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:
FWS/R1/2023-0006068
xRef: 01EWFW00-2020-F-0216

Allyson Purcell, Chief
Anadromous Production and Inland Fisheries Branch, Sustainable Fisheries Division
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1201 NE Lloyd Boulevard, Suite 1100
Portland, Oregon 97232-1274

Dear Ms. Purcell:

Subject: Biological Opinion on the Chum Salmon Hatchery and Genetic Management Plans in the Skagit River Watershed

This letter transmits the U. S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) on the proposed National Marine Fisheries Service's (NMFS) 4(d) rule determination for three chum salmon (*Oncorhynchus keta*) hatchery programs located in the Skagit River basin, Skagit County, Washington, and its effects on bull trout (*Salvelinus confluentus*) and designated critical habitat for the bull trout. 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). The USFWS received your November 13, 2019, request for formal consultation on November 14, 2019. The USFWS requested additional information and clarification on the proposed action and Biological Assessment (BA) from the NMFS on October 21, 2021, and we received that information and clarification on December 20, 2021.

The enclosed Opinion is based on information provided in the September 17, 2019, BA, the July 7, 2021, Addendum to the BA, action agency feedback on the BA, co-manager meetings, telephone conversations, e-mail, and other sources of information cited in the Opinion. A complete record of this consultation is on file at the USFWS' Washington Fish and Wildlife Office in Lacey, Washington. An electronic copy of this Opinion will be available to the public approximately fourteen days after it is finalized and signed. A list of Opinions completed by the USFWS since October 1, 2017, can be found on the USFWS' Environmental Conservation Online System or ECOS website at https://ecos.fws.gov/ecp/report/biological-opinion.html.

The BA also included a request for USFWS concurrence with (a) “not likely to adversely affect” determination(s) for certain listed resources. The enclosed document includes a section separate from the Opinion that addresses your concurrence request(s). We included concurrences for the marbled murrelet (*Brachyramphus marmoratus*) and the northern spotted owl (*Strix occidentalis caurina*). The rationale for these concurrences is included in the Concurrences Section of this Opinion.

If you have any questions regarding the enclosed Opinion, our response to your concurrence requests, or our shared responsibilities under the Act, then please contact Molly Good (molly_good@fws.gov), Sam Betances (sam_betances@fws.gov), and/or Curtis Tanner (curtis_tanner@fws.gov).

Sincerely,

CURTIS TANNER

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Date: 2022.10.25 16:44:41 -07'00'

Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Enclosure(s)

cc:
NMFS, Lacey, WA, (M. Celedonia)
WDFW, Olympia, WA, (B. Missildine)
USIT, Sedro-Woolley, WA, (R. McClure)
SSIT, Darrington, WA, (G. Kirby)
Swinomish Indian Tribal Community, La Conner, WA (C. Ruff)

Endangered Species Act – Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
2023-0006068

Chum Salmon Hatchery and Genetic Management Plans in the Skagit River Watershed

Skagit 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

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Brad Thompson, State Supervisor Washington Fish and Wildlife Office	Date

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ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
Basin	Skagit River basin
BIA	Bureau of Indian Affairs
BMPs	Best Management Practices
cfs	cubic feet per second
CHU	Critical Habitat Unit
cm	centimeter
Control Policy	Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State
CRU	Coastal Recovery Unit
DPS	distinct population segment
Ecology	Washington State Department of Ecology
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)
FMO	foraging, migratory, and overwintering
ft	feet
HGMP	Hatchery and Genetic Management Plan
ITS	Incidental Take Statement
km	kilometer
km^2	square kilometer
LW	large wood
m	meter
mm	millimeter
MS-222	tricaine methanesulfonate
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
Opinion	Biological Opinion

ACRONYMS AND ABBREVIATIONS

PBF	physical and biological feature
PCE	primary constituent element
PSE	Puget Sound Energy
PSMU	Puget Sound Management Unit
Recovery Plan	Recovery Plan for the Coterminous U.S. Population of Bull Trout
RM	river mile
RPM	Reasonable and Prudent Measure
RSI	Remote Site Incubator
SCL	Seattle City Light
SFEG	Skagit Fisheries Enhancement Group
SRFB	Salmon Recovery Funding Board
SSIT	Sauk-Suiattle Indian Tribe
Swinomish	Swinomish Indian Tribal Community
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USIT	Upper Skagit Indian Tribe
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
µg/L	microgram per liter

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1 INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) and concurrences based on our review of the proposed National Marine Fisheries Service's (NMFS) 4(d) rule determination for three hatchery programs propagating chum salmon (*Onchorhynchus keta*) in the Skagit River basin (Basin), Skagit County, Washington. The Opinion addresses bull trout (*Salvelinus confluentus*) and designated critical habitat for the bull trout, and the Concurrences Section addresses effects on the marbled murrelet (*Brachyramphus marmoratus*) and the northern spotted owl (*Strix occidentalis caurina*) in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). The USFWS received your November 13, 2019, request for formal consultation on November 14, 2019.

The Opinion is based on information provided in the September 17, 2019, Biological Assessment (BA), action agency feedback on the BA, co-manager meetings, telephone conversations, e-mail, and other sources of information cited in the Opinion. A complete record of this consultation is on file at the USFWS' Washington Fish and Wildlife Office in Lacey, Washington.

2 CONSULTATION HISTORY

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

- On November 13, 2019, the NMFS, one of the federal action agencies, requested formal consultation on the proposed project and sent the BA to the USFWS. On November 14, 2019, the USFWS acknowledged receipt of this request and the BA.
- In 2020 and 2021, USFWS biologist (Judy Neibauer) participated in meetings and conference calls with the NMFS and co-managers including the Upper Skagit Indian Tribe (USIT), the Sauk-Suiattle Indian Tribe (SSIT), the Swinomish Indian Tribal Community (Swinomish), the Washington Department of Fish and Wildlife (WDFW), and Puget Sound Energy (PSE) to discuss the BA and the proposed action.
- On October 21, 2021, USFWS biologists (Molly Good, Ryan McReynolds, and Judy Neibauer) sent an official letter (Ref No: 01EWFW00-2020-F-0216) to the NMFS (Attn: Allyson Purcell) regarding the USFWS' review of the BA and a request for additional information.
- From the fall of 2021 through the duration of the consultation period, USFWS biologists (Sam Betances and Molly Good) participated in biweekly co-manager meetings.
- On December 20, 2021, the NMFS and co-managers responded to the USFWS' request and provided responses to the USFWS' summary feedback, line-by-line responses to the USFWS' comments on the BA, and NMFS' Proposed Action Section of their draft Opinion.
- In February and March 2022, following ongoing discussions regarding the Marblemount Hatchery, the NMFS coordinated with the USFWS and co-managers to reach consensus on a decision to consult on only the chum salmon hatchery programs in the Basin in this Opinion.
- On March 9, 2022, the USFWS held an internal project meeting with lead biologists to clarify information in the BA and gain additional insight regarding potential impacts to listed species and critical habitat.

- On March 10, 2022, the NMFS, co-managers, and the USFWS agreed to modify the proposed action for analysis to include only the chum salmon hatchery programs.
- On September 7, 2022, the USFWS sent a partial draft Opinion to the NMFS and co-managers for their review.
- On October 8, 2022, the USFWS sent a complete draft Opinion to the NMFS and co-managers for their review.
- On October 14, 2022, the USFWS received and addressed feedback on the draft Opinion from the co-managers.

3 CONCURRENCES

3.1 Marbled Murrelet

On October 1, 1992, the USFWS listed the marbled murrelet as a threatened species in California, Oregon, and Washington. The primary reasons for this listing included extensive loss and fragmentation of the old-growth forests that serve as marbled murrelet nesting habitat, resulting from timber harvest, fire events, insect disease, and human-induced mortality in the nearshore marine environment (i.e., foraging areas for marbled murrelet) due to the use of gillnets and accidental oil spills (57 FR 45328 [Oct. 1, 1992]). Although some threats, such as loss of nesting habitat on federal lands and gillnet mortality, have been diminishing since the 1992 listing, the primary threats to this species' persistence continue today (USFWS 2019a).

The areas in which project-related activities will be conducted comprise the geographic extent of the Basin, including the Cascade River and its tributaries, the Sauk River, and the mainstem Skagit River. Specifically, the proposed action includes hatchery facilities located on various tributaries to the Skagit and Sauk Rivers where chum salmon will be reared, acclimated, and released. Over the last few centuries, the Basin has been converted from mostly coniferous forest and wetlands to farmland and urban or residential areas. Outside of national park, forest, and wilderness areas, forested foothills and mountains have been converted from old growth to commercial tree farms and/or second growth forest (Skagit County 2021). Based on habitat suitability modelling (Raphael et al. 2016; Lorenz et al. 2021), the USFWS has confirmed the presence of marbled murrelet habitat that ranges in suitability in various proximities to the following Basin hatchery facilities:

- The Marblemount Hatchery is located more than 2,000 feet (ft) from any suitable marbled murrelet nesting habitat.
- The Sauk-Suiattle Hatchery is located near several small patches of marginally suitable marbled murrelet habitat, with the nearest patch situated approximately 250 ft (76.2 meters [m]) away from the facility (WDFW et al. 2019).
- The Upper Skagit (Red Creek) Hatchery is located more than 500 ft (152 m) from fragmented, marginally suitable marbled murrelet habitat, and more than 1,000 ft (305 m) from moderately-suitable marbled murrelet habitat.

Due to the proximity of these hatchery facilities to the nearshore marine environment, marbled murrelets may be nesting in patches of suitable habitat or transiting through the project areas on their way to marine waters. Operations at fully operating hatchery facilities will generally occur between 08:00 and 17:00 hours and, at release sites, only seasonally and for short periods of time (WDFW et al. 2019). In-air noise levels resulting from routine hatchery activities, trap-and-haul operations, and nearby vehicular traffic (i.e., during fish transport and release and/or maintenance activities) will be similar to the surrounding background (i.e., ambient) noise levels and will not substantially exceed these levels in the adjacent forest stands. Mechanical noise associated with the operation of motor vehicles, lawn mowers, generators, and/or the occasional use of heavy equipment at hatchery facilities may extend into the adjacent forests and, therefore, could be detectable to marbled murrelets. This noise may cause marbled murrelets to exhibit minor behavioral responses, such as scanning or head-turning behaviors, or increased vigilance, for short periods of time. However, the USFWS expects that these effects will be insignificant.

In summary, the USFWS does not expect that the proposed action will generate in-air noise at levels that exceed background noise levels in suitable marbled murrelet nesting habitat. Additionally, the proposed action will neither remove nor alter suitable nesting habitat. The USFWS does not expect that temporary exposures to elevated in-air noise experienced by marbled murrelets will measurably disrupt their normal behaviors (i.e., the ability to successfully feed, move, and/or shelter). Therefore, the USFWS concurs that the proposed action may affect, but is not likely to adversely affect, the marbled murrelet.

3.2 Northern Spotted Owl

On June 26, 1990, the USFWS listed the northern spotted owl (spotted owl) as a threatened species in northern California, Oregon, and Washington because of widespread habitat loss across the subspecies range and the inadequacy of existing regulatory mechanisms to conserve the species (55 FR 26114 [June 26, 1990]). Past and present habitat loss resulting from timber harvest, fire events, and other disturbance(s) continue to threaten the spotted owl (Davis et al. 2016). Since intensive studies on the species began in the 1980s, spotted owl populations are declining rangewide at an average rate of 3.8 percent per year, indicating that the species is increasingly at risk of extirpation (Dugger et al. 2016). The risk of extirpation is highest in the northern portion of the species' range, where invasive barred owls (*Strix varia*) are present, and the rate of population decline (i.e., due to interspecific competition) is steepest. If the current rates of decline continue, then the species in the northern portion of its range will likely diminish (and potentially become extirpated) in the future.

The areas in which project-related activities will be conducted include the Western Cascades and Western Lowlands spotted owl physiographic provinces. Each province represents a variety of forest zones, plant communities, and disturbance regimes that differ geographically with climate, topography, soils, and geology (Davis et al. 2016). In the Basin, most of the remaining stands of mature forests that meet the definition of suitable nesting, roosting, and foraging habitat for spotted owls are located on federal lands in the upland, forested areas to the west and/or northwest and east and/or southeast, within areas managed by the National Park Service (e.g., Ross Lake National Recreation Area) and U.S. Forest Service (e.g., Mount Baker-Snoqualmie National Forest). Based on ArcMap and the WDFW et al. (2019) GIS data, the USFWS has confirmed the presence of nesting, roosting, and foraging habitat that ranges in suitability for spotted owls in various proximities to the following Basin hatchery facilities:

- The Marblemount Hatchery is located within primarily scattered, younger forest stands in a rural and forested landscape. None of those stands meet the definition of suitable nesting habitat for spotted owls, but they may provide cover for dispersing individuals. The facility itself is not located in close proximity to suitable habitat, and the closest nesting habitat is more than 500 ft (152 m) away. The nearest activity center (i.e., a central location within a spotted owl pair's territory, such as a nest, tree, and/or a patch, where they roost consistently) is approximately 2.4 miles (3.9 kilometers [km]) to the northeast in the Mount Baker-Snoqualmie National Forest.

- The Sauk-Suiattle Hatchery is located approximately 4.6 miles (7.4 km) to the south of the nearest activity center on the Mount Baker-Snoqualmie National Forest (WDFW et al. 2019).
- The Upper Skagit Hatchery is located on the USIT Reservation, about 2.5 miles (4.0 km) northeast of the town of Sedro Wooley, Washington. The hatchery is located approximately 1 mile (2 km) from the closest patch of suitable nesting habitat and 6.8 miles (11 km) from the nearest spotted owl activity center.

Due to the distance of the hatchery facilities from suitable nesting habitat, the USFWS expects only spotted owl individuals to move through the area and occasionally use some of the nearby stands for roosting during the day, and dispersal and foraging during the night. Most operations at fully operational hatchery facilities will occur between 08:00 and 17:00 hours (WDFW et al. 2019). Spotted owls are largely nocturnal, but they forage opportunistically during the daytime. Thus, they will most likely be resting and/or sleeping (i.e., not moving) during operating hours. Mechanical noise associated with the operation of motor vehicles, lawn mowers, generators, and/or the occasional use of heavy equipment at hatchery facilities may extend into the adjacent forests and, therefore, could be detectable by spotted owls. This noise may cause individuals to exhibit minor behavioral responses, such as scanning or head-turning behaviors, or increased vigilance, for short periods of time. However, the USFWS expects that these effects will be insignificant.

As a result of the proposed action, short-term disturbance and/or temporary displacement of non-nesting spotted owls that may be roosting or dispersing in close proximity to a hatchery facility may occur. Roosting spotted owls seek perches in trees in which they can remain concealed during the daytime, and they are usually reluctant to flush. If an individual is perched in a tree near a hatchery site, then it may respond to increased activity (e.g., people walking close to and/or through adjacent forested areas or sudden loud noises). Researchers in the Pacific Northwest report that most spotted owl roosts, and virtually all nest sites, are located high enough in the forest canopy that individuals rarely flush even when someone walks directly under a roost or nest site (USFWS 2003). Because all of the hatchery facilities are more than 500 ft (152 m) from stands that meet the definition of suitable nesting, roosting, and foraging habitat, the USFWS considers effects on nesting spotted owls to be discountable.

In summary, the USFWS does not expect that the proposed action will generate mechanical noise levels that exceed background levels or require that people walk in, or near, suitable habitat for spotted owls. Additionally, the proposed action will neither remove nor alter suitable nesting habitat. The USFWS does not expect that temporary exposures to temporarily elevated mechanical noise experienced by northern spotted owl will measurably disrupt normal behaviors (i.e., the ability to successfully feed, move, and/or shelter). Therefore, the USFWS concurs that the proposed action may affect, but is not likely to adversely affect the spotted owl.

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 (U.S.) or upon the high seas (50 CFR 402.02).

5.1 Scope of Analysis

The co-managers[1] are applying for authorization under the NMFS' Limit 6 of the ESA's 4(d) Rule regarding continued operations and maintenance of three chum salmon hatchery programs located and operating in the Basin. This Opinion evaluates whether or not the proposed federal action complies with the provisions of section 7(a)(2) of the ESA and NMFS' Limit 6 of the 4(d) Rule for resource management plans developed jointly by the states and tribes within the *U.S. v. Washington* construct. The USFWS' analysis of effects of the hatchery programs under consideration in this Opinion includes any federal actions involving broodstock collection; fish rearing (i.e., including egg incubation and juveniles rearing, and release); operation and maintenance of hatchery facilities; and, associated research, monitoring, and evaluation.

This Opinion summarizes details about three chum salmon hatchery programs jointly managed by the co-managers in the Basin. This Opinion also analyzes and summarizes the effects of the proposed action, which involves the continued operations of only the chum salmon hatchery programs at the Marblemount Hatchery, Sauk-Suiattle Hatchery, and Upper Skagit Hatchery. All three of the chum salmon hatchery programs are existing, ongoing programs. The purpose of the chum salmon hatchery programs, collectively, is to supplement and rebuild the natural chum salmon population in the Skagit River, which experienced a substantial decline starting in 2007 and has remained depressed since then. The Upper Skagit Hatchery chum salmon program in the lower portion of the Skagit River (downstream of the Seattle City Light [SCL] dams: Ross, Diablo, and Gorge) also supports the cultural enrichment for, and environmental education awareness in, the Skagit River Tribal Community and surrounding communities (NMFS 2022a).

The approach to include only the chum salmon hatchery programs as part of the proposed action reflects early coordination among the USFWS, NMFS, and the co-managers during which a consensus was reached on the decision to provide consultation on only those programs in this Opinion (M. Celedonia in litt. 2022). This decision considered the Bureau of Indian Affairs' (BIA) ongoing disbursement of funds for operation and maintenance of two of these chum salmon hatchery programs and funding by the USFWS, provided to the WDFW through its Sport Fish Restoration Act (i.e., Dingell-Johnson Act) grants program. The USFWS provides grants to WDFW for hatchery facility operations, which include at least a portion of the funding for operation of the Marblemount Hatchery, generally, and one of their chum programs, specifically. This Opinion will not separately discuss the funding actions other than to note their relationship to the consultation.

The co-managers have previously described each chum salmon hatchery program in detail in Hatchery and Genetic Management Plans (HGMPs), submitted to the NMFS for review (SSIT 2018; USIT 2022; WDFW 2022). The proposed action considered in this Opinion is subsumed within the effects of operating the hatchery facilities and programs pursuant to the HGMPs, including any associated research,

[1]The Skagit River Fisheries co-managers include the Upper Skagit Indian Tribe, the Sauk-Suiattle Indian Tribe, the Swinomish Indian Tribal Community, and the Washington Department of Fish and Wildlife. Throughout this Biological Opinion, the U.S. Fish and Wildlife Service will refer to this group as the co-managers.

monitoring, and evaluation. For HGMPs determined through NMFS' review to satisfy the 4(d) Rule criteria, ESA section 9 take prohibitions will not apply to hatchery activities managed in accordance with the plans.

Collectively, the NMFS, BIA, and USFWS are the federal action agencies. NMFS is included as an action agency because of its proposed determination on the plans, while the BIA and USFWS are included as action agencies because of their funding of the programs. The NMFS is the designated lead federal agency for the conduct of this consultation pursuant to BIA and the USFWS request and mutual agreement among the agencies.

5.2 Term of Consultation

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

The effects of the hatchery program operations evaluated in this Opinion cannot reasonably be evaluated beyond 20 years. The USFWS expects that climate change will have substantial implications for environmental baseline conditions, bull trout populations in the Lower Skagit River Core Area, hatchery program and facility operations, and the success of recovery programs. Because the nature and extent of climate change, and the effects of climate change, cannot be predicted with adequate certainty beyond 20 years, the USFWS cannot evaluate effects of the proposed action on bull trout and/or designated critical habitat for the bull trout after this time. Therefore, this consultation will expire 20 years from issuance, at which point, NMFS will reinitiate consultation on these actions (USFWS 2018a).

5.3 Hatchery Programs and Facilities

The Skagit River chum salmon hatchery programs and facilities included in this proposed action are listed in Table 1. Each of these programs is integrated and, thus, they are reproductively connected to, and/or integrated with, natural fish populations for primarily recovery and educational purposes.

Table 1. Chum salmon hatchery programs and facilities in the Skagit River basin considered for 4(d) Limit 6 authorization.
(WDFW et al. 2019)

Hatchery Program	Facility
Skagit River Fall Chum Salmon	Marblemount Hatchery
Chum Salmon Remote Site Incubator	Sauk-Suiattle Hatchery
Upper Skagit Chum Salmon	Upper Skagit Hatchery

*The U.S. Fish and Wildlife Service previously evaluated and provided coverage for two additional Baker Lake hatchery programs and operations in the Baker River Hydroelectric Project (Ref No: 13410-2006-F-0019). Thus, these programs and the Baker River watershed are excluded from this Opinion (USFWS 2007).

The locations of these hatchery programs and facilities are depicted in Figure 1Figure 1.

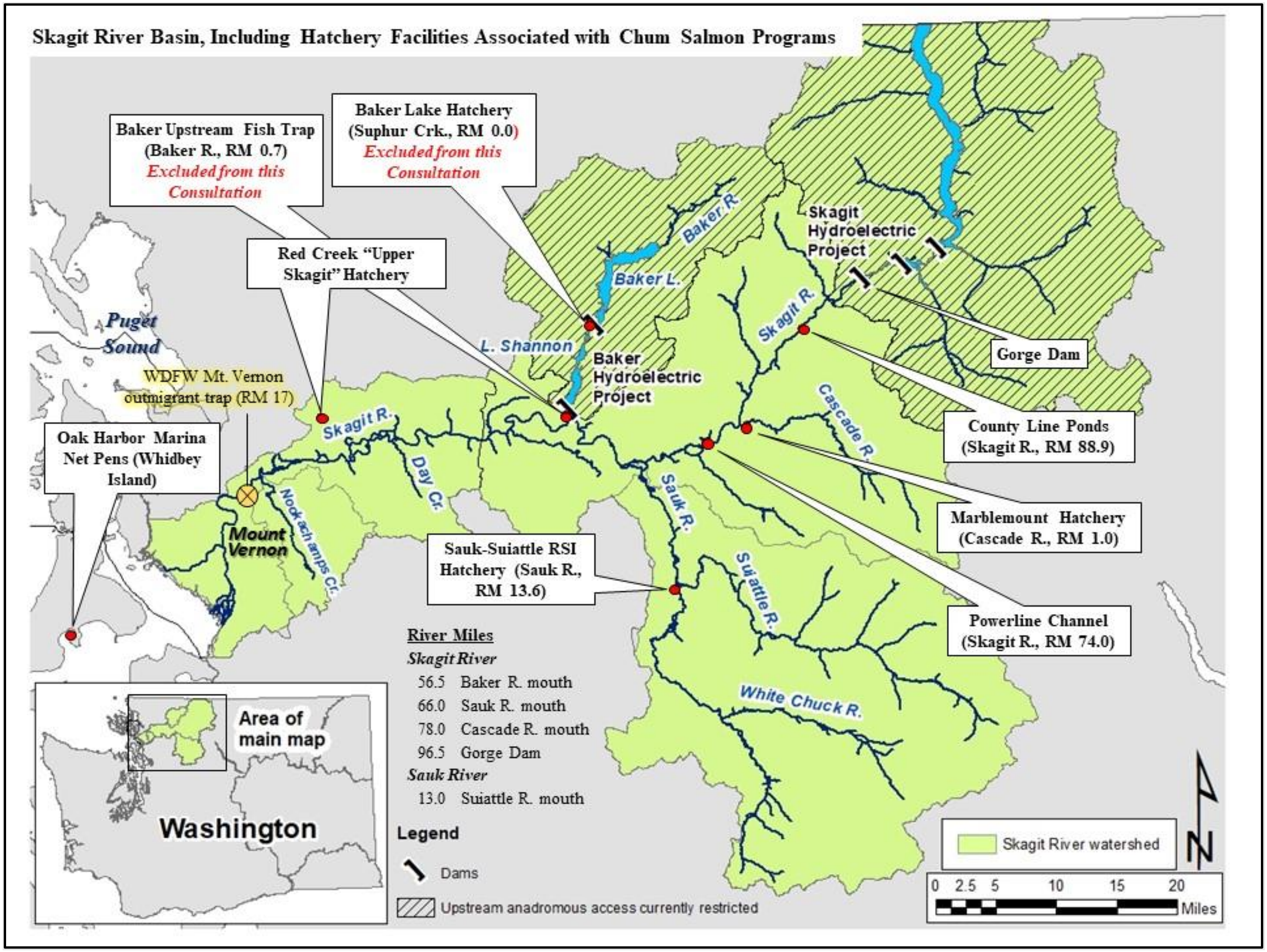

Figure 1. The Skagit River basin and locations of hatchery facilities supporting the chum salmon programs, and their relevance to this consultation.
(WDFW et al. 2019)

The Marblemount fish hatchery is a WDFW-owned and operated facility. The Marblemount Hatchery is located at river mile (RM) 1 on the Cascade River (or approximately 0.2 RM on Clark Creek, a tributary to the Cascade River). The hatchery facility includes weirs and an adult trap situated on Clark Creek, and a water intake and fish ladder situated on Jordan Creek; both Clark and Jordan Creeks are tributaries to the Cascade River. In 2018, hatchery infrastructure on Jordan Creek underwent major renovations, which included upgrades to the water intake structures and construction (replacement of) a fish ladder, which provides unimpeded fish passage in Jordan Creek (USFWS 2018). Overall, the primary purpose of the hatchery program at this facility is to support stock recovery (WDFW et al. 2019). In response to low returns of chum salmon (i.e., below adult escapement goals and harvest levels), the co-managers have initiated a new recovery program at the Marblemount Hatchery to increase juvenile production and adult returns of fall chum salmon in the Skagit River (WDFW et al. 2019).

The Sauk-Suiattle Hatchery is located on tribally-owned land adjacent to stewardship land and the SSIT Reservation. The incubators are situated on hatchery property next to Hatchery Creek (WRIA 04-1062), a small tributary that drains into the Sauk River at RM 13.4. There, the co-managers hold chum salmon fry in Redd Zone incubators and feed them for approximately one month while they acclimate to the stream before releasing them. The Sauk River is the largest tributary to the Skagit River, and it drains into the Skagit River near the town of Rockport at RM 67.2. At the Sauk-Suiattle Hatchery, the Chum Salmon RSI Program is propagated for recovery purposes (WDFW et al. 2019).

The USIT owns and operates the Upper Skagit Hatchery. The hatchery is located on the USIT Reservation, in the lower portion of the Skagit River, about 2.5 miles (4.0 km) northeast of Sedro Wooley, Washington. Red Creek is a tributary to Hansen Creek, which drains into the Skagit River at RM 24. At the Upper Skagit Hatchery, the Upper Skagit Chum Salmon Program is propagated for cultural and environmental education purposes (WDFW et al. 2019)

5.4 Broodstock Collection

The co-managers propose to collect adult salmon for broodstock in a variety of ways, depending on the hatchery program and facility. Table 2 includes summary details about broodstock collection at the chum salmon hatchery programs and facilities in the Basin.

Table 2. Proposed broodstock collection and spawning details for the three chum salmon hatchery program and facilities in the Skagit River basin.

Hatchery Program	Facility	Source	Collection Location	Collection Methodologies[a,b]	Broodstock Goal	Collection Timing and Duration	Spawning Protocol
Skagit River Fall Chum Salmon	Marblemount Hatchery	Skagit River	Marblemount Hatchery Adult Trap and Holding Pond; Skagit River, above RM 69	Modified drift gill net/tangle net (6.75 inches [171 mm]); seining, fish trap	4,900	October to December	Matrix
Chum Salmon Remote Site Incubator	Sauk-Suiattle Hatchery	Sauk River	Sauk River, RMs 12 to 18	Modified drift gill net, set gill net (6.25 inches to 7.75 inches [159 mm to 197 mm])	100	November	Pairwise
Upper Skagit Chum Salmon	Upper Skagit Hatchery	Skagit River	Skagit River, below RM 57	Modified drift gill net/tangle net (5.5 inches [140 mm])	500	Mid-October to mid-December	Matrix

[a]Gill net sizes are stretch size.

[b]Regarding the Skagit River and Upper Skagit River chum salmon programs, "modified drift gill net/tangle net" are repurposed nets that are modified to function more as tangle nets. Rather than stretching around the cork and lead-lines, these nets are hung loosely so that fish become entangled in the mesh rather than attempt to swim through the net and become "gilled." The co-managers will attend nets at all times while deployed in the river. Soak time (i.e., net time in the water per deployment) will be short in duration, approximately 3 to 15 minutes (NMFS 2022a).

[c]The co-managers will attend drift gill nets and set gill nets at all times while deployed in the river. For drift gill netting, soak time will be short in duration, approximately 3 to 15 minutes. For set gill netting, the co-managers will retrieve nets at the first sign that a fish is captured (NMFS 2022a).

At the Marblemount Hatchery, the co-managers are prepared to collect Skagit River fall chum salmon for broodstock as the adult fish return to the hatchery and voluntarily enter the hatchery trap and adult holding pond. While there is no broodstock collection infrastructure in the mainstem Skagit or Cascade Rivers, the Marblemount Hatchery includes a weir and an adult trap on Clark Creek. The adult trap consists of a fish ladder with a V-Trap that leads into a collection pond, which is 200 ft (61.0 m) long and 10 ft (3.0 m) wide (i.e., 2,000 square feet [185.8 square meter]). The pond is fenced along its perimeter to prohibit predator entry. The now-functional fish ladder provides up- and downstream fish passage in Jordan Creek, however the ladder is not used for broodstock collection. For the purposes of chum salmon broodstock collection, the co-managers propose to operate the adult trap on Clark Creek continually (i.e., 7 days per week, 24 hours per day) during November and December. The co-managers will assess the pond daily to observe general fish conditions, abundance, and behavior, and, in typical conditions, the WDFW will sort fish in the trap and remove any non-target species (fish) once per week. The WDFW will hold these fish in a section of the pond until sorting is complete. Then, the WDFW will remove fish from the pond with bare hands and place fish in large totes (i.e., approximately 250 gallons). Up to 5 fish may be loaded into a tote, and fish may spend up to 5 minutes in the totes before they are released into the river. The WDFW will fill totes with surface water from the pond intake immediately prior to placing any fish in them. After the WDFW loads fish into the totes, they will place a lid on each tote and drive them to the release location near the hatchery's surface water intake on the Cascade River. The WDFW will remove fish from the totes with bare hands and gently release them (i.e., with minimal in-air vertical drop) into slow-moving water along the shoreline (NMFS 2022a). Only trained fisheries professionals, who are knowledgeable about best practices for minimizing fish stress and maximizing safety, will handle, transport, and release non-target species (WDFW et al. 2019).

All three chum salmon hatchery programs will use in-river netting at locations in the Skagit and Sauk Rivers during various times of the year to collect some or all broodstock (Table 2). The co-managers will conduct netting activities that result in the collection of live, healthy fish and minimization of harm, injury, and/or fish mortality. Net time in the water per deployment (i.e., soak time) will be short in duration (i.e., approximately 3 to 15 minutes) in order to minimize fish stress and injury to target and non-target species. Only trained fisheries professionals will carry out the netting activities. These professionals must be knowledgeable about proper net deployment, monitoring, and retrieval procedures; fish identification; Best Management Practices (BMPs) for removing adult salmonids from net gear in manners that minimize fish stress and maximize safety; and BMPs for releasing excess or non-target species into the river in manners that minimize fish stress and maximize safety. These professionals must also attend nets at all times while they are deployed in the rivers (WDFW et al. 2019).

5.5 Hatchery Incubation, Rearing, and Release

Table 3 includes summary details about incubation, rearing, and release practices/protocols at the three chum salmon hatchery programs and facilities in the Basin (Table 3).

Table 3. Proposed release goals and practices/protocols for the three chum salmon hatchery program and facilities in the Skagit River basin.

Hatchery Program	Facility	Number and Life Stage	Marking and Tagging[a]	Egg Incubation and Release Location	Acclimation Site, Duration	Volitional Release	Release Location(s)	Release Month(s)
Skagit River Fall Chum Salmon	Marblemount Hatchery	5 million fed fry	100 percent otolith marked or parentage-based tagged	Marblemount Hatchery	None[a]	Yes (for on-station releases) and no (for off-station releases)	Skagit River, RMs 66 to 96[b] (more than 60 percent of total release); Marblemount Hatchery (≤ to 40 percent of total release)	April
Chum Salmon Remote Site Incubator	Sauk-Suiattle Hatchery	125,000 fry	None	Marblemount Hatchery (to eyed-egg state); Sauk-Suiattle Remote Site Incubator Hatchery (to fry stage)	None	No	Sauk River, RM 14.5 (50,000 fry); Hatchery Creek, RM 0.2 (50,000 fry); Lyle Creek, RM 0.5 (25,000 fry)	April to May
Upper Skagit Chum Salmon	Upper Skagit Hatchery	450,000 fry	None	Upper Skagit Hatchery	None	No	Skagit River, below RM 57	April to May

[a]Acclimation and imprinting at off-station releases is intentionally avoided in order to maximize spatial distribution of returning adults throughout the natural range of Skagit River fall chum salmon.

[b]The National Marine Fisheries Service 4(d) approval of the three chum salmon hatchery programs enable the co-managers to release Skagit River fall chum salmon at one or more locations in the Skagit River, RM 67 to 96, based on localized chum spawner abundances and co-manager agreement. Currently-identified potential and/or utilized sites include County Line Ponds (RM 88.9), Powerline Channel (RM 74.0), and the Skagit River Slough at Rockport Park (RM 66.5). In the future, the National Marine Fisheries Service and co-managers may use additional or alternative release sites in the Skagit River.

During rearing, the co-managers will conduct regular fish health inspections. If they suspect and/or identify disease agents, then they will conduct more frequent inspections. Only qualified fish health professionals (Fish Health Specialists and Pathologists) will conduct final pre-release fish health inspections. These professionals will conduct inspections for all fish production according to current BMPs for pathogen prevention, monitoring, and control established in the "Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State" (Control Policy) (WDFW and WWTIT 2006).

Inter-annual variability in fecundity and in-hatchery survival rates may result in excess juvenile fish at the time of release(s). However, the co-managers anticipate that production overages greater than 10 percent of population targets, in any given year, will be infrequent. If the running 5-year average production—beginning in the release year that the NMFS makes a determination on the program—for a species-stage is more than 105 percent of the level described, then the co-managers will notify the NMFS.

Generally, the chum salmon hatchery programs will adhere to rearing and release practices/protocols that encourage rapid seaward migration and minimize the period in which hatchery-origin juvenile fish spend in freshwater. As such, the co-managers propose to release fish only at natural outmigration times for their species. The co-managers may consider the release(s) of hatchery-origin juveniles prior to the target release date in the event of an emergency (e.g., loss of water). In this situation, the co-managers will notify the NMFS within 48 hours of the release, and they will provide information on the release location(s) and size and number of released fish (NMFS 2022a; WDFW et al. 2019).

5.6 Pathogen Prevention, Monitoring, and Control

The three chum salmon hatchery programs and facilities in the Basin (Table 1) will adhere to BMPs for preventing, monitoring, and controlling pathogens in the hatchery environment(s) as detailed in the Control Policy (WDFW and WWTIT 2006). Both the WDFW and Western Washington Treaty Indian Tribes have trained and knowledgeable fish health professionals that will guide the design and implementation of the prevention, monitoring, and control programs for hatchery programs and facilities included in the proposed action. These programs include: pertinent nutrition; sufficient water flow and water chemistry; fish loading and density indices; fish handling; disinfecting procedures; and, chemical and drug treatment standards, guidelines, and protocols. The co-managers will ensure that hatchery managers and staff will be trained and knowledgeable in recognizing outward signs of pathogen(s) presence and protocols for pathogen prevention and treatment(s). They will promptly report suspected pathogen(s) presence to the appropriate fish health professionals, who will then investigate and recommend corrective measures, as necessary. In addition, fish health professionals will conduct routine (monthly) evaluations of rearing conditions and perform (as needed) lethal sampling upon detection of pathogens of concern in hatchery-raised fish. The co-managers will develop treatment plans and implement them, as necessary. They will also document and maintain findings and result of pathogen monitoring and treatment(s).

The co-managers will use disinfectants, antibiotics, medications, and anesthetics at the hatchery facilities, as needed. Of these, disinfectants (e.g., formalin, povidone-iodine, and iodophor) will be the chemicals used in the largest quantities.

The co-managers will infrequently and intermittently use chemicals in water that flow through a hatchery facility (i.e., process water). They will be absent from effluents at most times. The tribal and state fisheries co-managers may use povidone-iodine to treat eggs after fertilization and, less commonly, to disinfect equipment including nets and boots. As it sits out and is used, ovidone-iodine degrades over time. Unused chemicals and spent solutions are disposed of in approved upland facilities.

The disposition of fish carcasses resulting from euthanization (of excess hatchery-origin adult fish) and/or incidental mortality (i.e., during holding for broodstock collection) may occur in natural waters for nutrient enhancement, on land (through burial), and/or be distributed for human consumption or other uses (e.g., ceremonial). Distributing carcasses for nutrient enhancement purposes will require approval(s) from a fish health professional (NMFS 2022a).

5.7 Proposed Research, Monitoring, and Evaluation

The co-managers may implement a variety of research, monitoring, and evaluation activities to assess the effects of the three chum hatchery programs and facilities in the Basin (Table 1) on naturally reproducing fish populations. The goals of these activities are to obtain additional data and information to support adaptive management of the hatchery programs; enhance understanding of the effects of these hatchery programs on both federally listed and unlisted fish species and populations; and, to meet HGMP performance criteria.

5.7.1 General Research, Monitoring, and Evaluation

The co-managers may integrate some of the proposed hatchery research activities with non-hatchery related activities. For example, the co-managers will continue to monitor (annually) adult spawner and juvenile production in the Basin to identify trends in abundance and distribution of naturally reproducing salmon and steelhead populations. They will also use these data to monitor HGMP performance criteria. As another example, the WDFW, through their operation of rotary screw and/or incline plans traps (at RM 17 in the Skagit River), will monitor (annually) abundance and productivity of naturally-reproducing salmonid populations. The trapping operation is covered under a separate 4(d) authorization, renewed annually by NMFS. The co-managers propose to continue these spawner abundance juvenile trapping activities into the foreseeable future.

The co-managers may track, record, and maintain the following data to evaluate hatchery program performance and efficacy:

- The species, date and location of capture(s), sex (if possible), life history form and/or approximate length, origin (i.e., hatchery or natural), mark/tag presence, and general condition/disposition (i.e., noting injury[ies], whether or not the fish

  was released alive or died) of all target and non-target salmonids (e.g., bull trout) during in-river broodstock collection (e.g., gill netting) and/or trapped at collection facilities or smolt traps; and,
- The number of adult male, adult female, and subadult fish spawned for both hatchery- and natural-origin broodstock, and the number of eggs collected and fertilized for each hatchery spawn day.

5.8 Operations and Maintenance of Hatchery Facilities

The co-managers propose to carry out routine maintenance activities for "watered" facilities including ponds, troughs, incubators, pumps, water diversions, outfalls, plumbing, and weirs, in addition to buildings and grounds. They will also require weir repairs and adjustments, as necessary. The co-managers will remove minor debris accumulations from surface water diversion structures and from discharge outfall structures to maintain their integrity and performance. A WDFW Hydraulic Project Approval permit, which specifies allowable in-water work windows and BMPs to minimize introduction of pollutants into waterways, will be implemented by the co-managers to ensure that activities performed in and/or near surface waters avoid and minimize harm to fish and their habitat.

The Marblemount Hatchery was constructed in-line with Clark Creek; as Clark Creek flows through the hatchery grounds, it becomes highly integrated as part of the hatchery (Figure 2). A portion of Clark Creek is diverted to hatchery raceways via a surface water intake as the stream first enters the hatchery grounds. The remainder of Clark Creek flows into and through the hatchery by one of the following three pathways: the 1) adult trap and adult holding pond; 2) steelhead channel; and, 3) asphalt-lined rearing channels and release/bypass channel.

There are three weirs at the hatchery (Figure 3); two on Clark Creek (i.e., the steelhead channel upper weir [A] and the lower steelhead channel and adult trap weir [B], and the third near the mouth of the bypass/release channel [C]). The two on Clark Creek are height and velocity barriers, and the third is a picket-style weir (NMFS 2022a).

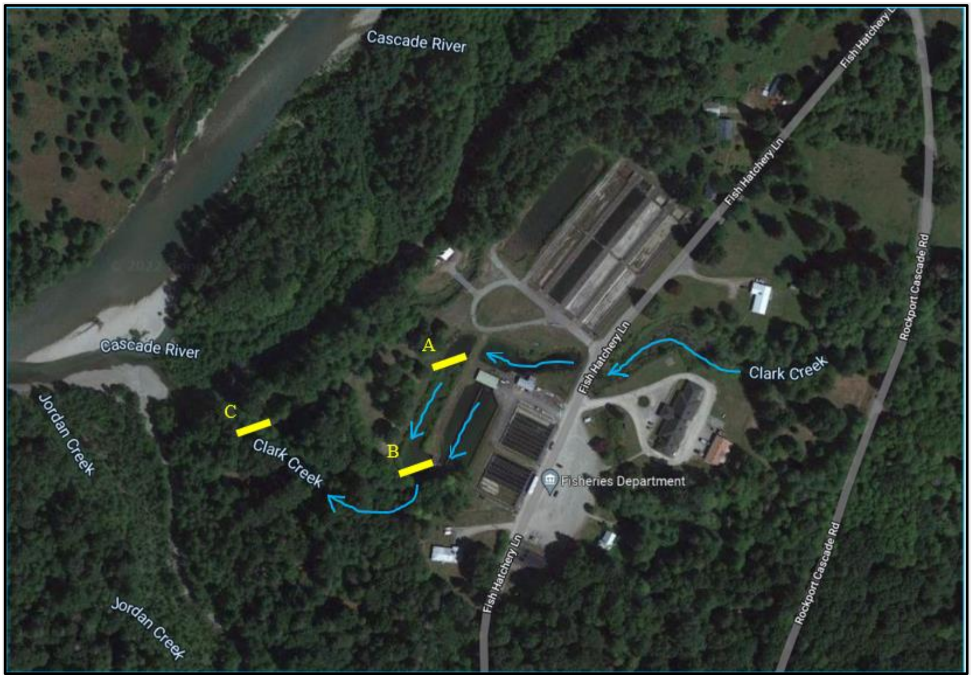

Figure 2. Aerial view of the Marblemount Hatchery, including flow direction of Clark Creek through the facility (blue) and location of the three weirs and adult trap. A is the steelhead channel upper weir, B is the lower steelhead channel and adult trap weir, and C is the bypass/release channel weir.

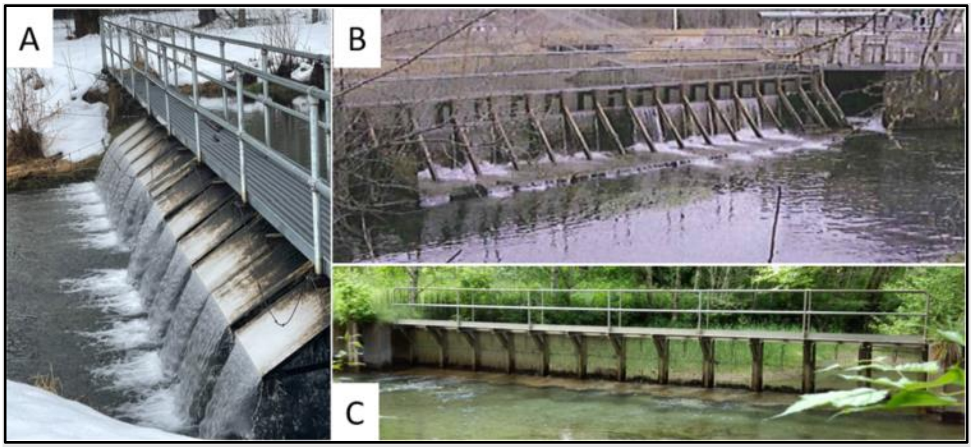

Figure 3. Photographs of the three weirs at the Marblemount Hatchery, which include: the steelhead channel upper weir (weir A); lower steelhead channel and adult trap weir (weir B); and, the bypass/release channel weir (weir C).
(NMFS 2022a)

At the Marblemount Hatchery facility, staff regularly maintain ponds and raceways which includes vacuuming to remove waste. As there is no pollution abatement pond, waste is pumped on the ground and distributed for upland disposal to prevent waste-laden water from reaching surface waters. The hatchery also maintains a settling pond which is periodically (approximately once every two years) cleaned to remove solids that are also disposed to upland locations on the hatchery ground or commercial sites. Cleaning the settling pond requires dredging and use of heavy equipment and is regulated and done in accordance with the WDFW Hydraulic Project Approval permit.

Other hatchery facilities maintenance will include building and grounds maintenance (e.g., painting, minor building repairs, security repairs, weeding, and mowing). The hatchery staff may use chemicals including Roundup and Rodeo (aquatic formulation of glyphosate) during grounds maintenance. The hatchery staff will not apply Roundup within 300 ft (91.4 m) of water; rather, they will apply Rodeo or other aquatic approved chemicals, as necessary, within areas in closer proximity to the water. All chemical applications will occur in dry conditions (i.e., either not raining or not expected to rain) via a backpack sprayer.

At the Marblemount Hatchery, fish released from raceways exit through a pipe that discharges into an area in close proximity to the adult ladder and trap. The pipe is outfitted with exclusionary grating at its outlet to prohibit natural fish from entering it. The grating is hinged so that, when hatchery fish are being released, a rope is pulled, which lifts the bottom of the grating so that juvenile fish can swim freely. On the morning of release, the hatchery managers open the grating, and keep the grating open for up to 8 hours, to allow fish to exit. This practice occurs approximately nine times per year, during April (NMFS 2022a). The grating has rolled corners and no sharp edges, which minimizes the potential for fish injury and/or mortality.

5.8.1 Water Withdrawal and Discharge

Under the Clean Water Act, the Environmental Protection Agency (EPA), regulates the direct discharge of hatchery facility effluent through National Pollutant Discharge Elimination System (NPDES) permits. For hatchery facilities that are not located on federal and/or tribal lands within Washington, the EPA delegates its regulatory oversight to the State. Thus, the Washington State Department of Ecology

(Ecology) issues and enforces NPDES permits that ensure that water quality standards for surface and marine waters remain consistent with public health and enjoyment, and the propagation and protection of fish, shellfish, and wildlife.

All hatchery facilities require a NPDES permit for effluent discharge(s) resulting from facilities that rear 20,000 pounds or more of fish annually and/or that feed 5,000 pounds or more of feed during any calendar month. For the chum salmon hatchery programs and facilities included in this consultation that require a NPDES permit, the co-managers are already operating in compliance with these permits, which are issued by Ecology. For example, under its NPDES permit, the Marblemount Hatchery monitors certain water quality parameters (e.g., total suspended solids, settleable solids, and in-hatchery water temperature), selected by the EPA and Ecology. The Marblemount Hatchery has an established record of no exceedances for, at least, the past 10 years (NMFS 2022a). The other hatchery facilities and programs included in this consultation will operate below production and feed thresholds that would otherwise require NPDES permits.

The three chum salmon hatchery programs and facilities in the Basin will use water non-consumptively. The co-managers propose to withdraw water and discharge effluent at respective facilities in the following ways:

- The Marblemount Hatchery will withdraw water and discharge effluent all year. This facility uses water from both surface (from Cascade River, Clark Creek, and Jordan Creek) and groundwater (from five wells) sources. According to current water rights, the co-managers propose to withdraw water up to the following quantities: 30 cubic feet per second (cfs) from the Cascade River; 25 cfs from Clark Creek; 15 cfs from Jordan Creek; and, 10 cfs from the wells. The water withdrawals affect approximately 1,650 ft (502.9 m) of the Cascade River, 650 ft (198 m) of the accessible (to anadromous fish) portion of Clark Creek, and 1,310 ft (399.2 m) of Jordan Creek (i.e., the distance between the intake and discharge). While the Cascade River surface water intake does not include an in-channel diversion structure, its intake screening does not meet either current NMFS (2011, 2022b) or previous NMFS (1995, 1996) compliance standards. However, the WDFW has requested funding from the Washington State Legislature to bring the intake screening up to current NMFS standards. They have requested pre-design, design, and permitting funding in the 2023-2025 Biennium, and construction funding in the 2025-2027 and 2027-2029 Biennium, however this funding is not guaranteed. The Clark Creek water intake is located above the permanent weir, which serves as an impassable barrier for anadromous fish. The Jordan Creek intake includes an in-channel water diversion structure that enables volitional upstream and downstream fish passage. The Jordan Creek intake screening and passage structure meet NMFS (2011) standards. Current NMFS (2022b) standards are very similar to those used to guide the 2018 Jordan Creek design upgrades and, therefore, it is likely that the intake is highly protective of listed fish. Water that is withdrawn to be used in the hatchery facilities is unavailable to these creek(s) and river reaches. The NMFS and co-managers propose to discharge effluent from the hatchery facilities in accordance with NPDES permit WAG 13-3015 (NMFS 2022a).
- The Sauk-Suiattle Hatchery will withdraw water and discharge effluent between November and May of each year. This facility uses up to 0.1 cfs of surface water (from Hatchery Creek) and/or groundwater. The surface water withdrawal affects approximately 150 ft (45.7 m) of the creek. At this facility, intake screening meets current NMFS (2011) standards. Currently, there is a barrier (i.e., culvert) that blocks anadromous fish passage downstream of the intake, though the barrier is unassociated with the hatchery facility. If the barrier is addressed/remedied and anadromous fish

passage is restored, then the SSIT proposes to upgrade the intake to meet NMFS standards in place at the time. This facility will provide up to approximately 320 pounds of fish per year and, therefore, does not require a NPDES permit (NMFS 2022a).

- The Upper Skagit Hatchery will withdraw water and discharge effluent between November and May of each year. This facility uses up to 0.56 cfs of surface water from the creek and up to 0.12 cfs of groundwater (NMFS 2022a). The surface water withdrawal affects approximately 700 ft (213 m) of the creek. At this facility, intake screening has clear openings of 3.18 millimeter [mm] (0.32 centimeter [cm]), which is nearly twice as large as the 1.75 mm (0.18 cm) indicated in both current NMFS (2011, 2022b) and previous NMFS (1995, 1996) compliance standards. Other aspects of the screening (e.g., cleaning and maintenance plan) meet current standards. This facility provides up to approximately 650 pounds of fish per year and, therefore, does not require an NPDES permit (NMFS 2022a).

5.9 Conservation Measures

The following subsections summarize conservation/minimization measures, in addition to those stated above in the description of the proposed action.

5.9.1 Broodstock Collection

During broodstock collection at all hatchery facilities, the co-managers will minimize stress and injury to fish, especially during capture and handling of incidentally-captured and/or non-target species such as bull trout. The co-managers will adhere to the following general BMPs:

- Attend to nets (e.g., modified gill nets/tangle nets, and set nets) at all times;
- Maintain short seine sets (i.e., less than 10 minutes), as necessary;
- Free incidentally-captured fish from the capture gear as soon as possible and with the minimum handling necessary;
- Handle all incidentally-captured fish in the water to the greatest extent practicable, while in-air handling will occur only to the extent absolutely necessary;
- May hold incidentally-captured fish for up to 5 hours, during daylight hours, in portable, fully enclosed net pens, flexible and/or rigid fish tubes (i.e., large-diameter, perforated PVC pipes with end caps), and release them immediately after broodstock collection activities are complete;
- Avoid recapturing the same bull trout individuals, when practicable;
- Ensure that individuals engaged in broodstock collection activities will be trained and knowledgeable in fish identification and safe fish handling procedures and protocols; and,
- Record and report all bull trout encounters to the USFWS and WDFW.

Additionally, during in-river broodstock collection for the Skagit River Fall Chum Salmon Program at the Marblemount Hatchery, the co-managers will adhere to the following practices while seining:

- Land all captured fish as quickly as possible; and,
- Keep seine sets short (i.e., typically less than 10 minutes) (NMFS 2022a; WDFW et al. 2019).

5.9.2 Hatchery Incubation, Rearing, and Release

The co-managers will monitor (annually) the size and timing of hatchery releases to identify spatial and/or and temporal overlap among natural-origin and hatchery-origin juvenile out-migrant populations.

5.9.3 Pathogen Prevention, Monitoring, and Control

The co-managers will continue to operate all hatchery facilities in compliance with the Control Policy (WDFW and WWTIT 2006). Hatchery staff and fish health professionals will monitor (daily and monthly) fish health. Hatchery staff will carry out treatments, as recommended by fish health professionals, consistent with operation practices/protocols (NMFS 2022a; WDFW et al. 2019).

5.9.4 Water Withdrawal and Discharge

At the Marblemount Hatchery, the co-managers will regulate all hatchery effluent discharge(s) through NPDES permits administered by Ecology. Other hatchery facilities included in this consultation will operate below production and feed thresholds that would otherwise require NPDES permits.

5.9.5 Operations and Maintenance of Hatchery Facilities

The co-managers will continue to carry out standard hatchery maintenance procedures, including removing sediment from hatchery ponds and monitoring influent and effluent discharges in accordance with NPDES standards.

Chemicals typically used for ground maintenance include Roundup, Rodeo, and Crossbow herbicides. The application of these chemicals will follow manufacturer’s recommendations and will occur away from the water and during only dry periods to avoid runoff(s) (NMFS 2022a; WDFW et al. 2019).

5.10 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, the USFWS 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 places within, and/or immediately adjacent to, the Basin, including the mainstem Skagit River and its tributaries, along with four main sub-basins: Cascade, Sauk, Skagit, and the Suiattle River watersheds, as depicted in Figure 4. The action area includes all waters in which broodstock collection, egg incubation, juvenile rearing and release, water withdrawal, effluent discharge(s), facility operations maintenance, monitoring, and disturbances will occur and that are associated with the chum salmon hatchery program activities, including bull trout capture and handling, sediment disturbance, in-air sound, and intra- and interspecies interactions. The action area includes all waters in which chum salmon originating from the three chum salmon hatchery programs in the Basin are likely to move/migrate, potentially stray, and spawn.

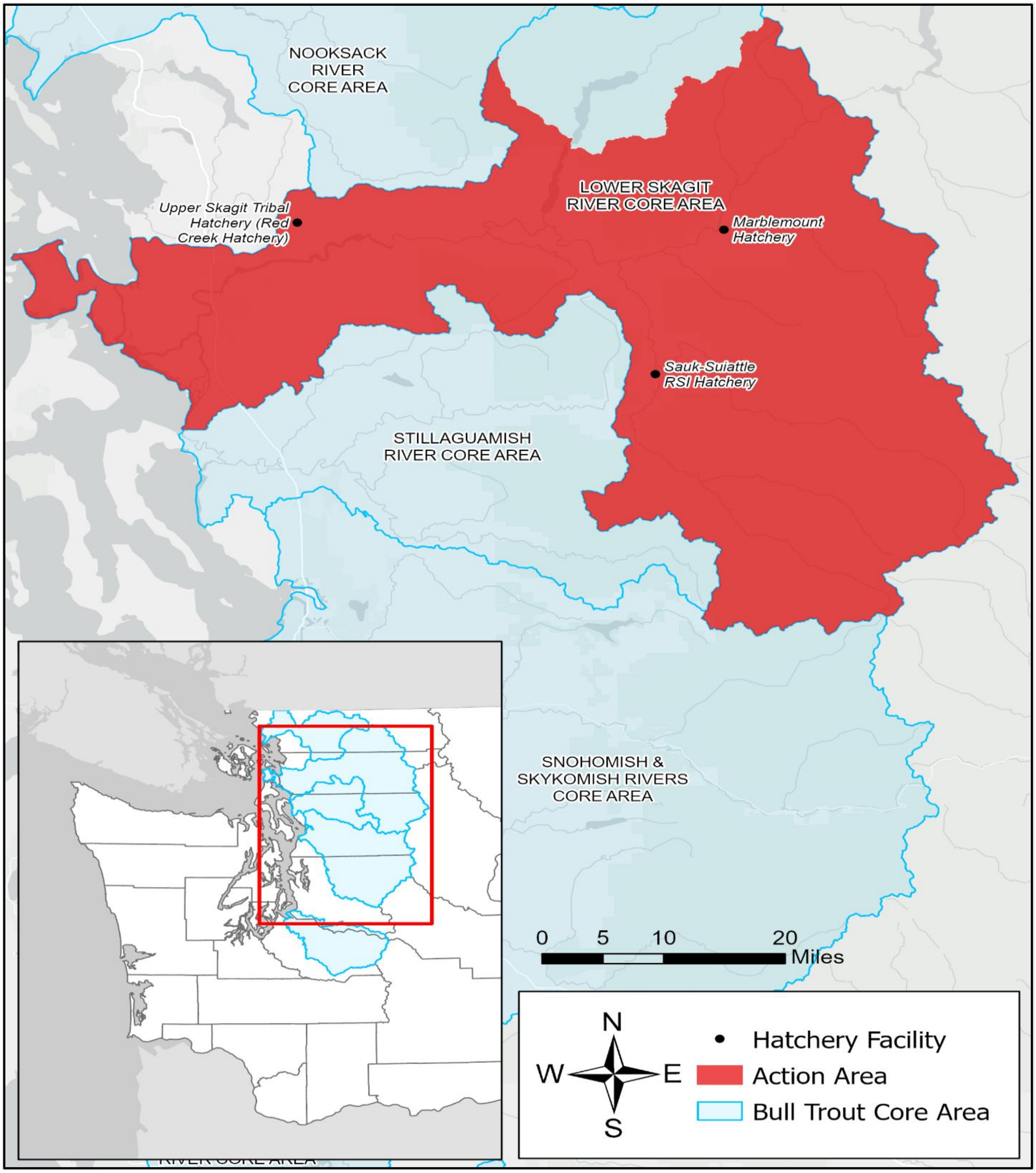

Figure 4. Map of the action area, which includes the three chum salmon hatchery facilities in the Skagit River basin.

6 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

6.1 Jeopardy Determination

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

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

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

6.2 Adverse Modification Determination

Section 7(a)(2) of the ESA requires that federal agencies ensure that any action they authorize, fund, or carry out is not likely to destroy or to adversely modify designated critical habitat. A final rule revising the regulatory definition of "destruction or adverse modification of critical habitat" was published on February 11, 2016 (81 FR 7214). The final rule became effective on March 14, 2016. The revised definition states: "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features."

Designations of critical habitat prior to February 11, 2016 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 a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. For those reasons, in this 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.

Our analysis for destruction or adverse modification of critical habitat relies on the following four components: 1) the Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of essential features, PCEs, or PBFs, depending on which of these terms was relied upon in the designation, the factors responsible for that condition, and the intended recovery function of the critical habitat overall; 2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; 3) the Effects of the Action, which determines the direct and indirect impacts of the proposed federal action and the effects of any interrelated or interdependent activities on the essential features, PCEs, or PBFs and how those effects are likely to influence the recovery role of affected critical habitat units (CHUs); and, 4) cumulative effects, which evaluates the effects of future, non-federal activities in the action area on the essential features, PCEs, or PBFs and how those effects are likely to influence the recovery role of affected CHUs.

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

7 STATUS OF THE SPECIES: Bull Trout

On November 1, 1999, the USFWS listed the bull trout as a threated species in the coterminous U.S. (64 FR 58910). The combined effects of habitat degradation, fragmentation, and alterations associated with incidental angler harvest, entrainment, barriers (e.g., dams and/or other diversion structures) to migratory corridors, poor water quality, dewatering, road construction, maintenance, mining, grazing, and the establishment of non-native species continue to threaten bull trout throughout its range. The order, frequency/intensity, duration, and magnitude of these effects vary by area and among bull trout local populations (USFWS 2015a).

The USFWS' 2015 Recovery Plan for the Coterminous U.S. Population of Bull Trout (Recovery Plan) identifies six Recovery Units within the listed range of the species. The Recovery Plan further classifies each Recovery Unit into multiple bull trout core areas[2], and each core area includes one or more bull trout local populations (USFWS 2004). Within the coterminous U.S., the USFWS recognizes 109 occupied core areas, comprising more than 600 bull trout local populations (2015a, 2015b). Core areas are functionally similar to bull trout metapopulations, as bull trout within a core area are more likely to interact—both spatially and temporally—than those from separate core areas (Dunham and Rieman 1999). The USFWS has also identified marine or mainstem riverine habitats, outside of bull trout core areas, that provide critical foraging, migratory, and overwintering (FMO) opportunities for bull trout that move through multiple core areas. Shared habitat areas support the viability of bull trout populations by contributing to successful foraging, dispersal between and among core areas, and overwintering survival (USFWS 2015a, 2015b).

Since the federal bull trout listing, few changes in the general distribution of bull trout have occurred. The USFWS is unaware that any known, occupied bull trout core areas have been/become extirpated (2015a). However, the USFWS has observed declines in population density in many of the core areas, while only few core areas have maintained or substantially increased with respect to their population density.

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.

[2]A core area is the basic unit on which to gauge bull trout recovery within a recovery unit. A core area is composed of core habitat (i.e., habitat that could supply all elements for the long-term security of bull trout) and a core population (i.e., a group of one or more bull trout local populations that exist within core habitat).

8 STATUS OF DESIGNATED CRITICAL HABITAT: Bull Trout

On October 18, 2010, the USFWS issued a final revised critical habitat designation for the bull trout (70 FR 63898). The critical habitat designation further classifies bull trout Recovery Units into 32 CHUs, dispersed throughout the coterminous range of the species in Idaho, Montana, Nevada, Oregon, and Washington (USFWS 2010a; 2015a). Designated critical habitat is composed of two primary use-types, including: 1) spawning and rearing; and, 2) FMO habitat. CHUs and their subunits generally encompass one or more bull trout core areas, and they may include FMO habitat, outside of core areas, that is integral to the survival, recovery, and conservation of bull trout (USFWS 2010a). The conservation role of designated critical habitat for the bull trout is to support current and future viable core areas and their local populations (75 FR 63943).

The critical habitat designation excludes some critical habitat segments. For example, critical habitat for the bull trout excludes: 1) waters adjacent to non-federal lands covered by legally-operative Incidental Take Permits for Habitat Conservation Plans, issued under the ESA, in which bull trout is a covered species on or before the publication of the 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 collective efforts, and where the tribes indicate inclusion would impair their relationship with the USFWS; and/or, 3) water where impacts to national security have been identified (75 FR 63898) (USFWS 2010b).

8.1 Primary Constituent Elements

Bull trout have more specific habitat requirements than most other salmonids (USFWS 2010a; 2010b). The predominant habitat components influencing their distribution and abundance include the following: water temperature; cover; channel form and stability; spawning and rearing substrate(s) type and substrate conditions; and, access to migratory corridors. Revised in 2010, the nine PCEs for bull trout include:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (i.e., 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 (LW), 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 (from 36°F to 59°F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of non-native predatory fish species (e.g., lake trout [*S. namaycush*], walleye [*Sander vitreus*], northern pike [*Esox Lucius*], and smallmouth bass [*Micropterus dolomieu*]); interbreeding (e.g., brook trout [*S. fontinalis*]); or, competing (e.g., brown trout [*Salmo trutta*]) that, if present, are adequately spatially and temporally isolated from bull trout (USFWS 2010a; 2010b).

For a detailed account of the status of 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 ESA (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, state, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed federal projects in the action area that have undergone section 7 consultation, and the impacts of state and private actions which are contemporaneous with the consultation in progress.

9.1 General Baseline Conditions

The following subsections describe parts of the environmental baseline as they relate to bull trout and designated critical habitat for the bull trout in the action area. The BA (WDFW et al. 2019) includes additional details about the environmental baseline, offering a broader lens and larger scope through which to consider the effects of the proposed action over time.

9.1.1 Skagit River Basin

Nestled in the northwestern Cascades, the Basin extends from headwaters in southwestern British Columbia to the mouth of the river in the Puget Sound lowlands, draining a total area of approximately 3,093 square miles (8,011 square kilometers [km^2]) (USFWS 2004). There are three major tributaries to the Skagit River, which include the Baker, Cascade, and Sauk-Suiattle Rivers. The Sauk-Suiattle River is the largest tributary to the Skagit River, draining a total area of 732 miles (1,178 km). The Basin is comprised of two geographic regions including the lower and upper portions of the Skagit River (USFWS 2004). SCL operates three hydroelectric dams (i.e., Ross, Diablo, and Gorge) on the Upper Skagit River, and PSE operates two hydroelectric dams (i.e., Lower and Upper Baker) on the Baker River. These projects generate hydropower and provide flood control and recreational opportunities (Corps 2014; Lee and Hamlet 2011).

Natural vegetation in the Basin includes Douglas fir (*Pseudotsuga menziesli*), Pacific silver fir (*Abies amabilis*), red alder (*Alnus rubra*), subalpine fir (*A. lasoicarpa*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), and other mixed conifers. Human activities (e.g., logging and the construction of levees and dikes) and overall development in the Basin have created a strong local economy, but they have also dramatically impacted the hydrology of the Basin as a whole, the geomorphology of the Skagit River valley, and ecosystems, primarily in the lower basin. The lower mainstem of the Skagit River is considered to have the most degraded instream habitat in the Basin due to degradation of floodplain areas, extensive loss of wetlands, channelization, lack of in-channel LW, sedimentation, and impacts resulting from high road density and flood control levees. Headwater areas of the Basin, although they have been logged and developed for water resource management purposes, are relatively pristine (Lee and Hamlet 2011).

Mean annual precipitation in the upper portion of the Skagit River is approximately 254 cm (2.54 m), with mean air temperatures of 7.2°C to 21.2°C (45°F to 70.2°F) in the summer and 10.6°C to 2.2°C (51.1°F to 36°F) in the winter. The U.S. Geological Survey (USGS) maintains 15 monitoring stations throughout the Basin that measure discharge and gage height and, at some sites, also evaluate water temperature, sediments, and other water quality data. In the upper reaches of the Lower Skagit River Core Area, near Newhalem, Washington, the mean annual stream temperature of the Skagit River is 7.59°C (45.7°F) and the mean annual flow is 4,513 cfs (USGS Gage 121780000). In the upper reaches of the Skagit River, near Marblemount, Washington, mean annual stream temperature of the Skagit River is 7.82°C (46.1°F) and the mean annual flow is 6,114 cfs (USGS Gage 12181000). Near the confluence of the Skagit and Cascade Rivers, in close proximity to Marblemount, Washington, the Cascade River has a mean annual stream temperature of 7.73°C (45.9°F) and a mean annual flow of 1,101 cfs. There is additional historical USGS data from the 1940s on other systems, including Jordan and Clark Creeks, however current, more comprehensive data is lacking. The Sauk River, near Sauk, Washington, has a mean annual stream temperature of 8.61°C (47.5°F) and a mean annual flow of 4,374 cfs. Snowmelt primarily feeds the Sauk River, and it is the largest source of sediment to the Skagit River (Skagit Watershed Council 2011). While there is not an operational USGS gage on either Red or Hansen Creeks, the annual mean flows for the two years on record were 15 cfs (1944) and 23.3 cfs (1945), respectively. Based on the gage located north of the Upper Skagit Hatchery on Hansen Creek, Ecology estimates the annual mean flow to be 25.4 cfs. Northeast of the Skagit River, the Mount Vernon USGS gage measures the highest flows, generally occurring in June, as they are associated with spring and summer snowmelt (USGS 2022). Typically, low flows occur in September.

Of all the drainages in the Puget Sound (also referred to as the Salish Sea), the Skagit River is the largest and produces the greatest number of salmonid species and the greatest abundance of salmonids. The Skagit River is home to bull trout, all five Pacific salmon and steelhead, rainbow, and cutthroat trout (*O.* spp.) (Corps 2014). The Skagit River delta, with its mixed landscape of estuarine, intertidal, and agricultural habitats, also supports larger wintering populations of migratory birds including waterfowl and shorebirds.

There are five tribal nations with reservations or Usual and Accustomed fishing rights in the Basin. These tribal nations include: the USIT, the SSIT, the Swinomish, the Samish Indian Nation, and the Lummi Nation. The tribal nations are active and influential participants in management of the Basin (through the Skagit River System Cooperative, for example) and have strong cultural and economic interests in the Basin (Corps 2014).

9.1.2 Coastal-Puget Sound Distinct Population Segment

In 1999, as part of the federal listing, the USFWS issued a final rule determining the threatened status for the Coastal-Puget Sound Distinct Population Segment (DPS) of bull trout. Bull trout from the Coastal-Puget Sound DPS occur in the action area. The Coastal-Puget Sound DPS is unique and important to the species rangewide because it contains the only anadromous form of bull trout in the coterminous U.S. (Rieman and McIntyre 1993; USFWS 2004). Thus, of the five DPS of bull trout, only the Coastal-Puget Sound DPS provides the opportunity to conserve all known life history forms (i.e., fluvial, adfluvial, resident, and anadromous) of the species. The loss of this DPS would significantly reduce the overall range of the taxon (64 FR 58910). The Puget Sound Management Unit (PSMU) is one of the two management units comprising the Coastal-Puget Sound DPS of bull trout (USFWS 2004). The PSMU includes reservation land, tribally owned lands, and/or tribal fishing areas of various tribes including the USIT, the SSIT, the Swinomish, the Samish Indian Nation, the Lummi Nation, and more (USFWS 2004). The action area is located, broadly, in the Coastal Recovery Unit (CRU). In the CRU, there are 21 designated existing bull trout core areas and 4 historically occupied core areas that have the potential of reestablishment. The only core areas that currently support anadromous, local populations of bull trout occur in the Puget Sound and the Olympic Peninsula geographic regions, which are located entirely within Washington (USFWS 2015a, 2015b). Within the CRU, there are eight Puget Sound Core Areas, including the: Chilliwack River, Nooksack River, Upper Skagit River, Lower Skagit River, Stillaguamish River, Snohomish and Skykomish Rivers, Chester Morse Lake, and the Puyallup River Core Areas (USFWS 2015c). Only five of these core areas however, are connected to the Puget Sound and, therefore, pertinent to this consultation. The action area is located in the Lower Skagit River Core Area.

Anadromous bull trout forage, migrate, and overwinter along the nearshore (i.e., generally, in waters less than 33 ft (10 m deep), and they are opportunistic foragers, often traveling to access and forage on seasonally abundant prey resources (e.g., forage fish including surf smelt [*Hypomesus pretiosus*], Pacific herring [*Clupea pallasii*], Pacific sand lance, and other small schooling fish), keying in, particularly, on spawning beaches (Kraemer 1994). Bull trout migrate and/or move from freshwater to marine areas between March and July, while the majority of individuals return to freshwater tributaries by August (Goetz et al. 2012; Hayes et al. 2011). Due to the life history requirements of bull trout, the USFWS expects that some level of mixing and/or interactions within marine waters occurs among anadromous individuals originating from various core areas.

Although research studies have documented bull trout moving from marine waters into non-natal rivers and tributaries, the USFWS does not yet understand the full extent of this behavior. Regardless, we anticipate that anadromous bull trout originating from several nearby core areas may be present within the action area simultaneously. For instance, due to the proximity of the Lower Skagit River Core Area to the Nooksack, Snohomish and Skykomish, and Stillaguamish River Core Areas (Figure 5), the USFWS assumes that bull trout individuals are more likely to move into these core areas than other core areas (e.g., Puyallup River Core Area) from the action area. Bull trout in the Chester Morse, Chilliwack, and Upper Skagit River Core Areas are functionally isolated from the Puget Sound, either because of dams or the fact that the core area is associated with the Fraser River in Canada and, thus, bull trout individuals are unlikely to access these core areas from the action area.

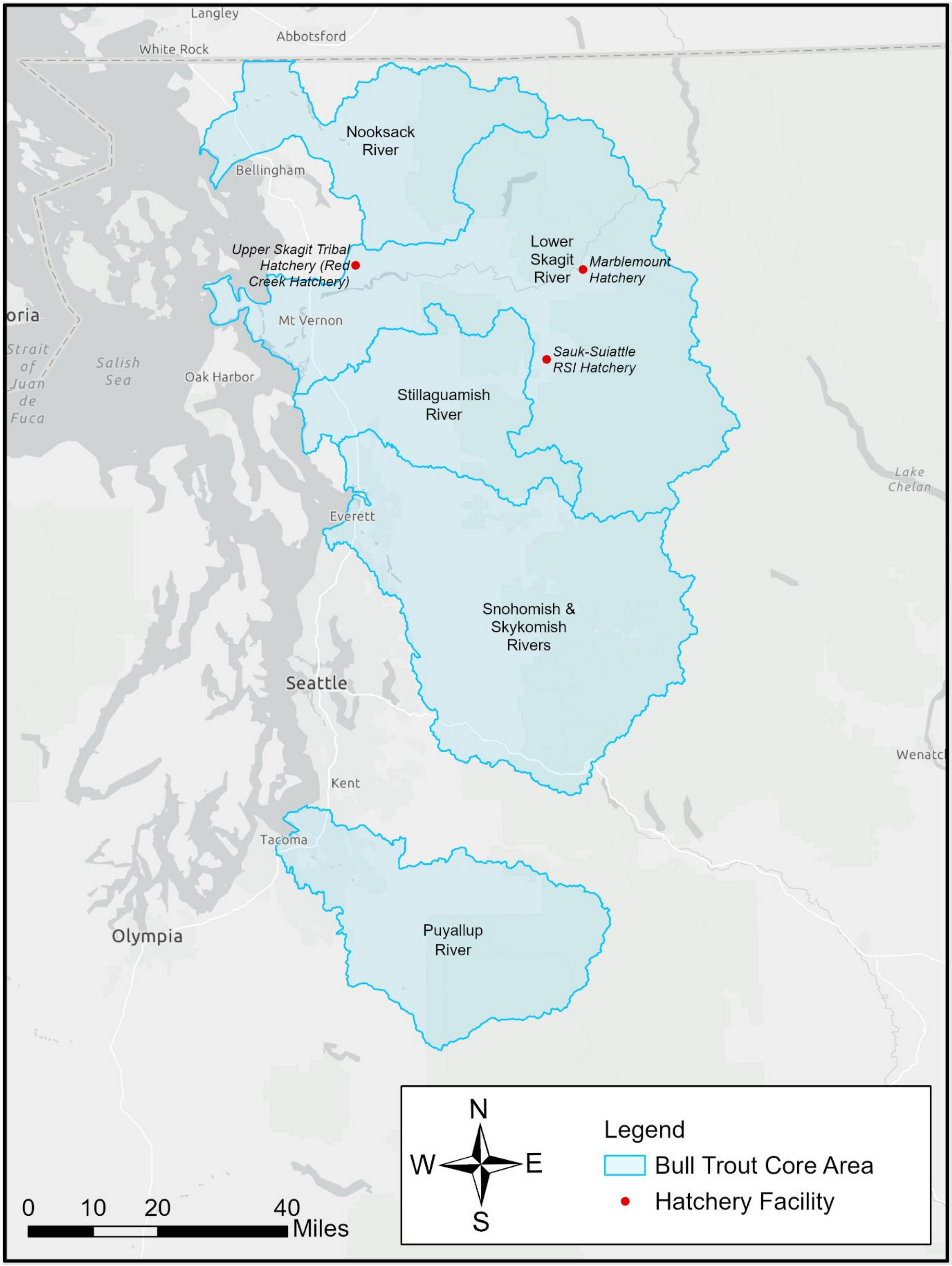

Figure 5. Map of five of the eight core areas in the Puget Sound Geographic Region, including only those that are directly connected to the Puget Sound.

9.1.2.1 Puget Sound Geographic Region

Residential and industrial development have resulted in increased bank armoring, and expansions of marinas, piers, and docks in the Puget Sound, thereby impacting bull trout and their prey resources. In most areas, these threats are ongoing and persistent. However, restoration actions including fish passage improvements, levee setbacks, estuary rehabilitation, and others are enhancing the habitats that support bull trout. Such benefits are achieved over time and may not be immediately measurable.

In 2015, the Puget Sound geographic region was composed of three core areas—the Lower Skagit River, Upper Skagit River, and the Chilliwack River Core Areas—that were considered bull trout population strongholds. Two core areas—the Stillaguamish River and the Puyallup River Core Areas—were considered to have small bull trout population sizes (USFWS 2015a). Bull trout surveying and monitoring within individual core areas occurs at different levels and frequencies. While some core areas are characterized by long-term data that can be used to provide information on the status and trends of bull trout local populations, other core areas are not; in these cases, the USFWS advocates that, when appropriate, information be extrapolated to other core areas when and where that information is currently lacking. Based on what we know from bull trout surveying and monitoring conducted through 2021, the Puget Sound geographic region of the CRU is exhibiting unstable and/or declining bull trout numbers in several core areas.

In general, anadromous bull trout use shallow nearshore, subtidal, and intertidal waters to carry out their life history strategies. Upon entering marine waters, bull trout can make extensive, rapid migrations, usually in nearshore marine areas. Within the Puget Sound geographic region, there are no physical barriers to bull trout that migrate and/or move among core areas and enter into the Puget Sound. Bull trout occur regularly throughout the nearshore marine areas of the north Puget Sound, and there are ongoing studies of bull trout use of the Puget Sound nearshore (Goetz et al. 2004; 2021). The USFWS assumes that variable levels of spawning migrations occur across the action area and, therefore, during the marine residency period (between March and July), up to approximately 55 percent of the anadromous adult and subadult migratory individuals from each core area could be in Puget Sound (Brenkman and Corbett 2005; Goetz et al. 2007, 2021). Based on this information, the USFWS conservatively assumes that fewer than 25 percent of the anadromous bull trout will remain in marine areas during the non-marine residence period (between August and March).

Seasonally, bull trout may use reaches of river systems and estuaries that are unlikely to support spawning populations of bull trout, such as the Samish and Duwamish Rivers. While occupying these areas, bull trout may forage on juvenile salmonids and/or other fish species. The extent of prior and current bull trout use of smaller, independent creek drainages that discharge directly into the Puget Sound is not well known, however these water bodies still uniquely contribute to enhancing the potential prey resource base for bull trout that use adjacent nearshore marine waters and/or other parts of the Puget Sound.

9.1.3 Hatchery Facilities in the Action Area

The hatchery programs and facilities in the action area are located (Figure 1) and operated in the Basin (downstream of the SCL dams). The following subsections summarize information about the three chum salmon hatchery facilities, which are analyzed in this Opinion.

9.1.3.1 Marblemount Hatchery

The Marblemount Hatchery is a fully functional, WDFW-owned and -operated hatchery located at RM 1 on the Cascade River (or approximately 0.2 RM on Clark Creek). The hatchery operates several salmonid rearing programs for salmon, steelhead, and trout. There is a permanent weir on Clark Creek, which is operated most of the year (between May and mid-March or later). The weir blocks access for fish to approximately 0.5 mile (0.8 km) upstream (between the hatchery and its feeder spring). However, during high flow events, water moves over the screens of the lower weir, and juvenile fish can swim up Clark Creek and become entrained. The frequency of these high flow events varies annually, but, generally, they either do not occur or can occur up to once or twice per year (B. Dymowska in litt. 2022). At present, the WDFW and co-managers have not observed any entrained fish above the weir. There is a fish ladder on Jordan Creek, located at the water intake structure for the hatchery, which provides fish passage.

Hatchery effluent is primarily discharged into the Cascade River. The most common effluents discharged during hatchery operations include: formalin used for egg, juvenile, and adult treatments to prevent fungal and parasitical infections; iodine used for disinfection and water hardening eggs; tricaine methanesulfonate (MS-222), an anesthetic used for fish sedation during marking and/or handling; antibiotics used to treat occurring diseases, as necessary; and, bleach and sodium sulfonate for disinfection during fish marking. Effluent from raceways 1, 2, and 3 is directly discharged into the river. Additionally, well water from these three raceways and adult holding pond and smolt release channel is discharged into the river.

At Marblemount Hatchery, the co-managers clean standard ponds on a weekly basis, and channels twice per year. Given the relatively low volume of discharge from this facility relative to the receiving waters, even at the lowest annual flow periods, the co-managers expect effluent to be highly diffuse and diluted within a short period of time. The Marblemount Hatchery has an established record of no exceedances for the past 10 years.

9.1.3.2 Sauk-Suiattle Hatchery

The Sauk-Suiattle Hatchery is a small, tribally-owned facility located adjacent to Hatchery Creek, a left-bank tributary to the Sauk River. The Sauk-Suiattle Hatchery is not a full fish hatchery; rather, this facility is a remote site incubator (RSI) specific to the Sauk River chum salmon program. Hatchery managers hold chum salmon fry in Redd Zone incubators before releasing them into the Sauk River during April and May. Though the Water River Inventory Assessment catalog reports that chum and coho salmon do use the tributary, the co-managers have not observed any fish above and below the culvert located at Christian Camp Road and State Route 530. There are plans to remove this culvert in the future as the fish barrier is neither associated with nor owned by the SSIT.

9.1.3.3 Upper Skagit Hatchery

The USIT owns and operates the Upper Skagit Hatchery, which is located on the USIT Reservation. Red Creek is a small creek that has been impacted by prior and current logging operations. Both Red and Hansen Creeks are listed on Ecology's 303(d) List of Impaired Waters. The Upper Skagit Hatchery is a small facility that incubates eggs for a few months and rears fry only for a few weeks before release. Although extensive habitat restoration projects have enhanced Hansen Creek, Red Creek is still characterized by partial barriers below the hatchery operations area that limit movements and migrations of other salmonids. Bull trout, Chinook salmon, and steelhead have not yet been observed in Red Creek (WDFW et al. 2019).

9.2 Current Condition of the Species in the Action Area

The action area for this proposed federal action is based on the geographic extent of the places within, and/or immediately adjacent to, the Basin, including the mainstem Skagit River and its tributaries downstream of the confluence of the Cascade and Skagit Rivers, near the town of Marblemount and the lower reaches of the Cascade, Sauk, and Suiattle River watersheds, and the lower Skagit River (Figure 4). The action area includes all waters where fish originating from the proposed chum salmon hatchery programs are likely to move/migrate, potentially stray, and spawn. The action area does not include the Baker River watershed or areas upstream of the SCL dams near Newhalem (Upper Skagit River Core Area).

The USFWS recognizes 20 bull trout local populations in the Lower Skagit River Core Area (USFWS 2004, 2021a). The action area does not include the two bull trout local populations in the Baker River watershed. We expect that core areas with more than 10 interconnected local populations are characterized by a diminished rate of local extirpation and adverse effects from naturally occurring events (USFWS 2004). Sixteen of the eighteen local populations of bull trout are in the core area and, thus, in the action area; four local populations are in tributaries draining into the Skagit River (i.e., Bacon Creek, Goodell Creek, Illabot Creek, Newhalem Creek, and Stetattle Creek), two are in the Cascade River drainage (i.e., South Fork Cascade River and Upper Cascade River local populations), eight are in the upper Suiattle River drainage (i.e., Buck Creek, Downey Creek, Lime Creek, Milk Creek, Straight Creek, Sulphur Creek, Tenas Creek, and Upper Suiattle Creek local populations), and two are in the Sauk River watershed (i.e., Forks of Sauk River, Lower White Chuck River, and Upper White Chuck river local populations).

Bull trout occur throughout the Skagit River and express fluvial, adfluvial, resident, and anadromous life history forms. Fluvial bull trout forage and overwinter in the larger pools of the upper portion of the Skagit River and, to a lesser degree, in the Sauk-Suiattle River watershed (Kraemer 2001). A small number of adfluvial juvenile bull trout originating from local populations in the upper Baker Lake headwater area (outside of the action area) could potentially use the mainstem Skagit River for foraging and/or overwintering purposes. Bull trout populations that express the resident life history form can be found throughout the Basin and often co-occur with migratory life history forms. The life history expression of bull trout is highly plastic; individuals may change life history forms during their lifetimes (USFWS 2008). Additionally, the life history form(s) of progenies may vary from that of the parents (Brenkman et al. 2007; Rieman and McIntyre 1993). The closest populations of bull trout to the Lower Skagit River Core Area are located in the Nooksack and Stillaguamish River Core Areas. Anadromous bull trout from these two adjacent core areas may forage and/or overwinter in the Skagit River and, thus, may be seasonally present throughout the action area.

Many adult and subadult bull trout use the lower portions of the Skagit River, estuary, and nearshore marine areas extensively for foraging and rearing. Key spawning and early rearing habitat is generally located in the upper portion of the Skagit River, on federally protected lands including the North Cascades National Park, North Cascades National Recreation Area, Glacier Peak Wilderness, and the Henry M. Jackson Wilderness Area. National Park and Forest lands, Recreation Areas, and Wilderness Areas contain most of the best available remaining spawning and rearing habitat for bull trout, steelhead, and salmon (USFWS 2004).

The following subsections summarize the status of the Lower Skagit River Core Area bull trout local populations.

9.2.1.1 Abundance and Productivity

Based on the available information, the Lower Skagit River Core Area contains the largest spawning population of bull trout in Washington. During the 5-year review conducted in 2008, the USFWS estimated bull trout adult abundance to be between 2,500 and 5,000 individuals based on partial spawner survey data from less than half of this core area (USFWS 2008). While abundance data for most bull trout local populations is severely limited and/or outdated, the USFWS acknowledges that bull trout adult abundance has declined since 2008. We describe these data below. More recent, new, and/or higher quality survey data for most local populations is critical in order to reach more confident conclusions regarding bull trout abundance in this core area.

Since 2002, various agencies (e.g., WDFW) have conducted spawning ground surveys and bull trout redd counts in the Lower Skagit River Core Area. The peak number of redds was observed in 2006 (n = 855) and 2014 (n = 1,010). Between 2015 and 2020, the number of bull trout redds decreased to the lowest number of redds observed since 2002 (n = 109). Similarly, the 6-year mean shows a decline in bull trout redd numbers between 2014 and 2020.

In 2020, redd numbers declined in most streams, with the lowest number of redds found in Illabot Creek (n = 8) and the South Fork Sauk River (n = 2, redd density = 0.5 redds per mile). During exploratory surveys of Goodell Creek, WDFW observed and flagged 9 redds (Fowler 2021). Based on these data, while habitat quality is generally satisfactory across this core area, bull trout abundance appears to be declining in the Lower Skagit River Core Area (Fowler 2019-2021; McKinney et al. 2021). Cumulatively across the bull trout spawning index reaches, the number of redds observed in 2020 (excluding Goodell Creek) was 42.9 percent less than what was observed in 2019.

Following the overall decline in bull trout redd counts in the Lower Skagit River Core Area, the USFWS has observed similar declines in captures of juvenile bull trout in the outmigrant smolt trap at RM 17 in the mainstem. Based on the available information, the USFWS estimates that the current bull trout population in the Lower Skagit River Core Area is likely less than half (current abundance estimate is between 1,000 and 1,500 breeding adults, approximately) of the abundance estimates presented in the 2008 status review, published 15 years ago. Figure 6 depicts declining trends observed during annual bull trout surveys and redd counts conducted at certain index reaches from 2006 to the present.

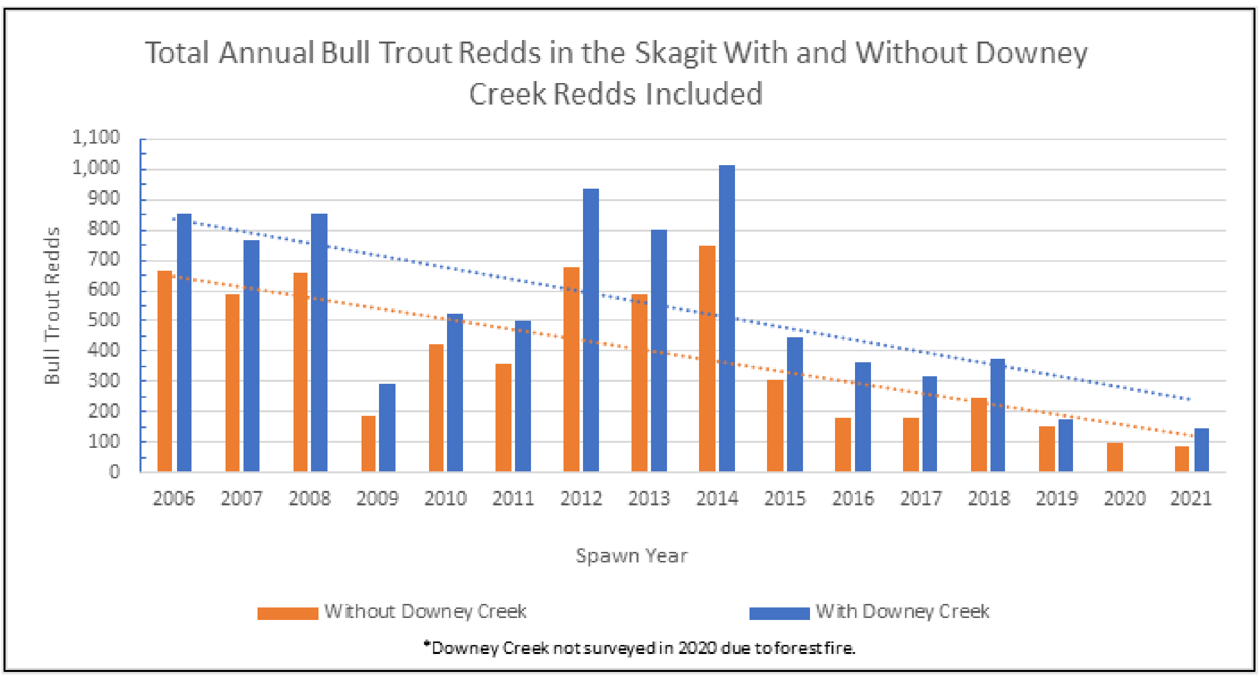

Figure 6. Summary data of Skagit River basin bull trout redds from all monitored spawning populations from 2006 to 2021. From 2009 to 2013, the Illabot Creek spawning population was not monitored due to

road washout. In 2016 and 2020, monitoring was incomplete due to stream conditions and wildfires. In 2020, monitoring efforts included surveys of Goodell Creek.
(Fowler 2021; A. Fowler in litt. 2022a)

Puget Sound Energy, which owns and manages the Baker River Hydroelectric Facility, captures adult bull trout for upstream passage, above the dam, and juvenile bull trout for downstream passage. From 2015 to 2019, upstream passage of adult bull trout has declined, however the low number of individuals transported in 2006 and 2007 is similar to that transported in 2019 (n = 10) (PSE 2019, 2020). From 2015 to 2019, downstream captures of juveniles at the Upper Baker Reservoir have also declined (from n = 129 to n = 32, respectively). In 2015 in the Lower Baker Reservoir, PSE captured 81 juvenile bull trout. In 2018 in the Lower Baker Reservoir, PSE observed the second highest number of captured juveniles since 2003 (n = 28).

While the USFWS once considered the Lower Skagit River Core Area to be one of the remaining bull trout strongholds in the CRU and, thus, at "low risk" for extirpation, the declining redd counts, number of individuals captured in smolt screw traps, and observations of bull trout during spawning surveys indicate a decreasing trend in bull trout abundance and productivity in this core area (Fowler 2019-2019; PSE 2019, 2020; USFWS 2008, 2015a).

9.2.1.2 Connectivity

Currently, in the Lower Skagit River Core Area, bull trout can migrate upstream as far as Gorge Dam. Historically, bull trout may have been able to migrate as far as Diablo Dam, located approximately 4.0 miles (6.4 km) upstream of Gorge Dam, however there is no consensus on the location of the end of anadromous passage, upstream of Gorge Dam (A. Fowler in litt. 2022b). None of the three dams currently have facilities to provide either up or downstream fish passage. The tribes are currently challenging SCL to conduct further studies and provide fish passage at the dams under the Federal Energy Regulatory Commission's relicensing process for continued operation of the dams.

Connectivity within the Baker River system, and between this system and other local populations, is partially obstructed by the Lower and Upper Baker dams, owned and operated by PSE. Bull trout passage across the dams has improved with the construction of new passage infrastructure (i.e., an adult trap-and-haul facility for upstream migrants and floating surface collectors for juveniles migrating downstream) and implementation of enhanced fish passage protocols and monitoring. The overarching bull trout passage strategy is the most effective one that can be achieved with these dams in place. However, there are limitations that prevent the passage measures from being fully effective in ensuring safe transport, which places the two bull trout local populations above the dams—Baker Lake and Lake Shannon—at an increased risk of extirpation. It is unknown how many adfluvial bull trout originating from the Baker River populations may be present or utilize the action area downstream of the confluence with the Skagit River.

9.2.1.3 Threats

There are five primary threats to bull trout in the Lower Skagit River Core Area, which include: 1) legacy forest management; 2) flood control; 3) agricultural practices and residential development and urbanization; 4) climate change; and, 5) fish passage issues (USFWS 2015a).

Impacts to the estuarine nearshore foraging habitats, along with general declines in forage fish (e.g., surf smelt, Pacific herring, and Pacific sand lance) in the marine nearshore areas of the Puget Sound also limit the resiliency and fitness of the anadromous life history form (Greene et al. 2015; Therriault et al. 2009).

Anadromous salmon represent a vital prey resource for bull trout in the Lower Skagit River Core Area. Declines in abundance of anadromous salmonids have reduced the bull trout prey resource base and may continue to limit the abundance and productivity of bull trout local populations in the Lower Skagit River Core Area (USFWS 2008). Bull trout abundance and growth rates are positively correlated with the abundance of spawning anadromous salmonids in the Skagit River and elsewhere (Copeland and Meyer 2011; Kraemer 2003; Zimmerman and Kinsel 2010). There have been other, similar correlations observed for other species as well (Bentley et al. 2012; Nelson and Reynolds 2014). Spawning fish and carcasses also stimulate ecosystem productivity, thereby increasing the abundance of aquatic macroinvertebrates and resident fish species (Cederholm et al. 1999; Copeland and Meyer 2011; Moore et al. 2008; Rinella et al. 2012). These macroinvertebrates and fish also comprise an important part of the bull trout prey resource base in the Lower Skagit River Core Area (Lowery and Beauchamp 2015). In their absence, the USFWS expects to see further declines in overall bull trout abundance.

9.3 Current Condition of Designated Critical Habitat in the Action Area

Within the CRU, the USFWS identified 8 CHUs and 26 Critical Habitat Subunits (i.e., based on bull trout abundance and distribution, connectivity, and general trends) as essential to the survival, recovery, and conservation of bull trout. Of these, the Puget Sound CHU is within the action area and corresponds with the geographic area described for bull trout. The Puget Sound CHU encompasses approximately 1,144 miles (1,840 km) of streams, 425 miles (684 km) of marine shoreline, and 40,182 acres (162.61 km^2) of lakes and reservoirs (USFWS 2010a). The USFWS has identified this area as a key area in supporting anadromous populations of bull trout throughout the Puget Sound and outer coast of Washington. The Lower Skagit River CHU is essential to bull trout conservation because it represents a stronghold for the anadromous life history form and the species within the CRU (USFWS 2010a).

The action area supports FMO habitat for bull trout in the Skagit River watershed. Outside of the action area, key spawning and rearing habitat is located in the upper portion of the Skagit River. Throughout the action area, which includes areas in which fish originating from the proposed hatchery programs are likely to migrate and move, the current condition of designated bull trout critical habitat varies considerably. Current conditions reflect natural variability, patterns of disturbance and recovery from both natural and man-made events, and the effects of earlier and concurrent, unrelated activities occurring in the riparian areas, nearshore marine environments, and the mainstem Skagit River and tributaries such as the Cascade and Sauk Rivers. While the condition of critical habitat in the upper portion of the Skagit River is still largely functional and protected on federal lands, the lower mainstems of the Skagit, Cascade, and Sauk Rivers, downstream of the communities of Marblemount and Darrington, have been degraded by roads, powerlines, and development in the floodplains, extensive bank armoring, and flood control levees. Removal of mature riparian vegetation, bank armoring, and the construction of levees have degraded instream habitat conditions and constricted the river channels, resulting in increased water velocities, bank scouring, elevated levels of turbidity, loss of side channel connectivity, and increased flooding. Natural shoreline habitat complexity is either mildly or moderately impaired throughout much of the action area. The same can be said for the condition of the bull trout prey resource base. At some locations, these habitat features and the function of critical habitat may be moderately or severely impaired.

9.3.1 Factors Responsible for the Condition of the Species

Forest management, flood control, agricultural practices and residential development and urbanization, fish passage issues, and climate change have limited the presence, abundance, and distribution of bull trout in the Basin and Lower Skagit River Core Area. These activities and/or developments have negatively affected important FMO habitat for bull trout and their prey resource base.

9.3.2 Factors Responsible for the Condition of Critical Habitat

Designated critical habitat for the bull trout is comprised of nine PCEs. These PCEs describe habitat components or features that are critical to the primary biological needs of bull trout, which include foraging, sheltering, reproduction, rearing, dispersal, and genetic exchange. Currently, all PCEs are present in the Basin. The USFWS describes the baseline conditions for each PCE in the action area below:

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

In the action area, springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) all contribute to water quality and quantity and provide thermal refugia. Streambanks in the upper portion of the action area are mostly intact with functional mature forest riparian buffers. The lower portions of the Skagit and Sauk Rivers have been channelized with extensive bank armoring and levees, reducing hyporheic connectivity and groundwater inflow. While water withdrawals for irrigation and development may be affecting groundwater inflow in the lower portion of the Skagit River to some degree, the combination of bank armoring, channelization (disconnecting the river from the floodplain), and water withdrawals likely has negatively affected water temperatures and groundwater inflow (cold water refugia) to some degree, especially in the lower mainstem of the Skagit River. In the action area, as a whole, this PCE is moderately impaired but still functional.

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

Downstream of the SCL dams, there are no fish passage barriers in the Skagit River above Marblemount and the confluence of the Baker River. Additionally, there are no up- or downstream impediments to migration in the Cascade River, Sauk River, Suiattle River, or any of the other major fish-bearing tributaries in the action area. Connectivity among most of the Skagit River local populations and foraging areas ranges from good to excellent. This PCE is currently functioning in the action area.

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

The Basin supports bull trout, all five Pacific salmon and steelhead, rainbow trout, cutthroat trout, and several other cold water fish species, and it is one of the most productive basins in Washington. In the action area, the bull trout prey resource base is seasonally augmented (i.e., from the productivity of wild runs of Chinook and coho salmon and steelhead) during hatchery releases of juvenile chum, Chinook, coho, sockeye salmon and, until 2014, winter steelhead (B. Missildine in litt. 2022). In general, the Skagit, Cascade, Sauk, and the Suiattle River watersheds are productive systems and important spawning and rearing areas for salmonids and other native fish species in this Basin. The upper watersheds have extensive forest cover and mature riparian buffers, which are essential to the contribution of LW into the system that creates habitat for juvenile salmonids as well as terrestrial and aquatic invertebrates. The largely intact conditions of the riparian areas provide an abundant prey resource base for bull trout. However, while prey resource abundance is maintained by natural productivity and augmented through hatchery production, there is an overall decline in salmonid populations and prey resources in the Basin. In the action area, this PCE is currently moderately impaired or functioning at risk.

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

Natural stream conditions in the upper watersheds (upstream of the action area) are relatively intact and largely protected on federal lands. However, stream habitat conditions in the action area and lower portions of the Skagit, Cascade, and Sauk Rivers have been degraded over time due to timber harvest, road development, channelization and the construction of levees, and agriculture. Roads, powerline corridors, and general development in the floodplains have constrained the river channels, resulting in extensive bank armoring, loss of mature riparian vegetation, limited LW to form deep pools, and disconnected side and off-channel rearing areas, all of which is contributing to an increased risk of slope failure, stream sedimentation, flooding, and degradation of instream habitat. There is little development along rivers and tributaries in the upper portion of the Skagit River, and, thus, there are abundant side channels, gravel bars, deep pools, and log jams. Apart from some apparent bank stabilization in the lower portions of the floodplains, the Skagit, Cascade, Sauk, and the Suiattle Rivers are largely unconfined upstream of the chum salmon hatchery facilities (upstream of the communities of Marblemount and Darrington). In the action area overall, this PCE is considered slightly to moderately impaired.

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

The hydrological and temperature regimes in the Basin are strongly influenced by seasonal glacial melt, snow-on-snow, and rain-on-snow precipitation events. Snow melt generally maintains relatively cool water temperatures (below 15°C [59°F]) in the upper portion of the action area (i.e., the confluence of Sauk River to Marblemount) during the summer months (USGS 2022). Although stream temperatures in the lower portion of the Skagit River can reach 18°C (64°F) during the summer months, temperatures in the upper portion of the Skagit and Sauk Rivers meet the temperature criteria for the protection of listed salmonids of 13°C (55°F) between September 1 and May 15 (EPA 2008; USGS 2022). Many of the tributaries in the Skagit River experiencing elevated water temperatures are also characterized by impaired riparian function, sedimentation issues, and/or impaired flow conditions. Within the action area as a whole, this PCE is largely functional but at risk of being moderately impaired.

PCE 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-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 amount of fine sediment suitable to bull trout will likely vary from system to system.

This PCE is not present in the lower watershed; this PCE is present only in tributaries in the upper portion of the Skagit River watershed, which is used by bull trout for spawning and rearing purposes. The lowest spawning and rearing tributaries include Illabot and Bacon Creeks, located near the community of Marblemount. Illabot Creek is a small tributary to the Skagit, situated approximately 6.0 miles (10 km) downstream of the Marblemount Hatchery, and Bacon Creek is situated approximately 3.0 miles (4.8 km) upstream of the confluence of the Cascade and Skagit Rivers. Timber harvest, road construction and maintenance, and powerline installation have negatively impacted substrate conditions in some of the lower reaches of these two streams. The vast majority of suitable spawning and rearing habitat for bull trout is situated higher up in the watersheds. Much of this habitat is located in wilderness areas or protected areas. Overall, in the action area, this PCE is functioning, but potentially at risk due to climate change.

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

The three dams (owned and operated by SCL) in the upper portion of the Skagit River generate power for Seattle, Washingotn and provide flood control during high flow events, while the two Baker River dams are owned and operated by PSE. The operation of these five dams has altered the natural flow regime in the Skagit River downstream of Marblemount. Within the action area, peak, high, low, and base flows are all regulated, and depart significantly, on a seasonal basis, from the natural hydrograph. The magnitude of peak flows has decreased by 50 percent, likely affecting the development of side channel habitat (Beamer et al. 2000). Channel confinement, bank armoring, operation of the hydropower facilities, and lack of channel/floodplain roughness all contribute to heightened velocities and shear forces within the action area. The combined impacts of development in the floodplain and operation of the dams have resulted in the reduction, isolation, and general degradation of floodplain processes in the Skagit River. In the action area, this PCE is impaired and not functioning properly.

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

In the lower portion of the Skagit River, water quality is compromised with elevated levels of nutrients (e.g., lead and copper resulting from highway runoff), wastewater treatment, failing septic systems, and agricultural impacts. The Skagit River transports large quantities of coarse and fine sediment, resulting in high baseline turbidities. Water quality in the mainstem has been negatively impacted by high road densities, poor riparian conditions, hydro-modifications (dams), bank armoring, and floodplain development, which have confined the channel and are contributing to sediment deliveries and turbidity levels that exceed natural conditions, thereby impairing floodplain function. However, the majority of rivers and tributaries in the action area currently meet Washington's surface water quality temperature criteria for the protection of salmonid spawning and incubation. Water quality is satisfactory (overall) in the upper portion of the Skagit River and does not inhibit growth, normal reproduction, and survival of bull trout in the Lower Skagit River Core Area. Thus, in the action area, this PCE is functioning and only moderately impaired.

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

The lower portion of the Skagit River supports relatively few non-native competitive and/or predatory species of concern to bull trout. Potential inbreeding species such as non-native brook trout are known to occur in the upper portion of the Skagit River, but they are spatially and temporally isolated (associated with Ross Lake and its tributaries) in the lower portion of the action area. The USFWS has identified brook trout in the watershed in addition to several spawning and rearing streams. While brook trout spawning distribution is limited in this area, their habitat overlaps with bull trout habitat, and the USFWS has detected hybrids, thereby posing the risk of continued hybridization (and potential competition) with bull trout in the action area. However, the USFWS does not consider hybridization to be a current, primary threat to bull trout due to the uncertainty of impacts resulting from increased direct interactions among species. Overall, non-native, potentially competitive and/or predatory species do not limit normal bull trout growth, normal reproduction, and survival within the action area, nor do they impair this PCE.

9.4 Conservation Role of the Action Area

The action area is located within the CRU and the Lower Skagit River Core Area. The primary function of the habitat in the action area is to serve as a migratory corridor for bull trout moving between the spawning areas in the upper Skagit River watershed and the lower river or nearshore marine areas, depending on the life history form. The action area provides foraging and overwintering opportunities to support bull trout individuals as they grow larger and more fecund, and provides connectivity and enhanced resiliency among core areas in the Puget Sound CHU. The upper portion of the Skagit River provides spawning and rearing habitat to support a population of anadromous bull trout that is estimated to exceed 1,000 breeding adults. These habitats are essential to the conservation of species within this Lower Skagit River Core Area and, more broadly, to the overall survival and recovery of the bull trout in the Puget Sound CHU.

In most cases, the PCEs are functioning in the capacity needed to provide the conservation role for bull trout; however, some PCEs are moderately impaired and/or degraded in the lower watershed. Connectivity among spawning and rearing habitat and FMO habitat within the action area is necessary for ensuring that the anadromous life history form of bull trout persists with minimal risk(s). In core areas in which multiple bull trout local populations exist, maintaining connectivity (i.e., opportunity for interactions) among these populations through movement of anadromous individuals is critical in sustaining genetic diversity and recolonizing local populations that have become extirpated.

Bull trout are opportunistic foragers. Anadromous bull trout enter marine waters seasonally to prey on forage fish as well as juvenile salmonids and macroinvertebrates. These forage species depend on the nearshore marine environment and overall marine productivity to maintain their life history forms, abundance, and distribution. Bull trout from other nearby core areas (e.g., Nooksack and Stillaguamish) also likely use the lower portion of the Skagit River seasonally for foraging or overwintering. Currently, these locations are vulnerable to destruction and/or modification resulting from human activities due, broadly, to urban and rural development and other anthropogenic factors/influences. Existing conditions in some areas reduce the ability of the action area to fully support the conservation value of bull trout and critical habitat for the bull trout.

9.5 Climate Change

Consistent with USFWS policy, our analyses under the ESA 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). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature and/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). 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). 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.

Global mean surface temperatures in the Pacific Northwest are projected to change at the rates of 0.1°C to 0.6°C (0.2°F to 1.1°F) per decade, while changes in annual mean precipitation are projected to be variable, with a projected increase of 1 percent by the 2020s and 2 percent by the 2040s (ISAB 2007). Researchers project that these increases will be largest in the summer (Mote et al. 2014). In general, warmer temperatures have increased the frequency of warmer extremes and mitigated cooler averages (Abratzoglou et al. 2014; Mote 2003), while variable precipitation patterns are likely to affect annual runoff and streamflow in river systems. In glacial-dominated systems like the Skagit, Nooksack and Puyallup-White core areas, climate change is resulting in glacial retreats and loss of permanent snowfields. While the runoff during this transition phase maintains cooler water temperatures during the spring and summer snowmelt, temperatures will increase as snow and icefields are lost. Increases in region-wide summer temperature and, in certain areas, flooding, and decreases in summer flows are projected to threaten many sensitive freshwater species, including bull trout and other salmonids (Mote et al. 2014; USFWS 2015a).

The Recovery Plan summaries the USFWS' current knowledge of potential future climate change scenarios and their significance for bull trout recovery (USFWS 2015a). Bull trout rely on an abundance of diverse riverine, in-stream, and riparian habitat and cold water to carry out their foraging, overwintering, migratory, and spawning behaviors (USFWS 2015a). Thus, bull trout are, and will continue to be, particularly sensitive to the effects of warming climates and variable precipitation patterns and hydrologic regimes. Mean annual air temperature generally correlates with groundwater temperatures, which has been observed to strongly influence the distribution of many trout species (Rieman and Isaak 2007). In the Pacific Northwest, climate change will likely result in increasing air temperature, resulting in glacial retreat and loss of permanent snowfields, which will eventually negatively affect the availability of suitable cold-water habitat and refugia that is essential to support bull trout abundance and distribution, even in glacial-dominated systems (Dunham et al. 2014; Isaak et al. 2015). Additionally, climate change will likely result in more varied precipitation events such as increased flooding and more frequent high flood events, which could damage or destroy suitable bull trout habitat. Conversely, increased variability in precipitation events could also lead to lower summer flows, which would inhibit bull trout movement between and/or among important habitats (USFWS 2015a).

Bull trout require very cold (less than 10°C [50°F]) water for spawning and incubation (Dunham et al. 2014). In the Pacific Northwest, suitable spawning habitat is often found in well-connected/accessible, higher elevation river headwaters and tributaries. In consideration of climate change and impacts to hydrology, the USFWS anticipates that shifts in the timing, magnitude, and distribution of peak flows are also likely to be more pronounced in these high elevation areas, resulting in increased risk of scouring of redds (Battin et al. 2007). Increased magnitude of winter peak flows in high elevation areas is likely to affect the location, timing, and overall success of spawning and incubation among bull trout and other salmonids. Lower elevation river reaches are unlikely to provide suitable cold-water habitat for bull trout spawning, incubation, and juvenile rearing under current temperatures, let alone a warming climate. Thus, the general, anticipated effect(s) of climate change related to temperature and hydrological changes in these reaches may not be as extreme as those elsewhere. As warming occurs, thermal (i.e., cold-water) refugia will be essential to the persistence of many bull trout local populations.

Over a period of decades, climate change will likely threaten the integrity of all PCEs of designated critical habitat for the bull trout. Additionally, climate change may exacerbate other threats, including habitat degradation, both physically (e.g., reduced base flows and increased water temperature) and biologically (e.g., increased competition with other salmonids and/or non-native fish) (USFWS 2021b). The USFWS expects that projected changes in climate will create physical/biological conditions that negatively affect bull trout and designated critical habitat for the bull trout, including: varied geomorphology that reduces the presence or quality of FMO habitat; variable or elevated water temperatures that reduce bull trout survival; altered ground water exchange; and, overall contraction of the range/distribution of bull trout. In addition, increased/decreased stream flows resulting from variable precipitation patterns (e.g., extreme storm events) may lead to scouring of suitable habitat and/or fish stranding (USFWS 2015a). Increased frequency and extended period of wildfire activity may also result in habitat fragmentation and loss throughout the action area (Falke et al. 2015; USFWS 2015a).

In aquatic environments with water temperatures that approach, or are already at, the higher tolerance limits for bull trout, the USFWS believes that it will be unlikely for bull trout to adapt to, or avoid, these effects without access to cooler habitat(s). As the range and/or distribution of bull trout contracts, patch size (i.e., the contiguous catchment area of suitable FMO, spawning, and rearing habitat) decreases and connectivity is reduced. Bull trout populations will likely face increasing isolation (Dunham et al. 2014; Rieman and Isaak 2007), which could increase the risk of local extirpation (USFWS 2020). Due to variations in landform and geographic location across the range of the bull trout, it appears that some populations face higher biological risks (leading to increased loss, injury, and/or mortality) than others. For example, in areas with currently elevated water temperature(s), bull trout populations may already be at risk of adverse impacts from a changing climate (USFWS 2020).

There is still uncertainty associated with predictions regarding aquatic ecosystems and species abundance and distribution relative to the timing, location, and magnitude of climate change events, and the intensity of climate change effects (ISAB 2007). However, there is little doubt that climate change will affect many aquatic resources throughout the Pacific Northwest and Washington (Battin et al. 2007; Isaak et al. 2015; ISAB 2007; Mote et al. 2014; Rieman and Isaak 2007). In the Basin, the USFWS expects that climate change will negatively affect the Lower Skagit River Core Area by resulting in higher water temperatures, lower spawning flows, and higher magnitude of winter peak flows (Battin et al. 2007). We also expect that glacial retreat, snowpack reduction, bluff erosion, landslides, and increased peak flows will occur, resulting in higher rates of aggradation downstream (Lee and Hamlet 2011). Higher peak flows and aggradation may lead to higher levels of redd scour and smothering, resulting in mortality of eggs, incubating embryos, and pre-emergent bull trout. And, sea level rise will result in the loss of, and changes to nearshore and estuarine habitat. Overall, in the Basin, the USFWS anticipates that bull trout FMO habitats, spawning, and early rearing habitats, and individual bull trout, will be particularly vulnerable to future climate change impacts, especially given the existing altered hydrologic conditions within the Skagit River watershed and other similar systems.

Climate change is also likely to cause substantial seasonal changes in both natural and regulated flows, with more flow in the winter and spring and less in summer. The USFWS predicts that, by the 2080s, hydropower generation will increase by 19 percent in the winter and spring and decrease by 29 percent in the summer by the 2080s (Lee et al. 2016). Both current and proposed alternative flood control operations are shown to be largely ineffective in mitigating increasing flood risks in the lower portion of the Skagit River due to the distribution of flow in the Basin during floods (Lee et al. 2016). The USFWS believes that unusually low summer flows and record flood events in the mid-2000s were a primary contributor to basinwide declines in bull trout abundance and could indicate how climate change may affect bull trout in the Lower Skagit River Core Area (USFWS 2008).

The USFWS expects that the effects of climate change will continue to contribute to declines in bull trout abundance throughout the Basin. Although addressing the root causes of greenhouse gas emissions and climate change is not within our jurisdiction, management planning should account for these increased threats and proactively protect those habitats that we expect will best maintain cold water conditions that are suitable for bull trout (USFWS 2015a).

10 EFFECTS OF THE ACTION: BULL TROUT AND DESIGNATED BULL TROUT CRITICAL HABITAT

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

10.1 Exposures and Effects on Bull Trout

Adult, subadult, and juvenile bull trout, exhibiting various life history forms (e.g., resident, fluvial, adfluvial, and anadromous) are found throughout the Basin, in the Lower Skagit River Core Area, and, thus, in the action area. Rearing and foraging individuals may be found in nearly all anadromous reaches of the Basin as well as several isolated areas above the typical anadromous zone(s). The resident life history form is found throughout the Basin as well as in additional small tributaries. This form often coexists with migratory life history forms within the same local populations (USFWS 2004). The fluvial bull trout population within the Lower Skagit River Core Area typically forages and overwinters in the larger pools of the upper portion of the Skagit River and, to a lesser degree, the Sauk River. Many of the anadromous bull trout in the Basin use the lower portion of the Skagit River, estuary, and nearshore marine environments (e.g., Skagit Bay and Port Susan) exclusively for extended rearing and adult and subadult foraging.

Generally, bull trout primarily use the lower portion of the Skagit River and tributaries for FMO purposes, and they use the upper portion of the Skagit River for spawning and rearing. The three chum salmon hatchery facilities are neither located in nor immediately adjacent to known bull trout spawning and rearing areas or local populations (WDFW et al. 2019).

Given the locations of the three chum salmon hatchery facilities and programs in the Basin (Figure 1), coupled with the fact that the majority of proposed hatchery activities will be conducted in FMO habitat, the USFWS assumes that primarily adult and subadult bull trout individuals may be present in close proximity to the hatchery facilities during various times of the year and, thus, are likely to be exposed to hatchery activities (e.g., the capture of returning adult chum salmon for broodstock).

The Marblemount Hatchery is located at RM 1 on the Cascade River (or approximately 0.2 RM on Clark Creek, a tributary to the Cascade River). Spawning ground surveys and bull trout redd counts confirm that bull trout use the Cascade River (spanning from approximately RM 15 to the forks of the Cascade River in the upper Skagit River) for spawning and rearing purposes. Of the 20 bull trout local populations associated with the Lower Skagit River Core Area, 2 of these are directly associated with the upper Cascade River. During the 2020 survey and monitoring efforts, the WDFW reported the greatest number of bull trout redds in the Cascade River indices ($n = 62$). Redd density for the combined Cascade River indices was 10.7 redds per mile (Fowler 2021). Assuming the standard 2.5 adult bull trout per redd, this equates to approximately 155 adult bull trout, at minimum, associated with the Cascade River (Al-Chokhachy and Budy 2005). Juvenile bull trout may be present in tributaries to the Cascade River during rearing and for foraging purposes, and to escape high flow events during floods and/or springmelt runoff, however the extent to which juvenile bull trout occur in, or use, these tributaries is unknown.

The Sauk-Suiattle Hatchery infrastructure (incubators) is located adjacent to Hatchery Creek, a small tributary that drains into the Sauk River at RM 13.4. Two bull trout local populations are directly associated with the Upper South Fork Sauk River and Forks of the Sauk River. During the 2020 spawning ground surveys, the WDFW reported the lowest number of bull trout redds in the South Fork Sauk River (spanning from RM 4.5 to RM 9.3), with a redd density of 0.5 redds per mile and just 2 redds (at minimum, approximately 5 adult bull trout) (Al-Chokhachy and Budy 2005; Fowler 2021). In the Upper South Fork Sauk River bull trout local population, tagging data and scale analyses indicate that the migratory fish exhibit both fluvial and anadromous life history forms (USFWS 2004). The Forks of the Sauk River local population includes the North Fork Sauk River, downstream of the anadromous barrier at RM 41, and the South Fork Sauk River, downstream of Elliott Creek. In addition to these mainstem spawning areas, bull trout can spawn and rear in several small tributary streams. Additionally, the Suiattle River system has documented bull trout spawning and rearing in seven tributaries: Buck, Downey, Lime, Milk, Straight, Sulphur, and Tenas Creeks. Thus, both resident and migratory (fluvial and anadromous) adult bull trout may be present throughout the Suiattle River system (USFWS 2004).

The Upper Skagit Hatchery is located in the lower portion of the Skagit River, approximately 2.5 miles (4.0 km) northeast of Sedro Wooley, Washington. Adult and subadult bull trout may be present in the vicinity of this facility for foraging and/or overwintering purposes. In the Basin, bull trout spawning occurs in the fall months (between September and mid-November) in streams with cold-water springs and groundwater infiltration. Post-spawning fluvial and anadromous bull trout in other Puget Sound rivers often move to lower sections of the river system and, potentially, into marine habitats to overwinter. The USFWS assumes that adult and subadult bull trout originating from the Lower Skagit River Core Area will exhibit similar behavior patterns and, thus, may be present in low numbers in close proximity to the Upper Skagit Hatchery.

In the Basin, incubation and bull trout fry emergence times are unknown, although bull trout fry are most likely to emerge during the spring and early summer. Generally, bull trout subyearlings and/or fry remain relatively close to spawning areas to rear, and downstream movement of migratory life history forms does not begin until fish are yearlings or older (McPhail and Baxter 1996; USFWS 2004). Increased frequency of downstream movements of juvenile bull trout may occur due to displacement from high flow events and/or density-dependent displacement (Bellerud et al. 1997; Downs et al. 2006; Goetz 1989; McPhail and Baxter 1996). The WDFW smolt/screw trap located at RM 17 on the Skagit River has captured a small number of juvenile bull trout less than 150 mm (6.00 inches) in size at fork length, however it is uncertain whether or not these fish intentionally moved downstream or if they were inadvertently flushed downstream during high flow events (Kraemer 2001). While the number and frequency of intentional downstream movements of subyearlings (i.e., outmigrations) remain unknown, the USFWS assumes that these movements may occur and, thus, bull trout subyearlings and/or fry could be present (in low numbers) downstream of their natal rearing areas.

Foraging adult and subadult bull trout may be present in nearly all reaches of the Basin below migratory barriers (e.g., dams) throughout the year. There are limited data on migration timings of Lower Skagit River Core Area adult and subadult bull trout. The outmigration of fluvial and anadromous bull trout from rearing areas to lower watersheds and marine foraging habitats occurs between mid-March and July, which coincides with the outmigrations of juvenile coho and Chinook salmon (Zimmerman and Kinsel 2010). Anadromous adult bull trout that overwinter in freshwater outmigrate to marine habitats between March and May (Goetz et al. 2012, 2016; Hayes et al. 2011). Anadromous adult bull trout re-enter freshwater between May and August and then migrate upstream to spawning areas. Thus, the USFWS assumes that adult and subadult bull trout are moving throughout the Basin for migratory purposes between mid-March and August and into the fall (through November).

10.1.1 Insignificant and/or Discountable Effects

The following elements of the proposed action are likely to result in insignificant and/or discountable effects on bull trout.

10.1.1.1 Water Withdrawals and Hatchery Infrastructure

Fish rearing at the three chum salmon hatchery programs and facilities in the Basin requires water withdrawals from surface and/or groundwater sources. Surface water intakes can be a source of entrapment (i.e., entrainment and/or impingement) of bull trout if they are unscreened, poorly designed, and/or poorly placed. Hatchery managers often use surface water intake screens to deter or prevent fish from entering hatchery facilities through water intakes. Intake screens are designed to minimize risk of juvenile fish injury and mortality, specifically, through entrainment and impingement, and they are generally required for surface water intakes where fish are present. The presence and operation of certain hatchery infrastructure (e.g., weirs) can also be a source of entrapment of bull trout, particularly during high flow events. Generally, entrainment occurs when juvenile fish are diverted to an unsuitable area for survival, such as a through a surface water intake structure/pipe or over a physical barrier. Impingement occurs when fish encounter a physical barrier, such as a screen or weir, and they are unable to escape, usually due to high velocity flows. Both entrainment and impingement can lead to injury and/or mortality of individual bull trout.

At the Marblemount Hatchery, there are surface water intakes on the Cascade River, Clark Creek, and Jordan Creek. The USFWS discusses anticipated effects on bull trout resulting from the Cascade River surface water intake in the Adverse Effects Section of this Opinion. The surface water intakes on Clark Creek are not screened for fish because they lie above weirs that prohibit upstream movement of adult, subadult, and juvenile fish into these areas, except during occasional high flow events. The surface water intake on Jordan Creek includes screening and passage structure that meets NMFS (2011) standards and, therefore, the intake is likely to be highly protective of salmonids, including bull trout. Smaller, subadult bull trout (less than 150 mm [15 cm]) likely use the stream for foraging and overwintering purposes, and not spawning and/or rearing. Given the low likelihood that bull trout fry will be present in the area, coupled with the fact that the surface water intake is in compliance with current federal agency standards, the USFWS expects it will be extremely unlikely that adult and subadult bull trout and/or fry will be negatively affected (i.e., injured) by the Jordan Creek intake. In summary, due to the location and positioning of the surface water intakes on Clark Creek, and the screening quality and functionality of the intake on Jordan Creek, the USFWS expects that effects on bull trout associated with these intakes will be insignificant.

There are three weirs at the Marblemount Hatchery: two on Clark Creek and one near the mouth of the bypass/release channel (Figure 2 and Figure 3). The hatchery does not provide upstream passage above the weirs, and the steelhead channel upper weir (A) serves as the point of no return for adult fish (R. Mason in litt. 2022) (Figure 2). The USFWS discusses anticipated effects on bull trout resulting from the lower steelhead channel and adult trap weir (B) and the bypass/release channel weir (C) in the next subsection of this Opinion. During high flow events (i.e., when the river is above flood stage), larger salmonids, including adult and subadult bull trout that are present in the area (likely for migratory purposes), could become temporarily entrapped above any and/or all of the three weirs at the Marblemount Hatchery. In the history of the hatchery facility, weir A has overtopped only once, during which the entire facility flooded (A. Fowler in litt 2022a; R. Mason in litt 2022). Additionally, high flow events that could enable adult and/or larger subadult bull trout to pass over weir A are likely to occur during times of the year when the USFWS expects there to be few to no prey resources available in Clark Creek that would otherwise attract bull trout into this area. The USFWS believes it is extremely unlikely that adult and/or larger subadult bull trout will become entrapped in hatchery raceways above weir A. Because it is extremely unlikely that adult and/or subadult bull trout will be present in Clark Creek during these rare high flow events, we consider the effects on adult and subadult bull trout associated with the Clark Creek weir A to be discountable.

At the Sauk-Suiattle Hatchery, hatchery managers draw water above a culvert located at Christian Camp Road and State Route 530, and this culvert serves as a fish passage barrier. Though the Water River Inventory Assessment catalog reports that chum and coho salmon do use Lyle Creek, the co-managers have yet to observe any salmonids above and/or below the culvert. There are no plans to remove this culvert as the fish barrier is neither associated with nor owned by the SSIT. Hatchery managers have designed and operated the hatchery's surface water intake in compliance with current NMFS (2011, 2022b) standards. It is comprised of a stainless-steel intake box and angles screen, and no fish of any size can pass through it. Thus, the USFWS expects that effects on adult, subadult, and larger juvenile bull trout associated with the Sauk-Suiattle Hatchery will be insignificant.

The current surface water intakes at the Upper Skagit Hatchery meet neither current (NMFS 2011, 2022b) nor previous (NMFS 1995, 1996) compliance standards. The NMFS' (2022a) Opinion includes a Term and Condition that requires the co-managers to bring the screening into compliance with current NMFS (2011, 2022b) standards if the fish passage barrier below the Alpine Lake bridge is removed and there are observations of listed fish from above this location. Current screening at this facility involves clear, 3.18 mm (0.32 cm) wide openings, nearly twice as large as the 1.75 mm (0.18 cm) openings indicated in the NMFS compliance standards. Other aspects related to the screening, including a cleaning and maintenance plan, do meet current criteria. Though the screening poses a heightened risk of entrapment to any salmonid fry that may be present in the vicinity of the Upper Skagit Hatchery, there is no bull trout spawning or rearing in either the Red Creek or Hansen Creek subwatersheds. Because the closest suitable bull trout spawning and rearing habitat is in Illabot Creek, more than 50 miles (80 km) upstream from the confluence of Hansen Creek and the Skagit River, no bull trout fry will encounter the water intake structure or screens. Occasionally (seasonally), larger subadult and/or juvenile bull trout may use the lower portions of Hansen Creek for foraging or overwintering purposes, but they are unlikely to venture into Red Creek or smaller tributaries. Given the extremely low risk of entrapment and/or stranding at this hatchery, the USFWS considers effects on adult, subadult, and juvenile bull trout associated with the Upper Skagit Hatchery to be discountable.

In summary, bull trout entrapped in hatchery facility surface water intakes, screens, and/or barriers like weirs can experience increased injury and/or mortality. Adult and larger subadult bull trout are less likely to experience entrainment and impingement because these individuals are typically large and strong enough to avoid the intakes entirely and/or free themselves from the high velocity flows that could otherwise impinge them against screens or entrain them over weirs. Improved design and operation of hatchery facility intakes and weirs, including the monitoring of potential risk factors, can appreciably reduce the risks they pose to bull trout.

10.1.1.2 Maintenance Activities

In the Basin, operations at the three chum salmon hatchery programs and facilities generally occur between 08:00 and 17:00 hours. The co-managers propose to carry out routine maintenance activities for "watered" facilities including ponds, troughs, incubators, pumps, water diversions, outfalls, plumbing, and weirs, in addition to buildings and grounds. They will also require weir repairs and adjustments, as necessary. A WDFW Hydraulic Project Approval permit, which specifies allowable in-water work windows and BMPs to minimize introduction of pollutants into waterways, will be implemented by the co-managers to ensure that activities performed in and/or near surface waters avoid and minimize harm to bull trout, other salmonids, and their habitat (e.g., the use of heavy equipment).

At the Marblemount Hatchery, maintenance of the adult holding pond is a regular occurrence. The co-managers will clean ponds weekly, and clean channels twice per year. The co-managers will carry out standard maintenance procedures, including removing sediment from hatchery ponds and raceways. Hatchery staff will monitor influent and effluent discharges in accordance with their NPDES permit. The co-managers will periodically (approximately once every two years) remove solids from the settling pond and dispose of them at upland locations on the hatchery grounds or at commercial sites. Any use of heavy equipment in settling pond dredging will occur in accordance with an existing WDFW Hydraulic Project Approval permit. On rare occasions, to ensure quick cleaning prior to splitting ponds and/or moving and marking fish, the co-managers will dispose waste directly into the river. At these times, the ponds are usually clean.

Other hatchery facilities maintenance activities will include building and grounds maintenance (e.g., painting, minor building repairs, security repairs, weeding, and mowing). Chemicals, including Roundup and Rodeo may be used during grounds maintenance. All chemical applications will occur in dry conditions via a backpack sprayer. Hatchery staff will not apply Roundup within 300 ft (91.4 m) of water; rather, they will apply Rodeo or other aquatic approved chemicals, as necessary, within areas in closer proximity to the water. The three chum salmon hatchery programs and facilities described in this consultation will adhere to guidance and instructions for safe hatchery maintenance and use of chemicals.

Herbicides, such as glyphosate (e.g., found in Roundup and other herbicides), at environmentally relevant concentrations (from 0.3 micrograms per liter [μg/L] to 3 μg/L) can have neurotoxic effects on fish, potentially resulting in changes to typical exploratory and social behaviors. Further, the use of glyphosate can lead to oxidative stress in fish (Faria et al. 2021). At high doses, herbicides can be lethal to fish. However, the volume of herbicide applied annually at the three chum salmon hatchery programs and facilities is sufficiently low, and its rapid dilution, once in-stream, would be such that fish would be able to readily detect and avoid (i.e., swim away from) lethal and/or injurious doses of herbicide (Hildebrand et al. 1982; WDFW et al. 2019). Because herbicide use is relatively low, and that there are conservation measures (see Section 5.9 in this Opinion for additional details) in place to prevent chemicals from entering the water, the USFWS considers effects on bull trout associated with the use of herbicides to be insignificant.

As part of routine hatchery maintenance activities, the use of heavy equipment can contribute to increased levels of in-water noise and sound pressure waves, which can result in behavioral changes in bull trout, such as avoidance and/or reduced foraging, as well as barotrauma, including hemorrhages and ruptures of internal organs, swim bladders, and/or eyes (Nedwell et al. 2006; Popper and Hastings 2009; Popper and Hawkins 2019; Yelverton et al. 1975). For bull trout that weigh 2 grams or less, in-water noise greater than 183 dB_{SEL}, and, for bull trout that weigh greater than 2 grams, in-water noise greater than 187 dB_{SEL}, can result in injury and/or mortality. The USFWS does not expect that in-water noise from the use of heavy equipment will reach levels that would result in physical injury to juvenile, subadult, or adult bull trout that may be foraging in, migrating through, and/or overwintering in, or adjacent to, the hatchery facilities. Therefore, we consider the direct effects associated with short-term exposure to elevated levels of in-water noise resulting from hatchery maintenance activities on bull trout to be insignificant.

Hatchery operations often rely on outdoor artificial lighting in carrying out hatchery-related activities. At the Marblemount Hatchery, artificial lighting used at night, could attract juvenile bull trout from the Cascade River or nearby tributaries, and potentially expose them to increased levels of predation. The extent to which these lights may lead to increased levels of predation is unknown, but there is little or no information to suggest that predation is a significant pressure or threat at the location(s). Therefore, the USFWS expects that effects associated with increased predation on juvenile bull trout, associated with attraction to artificial lights, to be extremely unlikely and discountable.

10.1.1.3 Discharge of Hatchery Effluent

The following assumptions apply to this analysis of the discharge of hatchery effluent.

- Discharge of hatchery effluent is consistently implemented within appropriate NPDES permits;
- Any chemotherapeutic agents will be used and administered in accordance with the Food and Drug Administration and the American Fisheries Society guidelines; and,
- Any cleaning agents to be used is done so at their lowest effective concentrations.

At the three chum salmon hatchery programs and facilities in the Basin, fish rearing requires the use and discharge of surface and/or well water into streams, adjacent to the hatchery facilities. Hatchery water discharge may negatively affect several water quality parameters in the associated river system. Hatchery facility waste products include uneaten food, fish waste products (e.g., fecal matter, mucus, excretions, proteins, and soluble metabolites such as ammonia), chemotherapeutic agents (e.g., Formalin), cleaning agents (e.g., bleach, sodium sulfonate, and iodine), drugs (e.g., MS-222) and antibiotics, nutrients (e.g., various forms of nitrogen and phosphorus), as well as bacterial, viral, or parasitic microorganisms, and algae. Some of these waste products exist in the form of suspended solids and settleable solids, while others are dissolved in the water. In addition to the discharge of waste products, water temperature may increase and dissolved oxygen levels may decrease as water flows through the uncovered hatchery ponds and raceways. Hatchery maintenance activities, such as vacuuming and removal of accumulated sediment on the bottoms of hatchery ponds and raceways, may temporarily increase the concentration of some contaminants in the hatchery water system.

According to its NPDES permit (NPDES WAG13-3015), the Marblemount Hatchery operates an adult holding pond and raceways. Some direct discharge is associated with the adult holding pond, and there is continuous, direct discharge from the raceways into the Cascade River. Additionally, well water from these three raceways and adult holding pond and the smolt release channel is discharged into the river. However, suspended and settleable solids are removed from the ponds during cleaning before the effluent is discharged. Under the hatchery facility's NPDES permit, the following water quality parameters are monitored: total suspended solids (measured one to two times per month on composite effluent), maximum effluent and influent samples, settleable solids (measured one to two times per week through effluent and influent sampling), and in-hatchery water temperature (measured daily). The Marblemount Hatchery has an established record of no exceedances. Because flows in the Cascade River are generally high compared to the volume of discharge from the hatchery, effluent is rapidly diluted near the point of discharge. For this reason, the USFWS expects that suspended solids or settleable solids will neither measurably degrade nor diminish water quality or affect aquatic habitat in the Cascade River. Therefore, we consider the effects on bull trout associated with the discharge of effluent from the Marblemount Hatchery into the Cascade River to be insignificant.

The remaining two chum salmon hatchery programs and facilities in the Basin considered in this Opinion are not required to hold NPDES permits because their annual production is below 20,000 pounds and/or their use of feed is below 5,000 pounds. At the Sauk-Suiattle Hatchery, approximately 125,000 juvenile chum salmon are reared and released between November and May. The facility does not operate between June and September. Using NMFS' conservative assumption of 700 fish per pound, this facility rears approximately 179 pounds of chum salmon annually. Any effluent discharged from the holding tanks becomes rapidly diluted near the point of discharge in Lyle Creek and would be undetectable in the Sauk River. For these reasons, the USFWS expects that effects on bull trout associated with discharges from this small facility will be insignificant.

At the Upper Skagit Hatchery, the co-managers rear approximately 450,000 juvenile chum salmon between November and May. This hatchery also does not operate between June and September. Using NMFS' conservative assumption of 700 fish per pound, this facility rears approximately 643 pounds of chum salmon annually. Streamflow in Red Creek is generally low, and the creek can completely dry up in the summer months. Dilution of discharged effluent into Red Creek will not be as dispersed as it is in the Cascade, Sauk, and Skagit Rivers. Both Red Creek and Hansen Creek are listed on Ecology's 303(d) List of Impaired Waters. Stream temperatures and water quality in these streams are not suitable for bull trout most of the year. Any adult or subadult bull trout using the lower Skagit River for FMO purposes would only be attracted to Hansen Creek during the time of year when juvenile salmonids are being released from the hatchery and stream temperatures are within tolerance limits for bull trout. Effluent discharged from the Upper Skagit Hatchery during the time of year when the facility is operational (between November and May) would quickly disperse and be diluted before it reaches Hansen Creek or areas used by bull trout in the lower Skagit River. Therefore, the USFWS expects that effects on bull trout associated with discharges from the Upper Skagit Hatchery will be insignificant.

Hatchery rearing practices may expose bull trout to warmer water temperatures, lower dissolved oxygen, increased pollutants/chemicals, increased suspended sediments, and increased risk of disease transmission. The existing NPDES permit for the Marblemount Hatchery does not have specific discharge levels or monitoring requirements for water temperature. Water flowing through the adult holding pond and outdoor, unshaded raceways may experience heighted water temperatures via solar radiation and atmospheric conduction. At the hatchery facility, increases in water temperature will be most pronounced during the summer months. However, water temperatures in the hatchery and the Cascade River must be maintained to support rearing salmonids. Consequently, water temperature does not generally rise to levels that could be detrimental to salmonids. Additionally, effluent discharge volumes are low relative to the receiving waterbodies.

The existing NPDES permit for the Marblemount Hatchery does not have specific discharge levels and/or monitoring requirements for dissolved oxygen. Research studies regarding the effects of low dissolved oxygen on bull trout are limited. Studies conducted with other salmonid species such as Chinook and coho salmon and steelhead concluded that low levels of dissolved oxygen can have both lethal and sublethal (i.e., rate of embryonic development, time to hatch, and size of emerging fry) effects on embryonic and larval stages of development (Carter 2005). Additionally, low dissolved oxygen levels can negatively impact growth, feed conversion efficiency, and swimming performance of juvenile and adult salmonids (Bjornn and Reiser 1991). Further, salmonids have been found to actively avoid areas with low dissolved oxygen levels (Carter 2005).

Dissolved oxygen levels must be maintained at sufficient levels at all fish hatcheries to support rearing salmonids. Thus, at the Marblemount Hatchery facility, dissolved oxygen is not depleted to levels that would be detrimental to juvenile salmonids. Additionally, the USFWS anticipates that any decreases in dissolved oxygen levels in the effluent will be restored near the point of discharge. Further, falling water at the point of discharge has the potential to aerate and partially reoxygenate the water upon entry into the receiving waterbody, minimizing the potential for measurable effects on dissolved oxygen where bull trout may occur (Wang et al. 2020).

Bull trout are highly sensitive to sediment inputs (Bolton et al. 2001). The embryonic and alevin development stages are most sensitive to sediment inputs. Fine sediment intrusion to bull trout redds can negatively affect the survival of eggs and it is associated with earlier fry emergence (Bowerman et al. 2014). Additionally, high turbidity can alter feeding strategies in juvenile and adult salmonids and can also cause individuals to avoid these reaches (Bolton et al. 2001). At the Marblemount Hatchery, hatchery managers remove suspended and settleable solids from the pond during cleaning before the effluent is discharged. In the last 10 years, there has been no documentation of exceedances of ammonia, pH, fecal coliform, or other water quality parameters associated with suspended solids at the Marblemount Hatchery (Ecology 2022; NMFS 2022a). The maintenance and cleaning procedures will have minimal effects, due to rapid dilution near the point of discharge, any effects on bull trout associated with effluent discharges will not be measurable (i.e., insignificant).

Generally, hatchery managers use chemicals at the hatchery facilities sporadically and in relatively low volumes. Chemotherapeutic agents, like Formalin, are important to the salmonid rearing process, as they prevent and treat fungal and/or parasitic infections in adult salmonids, juveniles, fry, and eggs. However, chemotherapeutic agents must be used at low volumes to avoid deleterious effects on hatchery fish fitness and survival. Further, cleaning agents used to maintain rearing facilities can also be particularly detrimental to overall fitness and survival of salmonids, but the co-managers dilute these prior to discharge and use these intermittently. Hatchery effluent is expected to rapidly dilute at the point of discharge into the receiving waterbody, and effects will likely be localized to the point of discharge. Bull trout may detect and/or be attracted to effluent. They are opportunistic predators that feed on juveniles and eggs of anadromous salmonids and resident fish, and they can locate productive feeding areas using olfactory chemical cues left in the water by prey. Effluent discharged from the hatchery facilities likely contains relatively high concentrations of these chemical cues, which could attract bull trout to the immediate vicinity of the hatchery facility(ies) and mixing zones at the discharge locations. This behavior is most likely rewarded during the time of year when juvenile chum salmon smolts are being released in the spring.

Chemical cues found in effluent discharge have the potential to alter foraging behavior in bull trout and may reduce feeding efficiency compared to other natural cues and typical feeding responses or behaviors (USFWS 2016). There is documentation of regular observations of bull trout below other fish hatchery facilities during times of the year when hatcheries are releasing large numbers of juvenile salmonids, including chum salmon. However, beyond these anecdotal observations, there are no data or reports documenting the scope and magnitude of these effects, or the extent to which this phenomenon may measurably affect or alter normal bull trout behaviors.

Some infectious fish pathogens (bacterial, viral, fungal, or parasitic) may be transmittable through waste discharged from the hatchery. Naish et al. (2008) identified several mechanisms by which salmonid hatchery operations may affect pathogen risk to disease status of naturally reproducing or wild fish. Although these risks exist in theory, few well-documented cases exist in which hatchery fish have been directly linked to effects on the health and disease status of wild stocks (Naish et al. 2008). The potential for pathogen transmission is not fully understood, and it can be confounded by the natural occurrence of many of these infectious organisms in populations of salmonids. Additionally, the USFWS concluded that bull trout (which belong to the char family) may be inherently resistant to some disease agents that are more devastating to other salmonids (USFWS 2002). In controlled laboratory studies conducted by researchers from the Oregon State University on the Metolius River in central Oregon, Metolius bull trout exposed to high and low doses of the infectious stages of *Myxobolus cerebralis* (the causative agent in whirling disease) showed no signs of infection as measured by the presence of spores, clinical disease signs, or histopathology. Further, rainbow trout exposed simultaneously in the study showed high infection prevalence and disease severity. Similarly, no infections were detected in Metolius bull trout exposed to infection by *Ceratonova shasta* (a myxozoan parasite) (Bartholomew 2001). Disease studies conducted on bull trout from the Deschutes River basin (which includes the Metolius River) illustrated that they were relatively resistant to all strains of infectious Hematopeietic Necrosis Virus tested. Bull trout had detectable levels of the antigen to *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease, but showed no evidence of clinical disease.

Given the volume of effluent discharged from the three chum salmon hatchery facilities is extremely small relative to the receiving waters (Cascade, Sauk, and Skagit Rivers) used by bull trout, even during the lowest annual flow periods, it is likely that any of the effects of hatchery effluent on bull trout will be isolated to the immediate areas of discharge, highly diffused and diluted, and not measurable beyond the mixing zone. There are few observations of the presence of individual bull trout near any of the three chum salmon hatchery facilities. Adult and subadult bull trout use the lower portions of the Cascade, Sauk and Skagit Rivers for FMO purposes and would only be attracted to streams at the time of year when the chum hatchery facilities are releasing juveniles and water temperatures and quality are suitable for bull trout. The effects of hatchery effluent discharge on downstream aquatic life, including bull trout, are adequately minimized through compliance with federal and state permit requirements. Therefore, the USFWS expects that effects on bull trout associated with the discharge of hatchery effluent will be insignificant.

10.1.1.4 Species Interactions

Bull trout that are present near the release sites (Table 3) associated with the three chum salmon hatchery programs may be exposed to certain inter-specific interactions such as competition with, and predation by, hatchery-released fish. The expected size and rapid outmigration of hatchery-released chum smolts minimize the potential for predation and adverse competitive interactions with bull trout. Some hatchery-released fish may never be captured in fisheries, and they may not return to the hatchery facilities or be caught during broodstock collection. Instead, these fish may seek out spawning habitat and mates, and they may spawn in the wild (i.e., exhibiting straying behaviors). This presents the possibility of predation on bull trout by progenies of naturally-spawning, hatchery-origin fish. The degree to which hatchery-origin chum salmon and their progenies would interact with bull trout depends upon relative characteristics of each species, including, but not limited to, their: 1) size; 2) behavior; 3) habitat use; 4) abundance; and, 5) movement patterns. Inter-specific interactions between chum salmon and bull trout can also depend on habitat structure and system productivity (i.e., the degree to which fish populations may be food-limited and, thus, negatively impacted by a limited prey resource base (USFWS 2019b).

The following subsections describe the USFWS analysis of effects on bull trout associated with competition and predation. The USFWS is challenged in observing and measuring effects resulting directly from competition with, and predation of chum salmon on, bull trout. In addition, available research and information is insufficient to precisely determine the degree of adverse competitive interactions and predation that can be expected in a particular watershed from specific hatchery programs (USFWS 2017, 2019b).

10.1.1.4.1 Competition and Risk of Redd Superimposition

Competition for food and space among anadromous salmonids and bull trout may occur in spawning and rearing areas, migration corridor(s), and/or the marine environment. Competition may result from direct interactions, in which salmon may interfere with bull trout for access to limited resources, or indirect interactions, in which utilization of a limited resource (e.g., prey resource base) reduces the amount available for bull trout.

Progenies of adult hatchery-origin fish that stray and potentially spawn naturally in bull trout spawning and rearing areas may compete with juvenile bull trout for rearing space and resources, however the extent to which this occurs is unknown. In the action area, there is little to no spatial and/or temporal overlap between chum salmon and bull trout spawning and rearing areas (WDFW 2017). Increasing evidence suggests that, in areas in which bull trout co-occur with naturally reproducing salmon and steelhead, bull trout abundance is dependent on, and directly correlated with, naturally reproducing salmon and steelhead (Copeland and Meyer 2011; Kraemer 2003; Ratliff and Howell 1992; Zimmerman and Kinsel 2010). This suggests that the benefits of abundant, naturally-spawning salmon and steelhead are greater than any deleterious competitive interactions. Additionally, most returning adult hatchery-origin fish that stray and spawn naturally in the watershed likely do so in close proximity to their release sites (Dittman et al. 2010; Hoffnagle et al. 2008; Mackey et al. 2001; Quinn 1993; Williamson et al. 2010), which are situated adequately downstream of bull trout spawning and rearing areas (WDFW et al. 2019). Finally, the abundance of naturally-spawning salmon and steelhead are currently lower than historical levels, and the USFWS expects that any competitive interactions between bull trout and hatchery-released chum salmon will be infrequent, very limited in scope and scale, and not measurable or discernible. For these reasons, we consider the effects of potential interactions related to competition between bull trout and the progenies of hatchery-origin stray chum salmon to be insignificant.

It is possible that a few adult hatchery-origin chum salmon may stray and spawn naturally in the lower portions of bull trout spawning areas. However, based on the available information on documented chum salmon spawning areas and as discussed previously, there is little or no overlap between areas used by chum salmon and by bull trout for spawning and juvenile rearing. The USFWS expects that most adult stray hatchery-origin chum salmon will spawn in lower areas of the watershed relative to bull trout. Because of the separation between these species, the USFWS anticipates that relatively few, if any, hatchery-origin chum salmon will be present in bull trout spawning areas and, therefore, interfering with bull trout spawning. Additionally, bull trout typically select different water depths and velocities to spawn in than other salmonids, although the range of depths and velocities that some species, such as steelhead, have been observed spawning in do, occasionally, overlap with areas used by bull trout (Keeley and Slaney 1996). Even with this overlap in reach-scale spawning habitat between bull trout and other hatchery-reared salmonids such as steelhead, there is no evidence to suggest that there will be any competition for spawning habitats, potential destruction of bull trout redds via superimposition, or loss of deposited eggs associated with naturally-spawning chum salmon. Therefore, the USFWS considers the effects of potential interactions related to competition and superimposition of redds between bull trout and hatchery-origin chum salmon in spawning areas to be discountable.

In freshwater environments, the USFWS expects limited competition for prey resources between hatchery-released salmon (chum salmon) and bull trout, due to the: 1) short residence time of hatchery-reared chum salmon in freshwater; and, 2) differences in habitat selection, foraging behavior, and prey resource selection between bull trout and hatchery-released smolts. The three chum salmon hatchery programs are designed to ensure that released smolts rapidly (within days) out-migrate to marine waters. Therefore, any direct competitive interactions would occur, if they occur at all, within a short time period. Differences in habitat selection and foraging behavior would further minimize harmful competitive interactions. In contrast to hatchery-reared fish, which are typically surface-oriented, bull trout generally prefer colder water, and they are more closely associated with deeper portions of rivers (Flagg et al. 2000). Where bull trout co-occur with hatchery-released fish, larger subadult bull trout are likely to be feeding on hatchery-released juvenile salmonids. Because there is no evidence to suggest that hatchery-origin fish in the Basin deplete prey resources to the detriment of bull trout, the USFWS does not expect competitive interactions between bull trout and hatchery-released chum salmon smolts to be significant enough to measurably affect the survival and/or abundance of bull trout. Thus, the USFWS considers these effects to be insignificant.

In marine environments, hatchery chum salmon smolts and returning adults seasonally occupy waters at approximately the same time of the year as foraging adult and subadult bull trout. Thus, competitive interactions over broad spatial and/or temporal scales for prey resources may ensue. However, such outcomes are extremely unlikely and difficult to assess/measure due to the broad expanse of marine habitat available to these species in the nearshore areas of central Puget Sound relative to the abundance of salmonids and bull trout local populations in this area. There are no data to suggest that there are negative competitive interactions between bull trout and hatchery- or natural-origin salmonids in the central Puget Sound marine nearshore or in any other marine nearshore habitat that bull trout may occupy across their range. Additionally, there is no evidence to suggest that the hatchery-origin fish in Puget Sound, generally, or in the action area, specifically, deplete prey resources to the detriment of bull trout. For these reasons, the USFWS considers the effects of the proposed action on competition for prey resources in marine waters to be insignificant (USFWS 2017, 2019b).

10.1.1.4.2 Predation

Releasing hatchery fish (chum salmon) may result in predation on bull trout via the following pathways: 1) direct predation, whereby the chum salmon consume small, juvenile bull trout; 2) indirect predation, whereby large concentrations of released chum salmon attract predators that also prey on bull trout in the same area; and, 3) predation on juvenile bull trout by progenies of hatchery-origin adult chum salmon that spawn naturally in the Skagit River watershed. In consideration of hatchery-released fish, predation on naturally-produced juvenile salmonids and other fish is a potential concern when the hatchery fish are large enough to be piscivorous (i.e., larger than smolts) and when there is spatial and/or temporal overlap of predator and prey (Naman and Sharpe 2012). The magnitude of, and vulnerability to, predation resulting from hatchery fish releases depend on a combination of prey and predator abundance, the size of chum salmon in relationship to the size of bull trout occupying the same area, feeding habits of hatchery-origin chum salmon, and other factors (USFWS 2017, 2019b).

In consideration of the three chum salmon hatchery programs and facilities, the USFWS expects that adult, subadult, and/or large juvenile bull trout are present in the area(s) occupied by hatchery-released smolts, however direct predation by chum salmon on bull trout is extremely unlikely for several reasons. Juvenile outmigrant trapping from other Puget Sound watersheds indicates that outmigrating bull trout smolts are generally 120 mm (4.70 inches) in size at fork length and greater, which is too large to be preyed upon by hatchery-released chum salmon smolts. The USFWS expects that smaller-size bull trout (young juveniles) also occur in the upper Skagit River watershed, however they are likely to be present miles away from hatchery release sites and chum salmon migratory corridors or spawning areas. There are no data to suggest that hatchery-released juvenile chum salmon would move upstream into areas where young bull trout rear/are rearing. Generally, bull trout and Pacific salmon overlap in distribution, however the USFWS is uncertain of the degree to which these distributions overlap. Returning adult salmon are not typically known to prey on fish once they enter freshwater and begin their upstream migration. Therefore, the USFWS (2019b) does not anticipate that returning adult hatchery-origin chum salmon will prey on any bull trout.

Large concentrations of hatchery-origin juvenile chum salmon may attract predators (e.g., fish, birds, and mammals), which may also prey on natural-origin bull trout that occur in the same area (Hillman and Mullan 1989; Kostow 2009; Steward and Bjornn 1990; USFWS 1994). Hatchery-released juvenile salmonids exhibit riskier behaviors, which make them more susceptible to predation than natural-origin fish (Olla et al. 1998; Olla and Davis 1989). This may negate any effects of the larger predator aggregations, as the predators would be more likely to forage on prey that is easier and more efficient for them to capture. Further, all of the chum salmon hatchery facilities in the Basin are located far downstream of bull trout spawning and rearing areas. However, these relationships are complex and poorly understood. For these reasons, ascribing any predation on bull trout from predator aggregations induced by hatchery releases is speculative, at best.

In the Skagit River watershed, all of the chum salmon spawning and rearing areas are located in lower areas of the watershed relative to the bull trout spawning and rearing areas. Because there is virtually no overlap in spawning and rearing areas between these two species, any progenies of hatchery-origin, naturally-spawning chum salmon (strays) are extremely unlikely to rear in close proximity to areas used by small, juvenile bull trout, thereby reducing their exposure to predation. There are very few studies of predation by piscivorous fish on juvenile bull trout. In a research study focused on lake trout and northern pikeminnow (*Ptychocheilus oregonenesis*), Zollweg (1998) did not observe any juvenile bull trout in the stomachs of seven rainbow trout sampled in the Flathead River, Montana. Due to their small size, the USFWS considers bull trout fry to be the most susceptible life history state to predation, however, fry tend to be cryptic and hide in the substrate during the day, which helps them avoid predation (primarily by other larger bull trout). Bull trout fry typically remain in close proximity to where they were hatched and within the interstitial spaces of gravel and cobble substrates to a much greater extent than other salmonids (Pratt 1992; Rieman and McIntyre 1993), where the potential for predation by salmon and/or steelhead would be limited. In general and in the Skagit River watershed, in particular, juvenile bull trout occupy very different habitats than other, larger salmonids, which likely reduces their exposure to predation by these other species.

The USFWS expects that most hatchery-origin chum salmon will outmigrate to the marine environment relatively quickly (i.e., within 11 to 17 days of release, depending on the program), minimizing freshwater residence. These chum salmon are likely to emigrate to marine waters before becoming large enough to prey on any juvenile salmonids, including bull trout fry. While rearing in freshwater, their diets are comprised mostly of invertebrates. In general, salmonids become primarily piscivorous at lengths of 310 mm (12.2 inches) (Keeley and Grant 2001). The USFWS would expect that approximately 30 percent of salmonids at lengths of 198 mm to 210 mm (7.80 inches to 8.30 inches) could have some fish in their stomachs, though fish would not be a significant component of their diet (Keeley and Grant 2001; USFWS 2017, 2019b).

While juvenile bull trout habitat use and behavior are likely to limit their exposure to predation by chum salmon, most naturally-rearing salmonids outmigrate to the marine environment before becoming large enough to prey on juvenile bull trout. Because the locations, life history stages, timing of hatchery-origin chum salmon smolt releases, the rare (if at all) spatial and/or temporal overlap between adult spawning areas and small, juvenile bull trout, the USFWS considers significant competition and predation to be extremely unlikely. Therefore, the USFWS expects the effects on bull trout associated with potential competition with, and/or predation by, hatchery-origin chum salmon to be discountable.

10.1.2 Adverse Effects

The following elements of the proposed action are likely to result in impacts that are reasonably certain to result in adverse effects on bull trout. The USFWS anticipates that most of these impacts will adversely affect adult, subadult, and larger juvenile bull trout in areas used by individual bull trout for foraging, migrating and moving through, and overwintering throughout the Skagit River and larger tributaries in the upper Skagit River watershed, including the Sauk and Cascade Rivers.

10.1.2.1 Water Withdrawals and Hatchery Infrastructure

The surface water intake on the Cascade River at the Marblemount Hatchery is characterized by screening that does not meet either current NMFS (2011, 2022b) or previous NMFS (1995, 1996) compliance standards. The screens are comprised of stainless-steel profile bar (1.75 mm [0.18 cm] mesh). Additionally, there are gaps in the civil works (i.e., between the screen panels), an inadequate active cleaning system, excessive and inconsistent/non-uniform approach velocities, and inadequate screening area at some flow levels (NMFS 2022a).

The Cascade River is the only intake at the Marblemount Hatchery that is located in a bull trout migratory corridor, which connects lower river reaches to upstream bull trout spawning and rearing habitat. The closest bull trout spawning habitat is 15 miles (24 km) upriver from the intake structure, in Kindy Creek, near the Sonny Boy Road crossing. The Cascade River bull trout local population spawns and rears in the mainstem reach between RM 16 and the junction of the Cascade River forks, including the tributaries Kindy Creek and Sonny Boy Creek. Most of the bull trout spawning and rearing habitat in these two tributaries lies within the Glacier Peak Wilderness. Small, juvenile bull trout and fry typically hide in the interstitial spaces of streambed substrate, organic material, and undercut banks for the first year of their lives to avoid predation. These juvenile bull trout do not leave their natal streams or emigrate until they are approximately 1 to 2 years old or large enough to avoid predation (generally over 150 mm [5.90 inches] in size). However, it is possible that a small number of bull trout individuals may be accidentally swept downstream, potentially as a result of or in response to high flow events.

Any bull trout fry (less than 60 mm [2.4 inches]) that are swept downstream along the hatchery-side shoreline at the Marblemount Hatchery are likely to encounter the Cascade River surface water intake. The gaps in the civil works could be large enough for juvenile bull trout and fry to become entrapped. Additionally, there is an eddy in front of the screens, which compounds the risk for any bull trout fry to either become impinged or swept downstream. The full extent of the risk and resulting exposure depends on the number of bull trout fry that come into close contact with, or encounter, the intake.

Given the distance from the closest spawning and juvenile bull trout rearing areas, it is unlikely, but not impossible, that bull trout fry, will be present in the vicinity of, and encounter, the Cascade River surface water intake at the Marblemount Hatchery and, therefore, could be susceptible to entrainment and/or impingement at the screening. The WDFW has requested funding from the Washington State Legislature to bring the Cascade River surface water intake screening up to current NMFS (2011, 2022b) compliance standards. They have requested pre-design, design, and permitting funding to do so in the 2023-2025 Biennium, and construction funding in the 2025-2027 and 2027-2029 Biennium, however this funding is not guaranteed. Given the current population of adult bull trout in the Cascade River (approximately 155 adult bull trout, at minimum, half of which are females), low juvenile survival, distance from spawning and rearing habitat, and low potential for bull trout fry being accidentally swept downstream and being impinged on the intake screen, the USFWS estimates that, over the 20-year term of the consultation, between 1 and 4 (average, 2) bull trout fry will be adversely affected (i.e., injured or killed) by the Cascade River surface water intake at the Marblemount Hatchery.

There are three weirs at the Marblemount Hatchery: two on Clark Creek and one near the mouth of the bypass/release channel (Figure 2 and Figure 3). During high flow events (i.e., when the river is above flood stage), larger salmonids, including adult and subadult bull trout that are present in the area (likely for migratory purposes), could become temporarily entrapped above any and/or all of the three weirs at the Marblemount Hatchery. During high flow events, according to the co-managers, the lower steelhead channel and adult trap weir on Clark Creek (B) and the bypass/release channel weir (C) are more likely than the steelhead channel upper weir (A) to overtop (Figure 2 and Figure 3). The frequency, intensity, and duration of such high flow events are unknown, and neither is the extent to which bull trout may be capable of moving above weirs B and C during these events (Figure 3). The WDFW has indicated that the frequency of these high flow events varies annually, but, generally, they either do not occur or can occur up to once or twice per year (B. Dymowska in litt. 2022). Additionally, the WDFW and other co-managers have yet to observe any entrained bull trout and/or other salmonids above the weirs. However, the USFWS assumes that bull trout are present in the area and that, during a high flow event, any adult, subadult, and/or larger juvenile bull trout that moves upstream of the weir could become entrained into, and/or stranded in, hatchery infrastructure, ponds, and channels. As a result, these fish may experience delayed migration, predation, and/or starvation, particularly if the area they are inhabiting lacks cover and suitable habitat conditions, such as those areas of Clark Creek that run through the hatchery and the release/bypass channel.

Given the extensive migration patterns and movements of bull trout in the Basin, it is reasonable to assume that a small number of adult and subadult bull trout will be present in the vicinity of weirs B and C at the Marblemount Hatchery in the winter, during which high flow events generally occur. Thus, these bull trout may move over the weirs and become entrapped and/or pass back over the weirs and move downstream, undetected. Assuming two high flow events per year, and that few adult and subadult bull trout will be present and, thus, capable of moving over either weirs B and C during such event, we estimate that no more than two adult and/or subadult bull trout per year will encounter and/or be entrapped at the Marblemount Hatchery. Hatchery staff will not detect all of these individuals since some will be able to return back over the weirs and escape downstream. Thus, over the 20-year term of the consultation, no more than 5 adult and/or subadult bull trout will be adversely affected (i.e., injured or killed) by weirs B and C at the Marblemount Hatchery.

10.1.2.2 Broodstock Collection

Broodstock collection (i.e., the capture of live adult fish used for hatchery program use) of chum salmon in the Basin will be conducted by either trapping fish at the Marblemount Hatchery adult trap or using in-river collection methods such as seining or netting. Historically, few bull trout have been captured during these hatchery activities in the Basin (WDFW et al. 2019) (Table 4). The following subsections summarize the expected direct impacts to bull trout as a result of ongoing broodstock collection activities at the three chum salmon hatchery programs and facilities in the Basin. Table 2 provides additional information on capture methods, timing, and target numbers specific to the chum salmon program.

Table 4. Historical incidental capture of bull trout during hatchery broodstock collection activities for chum salmon in the Skagit River basin.
(WDFW et al. 2019)

Year	Skagit River Fall Chum Salmon[a]	Chum Salmon Remote Site Incubator[b]	Upper Skagit Chum Salmon[c]
	Facility Marblemount Hatchery	Sauk-Suiattle Hatchery	Upper Skagit Hatchery
	Collection Location Skagit River, above RM 69	Sauk River, RMs 12 to 18	Sauk River, RMs 8 to 27
	Collection Methodologies Adult trap and in-river netting	In-river netting	In-river netting
	Collection Time/Duration October to December	November	Mid-October to Mid-December
2010	0	NA	< 5
2011	0	NA	< 5
2012	0	NA	< 5
2013	0	NA	< 5
2014	0	0	< 5
2015	0	NA	< 5
2016	0	0	< 5
2017	0	0	< 5
2018	0	1	3

[a]Broodstock collection for the chum program has not begun yet, so there are no bycatch data available (WDFW et al. 2019, p. 5).
Broodstock collection for the chum program only occurred in 2014, 2016, 2017, and 2018. NA = no monitoring and/or reporting of bycatch.
[c]During broodstock collection in the lower mainstem Skagit River, associated with the Upper Skagit Hatchery, bull trout encounter numbers have not been recorded, historically. When adults and/or subadults have been encountered, they were released immediately or put into net pens if fishing was planned to continue in that area, as part of that event. The crew conducting this activity reported that, in recent years, there were fewer than five encounters, annually, and three encounters in 2018.

10.1.2.2.1 Marblemount Hatchery

At the Marblemount Hatchery, collection of adult chum salmon for broodstock is likely to result in the incidental capture and handling of bull trout during operation of the adult trap and in-river collection efforts (e.g., netting and seining). The physical presence of a trap or net in a river that is connected to, or in, a river where bull trout are either foraging, migrating/moving, or overwintering, can negatively affect bull trout that are incidentally captured by: 1) contributing to impingement, injury, or mortality as fish struggle in an attempt to escape the trap and/or net; 2) stress and physical injury (e.g., damage to skin, scales, and/or slime coat) during handling; 3) increasing vulnerability to physical injury or predation through corralling effects and fish holding behaviors at the trap; and, 4) causing physiological stress and disorientation after release, resulting in delayed foraging and migration and reduced or lost opportunities for spawning (USFWS 2017, 2019b).

Given the consistent annual captures of chum salmon reported in Table 1, it is reasonable to expect that bull trout individuals will be incidentally captured during in-river broodstock collection in the Skagit and Sauk Rivers, at all three chum salmon hatchery facilities. While all of the incidentally captured bull trout will be released, the collection methodologies used to capture and handle fish involve physical restraint, which puts these individuals at increased risk of injury or mortality.

Given that in-river broodstock collection of chum salmon will occur between November and December at the Marblemount Hatchery, broodstock collection activities will most likely affect adult and subadult bull trout that are either foraging in/adjacent to, and/or migrating/moving downstream from the Cascade River to the mainstem Skagit River, perhaps after spawning. At this time of year, it is also possible that some adult bull trout will still be migrating through the Cascade River to spawning habitat located in upper tributaries. While the USFWS anticipates that broodstock collection practices and protocols will minimize the risk of injury and mortality, we expect some minimal level of incidental injury or mortality associated with the capture and handling of bull trout.

Adverse effects on bull trout associated with the adult trap, situated on Clark Creek, include the potential for delayed migration, reduced spawning success (or missed spawning opportunities entirely), and/or delayed mortality associated with stress or injuries sustained in the adult trap and/or holding pool. Handling of bull trout may result in injury or death, either immediate or delayed. In general, fish handling leads to increased stress levels, reductions in disease resistance, increased osmotic-regulatory problems, decreased growth and reproductive capacity, increased vulnerability to predation, and increased mortality (Kelsch and Shields 1996; USFWS 2016). During handling, bull trout may also suffer from thermal stress or experience injuries resulting from descaling and/or losing their protective slime layer. Handling may also contribute directly or indirectly to disease susceptibility and transmission and/or increased predation, post-release. Smaller bull trout that experience increased stress, regardless of the cause or source, are most vulnerable to predation (Mesa and Schreck 1989; Mesa et al. 1994; USFWS 2016).

While trapping infrastructure is commonly used to achieve hatchery management and production goals, there are only a few studies that have focused on how it affects non-target species, referred to as bycatch. The existing studies (Clements et al. 2022; Kelly Ringel et al. 2014; Murauskas et al. 2014; USFWS 2016) indicate that trapping infrastructure (e.g., adult trap), which blocks fish passage, can have significant adverse effects (e.g., migration/passage delays, holding and avoidance, and severe and prolonged stress) on bycatch such as bull trout. Prolonged captivity in the infrastructure may delay upstream migration of spawners and require that fish spawn in suboptimal locations and/or less favorable habitats, may reduce overall spawning success, and result in a total loss of spawning opportunities for some individuals. Some upstream migrants that encounter the trapping infrastructure may experience injuries and/or may fail to enter the trap altogether, instead simply dropping back and ceasing upstream movement. While the hatchery managers should assess the adult trap and holding pond daily to observe general fish conditions, abundance, and behavior, they will generally only remove broodstock from the pond once per week. Therefore, any bull trout inadvertently captured in the adult trap at the Marblemount Hatchery may be retained in the holding pond for up to one week until the subsequent trap assessment is conducted. Chum salmon that are ready to spawn and are confined in a holding pond may fight for dominance, adding to the potential for stress and injury experienced by bull trout.

In addition to the adult trap, the Marblemount Hatchery chum salmon program will use in-river netting in the Skagit River (above RM 69) to collect adult chum salmon for broodstock between November and December. During this time, it is reasonable to assume that bull trout individuals will be incidentally captured in the Skagit River and handled during netting efforts. The co-managers propose to minimize these interceptions by using gill nets with larger mesh sizes (6.75 inch [171 mm] diameter]) to more efficiently and safely collect adult fish, including chum salmon and bycatch such as bull trout. Gill nets will be deployed from the bank under the bridge, spanning only a portion of the river. The co-managers also propose to deploy nets in smaller side channels and blind channels, where bull trout presence is expected to be lower than in the mainstem Skagit River. Lastly, the co-managers will consider alternative collection methodologies (beyond gill nets) to collect broodstock, such as snagging, angling, and/or beach seining (WDFW et al. 2019). They will record and report all bull trout encounters, and they will release all bull trout that are inadvertently captured during broodstock collection activities and return them to the Cascade River. There are no weirs or obstructions to upstream movement or migration for bull trout in the Cascade River.

In-river collection methodologies like netting are likely to result in entanglement and increased handling times, leading to adverse effects on bull trout such as injury and delayed mortality. The 6.75-inch (171 mm) gill net mesh opening size is narrower than the girth (abdomen, but not gills) of adult bull trout and, given these dimensions, the USFWS anticipates that only large, adult bull trout (greater than or equal to 661 mm [26.0 inches] long) are likely to be captured, resulting in fewer cases of entanglement of subadult bull trout. However, if adult bull trout become entangled in gill nets, efforts to free them from entanglement could result in damage to their scales and other injuries. Given the mesh size and fact that nets will be used in areas of the Skagit River and time of year when fewer adult bull trout are present, the USFWS expects that mostly larger, adult bull trout will be captured and entangled in the gill nets, while smaller subadult bull trout will be minimally (infrequently, if ever) affected.

In a meta-analysis, Patterson et al. (2017) estimated mortality risk to incidentally captured salmonids, based on gear type, capture time, and handling time, using 34 gill net and 18 seine mortality studies. The authors concluded that the risk of immediate mortality is less than 5 percent when entanglement and handling times are short (Table 5). Post-release mortality rates may increase to 17 percent, depending on the collection methodology, for slightly longer entanglement and handling times (USFWS 2016) (Table 6). The co-managers should minimize their time handling bull trout as much as possible to minimize additional stress and potential injury and/or delayed mortality. Given the combination of various broodstock collection methodologies, the amount of time bull trout may spend in nets before the net is retrieved (e.g., between 3 and 10 minutes, depending on collection methodology), variability in entanglement and handling times (e.g., between 10 seconds and 1 minute), and differences in hatchery staff experience in collecting broodstock, the USFWS anticipates that the risk of mortality (either immediate or delayed) experienced by bull trout may range, at minimum, from 5 percent to 17 percent, and likely may be higher than 17 percent. Because the USFWS must err on the side of the species and consider worst-case scenarios, the USFWS anticipates that up to 25 percent of the bull trout incidentally captured in nets for in-river broodstock collection of adult chum salmon at the Marblemount Hatchery may be injured and/or killed.

In estimating the number of incidentally captured bull trout in chum salmon broodstock collection efforts at the Marblemount Hatchery (and for other hatchery programs and facilities), the USFWS relied on information collected over time, and produced, by the co-managers. The co-managers have experience using similar broodstock collection methodologies for ongoing hatchery programs, and for other purposes, throughout the Basin. Also, the co-managers are knowledgeable about general seasonal movement(s), habitat use, and abundance patterns of bull trout and other salmonids in the watershed. In Table 5, the USFWS summarizes the co-managers' estimate of potential capture and mortality of bull trout for the three chum salmon hatchery programs and facilities, based on their best professional judgement and experience (WDFW et al. 2019).

Table 5. Co-managers' estimates of potential annual capture and mortality of bull trout resulting from chum salmon hatchery facility components and program activities in the Skagit River basin. (WDFW et al. 2019)

Hatchery Program	Facility Components and Program Activities	Live	Die (Mortality)
Skagit River Fall Chum Salmon	Marblemount Hatchery Adult trap Collection methodologies[a]	 2 20	 1 5
Chum Salmon Remote Site Incubator	Sauk-Suiattle Hatchery Collection methodologies	 5	 2
Upper Skagit Chum Salmon	Upper Skagit Hatchery Collection methodologies	 5	 2

[a]Collection methodologies broadly refer to in-river netting activities associated with adult chum salmon broodstock collection.

Given the extensive migration patterns and movements of bull trout in the Basin, it is likely that adult and subadult bull trout will be present in the vicinity of the Marblemount Hatchery during chum salmon broodstock collection (between November and December). A proportion of these bull trout could move into the adult trap and remain in the holding pond for up to one week. In consideration of this possibility and the co-managers' best professional judgment (Table 5), the USFWS estimates that up to 2 adult and/or subadult bull trout will be adversely affected by the adult trap and holding pond at the Marblemount Hatchery and, of, these, up to 1 bull trout will die (direct or delayed mortality from stress, injury, infection, etc.). Thus, over the 20-year term of the consultation, 40 adult and/or subadult bull trout will be adversely affected by the adult trap and holding pond at the Marblemount Hatchery.

The USFWS expects up to a 25 percent mortality rate for bull trout bycatch resulting from in-river netting for chum salmon at the Marblemount Hatchery. Based on the co-managers' best professional judgement (Table 5), the USFWS expects that up to 20 adult bull trout per year will be adversely affected by in-river netting efforts and, of these, up to 5 adult bull trout will die as a result of immediate or delayed mortality. Over the 20-year term of the consultation, 400 bull trout will be adversely affected by in-river netting efforts associated with the Marblemount Hatchery and chum salmon program.

10.1.2.2.2 Sauk-Suiattle Hatchery

At the Sauk-Suiattle Hatchery, collection of adult chum salmon for broodstock is likely to result in the incidental capture and handling of bull trout. However, given historical numbers of incidentally captured bull trout (Table 4), the USFWS does not anticipate that broodstock collection efforts in the Sauk River will capture, injure, and/or kill a large number of bull trout relative to number of bull trout present in that system.

In-river broodstock collection of chum salmon will occur during November. Hatchery managers will conduct collection efforts along a 5-mile (8-km) stretch of the Sauk River originating from just downstream of the Sauk/Suiattle River confluence to an area near Bryson Road, south of the tribal reservation. The USFWS anticipates that in-river collection efforts will most likely affect adult and/or large subadult bull trout that are either foraging, migrating/moving/returning from spawning areas in the upper Skagit River watershed, and/or overwintering in the Sauk River and associated tributaries. However, the extent of the area in which broodstock activities will be conducted and post-spawning adult bull trout may be present, in November, is unknown. This reach of the river provides suitable FMO habitat for bull trout, and it is characterized by water temperatures that are well within the optimal range for bull trout. Thus, the USFWS expects adult and/or large subadult bull trout to be present during in-river netting activities. While we expect that collection practices and protocols will minimize the risk of injury and delayed mortality, we anticipate some minimal level of incidental capture and handling of bull trout associated with chum salmon broodstock collection.

Similar to those adverse effects predicted at the Marblemount Hatchery, potential adverse effects of in-river netting on bull trout in the Sauk River include increased entanglement events and handling times, resulting in injury(ies) and, potentially, immediate and/or delayed mortality experienced by bull trout. Given the proposed range of gill net mesh opening size (6.25 inches to 7.75 inches [159 mm to 197 mm]), the USFWS anticipates that a proportion of adult and/or large subadult bull trout present in the area will be incidentally captured, resulting in low selectivity for the majority of bull trout that may be encountered. The 6.25 inch [159 mm] gill net mesh size is narrower than the girth (abdomen, but not gills) of adult bull trout and, given these dimensions, the USFWS anticipates that adult bull trout and large subadult bull trout, if entangled, could experience adverse effects (e.g., increased stress) resulting from damage to their scales.

The USFWS expects up to a 25 percent mortality rate for bull trout bycatch resulting from in-river netting for chum salmon at the Sauk-Suiattle Hatchery. Based on historical numbers of incidentally captured bull trout (Table 4) and the co-mangers' best professional judgment (Table 5), the USFWS expects that up to 5 adult and/or large subadult bull trout per year will be adversely affected by in-river netting efforts and, of these, 2 adult and/or large subadult bull trout will die as a result of immediate or delayed mortality. Over the 20-year term of the consultation, up to 100 bull trout will be adversely affected by in-river netting efforts associated with the Sauk-Suiattle Hatchery and chum salmon program.

10.1.2.2.3 Upper Skagit Hatchery

At the Upper Skagit Hatchery, collection of adult chum salmon for broodstock is likely to result in the incidental capture and handling of bull trout. However, given historical numbers of incidentally captured bull trout in the Skagit River (Table 4), the USFWS does not anticipate that broodstock collection efforts will capture, injure, and/or kill a large number of bull trout relative to the local bull trout populations in the Lower Skagit River Core Area.

Given that broodstock collection of adult chum salmon will occur between mid-October and mid-December, in-river netting activities will most likely affect adult and/or large subadult bull trout that are either foraging, migrating/moving through (for spawning purposes), and/or overwintering in the Skagit River and associated tributaries. However, the extent of the area in which broodstock activities will be conducted and post-spawning adult bull trout may be present, between October and December, is unknown. While the USFWS expects that collection practices and protocols will minimize the risk of injury and delayed mortality, the USFWS anticipates some minimal level of incidental capture and handling of bull trout associated with chum salmon broodstock collection.

Similar to those adverse effects predicted at the Marblemount Hatchery and the Sauk-Suiattle Hatchery, potential adverse effects of in-river netting on bull trout in the Skagit River include increased entanglement events and handling times, resulting in injury(ies) and, potentially, immediate and/or delayed mortality experienced by bull trout. Given the gill net mesh opening size (5.5 inches [140 mm]) proposed, the USFWS anticipates that mostly adult bull trout and some subadult bull trout will be captured, resulting in low selectivity for the majority of smaller bull trout that may be encountered. In consideration of this gill net mesh opening size and gill net selectivity among other salmonids, the USFWS expects that a proportion of adult and subadult bull trout (greater than or equal to 539 mm [21.2 inches] long) present in the area will be incidentally captured (Bromaghin 2005).

The USFWS expects up to a 25 percent mortality rate for bull trout bycatch resulting from in-river netting for chum salmon at the Upper Skagit Hatchery. Based on historical numbers of incidentally captured bull trout (Table 4) and the co-mangers' best professional judgment (Table 5), the USFWS expects that up to 5 adult and/or large subadult bull trout per year will be adversely affected by in-river netting efforts and, of these, 2 adult and/or large subadult bull trout will die as a result of immediate or delayed mortality. Over the 20-year term of the consultation, 100 bull trout will be adversely affected by in-river netting efforts associated with the Upper Skagit Hatchery and chum salmon program.

Table 6 summarizes information about the components and activities associated with the three chum salmon hatchery programs and facilities in the Basin that lead to, or necessitate, the capture and physical handling of fish, thereby resulting in adverse effects on bull trout. This summary table highlights the maximum numbers of captures and mortalities that the USFWS expects on an annual basis.

Table 6. Chum salmon hatchery facility components and program activities and the resulting expected number of bull trout that are captured and that die, annually, in the Skagit River basin.

Hatchery Program	Facility Components and Program Activities	Maximum Captures (Expected)	Maximum Mortalities (Expected)
Skagit River Fall Chum Salmon	Marblemount Hatchery		
	Cascade River surface water intake	0.20	
	Weirs (B and C)	0.25[a]	
	Adult trap	2	1
	Collection methodologies	20	5
Chum Salmon Remote Site Incubator	Sauk-Suiattle Hatchery		
	Collection methodologies	5	2
Upper Skagit Chum Salmon	Upper Skagit Hatchery		
	Collection methodologies	5	2

[a]The U.S. Fish and Wildlife Service expects that no more than 5 bull trout will pass over the weirs during the 20-year duration of the consultation. Some of these fish may return back downstream undetected.

10.1.3 Beneficial Effects

Historically, returns of naturally-spawning salmon contributed large quantities of nutrients to otherwise nutrient-limited aquatic ecosystems. These nutrients, along with other ecological services (e.g., nutrient release and retention, disturbance, and release of aquatic macroinvertebrates), stimulated aquatic ecosystem productivity, including riparian vegetation, and supported large populations of resident and freshwater-rearing anadromous salmonids. Currently, declines in the abundance of naturally-spawning salmon in the Basin and, more specifically, in the Lower Skagit River Core Area, limit the contribution of nutrients in the mainstem Skagit and Sauk Rivers and associated tributaries. Hatchery-origin chum salmon carcasses could provide some of these aforementioned ecosystem services, and even though population levels are low (in comparison to historical levels), the USFWS expects to see modest beneficial effects to bull trout resulting from increased salmonid biomass.

The three chum salmon hatchery programs may produce a limited, direct forage benefit to adult and subadult bull trout. In freshwater areas, only adult and larger subadult bull trout are likely to consume juvenile chum salmon, due to the relatively large body size of the hatchery fish (Keeley and Grant 2001; Lowery 2009). Released as subyearlings and/or fry, chum salmon are smaller, and they could be available as prey to smaller size classes of bull trout. However, in the mainstem rivers, their temporal availability as prey for bull trout is somewhat limited given the rapid outmigration of hatchery-released chum salmon.

Returning hatchery-origin chum salmon that spawn naturally in the Skagit River watershed may provide some benefits to bull trout, as their offspring serve as an additional prey resource. Researchers have observed that the abundance of spawning anadromous salmonids like chum salmon has positively influenced the overall abundance, size, and growth rates of bull trout (Copeland and Meyer 2011; Kraemer 2003; Zimmerman and Kinsel 2010). Generally, anadromous salmon provide a prey resource base for bull trout in the form of eggs and freshwater-rearing juveniles, which can comprise a substantial proportion of bull trout diets in freshwater habitats (Lowery and Beauchamp 2015).

According to the information provided in the BA, the three chum salmon hatchery programs will collectively produce approximately 5.6 million chum salmon (Table 3) that will be released, annually, into the Skagit and Sauk Rivers (WDFW et al. 2019). These hatchery-released juveniles will undoubtedly provide additional prey resources for bull trout, thereby positively contributing to their overall survival, growth, and reproductive success, and ultimate recovery.

10.2 Effects on Designated Bull Trout Critical Habitat

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

The following PCEs are present in the action area. Of the PCEs present, some will not be affected by the proposed action.

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

The three chum salmon hatchery programs and facilities in the Basin will use water non-consumptively. At the Marblemount Hatchery, all surface water withdrawn for use in the hatchery is discharged back into the Cascade River. At the Sauk-Suiattle Hatchery and the Upper Skagit Hatchery, all water is also returned near the points of withdrawal. Since most water is returned to the streams of origin close to where it is withdrawn, and the amount of water use is relatively small (a maximum of 30 cfs), water use from these streams will have no measurable effect on groundwater recharge. Hatchery water used in rearing ponds may contribute to minor warming of the receiving water body at the point of discharge. However, given the relatively small area of the mixing zone, effects on thermal refugia are not expected to be measurable. Because hatchery operations will not measurably affect groundwater sources, springs, or thermal refugia, the USFWS considers effects on this PCE to be insignificant.

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

None of the weirs used at water intake structures or traps at the Marblemount Hatchery are located in designated critical habitat for the bull trout. The weir on Clark Creek blocks access for fish to approximately 0.5 mile (0.8 km) of the stream between the hatchery and its feeder spring. The stream is not designated critical habitat. The co-managers operate the Marblemount Hatchery adult trap most of the year (between May and March). The weir on Jordan Creek used to be a passage barrier, but this stream is also not designated critical habitat. The intake was rebuilt in 2018, and a new fish ladder now enables volitional upstream and downstream fish passage in Jordan Creek.

The channel-spanning nets (gill/tangle nets, seines) used for broodstock collection activities can serve as temporary barriers to fish movement and block connectivity to spawning, rearing, overwintering, and freshwater and marine foraging habitats (PCE 2) in designated critical habitat areas. The co-managers will use nets in the lower portions of the Cascade and Sauk Rivers and along more than 50 miles (80 km) of the Skagit River. Depending on location, flow conditions, and timing, the co-managers will use nets along the riverbank to capture returning adult salmonids, potentially blocking deep pools and/or side channels. The co-managers will use gill nets, tangle nets, and/or seines for broodstock collection at different times of the year, depending on the species targeted for collection for the various hatchery programs in the Basin. For the chum salmon hatchery programs in the Basin, specifically, broodstock collection occurs between October and December, annually. In-river collection methods involving the use of nets and beach seines will partially preclude bull trout movement and migrations throughout the areas where fish will be captured for use in the three chum salmon hatchery programs. Because the nets present a partial, intermittent, and/or seasonal barrier to migration and will preclude the PCE from functioning during the time when they are in use, the USFWS considers the effects of broodstock collection activities on this PCE to be limited and adverse.

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

None of the chum salmon hatchery programs and facilities are physically located in or immediately adjacent to designated critical habitat for the bull trout. Routine maintenance activities required to operate and maintain hatchery facilities do not involve the removal of riparian vegetation or in-water work that could measurably affect terrestrial or aquatic macroinvertebrates, a prey resource for bull trout. The discharge of hatchery effluent and release of juvenile hatchery-raised salmonids can serve as attractants and seasonal prey resources for adult and subadult bull trout. Although there are no documented and anecdotal accounts of bull trout feeding on hatchery-released smolts at the release sites associated with the three chum salmon hatchery programs and facilities, the USFWS expects that the proposed action could contribute positively to, and enhance, the prey resource base for bull trout, thus providing some beneficial effects on the current function of this PCE.

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 LW, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

None of the normal operation and maintenance activities conducted at any of the three chum salmon hatchery facilities will alter or measurably affect baseline PCE functions. Therefore, effects on this PCE are considered discountable.

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

At the three chum salmon hatchery programs and facilities in the Basin, water temperatures must be cold enough to support rearing juvenile salmonids. Thus, temperatures in the hatchery facilities do/should not rise to levels that are detrimental to juvenile salmonids. Minor warming may occur in rearing ponds prior to the water being discharged into the receiving waterbody. However, the volume of water discharged from the hatchery facilities is relatively small compared to the volume of the receiving waters, and any incremental increase in temperature is not expected to be measurable beyond the mixing zones at the point of discharge. For these reasons, effects to this PCE will not be measurable and will not affect the function of this PCE.

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

Neither the chum salmon program activities nor the hatchery facilities will be conducted anywhere in close proximity to, or located in, designated critical habitat (spawning and rearing) for the bull trout. The closest bull trout spawning habitat to the Marblemount Hatchery is located approximately 15 miles (24 km) upriver from the facility, in Kindy Creek. The nearest bull trout spawning habitat to the Sauk-Suiattle Hatchery is approximately 10 miles (16 km) upriver from the facility. The Upper Skagit Hatchery is more than 50 miles (80 km) from bull trout spawning and rearing habitat. Because this PCE is not present near any of the chum production facilities, effects on this PCE are considered discountable.

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

All surface water used at the Marblemount Hatchery, is discharged back into the Cascade River. The same is true for minor water withdrawals at the Sauk-Suiattle Hatchery and Upper Skagit Hatchery; all of the water is returned to the stream from which it was withdrawn. Within this area, there are no data and/or anecdotal accounts to suggest that water used at these hatchery facilities influences the natural hydrograph to the extent that this PCE would be measurably affected. For these reasons, effects on this PCE are considered insignificant.

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

The USFWS expects that the discharge of hatchery effluent into surface waterbodies will result in insignificant effects on water quality. The area affected by hatchery discharges is relatively small and will not measurably impair water quality in critical habitat or waterbodies that drain into critical habitat. The use of chemicals and other hatchery-related pollutants in the effluent, minor increases in water temperature (see PCE 5), and slight reductions in dissolved oxygen levels will not alter water quality downstream of the three chum salmon hatchery programs and facilities to the degree that would inhibit or measurably affect reproduction, growth, or survival of bull trout downstream of the facilities. In addition, discharge volumes are relatively small compared to the volumes of the receiving waterbodies. Thus, we expect that surface water used for hatchery programs and effluent discharges will have insignificant effects on water quality (PCE 8) or quantity (see PCE 7).

PCE 9: Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, and 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 USFWS does not expect that hatchery operations will result in the introduction of, and/or measurable changes in, populations of non-native predatory, interbreeding, or competitive species. Therefore, the proposed actions will have no effect on this PCE.

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

Cumulative effects include the effects of future state or private activities, not involving federal activities, which 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 ESA.

Existing and future agricultural activities and practices (e.g., livestock grazing, tilling, and crop and hay production) will continue to result in degraded water quality, especially in the lower Skagit River valley, where agricultural use is greatest in the Basin. These activities, which occur in the floodplain and adjacent to the riverbank, will, over time, lead to the loss of mature riparian buffers and, therefore, contribute to increased water temperature. With the implementation of enhanced agricultural and land-use activities and practices, conditions that currently limit and/or reduce instream habitat function, structure, and productivity may improve over the long term.

As Washington's human population continues to grow, so too will urban development (urbanization) increase and expand. Much of the current urban development is occurring throughout the Skagit River floodplain, resulting in increases in the amount of impervious surface area and, consequently, diminished riparian buffers. Increased urbanization can result in significant alterations in riverine hydrology and geomorphology, which can, and is likely to, impact fisheries resources and habitats. Additionally, increased logging activity throughout the Basin will result in the reduction of riparian vegetation and buffers (i.e., shade for fish), increased water temperature, and increased sedimentation. Further, increased mining pressure and associated practices within the headwaters of the Basin, a large portion of which is located in British Columbia, Canada, continue to threaten water quality and quantity in the downstream, U.S. portions of the Basin. The USFWS expects that the cumulative effects associated with these aforementioned activities and practices will continue to negatively impact bull trout and habitat conditions in the Basin that are critical in supporting their survival.

In response, governments, conservation groups, organizations, and citizens are working together to address these kinds of effects in hopes of enhancing the resiliency of bull trout and other salmonids, and the lands and waters upon which they depend. For example, local groups and non-profit/non-governmental organizations like the Skagit Fisheries Enhancement Group (SFEG) have led, and will continue to lead, communities within the Skagit River watershed (including the Skagit and Samish River watersheds) in habitat restoration and watershed stewardship to enhance salmon populations, which directly and indirectly benefit bull trout local populations. The Salmon Recovery Funding Board (SRFB), created by the Washington State Legislature in 1999, provides financial support (i.e., grants) to groups like the SFEG to restore salmon habitat and aid in other, related activities. In 2022, for instance, the SRFB awarded over $400,000 in grants to the SFEG in support of project goals that that range from enhancing fish passage (i.e., culvert replacement) to supplementing vegetation plantings. The SRFB awarded over 2.2 million dollars in grants to other non-federal groups, including SCL, the Skagit Land Trust, and the Skagit River System Cooperative in support of additional work research aimed towards conservation and recovery of salmonids, including bull trout, throughout the Basin (SRFB 2022).

The Upper and Lower Skagit River watersheds are the principal components of the Water Resource Inventory Areas (WRIAs) 3 and 4, respectively (Ecology 2016). In these WRIAs, increasing demands for water resulting from human population growth, declining groundwater levels in some areas, and the impacts of climate change add to complexities surrounding water management. While much of the water in the Upper Skagit watershed, for example, is already legally spoken for, state agencies like Ecology are working towards proposing and supporting mitigation projects and programs that provide legally secure water supplies for existing and future water uses throughout the Basin, while maintaining and protecting instream flows. These flows benefit salmonids, including bull trout. Ecology is already collaborating with local governments, tribes, landowners, and other stakeholders in the area to best determine the most cost-effective package(s) of actions to address both instream and out-of-stream needs (Ecology 2016).

The Puget Sound Salmon Recovery Plan (NMFS 2007) outlines regional, non-federal recovery efforts that are underway in hopes of meeting obligations to species and habitats under the ESA. The recovery plan includes local recovery goals, priority recovery actions, and monitoring needs of each watershed in the Puget Sound. The recovery plan served as the foundation for development of the Chinook Monitoring and Adaptive Management project, which focuses on garnering the regional support necessary to enable watersheds in implementing recovery strategies in their local areas. Additionally, in 2007, recognition of additional ecological concerns regarding Pacific salmon species led the State of Washington to establish a new state agency, the Puget Sound Partnership, to devise and implement a mutually shared set of priorities including coordinating the development of, and carrying out, the recovery plan and the Shared Strategy for Puget Sound. The recovery plan, monitoring and management project, and the Puget Sound Partnership are linked, so that one element informs the other and vice versa. Subsequently, a joint effort shared by federal and non-federal entities exists in the Puget Sound Federal Task Force to help integrate the work of the states, tribes, local governments, and other groups in developing a watershed recovery program plan for the Puget Sound, thereby potentially enhancing the resiliency of salmonids including bull trout (EPA 2022).

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

The Integration and Synthesis Section is the final step in assessing the risk posed to species and designated critical habitat as a result of implementing the proposed action. In this section, the USFWS adds the effects of the action and cumulative effects to the environmental baseline and, in light of the status of the species and critical habitat, we formulate the USFWS' 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 designated critical habitat.

12.1 Bull Trout

The action area is located, broadly, in the CRU and the Lower Skagit River Core Area. In the Lower Skagit River Core Area, the USFWS recognizes 20 bull trout local populations. Bull trout occur throughout the Skagit River and express fluvial, adfluvial, resident, and anadromous life history forms. Specific to the action area, fluvial bull trout forage and overwinter in the larger pools of the upper portion of the Skagit River and, to a lesser degree, in the Sauk-Suiattle River watershed. Anadromous bull trout, originating from several nearby core areas (e.g., Nooksack, Snohomish and Skykomish, and Stillaguamish River Core Areas), may be present within the action area (i.e., foraging and/or overwintering) simultaneously. Outside of the action area, key spawning and rearing habitat is primarily located in the upper portion of the Skagit River. National Park and Forest lands, Recreation Areas, and Wilderness Areas contain most of the best available remaining spawning and rearing habitat for bull trout, steelhead, and salmon.

Of the core areas associated with the CRU, the Lower Skagit River Core Area contains the largest spawning populations of bull trout in Washington. During the 5-year review conducted in 2008, the USFWS estimated bull trout adult abundance to be between 2,500 and 5,000 individuals based on partial spawner survey data from less than half of this core area (USFWS 2008). While abundance data for most bull trout local populations are severely limited and/or outdated, the USFWS acknowledges that bull trout adult abundance has declined since 2008. Based on the available information, the USFWS estimates that the current bull trout population in the Lower Skagit River Core Area is likely less than half (between 1,000 and 1,500 breeding adults, approximately) of the abundance estimates presented in the 2008 status review, published 15 years ago. The USFWS believe that current and emerging threats (e.g., agricultural practices, urbanization, and climate change) will exacerbate the decline in bull trout abundance throughout the Basin.

The proposed action includes management, operations, and other activities associated with three chum salmon hatchery programs at the Marblemount, Sauk-Suiattle, and Upper Skagit Hatchery facilities in the Basin. All three of the chum salmon hatchery programs are existing, ongoing programs that are unique in their infrastructure and their implementation of various activities (e.g., broodstock collection). The purpose of the chum salmon hatchery programs, collectively, is to supplement and rebuild the natural chum salmon population in the Skagit River. In this Opinion, the USFWS analyzed the effects of the proposed action on bull trout and designated critical habitat for the bull trout, identifying adverse, neutral, and beneficial effects of continued operation of the hatchery programs.

Implementation of the proposed action will result minimal exposure(s) to, and local effects on, bull that that forage and/or overwinter in, and migrate/move through, the action area. These effects will result from water withdrawals, hatchery infrastructure at the Sauk-Suiattle and Upper Skagit Hatcheries, maintenance activities, discharge of hatchery effluent, and inter- and intraspecies interactions. Based on differences in the location(s), life history stages, timing of releases, adult spawning areas of chum salmon and bull trout, the USFWS anticipates that effects, primarily ecological in nature, will be minor and will adversely affect few, if any, individual bull trout.

Implementation of the proposed action will result in harmful exposure(s) to, and adverse effects on, bull trout that forage and/or overwinter in, and migrate/move through, the action area. These effects will result from water withdrawals, unique aspects of the hatchery infrastructure (e.g., surface water intakes and weirs) at the Marblemount Hatchery and proposed in-river broodstock collection associated with all three chum salmon hatchery programs in the Basin. Operation of the Marblemount Hatchery, coupled with certain ecological conditions (e.g., high flow events), will likely result in occasional (infrequent) entrapment of bull trout at the Cascade surface water intake and behind weirs (B and C). Screening does not meet current NMFS (2011, 2022b) or previous NMFS (1995, 1996) compliance standards and, therefore, does not prevent injury to bull trout resulting from entrainment and/or impingement. Given the distance from the closest spawning and juvenile bull trout rearing areas, it is unlikely, but not impossible, that bull trout fry, will be present in the vicinity of, and encounter, the Cascade River surface water intake at the Marblemount Hatchery and, therefore, could be susceptible to entrainment and/or impingement at the screening. Additionally, high flow events may cause bull trout to become stranded above weirs and/or hatchery water intake systems. The USFWS expects that bull trout are present (in low numbers) in the vicinity of the hatchery facility and that, during a high flow event, any adult, subadult, and/or larger juvenile bull trout that moves upstream of the weir could become entrained into, and/or stranded in, hatchery infrastructure, ponds, and channels. We expect that adverse effects resulting from the

Marblemount Hatchery water withdrawals and hatchery infrastructure on bull trout will have a relatively minor impact at the scale of the CRU and/or Lower Skagit River Core Area populations.

Operation of the Marblemount Hatchery adult trap, in addition to in-river broodstock collection of adult chum salmon at all three hatchery facilities, will require annual incidental capture and handling of individual bull trout, though the USFWS expects that mortality(ies) resulting from handling will be low. Fluvial and anadromous adult and sub-adult bull trout that may be migrating/moving to and from the Skagit, Cascade, and/or Sauk Rivers during the times of the year in which broodstock collection will occur may be captured in the adult trap and/or during in-river netting activities. While hatchery managers will safely and efficiently handle any bull trout that are incidentally captured in the adult trap and during broodstock collection and release each bull trout at various release locations (Table 3), bull trout will likely experience stress, injury(ies), and mortality. The USFWS anticipates that the adverse effects of capture and handling on bull trout will be limited to individuals associated with the CRU and any of the 20 bull trout local populations in the Lower Skagit River Core Area. These effects and consequences are unlikely to cause a significant decline in abundance, distribution, reproduction, growth, or survival of bull trout at the scale of their coterminous range.

Additionally, implementation of the proposed action will result in incremental immediate and long-term beneficial effects on bull trout that forage and migrate/move through the action area. The three chum salmon hatchery programs in the Basin are likely to produce a limited, direct forage benefit to adult and subadult bull trout. Hatchery-released and returning hatchery-origin chum salmon that spawn naturally in the Skagit River watershed may provide some benefits to bull trout, as their offspring serve as an additional prey resource. Generally, anadromous salmon provide a prey resource base for bull trout in the form of eggs and freshwater-rearing juveniles, which can comprise a substantial proportion of bull trout diets in freshwater habitats. According to the information provided in the BA, the three chum salmon hatchery programs will collectively produce approximately 5.6 million chum salmon (Table 3) that will be released, annually, into the Skagit and Sauk Rivers (WDFW et al. 2019). Unfortunately, populations of all native salmon and steelhead in the Skagit River have been and continue to decline, even with increased hatchery production and restoration efforts. The hatchery-released juvenile salmonids, including those associated with the chum programs, will undoubtedly provide some additional prey resources for bull trout throughout the CRU and Lower Skagit River Core Area, thereby positively contributing to their overall survival, growth, and reproductive success, and ultimate recovery.

The three chum salmon hatchery programs in the Basin will affect a proportion of bull trout; other hatchery programs in the same area, with similar effects (insignificant/discountable, adverse, and beneficial), are ongoing. Thus, the anticipated injury(ies) and mortality of bull trout resulting from the chum salmon hatchery programs represent those associated with only a subset of the activities affecting bull trout population(s) throughout the entire watershed. Collectively, the impact of these hatchery programs on bull trout is likely to be more significant than what the USFWS has concluded in this Opinion. Considering only the three chum salmon hatchery programs, however, in the long-term, the USFWS expects that the CRU and Lower Skagit River Core Area bull trout populations will remain stable, though still trending towards a decline in abundance.

The foreseeable adverse effects of the proposed action will have a minor impact at the scale of the CRU and Lower Skagit River Core Area. The anticipated direct and indirect effects of the action, combined with the cumulative effects associated with future state, tribal, local, and private actions will neither limit nor reduce bull trout distribution, and will not measurably reduce the likelihood of persistence or recovery, at the scale of the local populations of the Lower Skagit River Core Area or nearby core areas. The anticipated direct and indirect effects of the proposed action will not alter the status of the bull trout at the scale of the CRU or coterminous range.

12.2 Designated Critical Habitat for the Bull Trout

The action area provides FMO habitat for bull trout throughout the Skagit River watershed. Outside of the action area, key spawning and rearing habitat is located in the upper portion of the Skagit River. Throughout the action area, which includes areas in which fish originating from the proposed hatchery programs are likely to move and migrate, the current condition of designated bull trout critical habitat varies considerably. Current conditions reflect natural variability, patterns of disturbance and recovery from both natural and man-made events, and the effects of earlier and concurrent, unrelated activities occurring in riparian areas, mainstem Skagit River and tributaries such as the Cascade and Sauk Rivers, and nearshore marine environments. While the condition of critical habitat in the upper portion of the Skagit River is still largely functional and protected on federal lands, the lower mainstems of the Skagit, Cascade, and Sauk Rivers, downstream of the communities of Marblemount and Darrington, have been degraded by roads, powerlines, and development in the floodplains, extensive bank armoring, and flood control levees. At some locations, these habitat features and the function of critical habitat may be moderately or severely impaired.

The action area provides nearly all of the PCEs of designated critical habitat for the bull trout. Most of these (PCEs 1, 4, 5, 7, 8, and 9) are not measurably or significantly affected by the proposed action. Regarding PCE 6, neither the chum salmon program activities nor the hatchery facilities will be conducted anywhere in close proximity to, or located in, designated critical habitat used by bull trout for spawning or rearing. Implementation of the proposed action and associated in-river broodstock collection activities will temporarily disrupt migration habitats or corridors, thereby adversely affecting PCE 2. Conversely, the USFWS expects that the implementation of the proposed action, which will result in enhanced foraging opportunities, will benefit PCE 3.

The Skagit River and its tributaries provide important FMO, outside yet still connected to other core areas, which is essential to the anadromous life history form of bull trout. The anticipated effects of the action, combined with the cumulative effects associated with future state, tribal, local, and private actions, will have limited adverse effects to the PCEs of designated bull trout critical habitat (PCE 2), but will not appreciably degrade the other PCEs of critical habitat within the CRU or Lower Skagit River Core Area. Although implementation of the proposed action will maintain the current degraded baseline, it is not expected to destroy or adversely modify critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional. Designated critical habitat will retain its current ability to establish functioning PCEs at the scale of the CRU and the action area. Critical habitat within the action area will not be further prevented from providing the intended conservation role for the species at the scale of the coterminous range and CRU.

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 and the cumulative effects, it is the USFWS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout and will not destroy or adversely modify designated critical habitat.

14 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA 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* in the definition of "take" in the ESA means an act which actually kills or injures wildlife. Such [an] act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the USFWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

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 co-managers, 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 ITS. If the NMFS 1) fails to assume and implement the terms and conditions or 2) fails to require the co-managers to adhere to the terms and conditions of the ITS 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 co-managers must report the progress of the action and its impact on the species to the USFWS as specified in this ITS [50 CFR 402.14(i)(3)].

15 AMOUNT OR EXTENT OF TAKE

The USFWS anticipates that incidental take of up to 650 bull trout is reasonably certain to occur as a result of implementation of the proposed action through the duration of the 20 year-long consultation period. The incidental take is expected to be in the form of harm (i.e., physical stress, injury, or mortality resulting from capture and/or impingement on screens). Table 7 summarizes the proposed action's activities that will result in incidental take, the forms of incidental take, and the bull trout life history stages affected by each occurrence of incidental take.

Table 7. A summary of adverse effects on, and incidental take (harm) to, bull trout associated with the chum salmon hatchery programs and facilities in the Skagit River basin during the 20 year-long consultation period.

Hatchery Program	Facility Components and Program Activities	Non-Lethal Disruption (Harm)	Non-Lethal Capture (Harm)	Injury/Death
Skagit River Fall Chum Salmon	Marblemount Hatchery			
	Cascade River surface water intake			< 5 fry/juveniles[a]
	Weirs (B and C)	5 adult/subadult		
	Adult trap	20 adult/subadult		20 adult/subadult
	Collection methodologies		300 adult/subadult	100 adult/subadult
Chum Salmon Remote Site Incubator	Sauk-Suiattle Hatchery			
	Collection methodologies		60 adult/subadult	40 adult/large subadult
Upper Skagit Chum Salmon	Upper Skagit Hatchery			
	Collection methodologies		60 adult/subadult	40 adult/large subadult

[a]Small juvenile bull trout and/or fry that become impinged or killed at the surface water intake screen cannot be monitored. The U.S. Fish and Wildlife Service base this estimate on the current population of adult bull trout in the Cascade River and probabilities of juvenile bull trout and fry being washed downstream.

16 EFFECT OF THE TAKE

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

17 REASONABLE AND PRUDENT MEASURES

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

- (RPM 1) Minimize the potential for surface water withdrawal on the Cascade River (Marblemount Hatchery) to entrap fry and small juvenile bull trout;
- (RPM 2) Monitor the extent to which high flow events introduce bull trout into areas of Clark Creek above hatchery weirs, and minimize adverse effects on bull trout; and,
- (RPM 3) Monitor and minimize adverse effects to bull trout associated with broodstock collection activities, including capture and handling of adult and larger subadults in nets and incidental capture of bull trout in the adult trap and holding pond (Marblemount Hatchery).

18 TERMS AND CONDITIONS

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

RPM 1: Minimize the potential for surface water withdrawals on the Cascade River (Marblemount Hatchery) to entrap bull trout.

To implement RPM 1, the co-managers shall:

- Following NMFS' guidance, within 10 years of issuance of this Opinion, the WDFW shall modify and/or replace the Cascade River surface water intake to be consistent with the most up-to-date NMFS compliance standards. The WDFW and NMFS shall notify the USFWS when the surface water intake has been modified to be consistent with NMFS criteria. Given that the funding to support these modifications/replacements is not guaranteed, this timeline may be adjusted with USFWS approval. The co-managers shall coordinate with the USFWS to develop a new timeline, as necessary.

RPM 2: Monitor the extent to which high flow events introduce bull trout into areas of Clark Creek above hatchery weirs, and minimize adverse effects on bull trout.

To implement RPM 2, the co-managers shall:

- Determine the minimum flow levels in the Cascade River and Clark Creek that are likely to compromise (i.e., breach) the hatchery weirs and result in fish being able to pass/move upstream, above the weir(s). To accomplish this, the co-managers shall:
    - Develop a plan to monitor and evaluate the extent to which the lower steelhead channel and adult trap weir (weir B) and the bypass/release channel weir (weir C) at the Marblemount Hatchery are breached during high flow events, such that adult and subadult bull trout are able to move into the area(s) upstream of the

weir(s). The plan shall describe surveying and monitoring/evaluation protocols that are designed to assess the extent to which bull trout move above hatchery weirs, thereby potentially becoming entrapped and/or stranded. This Term and Condition will become void if the weir is permanently removed and/or modified to enable safe downstream passage of adult and juvenile salmonids.

- Following NMFS' guidance, within 10 years of issuance of this Opinion, develop and implement the plan described above, in coordination with and subject to USFWS approval. The co-managers shall document any findings and conclusions in a report. The co-managers shall provide a copy of the plan/report to:

  Molly Good
  U.S. Fish and Wildlife Service
  Washington Fish and Wildlife Office
  510 Desmond Drive SE, Suite 102
  Lacey, Washington 98503
  (360) 753-9440

- Depending on the findings and conclusions of the plans/report, the USFWS may request that the surface water intake and flow pathways (i.e., diversion gates) on Clark Creek be upgraded to be consistent with the most up-to-date NMFS compliance standards at the time to minimize adverse effects on bull trout resulting from entrapment (i.e., entrainment, impingement) and/or stranding. If the USFWS and NMFS determine that this Term and Condition is necessary, within 10 years of issuance of this Opinion, the co-managers shall modify and/or replace flow pathways on Clark Creek to be consistent with the most up-to-date NMFS compliance standards at that time. The co-managers shall notify, the USFWS when the modifications and/or replacements are complete. This timeline may be adjusted with USFWS approval, and the co-managers shall coordinate with the USFWS to develop a new timeline, as necessary.

RPM 3: Monitor and minimize adverse effects to bull trout associated with broodstock collection activities, including capture and handling of adult and larger subadults in nets and incidental capture of bull trout in the adult trap and holding pond (Marblemount Hatchery).

To implement RPM 3, the co-managers shall:

- For all broodstock collection activities, ensure that individuals are trained and knowledgeable in fish identification and safe bull trout handling protocols and procedures.
- Ensure that bull trout captured in the adult trap and/or holding pond are safely released/returned to the river as soon as practicable.
- Release bull trout as quickly as possible, and as close as possible to the point of capture. All captured bull trout shall be released with the minimum handling time necessary to remove the fish from collection/capture gear and safely return it to the river.
- Maintain gill net/tangle net/seine sets at such a duration as to avoid killing bull trout. Nets and seines shall be attended at all times when deployed in the river.
- Report all captured bull trout to the USFWS. Reports shall include, at minimum, the date and location of capture and collection methodology(ies) (e.g., gillnet). Reports shall also

include, if/when practicable, the following information: life history form and/or approximate length of the fish, and general condition/disposition of the fish (i.e., signs of injury due to collection methodologies, whether or not the fish was released alive or died). Comprehensive data collection shall not preclude the safe and efficient handling, and release, of bull trout.

- Keep whole, put on ice, or freeze bull trout mortalities. Wrap frozen specimens directly in aluminum foil to preserve the specimen in a manner that allows for future analysis. Alternative arrangements regarding the preservation or use of mortalities are allowed if they are coordinated with the USFWS. The USFWS office listed below must approve of the request(s) in writing prior to the permittee implementing any alternative:

  Molly Good
  U.S. Fish and Wildlife Service
  Washington Fish and Wildlife Office
  510 Desmond Drive SE, Suite 102
  Lacey, Washington 98503
  (360) 753-9440

- While conducting in-river broodstock collection activities, report all incidental visual observations of bull trout to the USFWS. Reports shall include, at minimum, the date and location of each fish observed. Reports shall also include, if/when practicable, the following information: life history form and/or approximate length of the fish, and the general condition/disposition of the fish, noting any obvious signs of injury.

- Annually report all information specified in this Term and Condition to the USFWS. All reporting requirements shall be provided, electronically, by June 15 for the previous calendar year. This timeline may be adjusted with USFWS approval. The co-managers shall provide a copy of the report to:

  Molly Good
  U.S. Fish and Wildlife Service
  Washington Fish and Wildlife Office
  510 Desmond Drive SE, Suite 102
  Lacey, Washington 98503
  (360) 753-9440

- Notify USFWS within 48 hours after knowledge of exceeding any take threshold described in the ITS (including Table 7) or if any activities deviate from those described in the Proposed Action Section of this Opinion. The co-managers shall notify the USFWS via written correspondence and/or coordinate with the USFWS to discuss either of these situations.

The USFWS believes that no more than 650 bull trout will be incidentally taken as a result of implementation of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The federal agency must immediately provide an explanation of the causes of the taking and review with the USFWS the need for possible modification of the RPMs.

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

19 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA 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.

Regarding the three chum salmon hatchery programs and facilities in the Basin, the USFWS recommends that:

- The co-managers should broaden the geographical extent of spawning ground surveys and bull trout redd counts in the Lower Skagit River Core Area. Additional estimates and trend information would assist the USFWS when assessing and/or considering future actions in the core area.
- The co-managers should monitor and assess ecological interactions between bull trout and chum salmon in freshwater, and in nearshore habitats in the Puget Sound, to better understand how hatchery programs can aid in the conservation and recovery of bull trout.
- Because naturally-rearing chum salmon provide a seasonal prey resource base for bull trout, the WDFW should more fully evaluate the extent to which the chum salmon hatchery programs influence the abundance of naturally-rearing chum salmon in the Skagit River watershed.

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

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 USFWS where discretionary federal involvement or control over the action has been retained or is authorized by law and: a) if the amount or extent of taking specified in the incidental take statement is exceeded; b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; c) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or, d) if a new species is listed or critical habitat designated that may be affected by the identified action.

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APPENDIX A
STATUS OF THE SPECIES: BULL TROUT

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Appendix A
Status of the Species: Bull Trout

Taxonomy

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

Species Description

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

Legal Status

The coterminous United States population of the bull trout was listed as threatened on November 1, 1999 (USFWS 1999, entire). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 4; Brewin and Brewin 1997, pp. 209-216; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (USFWS 1999, p. 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, entire; Rieman et al. 2007, entire; Porter and Nelitz. 2009, pages 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

Life History

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, p. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 1). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, p. 1; Ratliff and Howell 1992, p. 10).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002, p. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007, p. 10). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995, Ch 2 pp.

23-24). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population Dynamics

Population Structure

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

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

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

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

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

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

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

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

Population Dynamics

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

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

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

Habitat Characteristics

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

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

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

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

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

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

Diet

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

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

Status and Distribution

Distribution and Demography

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

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

Coastal Recovery Unit

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

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

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

Puget Sound Region

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

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

Olympic Peninsula Region

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

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

Lower Columbia River Region

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

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

Klamath Recovery Unit

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

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

Upper Klamath Lake Core Area

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

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

Sycan River Core Area

The Sycan River core area is comprised of one local population, Long Creek. Long Creek likely faces greater risk of extirpation because it is the only remaining local population due to extirpation of all other historic local populations. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). This core area's local population is genetically distinct from those in the other two core areas (USFWS 2008b). This core area also is essential for recovery because bull trout in this core area exhibit both 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.

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

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

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

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

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

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

Upper Snake Recovery Unit

The Upper Snake Recovery Unit includes portions of central Idaho, northern Nevada, and eastern Oregon. Major drainages include the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and the Weiser River. The Upper Snake Recovery Unit contains 22 bull trout core areas within 7 geographic regions or major watersheds: Salmon River (10 core areas, 123 local populations), Boise River (2 core areas, 29 local populations), Payette River (5 core areas, 25 local populations), Little Lost River (1 core area, 10 local populations), Malheur River (2 core areas, 8 local populations), Jarbidge River (1 core area, 6 local populations), and Weiser River (1 core area, 5 local populations). The Upper Snake Recovery Unit includes a total of 206 local populations, with almost 60 percent being present in the Salmon River watershed (USFWS 2015e, p. E-1).

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

Salmon River

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

Connectivity within Salmon River basin core areas is mostly intact except for the Pahsimeroi River and portions of the Lemhi River. The Upper Salmon River, Lake Creek, and Opal Lake core areas contain adfluvial populations of bull trout, while most of the remaining core areas contain fluvial populations; only the Pahsimeroi contains strictly resident populations. Most core areas appear to have increasing or stable trends but trends are not known in the Pahsimeroi, Lake Creek, or Opal Lake core areas. The Idaho Department of Fish and Game reported trend data from 7 of the 10 core areas. This trend data indicated that populations were stable or increasing in the Upper Salmon River, Lemhi River, Middle Salmon River-Chamberlain, Little Lost River, and the South Fork Salmon River (IDFG 2005, 2008). Trends were stable or decreasing in the Little-Lower Salmon River, Middle Fork Salmon River, and the Middle Salmon River-Panther (IDFG 2005, 2008).

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

Boise River

In the Boise River basin, two large dams are impassable barriers to upstream fish movement: Anderson Ranch Dam on the South Fork Boise River, and Arrowrock Dam on the mainstem Boise River. Fish in Anderson Ranch Reservoir have access to the South Fork Boise River upstream of the dam. Fish in Arrowrock Reservoir have access to the North Fork Boise River, Middle Fork Boise River, and lower South Fork Boise River. The Boise River basin contains 2 of the 22 core areas in the Upper Snake Recovery Unit. The core areas in the Boise River basin account for roughly 12 percent of occupied habitat in the Upper Snake Recovery Unit and contain 29 of the 206 local populations. Approximately 90 percent of both Arrowrock and Anderson Ranch core areas are federally owned; most lands are managed by the U.S. Forest Service, with some portions occurring in designated wilderness areas. Both the Arrowrock core area and the Anderson Ranch core area are isolated from other core areas. Both core areas contain fluvial bull trout that exhibit adfluvial characteristics and numerous resident populations. The Idaho Department of Fish and Game in 2014 determined that the Anderson Ranch core area had an increasing trend while trends in the Arrowrock core area is unknown (USFWS 2015e).

Payette River

The Payette River basin contains three major dams that are impassable barriers to fish: Deadwood Dam on the Deadwood River, Cascade Dam on the North Fork Payette River, and Black Canyon Reservoir on the Payette River. Only the Upper South Fork Payette River and the Middle Fork Payette River still have connectivity, the remaining core areas are isolated from each other due to dams. Both fluvial and adfluvial life history expression are still present in the Payette River basin but only resident populations are present in the Squaw Creek and North Fork Payette River core areas. The Payette River basin contains 5 of the 22 core areas and 25 of the 206 local populations in the recovery unit. Less than 9 percent of occupied habitat in the recovery unit is in this basin. Approximately 60 percent of the lands in the core areas are federally owned and the majority is managed by the U.S. Forest Service. Trend data are lacking and the current condition of the various core areas is unknown, but there is concern due to the current isolation of three (North Fork Payette River, Squaw Creek, Deadwood River) of the five core areas; the presence of only resident local populations in two (North Fork Payette River, Squaw Creek) of the five core areas; and the relatively low numbers present in the North Fork core area (USFWS 2015e, p. E-8).

Jarbidge River

The Jarbidge River core area contains two major fish barriers along the Bruneau River: the Buckaroo diversion and C. J. Strike Reservoir. Bull trout are not known to migrate down to the Snake River. There is one core area in the basin, with populations in the Jarbidge River; this watershed does not contain any barriers. Approximately 89 percent of the Jarbidge core area is federally owned. Most lands are managed by either the Forest Service or Bureau of Land Management. A large portion of the core area is within the Bruneau-Jarbidge Wilderness area. A tracking study has documented bull trout population connectivity among many of the local populations, in particular between West Fork Jarbidge River and Pine Creek. Movement between the East and West Fork Jarbidge River has also been documented; therefore, both resident and fluvial populations are present. The core area contains six local populations and 3 percent of the occupied habitat in the recovery unit. Trend data are lacking within this core area (USFWS 2015e, p. E-9).

Little Lost River

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

Malheur River

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

Weiser River

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

St. Mary Recovery Unit

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

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

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

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

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

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

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

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

Reasons for Listing

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

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

Emerging Threats

<u>Climate Change</u>

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

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

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

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

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

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

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

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

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

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

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

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

Conservation

<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).

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APPENDIX B
STATUS OF DESIGNATED CRITICAL HABITAT: BULL TROUT

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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.

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