bull trout redds per year, and associated eggs and alevin, will be incidentally taken over the eight-year duration of the NF

Skykomish native summer steelhead outplant program. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The federal agency must immediately provide an explanation of the causes of the taking and review with the Service need for possible modification of the reasonable and prudent measures.

The Service is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Service's Washington Fish and Wildlife Office at (360) 753-9440.

19 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. We recommend to NMFS, that WDFW or an affiliate should conduct annual summer steelhead redd counts/surveys in the NF Skykomish River, and should document and report the extent to which these counts/surveys indicate clear indications of redd superimposition and disturbance or destruction of bull trout redds. The Service acknowledges that current constraints on seasonal access limit the ability to complete summer steelhead redd counts/surveys in some, or even most years. However, these constraints may be lessened in future years, and/or new technologies to facilitate access and counts/surveys may become available (e.g., drones). NMFS and WDFW should regularly assess and act upon improved access, to schedule and implement more complete summer steelhead redd counts/surveys in the NF Skykomish River.

2. We recommend to NMFS, that WDFW or an affiliate should conduct annual bull trout redd counts/surveys on the SF Skykomish River, Salmon Creek, and Troublesome Creek. Annual redd counts would provide improved population estimates and trends where current data are lacking. These estimates and trends would assist the Service when assessing or considering future actions in the Snohomish/Skykomish River bull trout core area.

3. We recommend to NMFS, that WDFW should initiate seasonal operations of the Sunset Falls Trap-and-Haul Fishway Facility (SFF) as early as possible. Initiating seasonal operations before July 1st is acceptable and would benefit bull trout.

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

20 REINITIATION NOTICE

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

21 LITERATURE CITED

Al-Chokhachy, R., P. Budy, and H. Schaller. 2005. Understanding the significance of redd counts: a comparison between two methods for estimating the abundance of and monitoring bull trout populations. North American Journal of Fisheries Management 25:1505–1512.

Battin, J.W., 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 Science 104(16):6720-6725.

Baxter, J.S., and J.D. McPhail. 1999. The influence of redd site selection, groundwater upwelling, and over-winter incubation temperature on survival of bull trout (*Salvelinus confluentus*) from egg to alevin. Canadian Journal of Zoology 77:1233-1239.

Baxter, C.V., C.A. Frissell, and F.R. Hauer. 1999. Geomorphology, logging roads, and the distribution of bull trout spawning in a forested river basin: Implications for management and conservation. Transaction of the American Fisheries Society 128:854-867.

Brenkman, S.J., G.R. Pess, C.E. Kloehn, K. Kristofer, and J.J. Duda. 2008. Predicting Recolonization Patterns and Interactions Between Potamodromous and Anadromous Salmonids in Response to Dam Removal in the Elwha River, Washington State, USA. Northwest Science, 82(sp1):91-106.

Brown, L.G. 1992. Draft management guide for the bull trout *Salvelinus confluentus* (Suckley) on the Wenatchee National Forest. Washington Department of Fish and Wildlife, Wenatchee, Washington.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. U.S. Dept. of Commerce, National Oceanic Atmospheric Commission. Status ESA Recovery Plan for Puget Sound Steelhead NOAA National Marine Fisheries Service review of West coast steelhead from Washington, Idaho, Oregon, and California (NMFS-NWFSC-27).

Chebanov, N.A. 1991. The effect of spawner density on spawning success, egg survival, and size structure of the progeny of the sockeye salmon, *Oncorhynchus nerka*. Journal of Ichthyology 31:103–109.

DeVries, P. 1997. Riverine salmonid egg burial depths: review of published data and implications for scour studies.

Dittman, A.H., D. May, D.A. Larsen, M.L. Moser, M. Johnston. 2010. Homing and spawning site selection by supplemented hatchery- and natural-origin Yakima River spring Chinook salmon. Transactions of the American Fisheries Society 139(4):1014-1028.

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 71:238-47. Canadian Journal of Fisheries and Aquatic Sciences 54:1685-1698.

Donaldson, E. M. 1981. The pituitary-interrenal axis as an indicator of stress in fish. *In* A. D. Pickering (Gibson and [ed.]), *Stress and fish,* pp. 11–47. Academic Press, New York.

Dunham, J., B. Rieman, and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fisheries Management 21:343–352.

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 63:133-143.

Fukushima, M., T.J. Quinn, and W.W. Smoker. 1998. Estimation of eggs lost from superimposed pink salmon (*Oncorhynchus gorbuscha*) redds. Canadian Journal of Fisheries and Aquatic Sciences 55:618–625.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, literature review. Willamette National Forest, Eugene, OR.

Guy, C.S., T.E. McMahon, W.A. Fredenberg, C.J. Smith, D.W. Garfield, and B.S. Cox. 2011. Diet overlap of top-level predators in recent sympatry: Bull trout and nonnative lake trout in Swan Lake, Montana. Journal of Fish and Wildlife Management 2(2): 183-189.

Hard, J.J., J.M. Myers, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Viability criteria for steelhead within the Puget Sound distinct population segment. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-129.

Hard, J.J., J.M. Myers, M.J. Ford, R G. Cope, G.R. Pess, R S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-81.

Hayes, J.W. 1987. Competition for spawning space between brown (*Salma trutta*) and rainbow trout (*S. gairdneri*) in a lake inlet tributary, New Zealand. Can. J. Fish. Aquat. Sci. 44:40-47.

Hillman, T.W. 1991. The effect of temperature on the spatial interaction of juvenile Chinook salmon and the redside shiner and their morphological differences. Doctoral dissertation. Idaho State University, Pocatello, ID.

Hoffnagle, T.L., R.A. Carmichael, K.A. Frenyea, 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.

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

Howell, P.J. and P.M. Sankovich. 2012. An evaluation of redd counts as a measure of bull trout population size and trend. North American Journal of Fisheries Management, 32:1-13.

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.

IPCC. 2014b. 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.

Iwama, G. K., J. C. McGeer, and N. J. Bernier. 1992. The effects of stock and rearing density on the stress response in juvenile coho salmon (*Oncorhynchus kisutch*). ICES Mar. Sci. Symp. 194:67– 83.

Iwama, G. K., A. D. Pickering, J. P. Sumpter, and C. B. Schreck. (Gibson and [ed.]) 1997. *Fish stress and health in aquaculture.* Soc. Exp. Biol. Sem. Ser. 62. Cambridge Univ. Press, Cambridge, U.K.

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.

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. WDF draft manuscript.

Lowery, E.D. 2009. Trophic relations and seasonal effects of predation on Pacific salmon by fluvial bull trout in a riverine food web, School of Aquatic and Fishery Sciences, University of Washington, Seattle, Wash.

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.

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.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. In The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, *edited by* M. M. Elsner, J. Littell, L. Whitely Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington.

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

McLaughlin, R. L., E. R. B. Smyth, T. Castro-Santos, M. L. Jones, M. A. Koops, T. C. Pratt, and L. Vélez-Espino. 2013. Unintended consequences and trade-offs of fish passage. Fish and Fisheries. 14:580-604.

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. Department of Zoology, University of British Columbia, Vancouver, British Columbia. Fisheries Management Report No. 104.

Mommsen, T. P., M. M. Vijayan, and T. W. Moon. 1999. Cortisol in teleosts: dynamics, mechanisms of action, and metabolic regulation. Rev. Fish Biol. Fish. 9:211–268.

NMFS (National Marine Fisheries Service). 2002. Biological opinion on the collection, rearing, and release of salmonids associated with artificial propagation programs in the middle Columbia River steelhead evolutionarily significant unit (ESU). National Marine Fisheries Service. Portland, Oregon. February 14, 2002.

NMFS. 2019. ESA Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). WCR/NMFS/NOAA. December 20, 2019. 174p.

Parenskiy, V. A. 1990. Relation between the spawning success of sockeye salmon, *Oncorhynchus nerka*, and behavior on spawning grounds. Journal of Ichthyology 30:48–58.

Pickering, A. D. (*editors*). 1981. Stress and fish. Academic Press, New York.

Pratt, K. L. 1992. A review of bull trout life history. pp. 5 - 9 *in* Howell, P.3. and D.V. Buchanan, *editors*. 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.

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. Chapter 2, in Falxa, G.A. and M.G. Raphael (*technical editors*), 2016: Northwest Forest Plan—the first 20 years (1994-2013): Status and trend of Marbled Murrelet populations and nesting habitat. Gen. Tech. Rep. PNW-GTR-933. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 132 pages.

Randall, D. J. and S. F. Perry. 1992. Catecholamines. In W. S. Hoar and D. J. Randall (*editors*), Fish physiology, Vol. 12B, pp. 255– 300. Academic Press, New York.

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, editors. Proceedings - Gearhart Mountain Bull Trout Workshop, Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Reeves, G. H., F.H. Everest, and J.D. Hall. 1987. Interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*) in western Oregon: the influence of water temperature. Canadian Journal of Fisheries and Aquatic Sciences 17:1603-1613.

Reid, S. G., N. J. Bernier, and S. F. Perry. 1998. The adrenergic stress response in fish: Control of catecholamine storage and release. Comp. Biochem. Physiol. 120C:1–27.

Rieman, B. E. and J. D. McIntyre. 1993. Demographic and Habitat Requirements for Conservation of Bull Trout. United States Department of Agriculture, Forest Service, Intermountain Research Station. General Technical Report INT-302. September 1993.

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.

Schreck, C. B. 1981. Stress and compensation in teleostean fishes: Response to social and physical factors. In A. D. Pickering (*editors*), Stress and fish, pp. 295–321. Academic Press, New York.

Schreck, C. B. 2000. Accumulation and long-term effects of stress in fish. In G. P. Moberg and J. A. Mench (*editors*), The biology of animal stress, pp. 147–158. CABI Publishing, Wallingford, U.K.

Shared Strategy for Puget Sound (SSPS). 2007. Puget Sound Chinook Salmon Recovery Plan – Monitoring and Adaptive Management Plan Volume I. Seattle, WA. 59pp.

Snohomish Basin Salmon Recovery Forum. 2005. Snohomish River Basin Salmon Conservation Plan. Snohomish County Department of Public Works, Surface Water Management Division. Everett, WA. 402pp.

SCPUD (Snohomish County Public Utility District). 2015. 2015 Temperature Study: Final Technical Report for the Sunset Fish Passage and Energy Project. Federal Energy Regulatory Commission No. 14295. *Prepared for* Public Utility District No. 1 of Snohomish County. *Prepared by* HDR, Inc. November 2015.

Steward, C., and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish; a synthesis of published literature. Idaho Cooperative Fish and Wildlife Research Unit. University of Idaho. Technical Report 90-1. Moscow, Idaho.

Swanberg, T.R. 1997. Movements of and habitat use by fluvial bull trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society 126:735-746.

Taniguchi, Y., Y. Miyake. T. Saito, H. Urabe and S. Nakano. 2000. Redd superimposition by introduced rainbow trout, *Oncorhvnchus mykiss*, on native charts in a Japanese stream. Ichthyol. Res. 47(2):149-156.

UCSRB (Upper Columbia Salmon Recovery Board). 2005. Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan. 327 p.

Underwood, K., S. Martin, M. Schuck, and A. Scholz. 1995. I nvestigations of Bull Trout (*Salvelinus confluentus*), Steelhead Trout (*Oncorhynchus mykiss*), and Spring Chinook Salmon (*O. tshawytscha*) Interactions in Southeast Washington Streams. Project No. 1990-05300, BPA Report DOE/BP-17758-2. 188p.

USFWS (U.S. Fish and Wildlife Service). 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.

USFWS. 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.

USFWS. 2008. Bull Trout (*Salvelinus confluentus*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Portland, Oregon. 55p.

USFWS. 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.

USFWS. 2015a. Revised in-air disturbance analysis for marbled murrelets. E. Teachout, U.S. Fish and Wildlife Service, Washington Fish and Wildlife Office, Lacey, WA. 17pp

USFWS. 2015b. Coastal Recovery Unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 160pp.

USFWS. 2019. Marbled murrelet (*Brachyramphus marmoratus*) 5-year status review. Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service. Lacey, May 2019. 118 pp.

van Leeuwen, C. H. A., J. Museth, O. T. Sandlund, T. Qvenild, L. A. Vøllestad. 2016. Mismatch between fishway operation and timing of fish movements: a risk for cascading effects in partial migration systems. Ecology and Evolution. 6(8):2414-2425.

Wedemeyer, G. and D. McLeay. 1981. Methods for determining the tolerance of fishes to environmental stressors. In A. D. Pickering (*editor*), Stress and fish, pp. 247–275. Academic Press, New York.

Wedemeyer, G., B. B. Barton, and D. J. McLeay. 1990. Stress and acclimation. In C. B. Schreck and P. B. Moyle (*editors*), Methods for Fish Biology, pp. 451-489. American Fisheries Society. Bethasda, MD.

Wendelaar Bonga, S. E. 1997. The stress response in fish. Physiological reviews. 77(3), 591-625.

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

WDFW (Washington Department of Fish and Wildlife) and WWTIT (Western Washington Treaty Indian Tribes). 1998 (Updated 2006). Salmonid disease control policy of the fisheries Co-Managers of Washington State. Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes, Olympia Washington. 37 pages.

WDFW (Washington Department of Fish and Wildlife). 2002. SaSi 2002. Olympia, WA. 724pp.

WDFW. 2015. Salmon Conservation Reporting Engine, Skykomish Bull Trout. Olympia, WA. https://fortress.wa.gov/dfw/score/score/species/population_details.jsp?stockId=8108 Accessed September 21, 2015.

WDFW. 2019a. South Fork Skykomish River Summer Steelhead Hatchery Program, Snohomish Watershed/ North Puget Sound. April 12, 2019. WDFW, Auburn, Washington. 61p.

WDFW. 2019b. Letter to Molly Gorman from (NMFS) from Andrew Fowler (WDFW). Bull Trout Population Abundance Data. December 20, 2019.

WDFW. 2020. Observations on bull trout and summer steelhead spawning in the Nork Fork Skykomish River. Internal department report. May 27, 2020. 5 p.

Weeber, M.A., G.R. Giannico, and S.E. Jacobs. 2010. Effects of Redd Superimposition by Introduced Kokanee on the Spawning Success of Native Bull Trout. North American Journal of Fisheries Management 30:47–54.

Zhang, Y., J.N. Negishi, J.S. Richardson, and R. Kolodziejczyk. 2003. Impacts of marine-derived nutrients on stream ecosystem functioning. The Proceedings of the Royal Society of Biology 270:2117-2123.

(This page intentionally left blank)

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 Dynamics

Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, p. 2). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989, p. 15). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, p. 138; Goetz 1989, p. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, p. i; WDFW et al. 1997, p. 16). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream habitats. Resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Brenkman and Corbett 2005, pp. 1075-1076; Goetz et al. 2004, p. 105). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002, pp. 96, 98-106). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993, p. 2).

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

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

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

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

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

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

Population Dynamics

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

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

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

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 4). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, p. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, p. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 2; Spruell et al. 1999, entire). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, p. 137; Pratt 1992, p. 5; Rieman and McIntyre 1993, p. 2).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, p. 4; Goetz 1989, p. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, p. 900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, p. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and McIntyre 1995, p. 287). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, p. 137; Goetz 1989, p. 19; Hoelscher and Bjornn 1989, p. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, p. 238). Maintaining bull trout habitat requires natural stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, p. 364). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, p. 141; Pratt 1992, p. 6; Pratt and Huston 1993, p. 70). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Diet

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

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997, p. 25). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2004, entire).

Status and Distribution

Distribution and Demography

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

Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. No new local populations have been identified and no local populations have been lost since listing.

Coastal Recovery Unit

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

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

---

[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

Climate Change

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

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

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

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

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

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

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

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

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007, p. 6720). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

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

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

Conservation

<u>*Conservation Needs*</u>

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

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

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

The 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, culvert replacement, and habitat restoration.

Mid-Columbia Recovery Unit

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

Columbia Headwaters Recovery Unit

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

Upper Snake Recovery Unit

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

St. Mary Recovery Unit

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

Tribal Conservation Activities

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

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. Kanda1 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 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.