United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Ecological Services
1009 College Street SE, Suite 215
Lacey, Washington 98503

In Reply Refer to:
FWS/R1/2022-0005090

October 17, 2024

Jeromy Jording, Branch Chief
Anadromous Hatcheries North
National Marine Fisheries Service
1009 College Street SE, Suite 210
Lacey, Washington 98503

Dear Mr. Jording:

Subject: Biological Opinion on the Nooksack River, Lummi Bay, Whatcom Creek, Samish River and San Juan Islands Hatchery Program

This letter transmits the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) on the proposed Nooksack River, Lummi Bay, Whatcom Creek, Samish River, and San Juan Islands (Nooksack-Samish) Hatchery Program or Hatchery and Genetic Management Plan located in San Juan, Skagit, and Whatcom counties, 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.*) (ESA). Your January 31, 2022, request for formal consultation was received on January 31, 2022.

The enclosed Opinion is based on information provided in the December 28, 2021, Biological Assessment (BA), e-mails, telephone conversations, field investigations, and other sources of information detailed/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 14 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 (ECOS) website at https://ecos.fws.gov/ecp/report/biological-opinion.html.

The BA included a request for USFWS concurrence with "not likely to adversely affect" determinations for certain listed resources. The enclosed document includes a section separate from the Opinion that addresses your concurrence requests. We included a concurrence for marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and designated critical habitat for these species. The rationale for these concurrences is included in the Concurrence Section of this Opinion.

The BA also included a "no effect" determination for Oregon spotted frog (*Rana pretiosa*). There is no requirement under the ESA for the USFWS to concur with "no effect" determinations; therefore, the determination rests with the action agency and our office does not provide this documentation. We recommend that you retain a copy of your agency's "no effect" determination with the administrative records for the Project.

If you have any questions regarding the enclosed Opinion, our response to your concurrence request(s), or our shared responsibilities under the ESA, then please contact Linnéa Gullikson (linnea_gullikson@fws.gov) or Scott Sebring (scott_sebring@fws.gov).

Sincerely,

MOLLY GOOD

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Date: 2024.10.18 07:57:52 -07'00'

for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Enclosure(s)

cc:
Lummi Nation, Bellingham, WA (T. Chance)
Nooksack Indian Tribe, Deming, WA (N. Currence)
National Marine Fisheries Service, Lacey, WA (M. Robinson)
Washington Department of Fish and Wildlife, Olympia, WA (B. Missildine)

Endangered Species Act – Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
2022-0005090

Nooksack River, Lummi Bay, Whatcom Creek, Samish River and San Juan Islands Hatchery Program

San Juan, Skagit, and Whatcom counties, Washington

Federal Action Agency:

National Marine Fisheries Service

Consultation Conducted By:

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

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for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

October 17, 2024
Date

TABLE OF CONTENTS

TABLE OF CONTENTS

Appendices

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BIA	Bureau of Indian Affairs
BMP	Best Management Practices
BTC	Bellingham Technical College
CFR	Code of Federal Regulations
CH	critical habitat
CHU	critical habitat unit
CHSU	critical habitat subunit
CRU	Coastal Recovery Unit
CWT	coded wire tag
DAM	destruction or adverse modification
DPS	Distinct Population Segment
EGC	European green crab
ELJ	engineered log jam
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
FMO	foraging, migratory, and overwintering
FR	Federal Register
FSA	Fisheries Settlement Agreement
HGMP	Hatchery and Genetic Management Plan
IBI	index of biological integrity
IPCC	Intergovernmental Panel on Climate Change
ITS	Incidental Take Statement
LLTK	Long Live the Kings
MBTSG	Montana Bull Trout Scientific Group
MB-SNF	Mt. Baker-Snoqualmie National Forest
murrelet	marbled murrelet
NGO	Non-governmental organization
Nooksack-Samish	Nooksack River, Lummi Bay, Whatcom Creek, Samish River and San Juan Islands
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NWIFC	Northwest Indian Fisheries Commission
Opinion	Biological Opinion
PBF	Physical and Biological Features
PCE	Primary Constituent Element
PPCP	pharmaceuticals and personal care products
PSE	Puget Sound Energy
PSP	Puget Sound Partnership
PST	Pacific Salmon Treaty
RM	rivermile
RM&E	research, monitoring, and evaluation
RPM	Reasonable and Prudent Measures
RU	Recovery Unit

spotted owl	northern spotted owl
UGA	Urban Growth Area
U.S.	United States
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington State Department of Ecology
WFWO	Washington Fish and Wildlife Office
WRIA	Water Resource Inventory Area

UNITS AND MEASURES

cfs	cubic feet per second
cy	cubic yard
dB	decibel
fpp	fish per pound
ft	feet
km	kilometer
m	meter
mi^2	square mile
mm	millimeter
ppm	parts per million
µg/L	micrograms per liter

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1 INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) and concurrence based on our review of the proposed Nooksack River, Lummi Bay, Whatcom Creek, Samish River and San Juan Islands (Nooksack-Samish) Hatchery Program or Hatchery and Genetic Management Plan (HGMP) located in San Juan, Skagit, and Whatcom counties, Washington. The Opinion address effects on bull trout (*Salvelinus confluentus*) and designated critical habitat (CH) for the bull trout. The Concurrence Section addresses effects of the proposed action on marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and CH for these species in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). Your January 31, 2022, request for formal consultation was received on January 31, 2022.

This Opinion is based on information provided in the December 28, 2021, Biological Assessment (BA), e-mails, telephone conversations, field investigations, and other sources of information detailed/cited in the Opinion. A complete record of this consultation is on file at the USFWS' Washington Fish and Wildlife Office (WFWO) in Lacey, Washington.

2 CONSULTATION HISTORY

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

- On January 31, 2022, the National Marine Fisheries Service (NMFS) requested formal consultation from the USFWS.
- Upon review of the consultation request, BA, and other materials, on May 24, 2023, the USFWS requested additional information from the NMFS regarding broodstock collection, water intake structures, and the juvenile monitoring programs.
- On June 15, 2023, the NMFS and the co-managers provided the requested additional information.
- On June 16, 2023, the USFWS clarified with the NMFS and co-managers the descriptions and details of the broodstock collection locations.
- On July 24, 2023, the USFWS requested and received from the NMFS and co-managers additional information on dredging activities at the Samish River Hatchery.
- On July 26, 2023, the USFWS initiated formal consultation on the Nooksack-Samish HGMP.
- Between August 24 and October 18, 2023, the NMFS and co-managers reviewed and provided feedback on the USFWS’ Description of the Proposed Action Section of the draft Opinion. On September 22, 2023, the USFWS met with the NMFS and co-managers to discuss the proposed action and, on October 18, 2022, the USFWS committed to incorporating additional details about research, monitoring, and evaluating (RM&E) activities in the revised description of the proposed action.
- Between October 25 and October 30, 2023, the USFWS requested and received from the NMFS and co-managers additional information regarding incidental take of bull trout associated with the proposed RM&E activities.

- On November 14, 2023, the NMFS provided presentation slides to the USFWS including additional information about adult salmon dispersion and increased Chinook salmon (*Oncorhynchus tshawytscha*) production at Kendall Creek Hatchery.
- Between December 7 and 22, 2023, the Washington Department of Fish and Wildlife (WDFW) shared with the USFWS information about off-site releases of Chinook salmon originating from Kendall Creek Hatchery.
- On August 19, 2024, the USFWS sent to the NMFS a complete draft Opinion for their review/feedback.
- On October 15, 2024, the USFWS sent to the NMFS a final Opinion.

3 CONCURRENCE

The NMFS determined, and the USFWS concurs, that the proposed action is not likely to adversely affect marbled murrelet (murrelet) and northern spotted owl (spotted owl) as well as designated CHs for these species.

3.1 Marbled Murrelet

On October 1, 1992, the USFWS listed the 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 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 current and historical marine distribution of the murrelet includes the southern Salish Sea (Puget Sound, Strait of Juan de Fuca) and the outer coast (WDFW et al. 2021, p. 22). Terrestrial nesting habitat distribution for the species includes western Washington within 55 miles of marine waters (WDFW et al. 2021, p. 22). Nest locations in Washington have been documented from near sea level to 4,200 feet (ft) elevation and inland to 36.5 miles from nearest marine waters (WDFW et al. 2021, p. 22). In Washington State, murrelets usually nest in older forests dominated by western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga menziesii*), and Western red cedar (*Thuja plicata*) (WDFW et al. 2021, p. 22).

As part of this action, the NMFS and co-managers from the WDFW, the Lummi Nation, and the Nooksack Indian Tribe propose the continued operation of Chinook, coho (*O. kisutch*), and chum (*O. keta*) salmon hatchery facilities in San Juan, Skagit, and Whatcom counties, including broodstock collection, off-site releases, and monitoring efforts (see the Description of the Proposed Action Section for more details). For this Opinion, the action area is comprised of places within or immediately adjacent to the Nooksack River Water Resource Inventory Area (WRIA) 1, including Whatcom Creek, the Samish River (WRIA 3), Lummi Bay, and the San Juan Islands where Chinook, coho, and chum salmon originating from the proposed hatchery programs will move and migrate, potentially stray, and potentially spawn naturally (WDFW et al. 2021, p. 17). Specifically, the proposed action includes hatchery facilities located on Kendall Creek (a tributary to the North Fork Nooksack River), the Middle Fork Nooksack River, Skookum Creek (a tributary to the South Fork Nooksack River), the Samish River, Whatcom Creek, an unnamed creek on Orcas Island, and along the flats of Lummi Bay (WDFW et al. 2021).

The USFWS expects murrelets to occur within the action area (WDFW et al. 2021, p. 22). While none of the hatcheries are located in murrelet critical habitat, there is CH located upstream of the Kendall Creek Hatchery in the North Fork Nooksack River sub-basin, upstream of the McKinnon Ponds facility in the Middle Fork Nooksack River sub-basin, and upstream of the Skookum Creek Hatchery in the South Fork Nooksack River sub-basin (Figure 1).

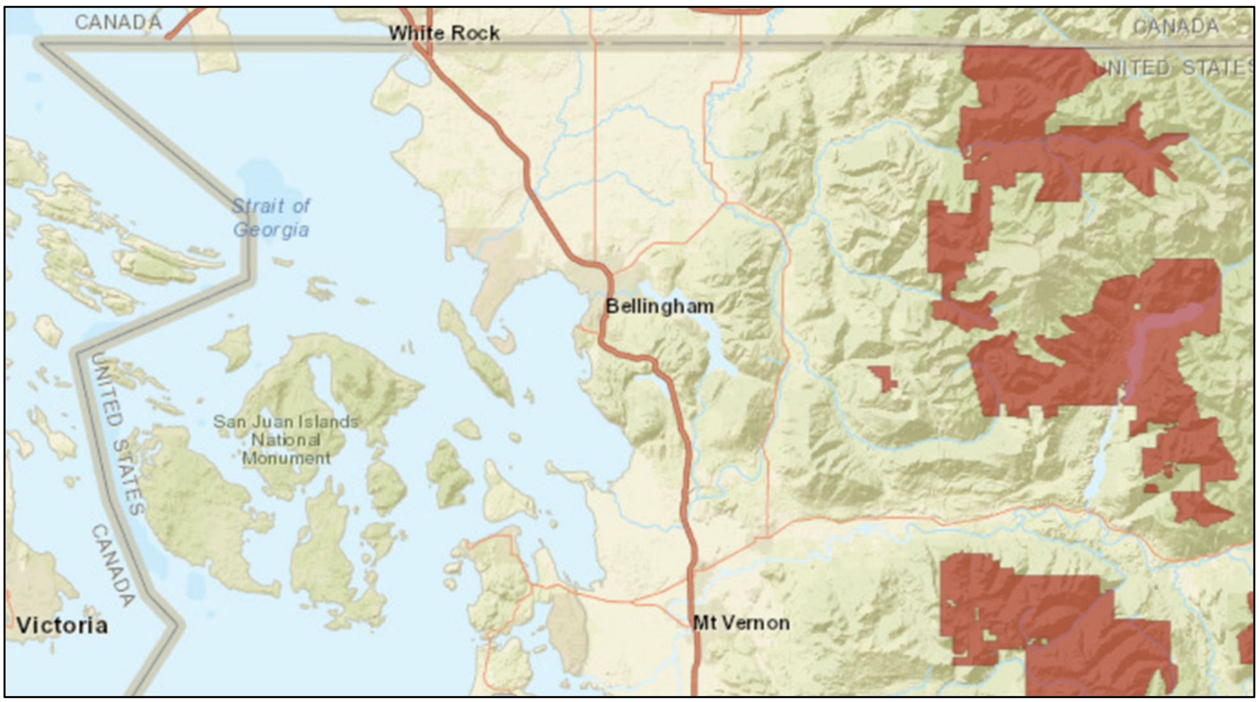

Figure 1. Designated CH for the murrelet in the action area. Designated CH areas are shown in red.
(USFWS 2023a, accessed via ECOS)

There is also suitable nesting habitat (Figure 2) for murrelets throughout much of the action area.

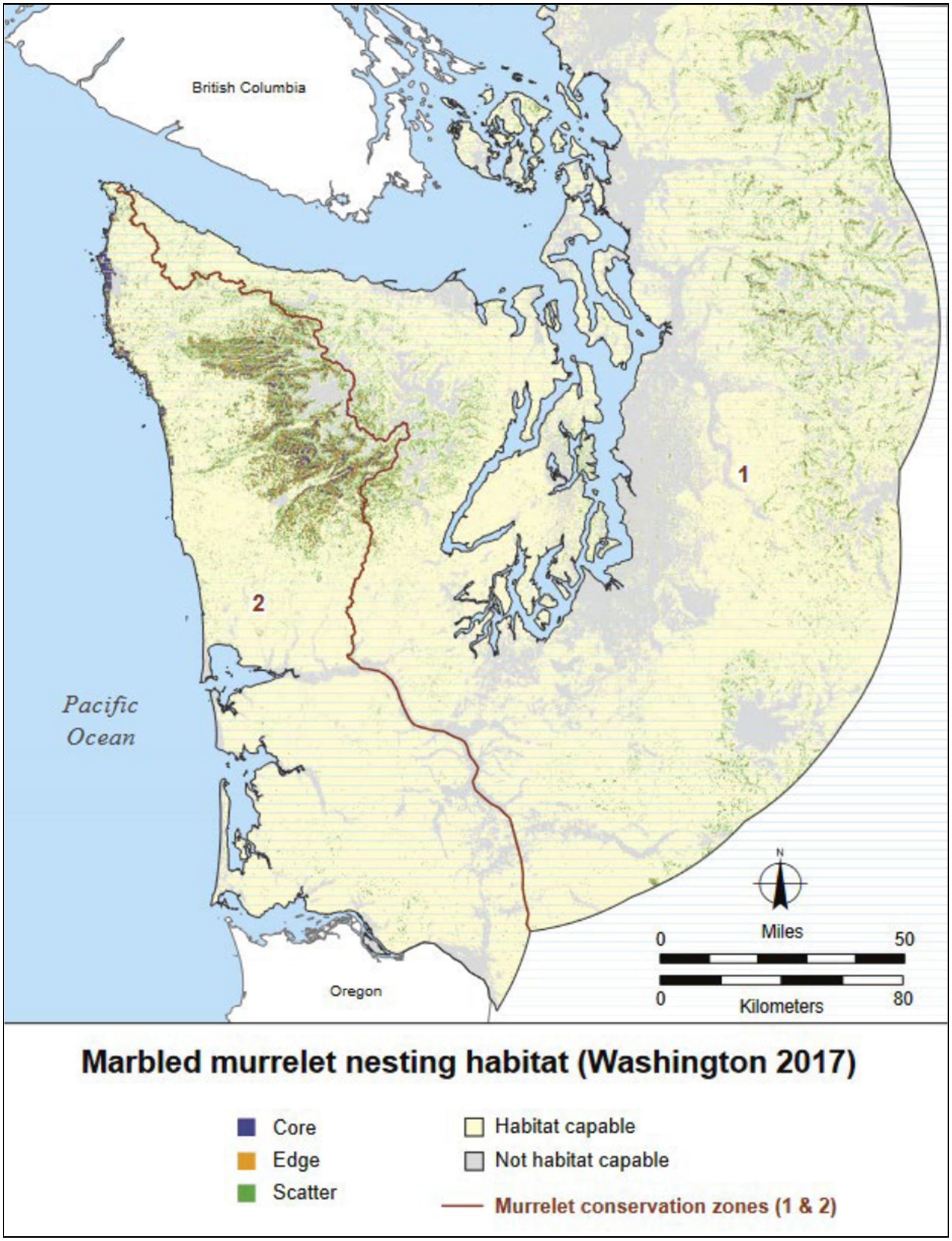

Figure 2. Map depicting higher probability nesting habitat for murrelets in Washington State. (Lorenz et al. 2021, p. 26)

In addition, murrelets have been observed foraging within nearshore marine habitat located in the action area. From 1992 to 1999, the WDFW conducted biannual murrelet surveys within Puget Sound and documented murrelets around Orcas Island, where the Glenwood Springs Hatchery is located (Nysewander et al. 2005, p. 23, p. 68). The WDFW also observed murrelets around Lummi Island, although not directly in Lummi Bay where the Lummi Bay Sea Ponds are located (Nysewander et al. 2005, p. 23, p. 68). Several murrelets were observed in Bellingham Bay, with one sighting being in relative proximity to the Whatcom Creek Hatchery (Nysewander et al. 2005, p. 68). Although murrelets have not previously been observed at any Nooksack-Samish hatchery facilities (WDFW et al. 2021, p. 17), the USFWS finds that there is sufficient evidence of murrelet presence in the action area to conservatively assume that there is potential for murrelets to nest in patches of suitable habitat, transit through the action area on their way to marine waters, and/or forage within marine nearshore habitat in the action area.

Regarding the hatchery facilities located near the Puget Sound shoreline (Glenwood Springs Hatchery, Lummi Bay Hatchery and Sea Ponds, and Whatcom Creek Hatchery), increased in-air noise from hatchery activities has the potential to disrupt communication (e.g., masking) between foraging murrelets, thereby impacting their ability to forage collaboratively and efficiently (USFWS 2023, p. 4). At these hatcheries, as well as the facilities further inland (Kendall Creek Hatchery, McKinnon Ponds, Skookum Creek Hatchery, and Samish River Hatchery), in-air noise may also cause flushing or behavioral changes in nesting murrelets, potentially disrupting parental care of eggs and nestlings (Smith et al. 2023, p. 168). However, operations at fully operating hatchery facilities will generally occur between 08:00 hours and 17:00 hours and, at release sites, only seasonally and for short periods of time. In-air noise levels resulting from routine hatchery activities and nearby vehicular traffic (i.e., during fish transport and release and/or maintenance activities) will be similar to the surrounding background/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 (i.e., dredging equipment) at hatchery facilities may extend into the adjacent forests and, therefore, could be detectable by murrelets. This noise may cause murrelets to exhibit minor behavioral responses such as scanning, head-turning, and/or increased vigilance for short periods of time (USFWS 2022, p. 3). However, the USFWS expects that these effects will be insignificant.

Murrelets may forage in the vicinity of the Lummi Bay Sea Ponds facility, which includes mesh net pens for rearing hatchery-origin salmonids. Murrelets can become trapped or ensnared in net pens of certain mesh sizes. However, hatchery managers use net pens at the Lummi Bay Sea Ponds for rearing juvenile chum and coho salmon that are between about 50-115 mm at the time of release. Net mesh size must be less than 0.5-inches to contain juvenile salmonids of this size, which are too small to present a risk to trapping or snaring of murrelets if they are present (WDFW et al. 2021, p. 22). Therefore, the USFWS considers this effect to be insignificant.

In summary, the proposed action will neither remove nor alter suitable nesting habitat for murrelets. Further, the USFWS does not expect that the proposed action will generate in-air noise at levels that exceed background noise levels in suitable murrelet nesting habitat, and mesh sizes of net pens will prevent trapping or ensnarement of murrelets. The USFWS does not expect that temporary exposures to elevated in-air noise experienced by 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 murrelet.

3.2 Northern Spotted Owl

On June 26, 1990, the USFWS listed the 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, pp. 23-24; USFWS 2022, p. 3). Since intensive studies on the species began in the 1980s, spotted owl populations are declining range wide at an average rate of 3.8 percent per year, indicating that the species is increasingly at risk of extirpation (Dugger et al. 2016, p. 70; USFWS 2022, p. 3). 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 (USFWS 2022, p. 3). 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 (USFWS 2022, p. 3).

Spotted owls live in forests characterized by dense canopy of mature and old growth trees, abundant logs, standing snags, and live trees with broken tops (WDFW et al. 2021, p. 22). Although they are known to nest, roost, and feed in a wide variety of habitat types, spotted owls prefer older, varied forest stands featuring multi-layered canopies of several tree species of varying size and age, both standing and fallen dead trees, and open space among the lower branches to allow flight under the canopy (WDFW et al. 2021, p. 22). Typically, forests do not attain these characteristics until they are at least 150 years to 200 years old (WDFW et al. 2021, p. 22). Like most owl species, the spotted owl nests in trees (WDFW et al. 2021, p. 22). Spotted owls do not build a nest. Instead, they use large cavities in old trees, or nest on a natural platform created by a large broken tree top or other natural tree deformity large enough to provide a stable nest site (WDFW et al. 2021, p. 22).

Although their preferred habitat is lacking within much of the action area, spotted owls may occur within the action area (WDFW et al. 2021, p. 22). While none of the hatchery facilities are located in spotted owl CH, there is CH located upstream of the Kendall Creek Hatchery in the North Fork Nooksack River sub-basin, upstream of the McKinnon Ponds facility in the Middle Fork Nooksack River sub-basin, and upstream of the Skookum Creek Hatchery in the South Fork Nooksack River sub-basin (Figure 3).

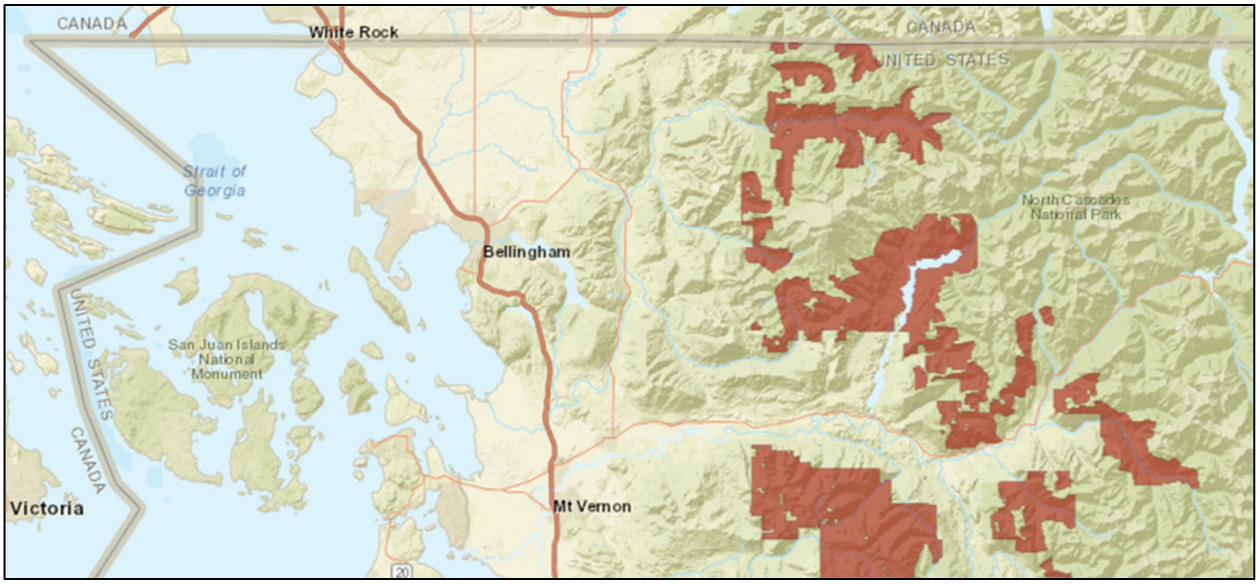

Figure 3. Designated CH for the spotted owl in the action area. Designated CH areas are shown in red.
(USFWS 2023b, accessed via ECOS)

There is a sparse amount of suitable nesting/roosting forest habitat within the action area (Figure 4). The USFWS thus conservatively assumes that spotted owls may occur within the action area.

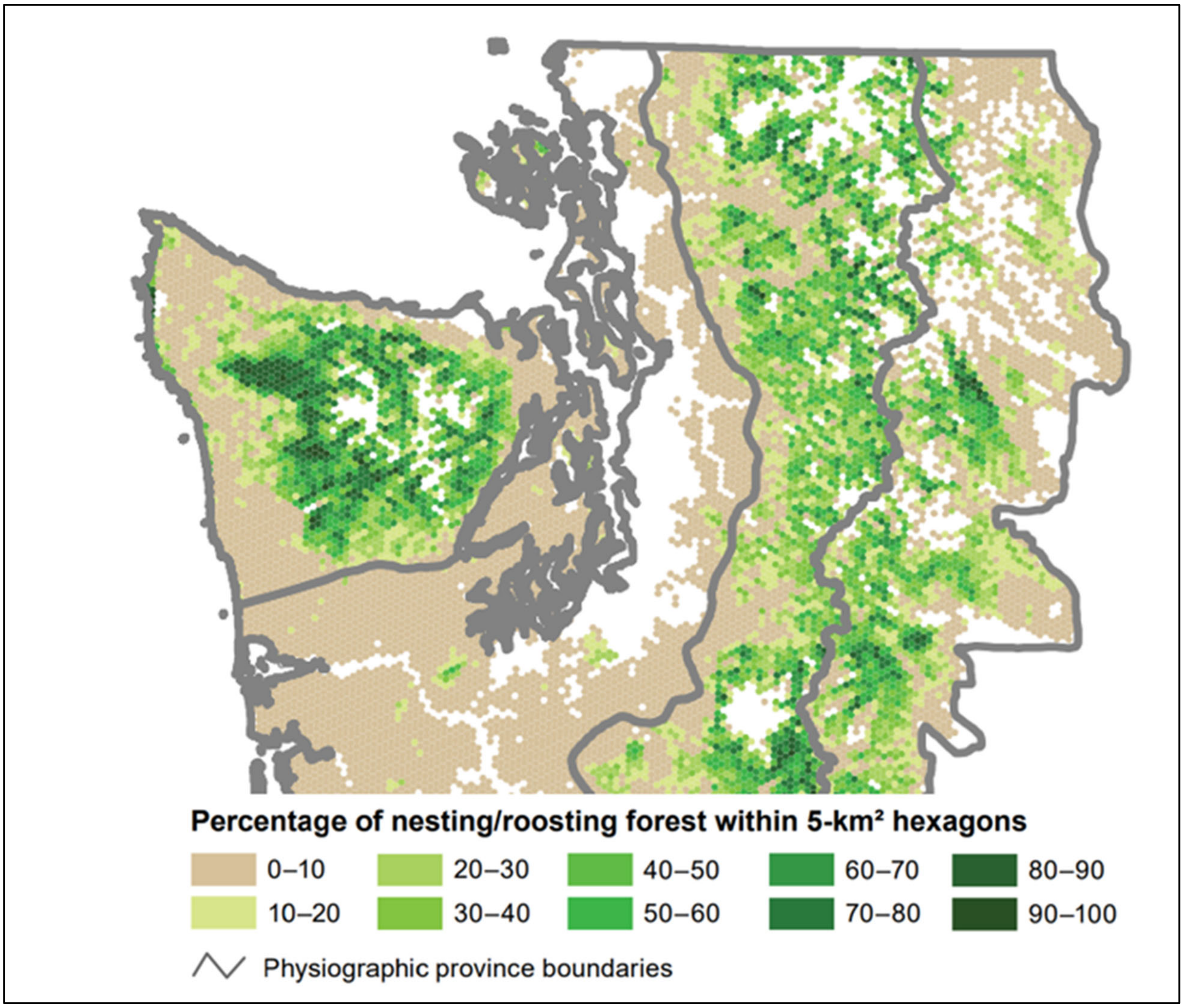

Figure 4. Spotted owl nesting/roosting forest habitat in Washington, modeled for 2017.
(Davis et. al 2022, p. 13)

Due to limited amount of suitable nesting habitat in the action area, the USFWS expects 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 hours and 17:00 hours. Spotted owls are largely nocturnal, but they forage opportunistically during the daytime (USFWS 2022, p. 3). Thus, they will most likely be resting and/or sleeping (i.e., not moving) during hatchery/facility operating hours (USFWS 2022, p. 3). 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 (USFWS 2022, p. 3). This noise may cause individuals to exhibit minor behavioral responses such as scanning, head turning, and/or increased vigilance for short periods of time (USFWS 2022, p. 3).

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. However, the USFWS expects that these effects will be insignificant.

Roosting spotted owls seek perches in trees in which they can remain concealed during the daytime, and they are usually reluctant to flush (USFWS 2022, p. 3). If an individual is perched in a tree near a hatchery site, then the owl may respond to increased activity (e.g., people walking close to and/or through adjacent forested areas or sudden loud noises) (USFWS 2022, p. 3). Research from the Pacific Northwest indicates 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 2022, p. 3). Adult spotted owls can flush from the nest without crushing their eggs or hurting their young, and adults are expected to return to the nest when the disturbance has subsided (USFWS 2015c, p. 7). Flushing from a nest infrequently and for a short duration is unlikely to result in a failed nest during incubation (USFWS 2015c, p. 7). In consideration of these factors, combined with the low level of suitable nesting habitat in the action area, the USFWS considers effects on nesting spotted owls to be insignificant.

In summary, the proposed action will neither remove nor alter suitable nesting habitat for spotted owls. Further, 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. The USFWS does not expect that temporary exposures to temporarily elevated mechanical noise experienced by 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).

The proposed action includes the following two components:

1. The NMFS' determination under limit 6 of the ESA 4(d) rule for ESA-listed Puget Sound Chinook salmon and Puget Sound steelhead (*O. mykiss*) (50 CFR § 223.203(b)(6)) concerning the WDFW's, Lummi Nation's, and Nooksack Indian Tribe's hatchery programs in the Nooksack River basin, the Samish River, Whatcom Creek, and Orcas Island; and,
2. The Bureau of Indian Affairs' (BIA) and the USFWS's ongoing disbursement of funds to five of the WDFW salmon hatchery programs listed in Table 1.

Table 1. Hatchery programs included in the proposed action, their plan/program operator, and their funding agencies.

Hatchery and Genetic Management Plan	Plan/Program Operator	Funding Agency(ies)
Kendall Creek North/Middle Fork Nooksack Native Spring Chinook Salmon Restoration Hatchery Program	WDFW	USFWS WDFW Pacific Salmon Treaty
Skookum Creek Hatchery Chinook Salmon Program	Lummi Nation	BIA Lummi Nation Pacific Salmon Treaty
Lummi Bay Hatchery Chinook Salmon Program	Lummi Nation	BIA Lummi Nation
Samish Fall Chinook Salmon Hatchery Program	WDFW	USFWS WDFW
Glenwood Springs Hatchery Fall Chinook Salmon Program	Long Live the Kings	WDFW Long Live the Kings
Whatcom Creek Hatchery Fall Chinook Salmon Program	Bellingham Technical College	WDFW Lummi Nation Bellingham Technical College
Skookum Creek Hatchery Coho Salmon Program	Lummi Nation	BIA Lummi Nation
Lummi Bay Hatchery Coho Salmon Program	Lummi Nation	BIA Lummi Nation
Kendall Creek Hatchery Coho Salmon Program	WDFW	BIA USFWS WDFW
Kendall Creek Hatchery Nooksack Fall Chum Salmon Program	WDFW	USFWS WDFW Lummi Nation
Lummi Bay Hatchery Coho Salmon Program	Lummi Nation	BIA Lummi Nation
Whatcom Creek Hatchery Chum Salmon Program	Bellingham Technical College	USFWS WDFW Lummi Nation Bellingham Technical College

Collectively, the NMFS, BIA, and the USFWS are the federal action agencies. The hatchery programs are funded by the BIA, USFWS' Office of Conservation Investment, WDFW, Lummi Nation, Bellingham Technical College (BTC), Long Live the Kings (LLTK), and the Pacific Salmon Treaty (PST) (refer to Table 1 for information specifying which funding agencies are associated with each hatchery program). The USFWS proposes partial funding of the WDFW hatchery programs at the Kendall Creek, Samish, and Whatcom Creek facilities through the Sport Fish Restoration Program. The hatchery programs are operated by BTC, LLTK, the WDFW, and Lummi Nation. Washington State and the Tribes (i.e., co-managers) manage the production and harvest of salmon and steelhead.

As part of the proposed action, the action agencies propose to authorize the operation and maintenance of 12 salmon hatchery programs. The co-managers intend all hatchery programs for the purpose of harvest augmentation, however only the Chinook salmon programs at Kendall Creek hatchery and Skookum Creek hatchery are intended operated for conservation purposes. Collectively, these hatchery programs will release more than 34 million juvenile salmon annually into the North Puget Sound Region.

The action agencies propose to operate eight isolated hatchery programs and four integrated hatchery programs (Table 2). Isolated programs generally rear fish originating only from hatchery-origin broodstock. They are designed to produce fish that do not spawn naturally and are not intended to establish, supplement, or support any populations occurring in the natural environment. The NMFS and co-managers propose isolated hatchery programs for three Chinook salmon programs, two coho salmon programs, and two chum salmon programs using fish native to the Nooksack River basin. Hatchery operators propose to use fall Chinook salmon in the Glenwood Springs, Samish, and Whatcom hatchery programs that have Green River hatchery broodstock lineage. As an alternative, locally adapted stock of chum salmon sourced from independent creeks in Bellingham and Samish bays may be used for the Whatcom Creek Hatchery and Lummi Bay Hatchery chum programs if deemed necessary to meet program goals.

The NMFS and co-managers also propose to operate four integrated hatchery programs (Table 2), which include both hatchery-origin and natural-origin fish in their broodstock. Hatchery operators manage integrated hatchery programs to maintain genetic similarity of hatchery-origin and natural-origin fish within target proportions. The proportional contribution is typically expressed by the proportion of hatchery-origin spawners or the proportion of natural-origin broodstock. Integrated programs ensure the genetic composition of ESA-listed species are not overly influenced by hatchery-origin individuals. The NMFS and co-managers proposed two integrated Chinook salmon hatchery programs, supported by Chinook salmon in the North Fork and South Fork of the Nooksack River, as well as one chum salmon program and one coho salmon program.

The objectives of these hatchery programs are to produce salmon for either/or both conservation and harvest augmentation, in addition to providing forage for the ESA-listed southern resident killer whale (*Orcinus orca*). All hatchery programs provide salmon for non-Tribal commercial and recreational harvest, and Tribal ceremonial, subsistence, and commercial harvest uses (Table 2).

5.1 Broodstock Collection

5.1.1 Standard Procedures

The NMFS and co-managers propose to use existing hatchery facilities such as seine nets, weirs, traps, and holding ponds to collect adult salmon for broodstock. Hatchery staff typically operate collection facilities for the duration of the spawning season, which varies considerably between species due to different run timing (Table 2). In general, most hatchery facilities are equipped with a trap or weir system that guides adult salmon into collection facility. Hatchery staff collect the majority of broodstock through a trap or weir system, although alternate broodstock collection methods are also described below in the event not enough adult salmon recruit to the hatchery trap. We describe primary and alternate broodstock collection methods below.

Table 2. Broodstock source, broodstock collection and juvenile incubation and rearing, size and location at release and long-term release objectives.

Hatchery program (and operator)	Species	Broodstocking			Incubation and rearing				Juvenile release	
		Broodstock origination		Broodstock source (and number collected)	Incubation location	Rearing location	Marking	Release size (and life stage)	Location (and timing)	Release objective
		Natural-origin	Hatchery-origin							
Nooksack River (WDFW)	spring Chinook salmon	x	x	NF Nooksack River (2,170)	Kendall Creek Hatchery		All otolith and adipose clip (AC), and 200,000 coded wire tag (CWT)	80-100 fish per pound (fpp) (subyearlings)	Kendall Creek, NF Nooksack near Boyd Creek (April-May)	2.2 million
	coho	x	x	NF Nooksack River (550)			All ad-clipped, and 45,000 CWT	17 fpp (yearlings)	Kendall Creek (April-May)	0.5 million
	fall chum	x	x	NF Nooksack River (4,500)			All otolith marked	400-800 fpp (fry)	Kendall Creek (April-May)	5 million
Skookum Creek (Lummi Nation)	Chinook salmon	x	x	SF Nooksack River (1,000)	Skookum Creek Hatchery		All CWT and otolith marked. Some AC, CWT, and thermally marked	50-85 fpp (fingerlings) and 120-200 fpp (parr)	Skookum Creek Hatchery (May - June). Also SF Nooksack River, RM 18.0 – 31.1 (April)	2 million
	coho	x	x	SF Nooksack River (4,800)			All ad-clipped, and 50,000 CWT	15-35 fpp (yearlings)	Skookum Creek (May – June)	Up to 1.2 million
Whatcom Creek (Bellingham Technical College)	fall Chinook salmon		x	Samish River and Whatcom Creek (300)	Kendall Creek Hatchery	Whatcom Creek Hatchery	All ad-clipped, and 50,000 CWT	80 fpp (subyearlings)	Whatcom Creek (May)	0.5 million
	chum		x	Whatcom Creek (2,700)	Kendall Creek Hatchery	Whatcom Creek Hatchery	All otolith	Up to 525 fpp (fry)	Whatcom Creek (May)	2 million

Hatchery program (and operator)	Species	Broodstocking			Incubation and rearing				Juvenile release	
		Broodstock origination		Broodstock source (and number collected)	Incubation location	Rearing location	Marking	Release size (and life stage)	Location (and timing)	Release objective
		Natural-origin	Hatchery-origin							
Samish Hatchery fall Chinook (WDFW)	fall Chinook		x	Samish River (4,320)	Kendall Creek Hatchery	Samish Hatchery	5.6 million AC; 200,000 CWT and AC; and 200,000 CWT	80 fpp (subyearlings)	Friday Creek and Samish River (May)	6 million
Lummi Bay Hatchery (Lummi Nation)	Chinook salmon		x	NF and MF Nooksack River (1,140)	Kendall Creek Hatchery	Lummi Bay Hatchery	All otolith marked, minimum of 50,000 CWT	65-120 fpp (subyearlings)	Lummi Bay Hatchery (early May)	2 million
	coho	x	x	SF Nooksack River (4,800)	Skookum Creek Hatchery or Kendall Creek Hatchery	Lummi Bay Hatchery	All AC and 50,000 CWT	15-30 fpp (yearlings)	Lummi Bay Hatchery (April-May)	2 million
	chum		x	Whatcom Creek Hatchery or Kendall Creek Hatchery; eventually Lummi Bay (8,800)	Lummi Bay Hatchery		Otolith marking	350-550 fpp (fry)	Lummi Bay Hatchery (April-May) and/or at Jordan Creek	Up to 10.25 million
Glenwood Spring Hatchery (LLTK)	Chinook salmon		x	Samish River (4,320)	Glenwood Spring Hatchery		All AC and 100,000 CWT	80 fpp (subyearlings) and 25 fpp (presmolt)	Puget Sound (May for subyearlings and June for pre-smolts)	0.8 million

Hatchery managers may collect a single species over the course of 3 months to 4 months. Hatchery managers operate collection facilities for Chinook salmon in the spring and summer, and switch to collecting coho salmon and chum salmon in fall and early winter. Thus, hatchery staff collecting two or more species of salmon for broodstock purposes may operate collection facilities for several months. As a result, hatchery staff may operate collection facilities for most of the year, depending on the number of species reared at each facility. During this time, non-target species such as bull trout may be encountered at several facilities. Hatchery staff will use a dip net to capture and relocate ESA-listed fish encountered in broodstock collection facilities and promptly release them at nearby locations as noted in Table 2.

5.1.2 In-River Broodstock Collection

To compensate for the potential for annual variability in environmental conditions in and around the action area, the co-managers propose to collect adult Chinook salmon and coho salmon from in-river locations if too few individuals return to hatchery collection facilities. The co-managers will use their best professional judgement to determine the level of returns requiring initiation of in-river emergency broodstock collection. Native Nooksack River spring Chinook salmon are experiencing low abundances and productivity. The co-managers have identified annual variability in environmental conditions in the South Fork Nooksack River (e.g., low streamflow and warm water temperature) that reduce recruitment of adult salmon to hatchery collection facilities. In the case of low adult returns to the hatchery facilities, the co-managers will respond by collecting adult salmon from a variety of in-river locations throughout the Nooksack River Basin.

5.1.2.1 Adult Chinook Salmon

The co-managers propose in-river broodstock collection of Chinook salmon for the Kendall Creek Hatchery and Skookum Creek Hatchery programs. Both hatchery programs have observed persistent low levels of natural-origin spawners that limit the success of these integrated conservation-oriented programs. To ensure hatchery staff can obtain sufficient adult fish to use for broodstock, the co-managers propose to use seine nets and block nets to collect natural-origin (adult) spring Chinook salmon in the North Fork and Middle Forks of the Nooksack River. If implemented, the co-managers anticipate collection times for Chinook salmon will occur from May through early September.

Consistently low returns of adult Chinook salmon in the South Fork Nooksack River suggest the necessity to conduct in-river collection of adult Chinook salmon for broodstock in this tributary. The co-managers anticipate collecting sufficient numbers of adult broodstock at the Skookum Creek Hatchery collection facility to meet egg take objectives (minimum 500,000 eggs) during most years. However, in the event insufficient numbers of adults return to the hatchery, the co-managers propose in-river collection of Chinook salmon in the South Fork Nooksack River. The co-managers propose that in-river broodstock collection may occur between river mile (RM) 0 and RM 25 of the South Fork Nooksack River. The co-managers also identified localized areas within the larger 25-mile reach of the lower South Fork Nooksack River where broodstock collection is most likely to occur (Figure 5). The co-managers identified large aggregations of

Chinook salmon (Figure 6) between RM 13 and RM 14.5 (T. Chance, personal communication, June 16, 2023). The co-managers propose using 2-inch to 3-inch mesh seines, gill nets, channel spanning weirs, and/or tangle nets to conduct in-river collection of adult Chinook salmon from July 1 to October 10.

Figure 5. Aggregation of Chinook salmon near in the South Fork Nooksack River.

Figure 6. Emergency in-river collection sites for adult salmon in the South Fork Nooksack River.

5.1.2.2 Juvenile Chinook Salmon

Hatchery managers prefer to use adult fish for broodstock because individuals have fully developed gametes and require little to no addition rearing prior extracting gametes. However, in rare circumstances when a fish stock or species population is extremely low and conservation importance is critical to preserving genetic diversity, hatchery managers collect juvenile fish for broodstock. Such programs are known as 'captive brood programs' because hatchery managers must rear juveniles in captivity to adulthood. Captive brood programs are expensive to operate because of the necessity to rear fish throughout their entire lifespan and are only used for the minimum amount of time until individuals can be released into the natural environment.

Adult Chinook salmon returns were so low during the mid-2000's that co-managers initiated a captive brood program at the Skookum Creek Hatchery. During 2007-2012 the co-managers established a captive brood program using juveniles originating from the few successfully spawned non hatchery-origin early-run spring Chinook salmon remaining in the South Fork Nooksack River. Successful implementation of this captive brood program at the Skookum Creek Hatchery helped prevent extirpation of this unique stock. However, given limited natural production of spring Chinook salmon in subsequent years the co-managers believe it may be necessary to resurrect the captive brood program. The co-managers propose the collect juvenile Chinook salmon for a captive brood program contingent upon collecting an insufficient number of adults at the Skookum Creek Hatchery. We provide additional details regarding the location and timing of juvenile Chinook salmon capture efforts to support the captive broodstock program.

The co-managers identified timing and locations of juvenile collection efforts based on the initial captive brood program collection efforts during 2007-2012. Hatchery co-managers may collect up to 3,000 natural-origin juvenile Chinook salmon from the North Fork, Middle Fork, and South Forks of the Nooksack River by using seines, block nets, and electrofishing equipment (Figure 7). The co-managers propose to use beach seine nets (6.5 ft by 29.5 ft with ⅛-inch braided mesh) for in-river juvenile Chinook salmon collection efforts (Lummi Indian Nation 2021 p. 19). The co-managers expect up to 300 individual seine sets per year may be necessary to obtain enough juvenile Chinook salmon to re-establish the captive brood program. The co-managers anticipate captive broodstock collection efforts may occur from March 1 to June 30. In the event the use of seine nets is ineffective, the co-managers propose to use electrofishing equipment to collect juvenile Chinook salmon.

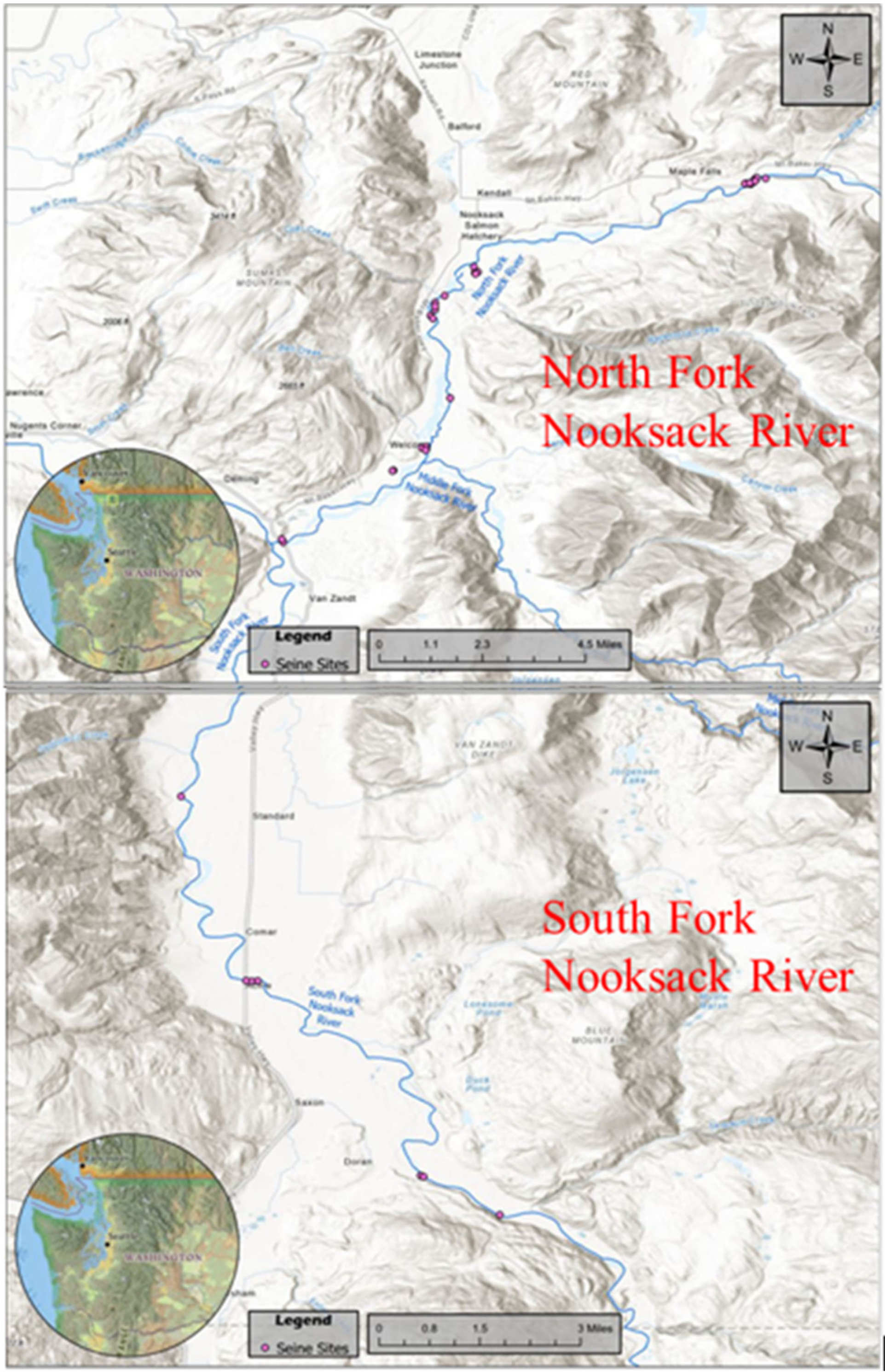

Figure 7. Hatchery co-managers identified locations (indicated by pink markers) where juvenile early-run spring Chinook salmon may be collected in the North Fork (top panel) and South Fork (bottom panel) Nooksack River if resurrecting the captive brood program is necessary.

5.1.2.3 Adult Coho Salmon

The co-managers propose in-river collection of natural-origin adult coho salmon at the Skookum Creek Hatchery. The co-managers propose to use primarily seine nets or weirs to collect coho from South Fork Nooksack River tributaries, including: Edfro Creek (RM 15.2), Cavanaugh Creek (RM 16.5), Fobes Creek (RM 18.0), Plumbago Creek (RM 18.5), Deer and Roaring Creek (RM 19.8), and other unnamed tributaries at RM 20.3, RM 21.3, and RM 22.2. If necessary, the co-managers will install channel spanning weirs on the small tributaries listed above to capture adult coho salmon. Due to the size of these tributaries, the weirs will be less than 15 ft wide. Alternatively, the co-managers propose to use hook and line angling as a secondary method to collect coho salmon broodstock in the mainstem South Fork Nooksack River from RM 0 to RM 25. Regardless of capture method and/or location, the co-managers propose coho broodstock collection efforts between November 1 and January 31. The co-managers propose to follow the general conservation measures described below in the Conservation Measures Section of this Opinion.

5.1.2.4 Adult Chum Salmon

The co-managers propose a primary and secondary method for broodstock collection of adult chum salmon associated with programs operated at Kendall Creek Hatchery and Whatcom Creek Hatchery. The primary method of collecting broodstock at each facility is a trap and/or brood collection pond; the secondary method is instream collection using block or seine nets. Hatchery managers developed alternate broodstock collection procedures in the event too few fish return to hatchery trap facilities. The proposed instream collection sites are independent tributaries to the Puget Sound: Chuckanut, Oyster, Colony, and Whitehall Creeks. The co-managers typically collect chum salmon programs from October through mid-December.

5.1.3 Post-Spawning Disposition of Adult Broodstock

The co-managers and hatchery staff will dispose of adult salmon after extracting eggs and sperm for fertilization and egg incubation. Hatchery staff will prioritize disposal of carcasses to a contracted fish buyer or by donating salmon to food banks or Tribal members. Hatchery staff may also send surplus salmon carcasses to local natural resource organizations for use in nutrient enhancement projects. Local natural resource organizations often distribute salmon carcasses into stream ecosystems. This mimics natural processes that distribute marine-derived nutrients and increases primary productivity that provides abundant forage items to juvenile salmonids.

5.2 Incubation and Rearing

The co-managers propose to rear juvenile Chinook, coho, and chum salmon for several months, depending on the species and desired release size as noted above in Table 2. Thus, hatchery managers will rear salmon for varying periods of time, less time for fish released as fry or subyearlings and longer for fish released as yearlings. Survival of hatchery-origin salmonids varies between years, and hatchery managers propose to compensate for this variability by releasing no more than 10 percent of the targeted release number. The co-managers also propose to compensate for excess production of juvenile salmon by applying a five-year running average of the total number of Chinook salmon released per program that will not exceed 5 percent of release targets for each program. The co-managers propose to mark and/or tag hatchery-origin Chinook salmon and coho salmon with an AD fin clip, CWT, and/or otolith mark.

The co-managers propose to transfer eggs and/or juvenile fish between hatcheries to increase in-situ rearing efficiency and, if necessary, to compensate for insufficient egg take from low adult fish returns. For example, the co-managers may rear eggs and/or juvenile salmon at Kendall Creek, Skookum Creek, Whatcom Creek, Lummi Bay, and Samish River hatcheries as well as the Sandy Point Incubation Facility, and the juveniles are then transferred to other hatcheries for release. The co-managers plan to use the Sandy Point Incubation Facility only for egg incubation and early rearing, whereas they plan to use the McKinnon Pond facility strictly for final acclimation and release of juvenile Chinook salmon.

5.3 Release

The co-managers propose to release fish from the spring through early summer (from February through June) at sizes varying from approximately 50 millimeters (mm) to 95 mm (i.e., fry and sub-yearling migrants) and 110 mm to 180 mm (i.e., yearling migrants). The co-managers propose to release juvenile Chinook salmon at several off-site locations, and generally using volitional or forced releases (Table 3). These include permanent facilities, such as the McKinnon Pond facility, an incubation pond facility co-operated by the Northwest Washington Steelheaders, a regional fisheries enhancement group, and Mt. Baker High School. This facility is located near RM 4.4 of the Middle Fork Nooksack River. The co-managers also propose to install and release fish from temporary rearing ponds in the North Fork and Middle Fork Nooksack River. In general, the co-managers propose to operate temporary rearing ponds for 6 weeks to 8 weeks, as necessary, to increase establishment of natural-origin Chinook salmon in the upper portions of the North Fork and Middle Fork Nooksack River. The co-managers propose to release the majority of fish during April to May, with some exceptions for releases of larger sized coho salmon later in the spring. Table 2 includes the proposed release numbers and sizes at release for each program.

Table 3. Proposed timing, duration, location, and strategies for hatchery salmon releases. Hatchery programs are ordered from north to south and east to west.

Hatchery Program	Release Duration	Release Location	Acclimation; Release Strategy
Kendall Creek Hatchery spring Chinook Salmon Restoration Program	April-May	Kendall Creek Hatchery	Direct plant at Kendall Creek Hatchery, MF Nooksack River locations (McKinnon Pond), and acclimation ponds in NF Nooksack River
		NF Nooksack	
		MF Nooksack	
Kendall Creek Hatchery Coho Salmon Program	April-May	Kendall Creek Hatchery	On-station release; forced release
Kendall Creek Hatchery Nooksack Fall Chum Salmon Program	April-May	Kendall Creek Hatchery	On-station release; forced release
Skookum Creek Hatchery Chinook Salmon Program	May 1 – June 20	Skookum Creek Hatchery	Volitional Release from Hatchery
	April 1 – April 30	Upper South Fork Nooksack	Direct plant

Hatchery Program	Release Duration	Release Location	Acclimation; Release Strategy
Skookum Creek Hatchery Coho Salmon Program	April-June	Skookum Creek Hatchery	Acclimated to water source; Volitional release from Skookum hatchery
Whatcom Creek Hatchery Fall Chinook Salmon	April-May	Whatcom Creek	Acclimated to water source, Forced release during high tide
Whatcom Creek Hatchery Chum Salmon Program	May	Whatcom Creek	On-station release, forced during high tide
Samish River Hatchery Fall Chinook Salmon	May	Samish holding pond into Samish River	Acclimated to water source; Volitional Release from hatchery
		Samish Hatchery into Friday Creek	
Lummi Bay Chinook Salmon	April-May	Lummi Bay Hatchery	Acclimated to sea pond water, forced release into seawater
Lummi Bay Hatchery Coho Salmon Program	April-May	Lummi Bay Hatchery, Lummi Sea Pond	Acclimated to Sea Pond water. Forced release from net-pen, volitional movement through tide-gates
Lummi Bay Hatchery Chum Salmon Program	March-May	Lummi Bay Hatchery	Six-week acclimation to salt water
	March-April	Jordan Creek; Jordan Creek RSI	Forced or volition release
Glenwood Springs Fall Chinook Salmon	May	Eastsound, Orcas Island	Volitional Release from Hatchery into seawater

5.4 Facilities Operations and Management

The NMFS and co-managers propose to provide water for egg culture and juvenile fish rearing by using surface water and/or groundwater sources (Table 4).

Table 4. Facility water withdrawal rights, withdrawal points, and water rights permits.

Facility	Water Volume in cubic feet per second (cfs)	Withdrawal Point(s)	Water Right Permit(s)
Kendall Creek Hatchery	35.5	5 groundwater wells	G1-10562C G1-23273
Kendall Creek Hatchery	22.36	Kendall Creek	S1-00317C
McKinnon Pond	2.23	"Peat Bog Creek"	S1-27351
Skookum Creek Hatchery	≤ 40	Skookum Creek	S1-22899
Whatcom Creek Hatchery	5.8	Whatcom Creek	S1-27351
Samish River Hatchery	15.0 8.13	Friday Creek	S1-CV3-P1037 S1-*22140C
Samish River Hatchery	8.0 7.0 10.0	Samish River	S1-*17762C S1-*20468C S1-24618C
Lummi Bay Hatchery	2.3	Nooksack River Lummi Bay	Not applicable
Sandy Point Incubation Facility	0.2	1 groundwater well with partial reuse system	Not applicable
Glenwood Springs Hatchery	0.95	Unnamed stream	S1-27036C

Most hatchery facilities included in the proposed action are equipped with water intakes that route surface water from streams through water conveyance lines into the hatchery. Hatchery managers have installed screens on all surface water intake structures to reduce the impingement and entrainment of fish into water conveyance systems. Engineers have designed intake screens to minimize the risk of juvenile fish injury and mortality through entrainment. Hatchery facilities meet current federal guidelines for surface water intake screening (NMFS 2011 pp. 111–112), but do not meet updated screening compliance outlined in the National Oceanic and Atmospheric Administration's Fisheries West Coast Region Anadromous Salmonid Passage Design Manual (NMFS 2022) with the exception of the freshwater intake screening for the Lummi Bay Hatchery. The action agencies will consult with the USFWS regarding effects on ESA-listed species resulting from the repair and/or replacement of hatchery intakes separately, once funding for this work is available.

Some hatcheries use saltwater to rear salmon or are equipped with filtration equipment to recirculate water and reduce overall water use. The Lummi Bay and Glenwood Springs hatcheries use saltwater or a mixture of freshwater and saltwater to rear juvenile salmon during certain time periods. Hatchery facilities that reuse water are equipped with a combination of filters, pumps, and ultraviolet light sterilization equipment. All hatchery operators, regardless of the water source used, have established water rights authorized by the Washington State

Department of Ecology (WDOE) or by the Lummi Nation. However, neither WDOE nor the Lummi Nation requires a permit for non-consumptive use of saltwater. Some facilities have maximum limits on water use to ensure adequate streamflow. Hatchery managers at Skookum Creek Hatchery, for example, will limit their water use to ensure mandatory minimum flow standards in surface waters. The WDFW is actively seeking to develop groundwater supply for programs at the Samish Hatchery but has not located a suitable groundwater supply to date.

The co-managers will operate hatchery facilities for several months per year and, in the case of Kendall Creek and Skookum Creek hatcheries, on a year-round basis. Hatchery operators will perform various maintenance activities including cleaning tanks, ponds, and raceways of accumulated fish waste and stream sediment, and intake structures obstructed by debris or vegetation that may decrease the efficacy of hatchery operations. The co-managers maintain surface water intake structures to ensure unobstructed water flow. Due to the consistent delivery of fine sediment at the Samish River Hatchery, the WDFW proposes to remove sediment and manipulate large wood to ensure the surface water intake at its facility remains unobstructed. This procedure is discussed below in greater detail. In addition, hatchery staff may also maintain hatchery equipment such as netting and exclusionary devices, incubation systems, tanks, ponds, raceways, water intakes, water treatment systems, intake pumps, and water reuse system pumps. Hatchery staff also complete ancillary routine activities, such as grounds maintenance, which includes mowing, brush cutting, weed trimming, herbicide application, road maintenance, and seasonal irrigation.

5.4.1 Water Intake Maintenance

The WDFW-operated hatcheries (Table 1) propose to dredge, annually, adjacent to the surface water intake at the Samish River Hatchery to remove accumulated sediment and debris to prevent reduced water supply to the hatchery facility. The WDFW-operated hatcheries propose to use an excavator equipped with a long-reach boom that is operated from an upland location adjacent to the Samish River Hatchery surface water intake structure. Under current requirements, the WDFW proposes to remove a maximum of 1,200 cubic yards (cy) of material no more than once per year during the state-approved in-water work window for the area (from August 1 to September 15) (WDFW 2021, p. all).

5.4.2 Effluent Release

All WDFW hatchery facilities included in this proposed action are operated under WDOE's National Pollution Discharge Elimination System (NPDES) general permit for effluent management. The Lummi Nation's Skookum Creek Hatchery and Lummi Bay Hatchery facilities operate under the Environmental Protection Agency's (EPA) Tribal upland NPDES permit, WAG130000. The Lummi Nation's Sandy Point Incubation Facility is exempt from NPDES requirements because effluent is not discharged directly to waters of the U.S. Instead, effluent from the Sandy Point Incubation System is discharged directly to the Lummi Nation wastewater treatment plant located on-reservation. The applicable effluent discharge rules for the WDFW hatchery facilities are described in the Upland Finfish Hatching and Rearing guidelines (WDOE 2021 p. 9) or in the Tribal upland hatchery NPDES permit's Limitations and Monitoring Requirements (pp. 15-29). Net pens associated with the Lummi Bay Hatchery programs are authorized under the EPA general permit WAG132000 for Tribal enhancement net pen programs. Hatchery operators are not required to obtain permits for State hatchery and net-pen facilities that release less than 20,000 pounds of fish per year or feed fish less than 5,000 pounds of fish feed per year. However, operators of all Tribal facilities and net pens, regardless of pounds of fish released or pounds of food fed, must be covered by the applicable Tribal NPDES permit. Fish production levels at Glenwood Springs, Whatcom Creek, and McKinnon Pond hatcheries are below the levels that require coverage under WDOE's NPDES permit.

Kendall Creek Hatchery, Samish River Hatchery, Skookum Creek Hatchery, and Lummi Bay Hatchery are equipped with effluent treatment systems (Table 5), which allow uneaten food and fish waste solids to sink to the bottom of the pond, thereby reducing water quality degradation into receiving waters.

Table 5. Facility coverage requirements and effluent systems included in the proposed action, and the associated receiving waters (presented from north to south and east to west).

Facility	NPDES Coverage Requirements* (yes/no)	Effluent Treatment System	Receiving Waterbody(ies)
Kendall Creek Hatchery	Yes	Abatement pond	Kendall Creek
Skookum Creek Hatchery	Yes	None	South Fork Nooksack River
McKinnon Pond	No	None	Peat Bog Creek
Whatcom Creek Hatchery	No	None	Bellingham Bay
Samish River Hatchery	Yes	Abatement pond	Friday Creek Samish River
Lummi Bay Sea Ponds	Yes	None	Lummi Bay
Sandy Point Incubation Facility	No	None	Lummi Bay
Glenwood Springs Hatchery	No	None	East Sound

*NPDES permits are not needed for State hatchery and net-pen facilities that release less than 20,000 pounds of fish per year or feed fish less than 5,000 pounds of fish feed per year (WDOE 2021 p. 9).

The WDFW hatchery operators file annual reports to WDOE providing data on water quality metrics (e.g., temperature and dissolved oxygen), chemical use (e.g., antibiotics, disinfectants, and therapeutants), and cleaning/flushing procedures at pollution abatement facilities, if applicable. Tribal hatchery operators submit an annual report for each facility under coverage to the EPA with similar reporting requirements.

5.5 Research, Monitoring, and Evaluation

The co-managers run research, monitoring, and evaluation (RM&E) programs throughout the Nooksack River watershed for various purposes. The RM&E program is designed to evaluate post-release performance of adult and juvenile salmon.

5.5.1 Juvenile Salmon Research, Monitoring, and Evaluation

The co-managers propose to implement an RM&E program to monitor hatchery-released juvenile Chinook salmon throughout the Nooksack River basin. The purpose of the proposed RM&E activities is to estimate migration rates of hatchery-origin juvenile Chinook salmon from freshwater to saltwater after release from the Kendall Creek Hatchery, the McKinnon Ponds, and the Skookum Creek Hatchery. This data will be used to evaluate habitat use and as a proxy for ecological interactions between individuals or groups.

As part of the RM&E program, the co-managers propose to operate rotary screw traps, fyke nets, beach seines, and seine nets to collect out-migrating hatchery-released juvenile Chinook salmon in the Nooksack River basin. These efforts support RM&E objectives for listed Puget Sound Chinook salmon in the Nooksack River basin. The co-managers will annually operate the rotary screw trap on the South Fork Nooksack River at RM 8.7. However, the co-managers may direct field staff to adjust the location of the screw trap to more suitable areas if shifting the location is necessary to facilitate efficient operation of the trap and for the safety of hatchery staff. Additionally, the co-managers will use beach seining in the South Fork Nooksack River basin, as well as seining in the North Fork and South Fork Nooksack River basins. Since beach seining may not be feasible to capture juvenile Chinook in many tributaries, the co-managers propose to use electrofishing as an alternative option for collecting juvenile Chinook salmon in the North Fork or South Fork Nooksack Rivers.

After juvenile Chinook salmon have been captured, the co-managers may use external and/or internal marking techniques such as epidermal-injected dye, fin clipping, injecting CWTs, or otolith marking. Marking allows the co-managers to evaluate growth rates, habitat use, and ecological interactions of individuals or groups during subsequent recapture events. The co-managers will clip the lower caudal fin of fish captured at the mainstem Nooksack River smolt trap (RM 4.6) or upper caudal fin of fish captured at the South Fork Nooksack River smolt trap (RM 8.7). In order to increase monitoring and genetic data for bull trout, the co-managers propose to mark bull trout captured during RM&E activities by clipping a small portion of the caudal fin (either lower or upper) to identify the trap in which these bull trout were initially captured. The co-managers will retain caudal fin tissue samples for genetic analyses. The co-managers may collect tissue samples from bull trout encountered in the process of seining or operating stationary collection facilities.

Juvenile Chinook salmon monitoring associated with the RM&E program will occur between March 1 to December 31 annually. The co-managers propose to operate the screw trap from March 1 to December 31, but will cease operation during periods in which water temperatures exceed 66 °F (19 °C), which typically extends from July 1 to September 15. However, the co-managers may resume operation of the smolt trap if conditions are acceptable.

The target species for the co-managers proposed smolt trapping and beach seining activities is spring-run Chinook salmon, although non-target fish may be captured incidentally. The co-managers propose to release non-target fish as soon as possible near the area of capture. By marking and/or tagging target fish collected at the trap, the co-managers will estimate migration rates and evaluate habitat use. The co-managers will use data to support basin-wide research needs for salmonids and char.

5.5.2 Adult Salmon Research, Monitoring, and Evaluation

The co-managers also propose RM&E for hatchery-origin adult salmon to assess compliance with objectives for the proposed hatchery programs and to identify escapement and temporal and spatial distribution of adult salmon spawners. The co-managers will monitor harvest of adult fish injected with CWTs in commercial, recreational, ceremonial and subsistence fisheries. The co-managers will also conduct comprehensive annual in-river surveys to monitor escapement of hatchery-origin Chinook salmon. Field staff will conduct in-river escapement monitoring via boat or foot that will consist of enumerating redds, live fish, and carcasses. Field staff will monitor escapement in the following streams: Nooksack River, Samish River, and potentially adjacent tributaries in the action area including Whatcom Creek, Dakota Creek, California Creek, Chuckanut Creek, Padden Creek, Squalicum Creek, Whitehall, Colony, and Oyster Creek. The co-managers will also survey adult Chinook salmon in the North, Middle, and South Fork of the Nooksack River basin.

The co-managers also propose to evaluate Chinook salmon egg to fry survival in all three forks of the Nooksack River basin by installing artificial incubation structures (e.g., egg boxes) with Chinook salmon implanted with fertilized eggs from hatchery- and/or natural-origin broodstock. The co-managers propose to monitor development of Chinook salmon larvae throughout the incubation and emergence life stages (Roni et al. 2016 pp. 1048–1051). The co-managers will monitor factors impacting Chinook salmon larval development, such as: redd scour, temperature, discharge, and fine sediment infiltration. Because this project aims to evaluate impacts to naturally constructed redds, the co-managers will construct most artificial redds within main channels reaches of the Middle, North, and South Forks of the Nooksack River and their tributaries where Chinook salmon are known to spawn. In addition, the co-managers plan to install artificial redds in areas where restoration actions are planned or have occurred. The co-managers propose to construct approximately 50 egg boxes annually over a period of 3 years to 7 years. As currently conceptualized, the co-managers propose to install egg boxes for a minimum of three consecutive years to enable an adequate evaluation of egg to fry survival rates to account for interannual variability.

5.6 Conservation Measures

In carrying out the proposed action, the co-managers propose the following conservation measures to ensure the conservation of affected species and their CHs:

- Field staff will check traps and weirs at least once every 24 hours, and potentially more frequently during peak juvenile salmon migration season;

- Staff conducting field sampling or operating weirs and traps will be trained in proper fish handling techniques to minimize the potential for stress and injury to bull trout; and,
- Hatchery staff will monitor for fish pathogens in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State (NWIFC and WDFW 2006).

The co-managers propose the following conservation measures during in-river broodstock collection activities involving use of a weir:

- Reserve use of weirs in areas where occurrence of bull trout is not expected; and,
- Check weirs at least once per day.

The co-managers propose the following conservation measures specific to adult chum broodstock collection:

- Collect natural-origin chum salmon from streams during the period when adult bull trout are least likely to be present, and in streams lacking any record of bull trout presence;
- Immediately cease broodstock collection activities in the event bull trout are observed; and,
- Complete daily checks for bull trout in the Samish River Hatchery brood pond and, if encountered, immediately pass bull trout upstream of the weir.

The co-managers proposed the following conservation measures when operating rotary smolt traps:

- Check traps, at minimum, every 24 hours; and,
- Check traps more frequently (up to every 2 hours) during peak migration periods.

The co-managers will adhere to the following conservation measures in conducting the egg to fry survival research project:

- Prevent disturbance to active, naturally constructed Chinook salmon redds while constructing artificial egg boxes or walking through areas where salmon may spawn; and
- Avoid placing egg boxes in areas where adult bull trout have been observed holding or spawning.

In accordance with provisions of WDFW's Hydraulic Project Approval (Permit number: 2019-9-6+02) for the Samish River Hatchery, the co-managers propose additional conservation measures to minimize exposure to and effects on fish from sediment removal adjacent to the Samish River Hatchery water intake (WDFW et al. 2021 pp. 1–10):

- Ensure heavy equipment is free of external petroleum-based products while working around state waters;
- When practicable, service, fuel, and maintain equipment in an upland area located a minimum of 200 ft from the waterway to prevent contamination of surface waters;

- Use a designated fueling area with enough spill containment materials to prevent a spill from reaching surface waters;
- Check equipment daily for leaks;
- Complete any required repairs to equipment in an upland location before using the equipment in or near the water;
- Remove only the amount of sediment necessary to maintain the function of the WDFW facility;
- Minimize the potential exposure and likelihood of injury occurring to fish by using a combination of crowding fish out (or herding) prior to completing the enclosure, block nets, seines, and electrofishing to exclude fish from the affected area prior to beginning sediment removal;
- Reposition wood and debris frequently enough to prevent the build-up of large wood jams;
- Remove and dispose of non-embedded debris in an upland location so it will not reenter the stream and remove and dispose of non-embedded small woody material in an upland area or return it to the stream downstream of the work area;
- Return non-embedded large wood into the stream channel downstream of the work area; and,
- Do not disturb large wood that is embedded in the streambed or banks.

5.7 Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. We carefully analyzed the complex life cycle and movements of Pacific salmon, and the overlap with bull trout, to determine meaningful and predictable effects of the proposed action on bull trout throughout the consultation period, which is indefinite until changes to hatchery operation(s) and maintenance cause a need for reinitiation. Juvenile salmon migrate from freshwater streams into the Puget Sound where they interact with other species and migrate to the North Pacific Ocean. Individual salmon may travel hundreds or thousands of miles from their natal streams during their life cycle.

The action area (Figure 8) includes all 12 hatchery facilities, the associated aquatic environments in which juvenile salmonids disperse immediately after release from hatchery facilities, and areas in which adult salmon may spawn. These include freshwater and estuary habitats downstream of hatchery release facilities in the Nooksack River, the Samish River, and Whatcom Creek, in addition to marine habitats adjacent to Glenwood Springs and the Lummi Bay Sea Ponds in which juvenile hatchery salmon rear and migrate. Because some species of Chinook salmon and chum salmon reside in freshwater and/or estuary habitats for extended periods and migrate through the marine waters in large groups with individuals from other watersheds (Bottom et al. 2005 pp. 149–156), the USFWS includes in the action area estuaries and relatively shallow nearshore marine areas where hatchery salmon may congregate prior to emigrating.

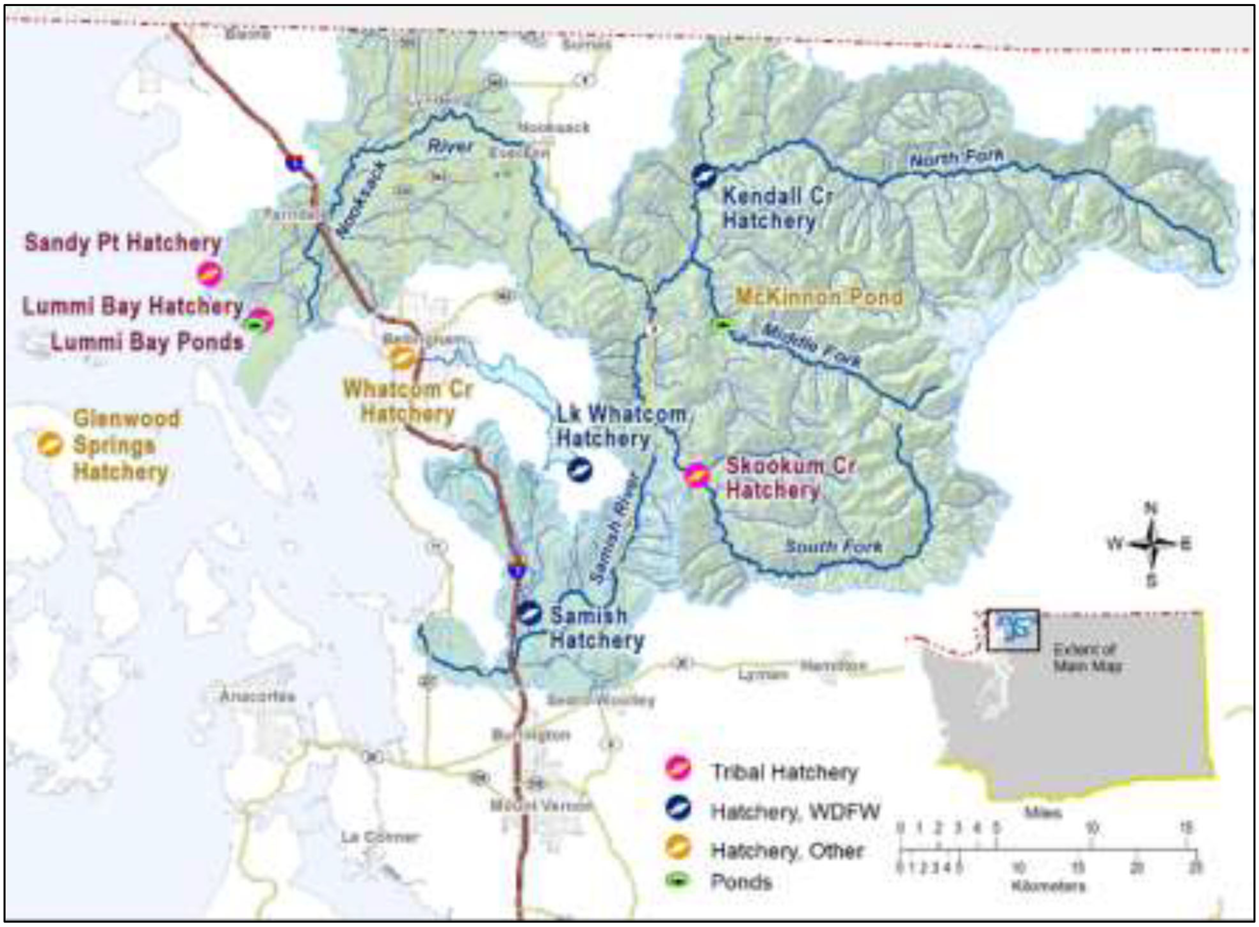

Figure 8. A broad depiction of the action area, which includes Nooksack, Samish, Whatcom, and San Juan Basin hatcheries and associated trapping, rearing, acclimation and release facilities (WDFW GIS Unit, 2018). The green section highlights the stream basins where the proposed hatchery programs are located: Nooksack River, Whatcom Creek, and Samish River. The facilities associated with each hatchery are color-coded with pink (Tribal hatchery), blue (WDFW hatchery), orange (other hatchery), and green (rearing ponds) to denote facility type.

The action area also includes the uppermost extent of freshwater habitats where adult Chinook, coho, and chum salmon migrate and spawn (i.e., within the Nooksack River, Samish River, and Whatcom Creek watersheds), and potentially stray, in the event they do not return to hatchery collection facilities.

6 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

6.1 Jeopardy Determination

In accordance with our regulations (see 50 CFR 402.02, 402.14(g)), the jeopardy determination in this Opinion relies on the following four components:

1. The *Status of the Species* evaluates the species' current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition; its survival and recovery needs; and explains if the species' current range-wide population retains sufficient abundance, distribution, and diversity to persist and retains the potential for recovery (USFWS and NMFS 1998).

2. The *Environmental Baseline* section of this biological opinion evaluates the past and current condition of the species in the action area relative to its reproduction, numbers, and distribution absent the effects of the proposed action; including the anticipated condition of the species contemporaneous to the term of the proposed action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species.

3. The *Effects of the Action* section of this biological opinion evaluates all consequences to the species that are reasonably certain to be caused by the proposed action (i.e., the consequences would not occur but for the proposed action and are reasonably certain to occur) and how those consequences are likely to influence the survival and recovery of the species.

4. The *Cumulative Effects* section of this biological opinion evaluates the effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation, on the species and its habitat, and how those effects are likely to influence the survival and recovery of the species.

In accordance with policy and regulation, the jeopardy determination is made by formulating the USFWS' opinion as to whether the proposed Federal action, including its consequences, taken together with the status of the species, environmental baseline, and cumulative effects, reasonably would be expected to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species.

6.2 Destruction or Adverse Modification Determination

In accordance with regulations and regional implementing guidance, the destruction or adverse modification (DAM) determination in this Biological Opinion relies on the following four components:

1. The *Status of Critical Habitat* section evaluates the range-wide condition of the critical habitat (CH) in terms of essential habitat features, primary constituent elements (PCEs), or physical and biological features (PBFs) that provide for the conservation of the listed species; the factors responsible for that condition; and the intended value of the CH for the conservation of the listed species.

2. The *Environmental Baseline* section of this biological opinion evaluates the past and current condition of the CH in the action area absent the effects of the proposed action; including the anticipated condition of the species and its CH contemporaneous to the

term of the proposed action; the factors responsible for that condition; and the conservation value of CH in the action area for the conservation of the listed species.

3. The *Effects of the Action* section of this biological opinion evaluates all consequences to CH that are reasonably certain to be caused by the proposed action (i.e., the consequences would not occur but for the proposed action and are reasonably certain to occur) and how those consequences are likely to influence the conservation value of the affected CH for the species in the action area.

4. *Cumulative Effects* section of this biological opinion evaluates the effects to CH of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation, and how those effects are likely to influence the conservation value of the affected CH for the species in the action area.

In accordance with regulation, the DAM determination is made by formulating the USFWS' opinion as to whether the effects of the proposed Federal action, taken together with the status of the CH, environmental baseline, and cumulative effects, reasonably would be expected to result in a direct or indirect alteration that appreciably diminishes the value of CH for the conservation of the species.

7 STATUS OF THE SPECIES: Bull Trout

The bull trout was listed as a threatened species in the coterminous U.S. in 1999. Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alteration (associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, and poor water quality), incidental angler harvest, entrainment, and introduced non-native species (64 FR 58910 [Nov. 1, 1999]). Since the listing of bull trout, there has been very little change in the general distribution of bull trout in the coterminous U.S., and we are not aware that any known, occupied bull trout core areas have been extirpated (USFWS 2015a p. iii).

The 2015 Recovery Plan for the Coterminous United States Population of Bull Trout (Recovery Plan) identifies six bull trout recovery units (RUs) (Figure 9) within the listed range of the species (USFWS 2015a p. ix).

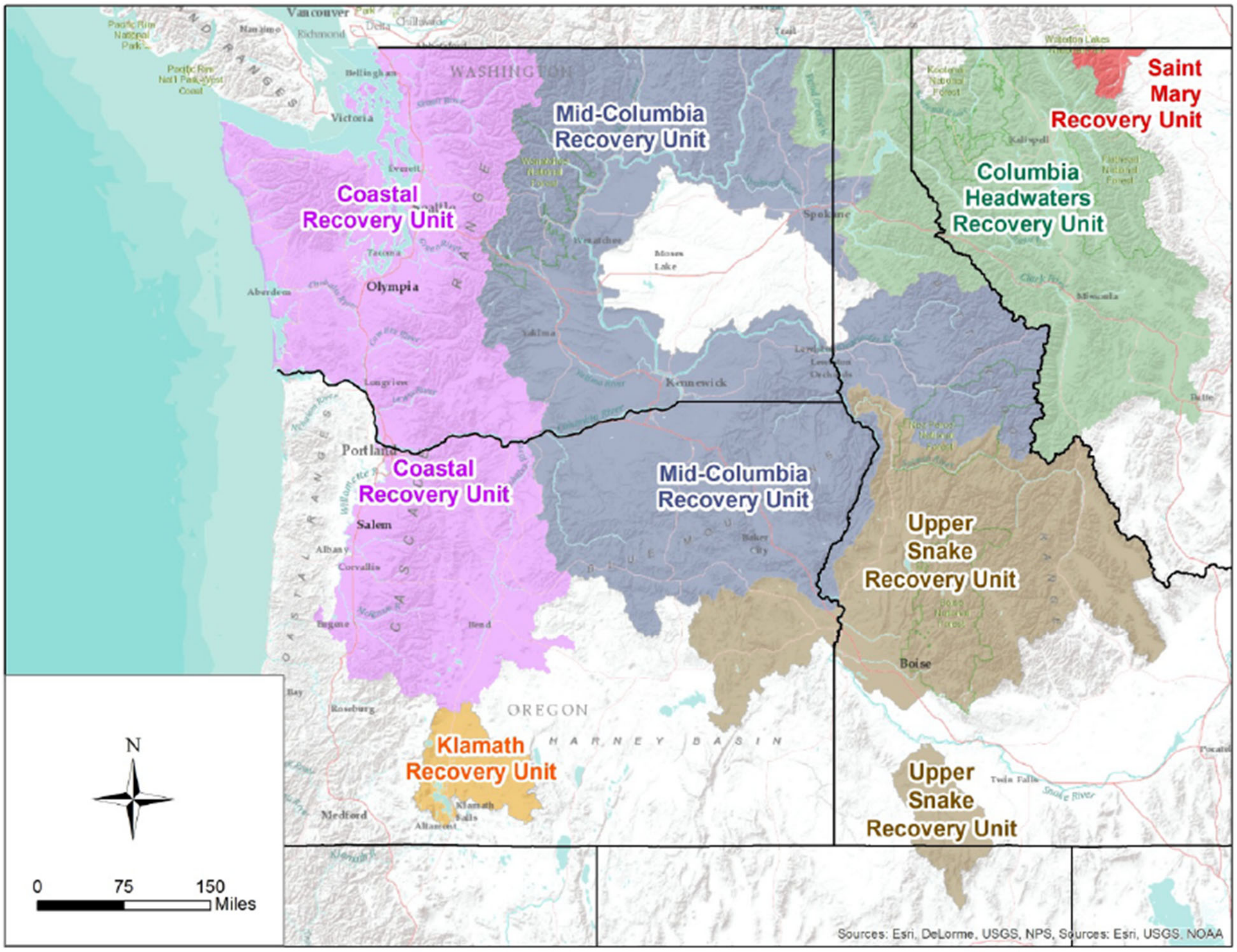

Figure 9. The six bull trout RUs, including the Coastal RU, Columbia Headwaters RU, Klamath RU, Mid-Columbia RU, Saint Mary RU, and Upper Snake RU (USFWS 2015a p. 36).

Each of the six RUs are further organized into multiple bull trout core areas, which are mapped as non-overlapping watershed-based polygons, and each core area includes one or more local populations. Within the coterminous U.S. we currently recognize 109 currently occupied bull trout core areas (USFWS 2015a pp. 34 and 113), which comprise 600 or more local populations (USFWS 2015a p. 34). Core areas are functionally similar to bull trout metapopulations, in that bull trout within a core area are much more likely to interact, both spatially and temporally, than are bull trout from separate core areas.

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

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

8 STATUS OF CRITICAL HABITAT: Bull Trout

On October 18, 2010, the USFWS issued a final revised CH designation for the bull trout (70 FR 63898). The CH designation further classifies bull trout RUs into 32 Critical Habitat Units (CHU) and 78 critical habitat subunits (CHSU), dispersed throughout the coterminous range of the species in Idaho, Montana, Nevada, Oregon, and Washington. Designated CH is composed of two primary use-types, including: 1) spawning and rearing; and 2) FMO habitat. The 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 (Figure 10).

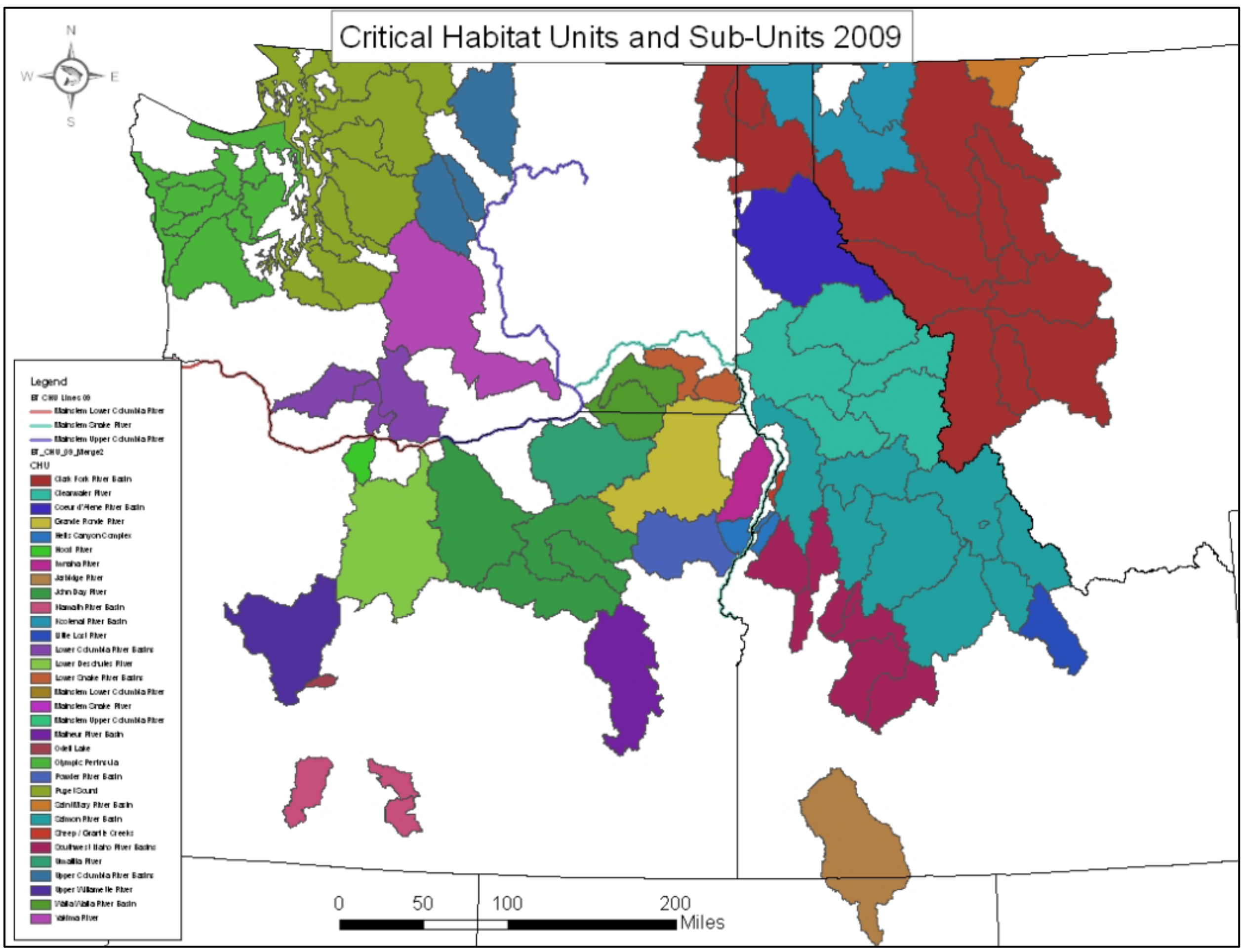

Figure 10. The CHUs and CHSUs for the bull trout.

The CH designation also includes approximately 911 kilometers (km) (566 miles) of marine and estuarine shoreline within the Puget Sound (USFWS 2010 p. 191). The conservation role of designated CH for the bull trout is to support current and future viable core areas and their local populations (75 FR 63943).

The CH designation excludes some CH segments. For example, CH 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).

8.1 Primary Constituent Elements

Bull trout have more specific habitat requirements than most other salmonids (USFWS 2010). 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, 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 (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 nonnative 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 temporally and spatially isolated from bull trout.

For a detailed account of the status of the designated bull trout CH, 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 condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The action area is based on geographic extent of freshwater, estuary, and marine habitats in which hatchery salmon may reside as described above in Section 5.7 (Action Area). These habitats include the East Sound, the Nooksack River basin, the Samish River basin, Whatcom Creek, and nearshore marine habitats adjacent to the eastern shores of the North Puget Sound.

9.1 General Baseline Conditions

The Nooksack River is the fourth largest tributary to Puget Sound. The Nooksack River has three principal forks (North, Middle, and South Forks) that flow westward through mostly steep, heavily forested terrain and drains approximately 2,036 square km (786 square miles (mi^2)) of land, of which 127 square km (49 mi^2) is in British Columbia (USFWS 2004 p. 28) . The North Fork receives runoff and sediment from Colman, Roosevelt, and Sholes glaciers on the north side of Mount Baker and mountains along the northern U.S. border with Canada. The Middle Fork Nooksack River drains the western flank of Mount Baker, including the Deming glacier. The North and Middle Forks converge on a relatively broad valley floor about 5 miles upstream from the community of Deming, forming the mainstem Nooksack River. Designated urban growth areas (UGAs) in the Nooksack watershed and the action area, in general, are located near the shoreline of the Puget Sound (Figure 11).

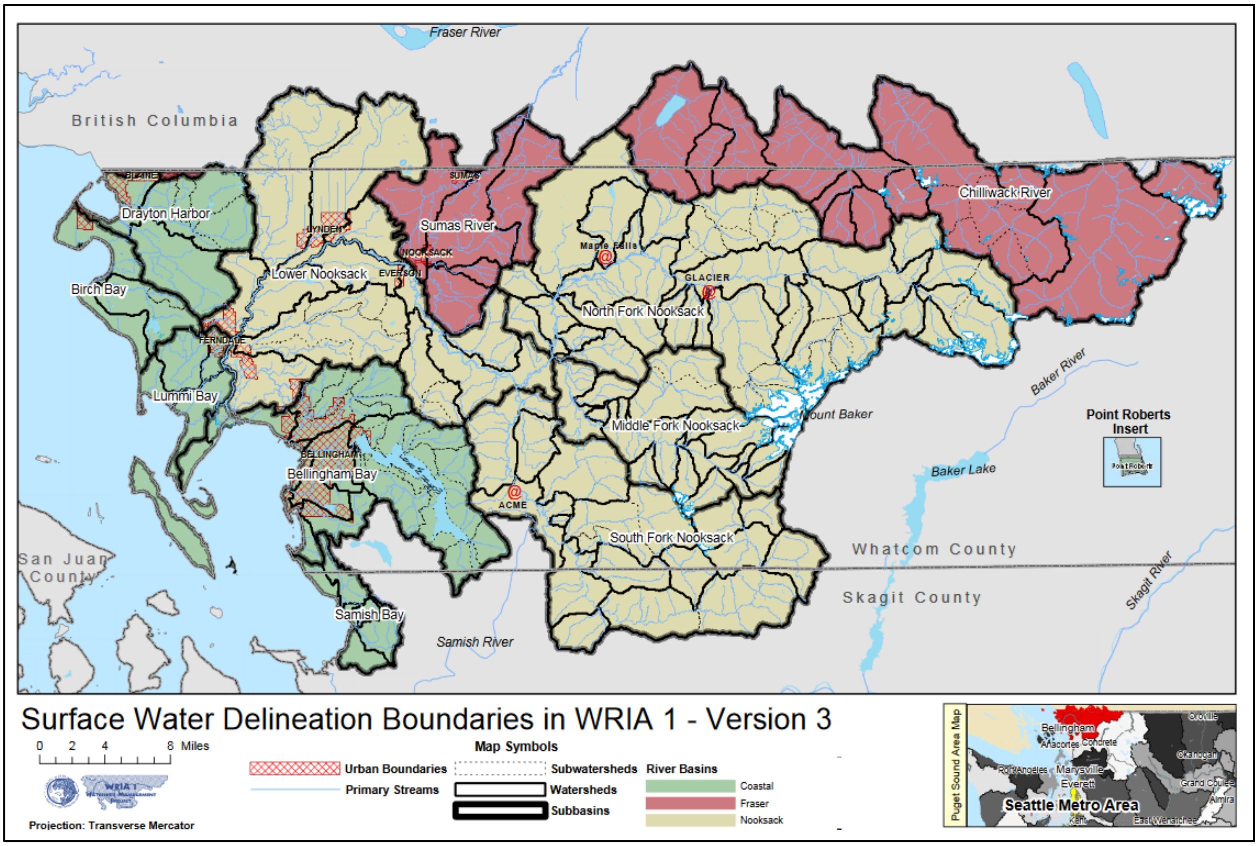

Figure 11. Surface water boundaries in the Nooksack River Basin and surrounding watersheds (Blake and Peterson 2005 pp. 67–70).

The United States Geological Survey (USGS) reported precipitation, streamflow, and flow stage in gathered from remote stations throughout the Nooksack River watershed from 1981 through 2013 (Anderson et al. 2019 p. 34). These authors found that spring precipitation increased in terms of monthly totals (about 2 inches per decade) and number of days with more than 0.1 inch per day (about 2 days per decade). The authors also found increases in river stage at downstream locations at the North Fork monitoring site and in the mainstem Nooksack River near Ferndale. It is not known whether the magnitudes of these trends are sufficient to contribute to drainage issues. The magnitude of change may have been sufficient to increase the duration and extent of drainage issues in low elevation areas where drainage depends on either low river stage or the elevation of the groundwater table relative to the land surface. While these observations in rainfall and streamflow are not specific to the entire action area, trends to the North Puget Sound region are likely similar.

The geographical characteristics of the Nooksack watershed include mountainous areas that influence precipitation and drainage patterns. The North and Middle Forks of the Nooksack originate from the glaciers and snowfields of Mount Baker (Figure 12) and are typically turbid with moderate summer flows due to glacial melt. The Middle Fork enters the North Fork at river mile 40.5 (Williams 1975 p. 34). The Middle Fork and its tributaries naturally carry high levels of suspended sediment and bedload. In particular the headwater tributaries of the Middle Fork are steep and prone to erosion of post-glacial debris and mobilization of glacial moraine deposits (USDA 2006 p. 29). The North Fork generally experiences peak flows in June and low flows in

March, while the South Fork most frequently peaks in May and December, with low flows in August, resulting in divergent flow and water temperature patterns. Mean annual discharge of the North Fork downstream from Cascade Creek is 781 cfs (USGS 2023a). The mean annual discharge for the Middle Fork is 495 cfs (USGS 2023b).

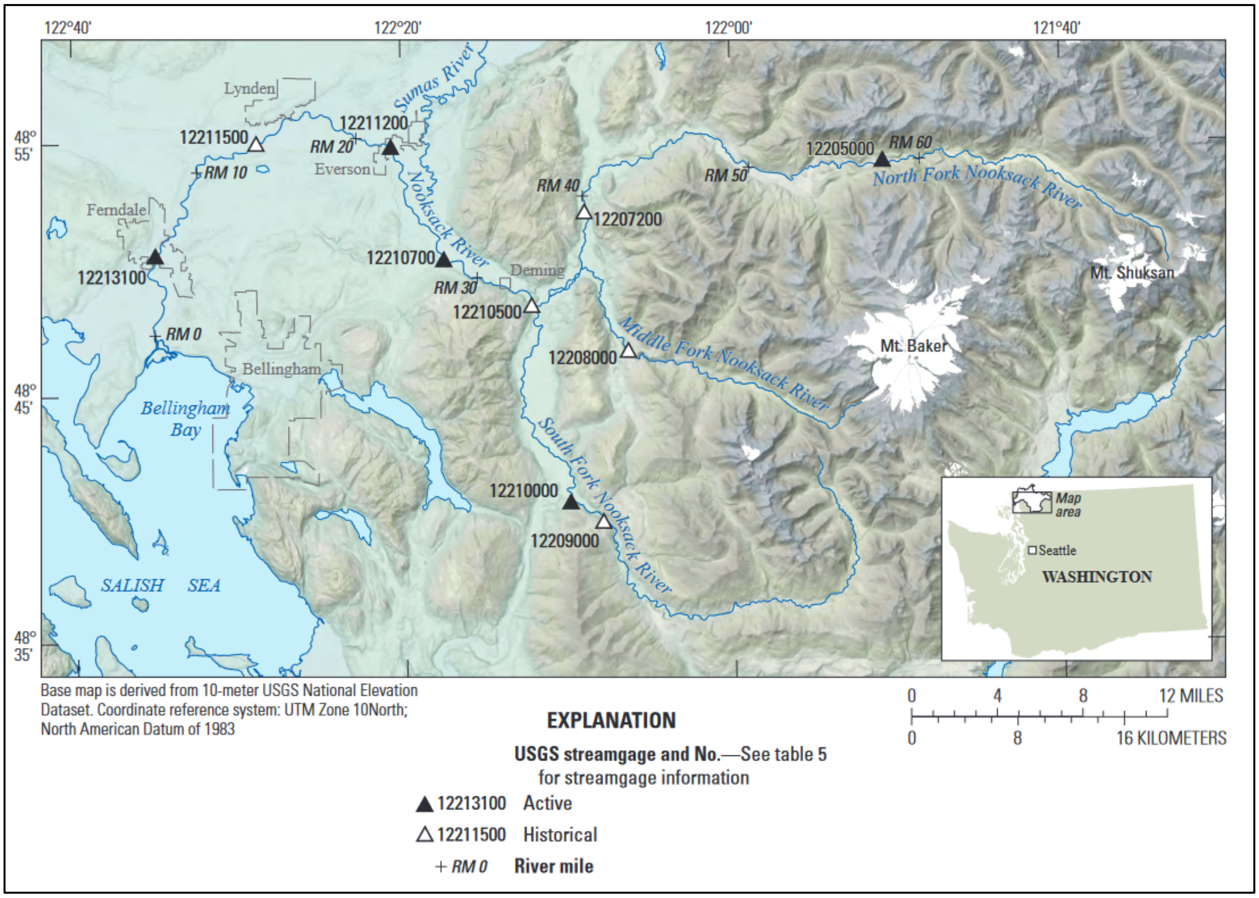

Figure 12. The USGS stream gauge locations in the Nooksack River Basin (Anderson et al. 2019 p. 2).

The South Fork Nooksack River drains mountainous and moderately forested terrain in the lower elevations between Mount Josephine and Goat Mountain (Figure 12). In its lower reaches, the South Fork Nooksack River drains through a broad, gently sloping valley to its confluence with the mainstem Nooksack River, about 1.5 miles upstream of Deming, Washington. Streamflow in the South Fork is influenced by seasonal rainfall and snowpack, and as a result experiences low flows during the summer, and areas where temperatures may exceed preferred thermal tolerances for bull trout (Jones et al. 2014 p. 210). As a result, the WDOE has included the South Fork Nooksack River on the U.S. EPA’s 303(d) list of impaired and threatened waterbodies for temperature, instream flow, and elevated fine sediment (USFWS 2004 p. 160). These habitat conditions impair the use and ability of bull trout to access spawning and rearing tributaries in the South Fork Nooksack River. The South Fork confluences with the North Fork to form the mainstem at river mile 36.6 (Williams 1975 p. 34). The mainstem Nooksack River has a mean annual discharge of 3,331 cfs at confluence of the North and South Forks (USGS 2023c). Downstream of this point the mainstem Nooksack River meanders northwest, west, and then south where it enters Bellingham Bay about 4 miles northwest of the city of Bellingham. Several tributaries flow into the mainstem Nooksack River, including Anderson, Smith, Fishtrap, and Tenmile Creeks.

Natural vegetation within the basin includes western hemlock, western red cedar, red alder (*Alnus rubra*), Sitka spruce (*Picea sitchensis*), black cottonwood (*Populus trichocarpa*), Douglas fir, and grand fir (*Abies grandis*). Land use for the Nooksack watershed is estimated at 40 percent Federal (National Park Service and U.S. Forest Service land), 33 percent forestry, 12 percent agriculture, 11 percent rural, 3 percent urban, 0.7 percent commercial and industrial, and 0.2 percent water and open space (Figure 13) (Blake and Peterson 2005 p. 43). Only the upstream-most reaches of the Nooksack watershed are in North Cascades National Park. Washington Highway 542 follows the lower section of the North Fork Nooksack River to Maple Falls and continues along Glacier Creek to the base of Mount Baker. Most of the watershed upstream of the North and South Forks of the Nooksack River is managed for timber production. Previous removal of all trees in the riparian areas on U.S. Forest Service lands has removed large wood from stream channels in the following areas on right-bank tributaries of the Middle Fork Nooksack River, middle reaches of Clearwater Creek, Wanlick Creek, and middle reaches of Bell Creek riparian areas (USDA 2006 p. 30). The USFS identified Wanlick Creek as a stream where wood removal had an adverse impact (increased fine sediment levels and elevated stream temperatures). These channel conditions resulted from natural landslides, snow avalanches, sediment inputs from road failures, and past practices of wood removal from streams. Washington Monument’s periodic snow avalanches and landslides temporarily dammed Wanlick Creek in 1990, 1995, and 2003 resulting in surge flows in the stream channel that substantially degraded habitat conditions for charr (USDA 2006 p. 30).

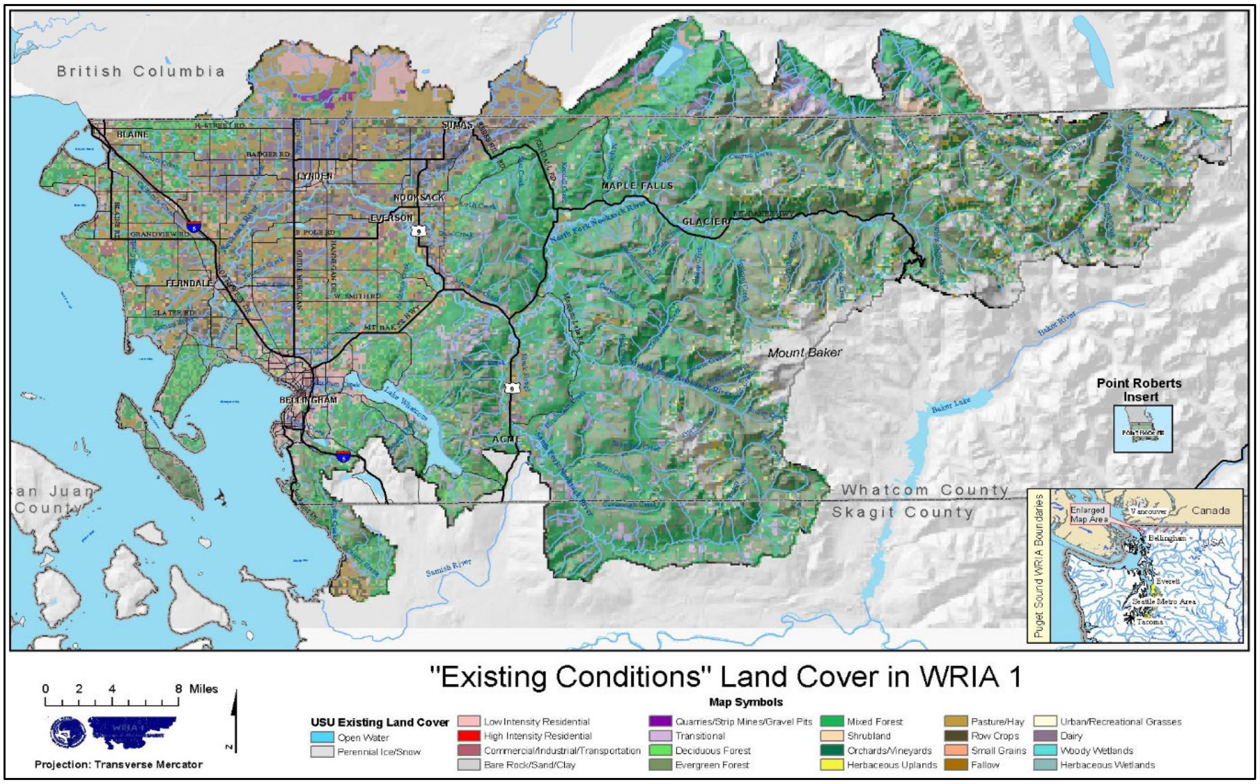

Figure 13. Land cover conditions in the Nooksack River watershed (Blake and Peterson 2005 p. 43).

Agricultural users have extensively altered surface-water systems in lowland areas of the Nooksack River and Samish River basins. The natural condition of the two watersheds consisted of large areas of wetland habitats (USFWS 2004 p. 160). Agricultural users installed drainage systems consisting of open ditches that are easily identified, while other parts consist of underground structures less visible. These systems have lowered the water table and dried the land ever since farming by settlers started in the area, in about 1850. Humans also filled in wetland habitats in many locations within the action area to facilitate agriculture and other anthropogenic use. Today, Whatcom County contains over 1,700 farms, the second highest number of any county in Washington State. Most of these farms are located in the Nooksack River basin.

The Samish River is about 29 miles in length and drains a total of 88 mi^2 of land. The river contains one major tributary, Friday Creek, which is formed at the outlet of Lake Samish, and located about 6.5 miles southeast of Bellingham. Mean annual discharge for the Samish River, near Burlington, is 246 cfs (1944 to 2001) (https://waterdata.usgs.gov). During very high flows (over 146,000 cfs) at Mount Vernon, a portion of the Skagit River can overflow to the Samish River and Bay. Land use in the floodplain is primarily rural with some suburban development. The Samish River estuary has been reduced by more than 92 percent (USFWS 2004 p. 43). Nearly the entire lower 8 miles of the Samish River basin is surrounded by agricultural lands with little to no riparian tree cover. Nonetheless, the USFWS noted that the Samish River supports an abundant and important forage base for bull trout consisting of coho, chum, Chinook salmon, and steelhead, even though it does not appear to have supported spawning habitat for bull trout (USFWS 2004 p. 128 and 136). The USFWS (2004 p. 128) considers the Samish River basin as FMO habitat for anadromous bull trout from the Nooksack and Skagit River basins, although the extent to which the species uses the Samish watershed is not well known.

Whatcom Creek is one of five relatively small tributaries that flow directly into Bellingham Bay. Whatcom Creek drains Whatcom Lake, a water body of nearly 5,000 acres in size located approximately 5 miles east of the city of Bellingham. Whatcom Lake was the source of drinking water for approximately half of all Whatcom County residents until the removal of a diversion structure on the Middle Fork Nooksack River in 2022. The outlet of Whatcom Lake forms Whatcom Creek, which flows through residential and commercial areas before entering Bellingham Bay. Urban and industrial land use is prevalent downstream of Whatcom Lake. Streamflow in Whatcom Creek varies from 15.21 cfs to 133.62 cfs and is highly influenced by fall and winter precipitation (Blake and Peterson 2005 p. 92). Whatcom Creek experiences low flows and warm water temperatures that likely limit usage of this tributary by bull trout during summer months.

The action area also includes hatchery facilities located on the shoreline of Lummi Bay and the East Sound on Orcas Island, as well as marine nearshore habitat in which both juvenile hatchery salmon and bull trout migrate. Upland and riparian land management practices are the primary threat to nearshore marine and estuarine habitats in the action area caused that are detrimental to anadromous bull trout and their marine forage fishes (e.g., juvenile salmon (*Oncorhynchus spp*.), surf smelt, Pacific sand lance, Pacific herring that form the prey base for bull trout (USFWS p. A-16).

Habitat conditions in the estuarine and nearshore marine habitats within the action area are relatively functional in comparison to other more developed locations of the Puget Sound, although recent studies show declines or lack of improvement in key areas. The Puget Sound Partnership (PSP) found development continues to threaten nearshore habitats that currently remain intact or are only partially modified (Puget Sound Partnership 2013 pp. 94–95), such as those in the North Puget Sound. Shoreline development armoring continues to prevent recovery of marine shoreline habitat, while also limiting spawning habitat for marine forage fishes (as noted above). The PSP reported the amount of eelgrass (*Zostera marina*) remained stable from 2003-2012 (Puget Sound Partnership 2013 p. 97). Eelgrass beds are a highly productive marine habitat used by salmonids for foraging and refugia. Researchers suggest that European green crab (EGC) (*Carcinus maenas*) reduce native bivalve molluscs and crab populations through competition or predation, particularly if the proliferation of EGC is unimpeded by management action (Grosholz et al. 2000 pp. 1214–1221; Kulhanek et al. 2011 pp. 194–200). As such, ecological impacts of this invasive species in marine and estuarine habitats of the action area continue to an issue of concern.

A large proportion of residential and urban landscapes consist of impervious surfaces (rooftops and roadway infrastructure) and the chemicals deposited on or released from impervious surfaces over the course of their use. Impervious surfaces rapidly shed stormwater runoff into municipal and wastewater outfalls, all of which deliver chemical contaminants directly into aquatic habitats (WDOE and King County 2011 p. 30). Thus, areas urbanized landscapes often have diminished groundwater recharge rates because there are no structures or natural features to facilitate absorption or filtration of precipitation through the soil. Moreover, stormwater runoff from impervious surfaces typically consists of dozens to hundreds of chemical contaminants that are harmful to fishes. These contaminants consist of oils, greases, polychlorinated biphenyls (PCBs), heavy metals (e.g., cadmium, copper, lead, mercury, zinc, etc.), polycyclic aromatic hydrocarbons (PAHs), microplastics, and other substances. The presence of chemical contaminants are common within urban areas and nearshore marine habitats (O'Neill et al. 2020 pp. 10–11).

10 CURRENT CONDITION OF THE SPECIES IN THE ACTION AREA

As noted above in Section 7 (Status of the Species) the Coastal Recovery Unit (CRU) contains bull trout populations spanning the Cascade Mountains in Oregon and Washington, the lower Columbia River, coastal Washington, and the Puget Sound. The current demographic status of bull trout in the CRU is variable. Populations in the Puget Sound region generally tend to have higher demographic status, followed by populations in the Olympic Peninsula, and finally populations in the Lower Columbia River region (USFWS 2015a p. A-6).

The USFWS defines bull trout core areas as the combination of core habitat (i.e., habitat could supply all elements for the long-term security of bull trout) and a core population (a group of one or more local bull trout populations that exist within core habitat), which constitutes the basic unit on which to gauge recovery within a RU (USFWS 2015a p. 71). Core areas require both habitat and bull trout to function, and the number (replication) and characteristics of local populations inhabiting a core area provide a relative indication of the core area's likelihood to persist. A core area represents the closest approximation of a biologically functioning unit for bull trout. Core habitat is defined as habitat that contains, or if restored would contain, all of the essential physical elements to provide for the security of and allow for the full expression of life history forms of one or more local populations of bull trout (USFWS 2015a p. 71). Core habitat may include currently unoccupied habitat if that habitat contains essential elements for bull trout to persist or is deemed critical to recovery.

There are eight bull trout core areas in the Puget Sound region, and it is likely that individuals from four core areas may occur within the action area during the period in which the proposed hatchery programs are operational. These include individuals from the Nooksack River, and potentially anadromous individuals from the Lower Skagit River, Stillaguamish River, and Snohomish and Skykomish Rivers Core Areas. Due, in part, to their interconnectedness and proximity, the North Puget Sound Core Areas are thought to be among the most abundant (in terms of bull trout individuals) and interconnected core areas in the CRU. Most core areas in this region still retain 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).

There is limited information on abundance of bull trout in the Nooksack River Core Area, in part because low elevation river reaches may be seasonally occupied by individuals from neighboring core areas in the north Puget Sound. Thus, spawning surveys are the most reliable means by which to document bull trout abundance status and trends. These data are collected on a consistent basis only within the Lower Skagit River Core Area. Spawning surveys conducted elsewhere, are at best, sporadic. There are no consistent spawning surveys or other metrics for adult abundance within the Nooksack River Core Area. Limited spawning surveys conducted by the Nooksack Indian Tribe in 2002 suggest adult abundance of 250 to 1,000 individuals (Currence 2008 p. 4).

Bull trout in the Coastal CRU use marine FMO habitat, which is unique among the coterminous bull trout distinct population segment (DPS). Several watersheds in the action area that are outside of bull trout natal areas provide connectivity to FMO habitat within estuary and marine waters. Marine and estuary habitats provide not only connectivity throughout core areas, but also FMO habitat, which provide essential support to bull trout at various life history stages. Bull trout have been documented in nearshore areas around Lummi, Whidbey, and Ika Islands (USFWS 2010 p. 191). For instance, Goetz et al. (2021 pp. 9–11) found that 84 percent of bull trout acoustically-tagged in North Puget Sound rivers subsequently ascended the same river after a period overwintering in Puget Sound, and those tagged in marine waters returned to either the Skagit, Snohomish, or Stillaguamish Rivers. These authors noted that most fish traveled between 12 miles and 25 miles from the river mouth, although some individuals traveled more than 90 miles at depths of 5 ft to 15 ft (Goetz et al. 2021 p. 11). Additionally, these authors noted that fish from Skagit and Stillaguamish Core Areas used non-natal watersheds for freshwater rearing and overwintering. Hayes et al. (2011 pp. 399–404) found that habitat use by bull trout in marine areas of the North Puget Sound was highly associated with shorelines and relatively shallow water, with most fish positions within about 0.25 miles from the shoreline and shallower than 13 ft. Research conducted in the Skagit River (Hayes et al. 2011 pp. 399–404) and the Hoh River (Brenkman and Corbett 2005 pp. 1075–1077; Brenkman et al. 2007 pp. 5–8) suggests that 57 percent to 85 percent of individual bull trout exhibit anadromy if connectivity is not inhibited. Because migratory connectivity is fully functional within the Nooksack River watershed, we believe that bull trout will exhibit similar rates of anadromy.

East Sound is a large inlet surrounded by Orcas Island and is located 18 miles from the nearest freshwater FMO habitat (Samish River) and about 20 miles to the Nooksack River estuary. Orcas Island is separated by Rosario Strait, a wide channel with minimum depths in excess of 150 ft deep. Based on observations by Goetz et al. (2021 pp. 8–14), Hayes et al. (2011 pp. 399–404), and others (Brenkman and Corbett 2005 pp. 1075–1077; Brenkman et al. 2007 pp. 5–8), it is unlikely that bull trout will migrate beyond nearshore areas to access adjacent tributaries. Therefore, despite the good condition of PCEs in marine habitat west of Rosario Strait, which includes portions of the action area, these areas are unlikely to be used by bull trout, or support conservation of the species.

The action area encompasses designated CH for the bull trout in two freshwater basins (Nooksack and Samish Rivers) and Puget Sound Marine FMO habitat. The lineal distance of designated CH in the Nooksack and Samish River basins contains approximately 377 km (231 miles) and 38.3 km (23.8 miles), respectively (USFWS 2010 pp. 89 & 167). Anadromous bull trout use nearshore habitat along the eastern shore of Puget Sound from the U.S.–Canadian border south to the Nisqually River delta. Bull trout have also been documented using the nearshore habitat of islands along this eastern shore, especially in the northern part of the Puget Sound.

The current distribution data for bull trout most likely underrepresent the amount of occupied marine nearshore habitat due to the depressed status of some bull trout populations exhibiting the anadromous life history; the seasonal and temporal variability in their migratory behavior; and perhaps most importantly, the difficulty of sampling for adult and subadult life stages in large estuarine and marine environments.

10.1.1 Nooksack River Core Area

The USFWS recognizes ten local populations within the Nooksack River Core Area: Lower Canyon Creek, Glacier Creek, Lower Middle Fork Nooksack River, Upper Middle Fork Nooksack River, Lower North Fork Nooksack River, Middle North Fork Nooksack River, Upper North Fork Nooksack River, Lower South Fork Nooksack River, Upper South Fork Nooksack River, and Wanlick Creek (Figure 14) (USFWS p. A-148). This core area supports anadromous and fluvial, and potentially resident life history forms.

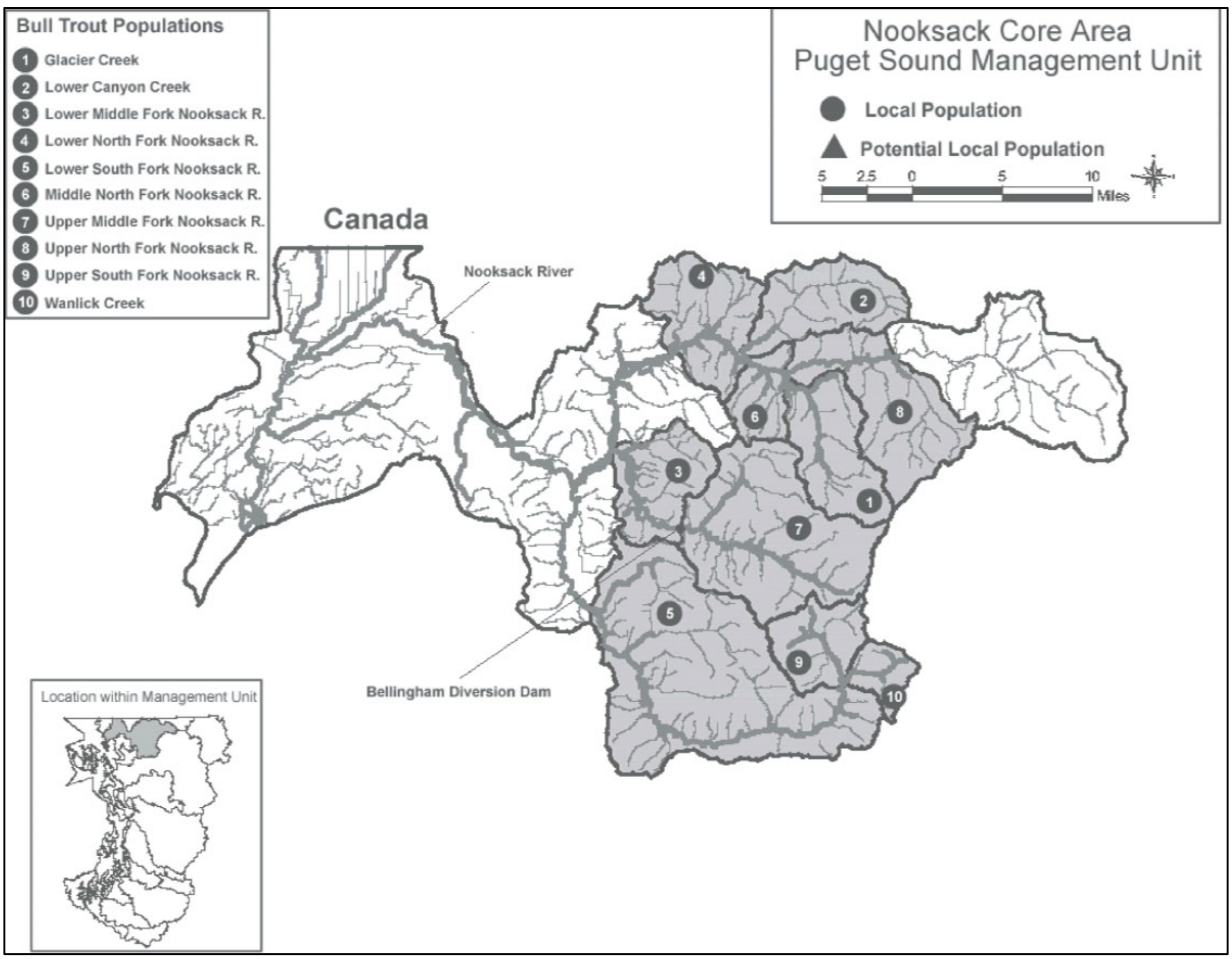

Figure 14. Local populations of bull trout in the Nooksack River Core Area. Highlighted streams are key freshwater habitat for recovery.

Bull trout and Dolly Varden (*S. malma*) co-occur in the Nooksack River watershed. The level of interaction between the two species and our understanding of the degree of overlap in their distributions indicates the two species co-occur in the North Fork Nooksack River and South Fork Nooksack River (Kopp 2022 p. 15). Trout Unlimited collected environmental genetics samples throughout the Nooksack River Basin from 2020 to 2022 (Kopp 2022 p. 15); analysis of these samples revealed bull trout and Dolly Varden co-occur in the middle reaches of the North Fork Nooksack River and upper reaches of the South Fork Nooksack River. Results of this research indicated bull trout are the most widespread species of char in the Nooksack River watershed.

10.1.1.1 Abundance and Productivity

The Nooksack River Core Area adult abundance is estimated between 500 individuals to 1,000 individuals based on limited spawn survey data (USFWS 2008 p. 35). Eight of the local populations likely have fewer than 100 adults each, based on the relatively low number of migratory adults observed returning to the core area. Biologists suspect that bull trout use of spawning habitat is limited to small areas in the North, Middle, and South Fork Nooksack Rivers and their tributaries (Currence 2007 p. 5). However, incidental observations of South Fork Nooksack River bull trout redds are occasionally noted during Chinook salmon surveys in the upper river. These researchers also noted incidental observations of bull trout staging prior to spawning, between RM 21 to 30, during these spawning surveys targeted at Chinook salmon. Although not complete counts, biologists have recorded adult bull trout numbers that are consistently in the single digits, suggesting a small population size. The Glacier Creek local population has approximately 100 adults, based on incidental redd counts and available spawning habitat. The Upper North Fork Nooksack River local population may support 100 adults, based on the persistent, small numbers of spawning adults observed in tributaries and available side channel habitat.

10.1.1.2 Connectivity

Restoration proponents completed removal of the Bellingham Diversion Dam on the Middle Fork Nooksack River in 2020, which reestablished full connectivity within this portion of the watershed and addressed one of the three primary threats to bull trout in the Nooksack River Core Area (USFWS p. A-10 to A-11). This core area now contains fewer physical impediments to connectivity that may limit movement of bull trout. However, biologists identified water quality conditions in the South Fork Nooksack River as an ongoing seasonal limitation to connectivity within this portion of the watershed.

10.1.1.3 Threats

The USFWS identified two primary threats to bull trout in the Nooksack River Core Area (USFWS p. A-10 to A-11):

1. Upland/Riparian Land Management: The Nooksack River was impacted by past forest management activities in addition to past and ongoing agricultural practices.

2. Water Quality: Climate Change. The combination of agricultural and forest management practices has led to widespread channelization and habitat degradation within the Nooksack River Basin. These activities have reduced the capacity of the core area to

support anadromous bull trout. Land management practices in the South Fork Nooksack River have created seasonally warm water conditions that degrades FMO and spawning and rearing habitat for the South Fork Nooksack River local population. The USFWS expects the degraded water quality conditions in the South Fork Nooksack River will worsen with effects from climate change.

The USFWS also identified additional threats to the Nooksack River Core Area, including the following:

- Depressed abundances of naturally reproducing salmon and steelhead populations in the Nooksack River system likely limit important bull trout prey resources and bull trout abundance. Abundance of spawning anadromous salmonids has been found to influence abundance, growth rates, and size of bull trout (Kraemer 2003 pp. 4–6; Zimmerman and Kinsel 2010 pp. 24–25; Copeland and Meyer 2011 p. all), as well as other species (Bentley et al. 2012 pp. 7–11; Nelson and Reynolds 2014 pp. 5–6). Anadromous salmonids provide a prey resource in the form of eggs and freshwater-rearing juveniles, which can make up a substantial proportion of the bull trout diet in freshwater habitats (Lowery and Beauchamp 2015 pp. 732–737). Spawning fish and carcasses also increase ecosystem productivity, thereby increasing the abundance of aquatic invertebrates and resident fishes (Cederholm et al. 1999 p. all), which may also provide important components of the bull trout diet (Lowery and Beauchamp 2015 pp. 732–737). Recovering naturally reproducing salmon and steelhead populations is an important component of bull trout recovery in the Puget Sound geographic region.
- Past timber harvest and harvest-related activities, such as roads, have caused the loss or degradation of several spawning and rearing areas. State forest practice regulations were significantly revised following the Forest and Fish Agreement (Washington Forest Practices Board 2001; Creutzburg et al. 2017 p. 504). These regulations are expected to significantly reduce the level of future timber harvest impacts to bull trout streams on private lands; however, most legacy threats from past forest practices will continue to be a threat for decades.
- Residential development, road networks, agricultural practices, and related stream channel and bank modifications have caused the loss and degradation of FMO habitat in mainstem reaches of the major forks and in several tributaries. Stormwater runoff from residential development and urbanization continues to be a significant contributor of non-point source water pollution in some areas (Washington State Conservation Commission 2002 p. 221). Impacts to marine foraging habitats have been, and continue to be, greatly affected by urbanization along nearshore areas in Bellingham Bay and the Strait of Georgia. For example, the Cherry Point herring stock was once a substantial prey resource, and its current diminished condition may appreciably affect bull trout.
- Incidental harvest poses a general threat to bull trout. There are currently no fisheries for bull trout in the Nooksack River watershed or nearby marine waters. However, bull trout are highly susceptible to incidental capture in fisheries targeting other species when those fisheries overlap in time and space with bull trout. Various commercial, tribal, and recreational fisheries in the Nooksack River watershed and nearby marine waters are open annually. Incidentally captured bull trout are exposed to inadvertent injury and immediate and delayed mortality associated with hooking, suffocation (e.g., from

gillnets), handling, stress and physical exhaustion, and predation [e.g., (Arlinghaus et al. 2007 pp. 105–125)]. Poaching and intentional killing (i.e., from anglers that believe bull trout are a threat to their preferred target species or confuse them with other species) are also a concern in some areas.

- Data collected by Kopp (2022 p. 15) indicated brook trout co-occur with bull trout and Dolly Varden in the mainstem Nooksack River and North Fork Nooksack River. Kopp (2022 p. 15) found that brook trout were widespread throughout the upper reaches of the North Fork Nooksack River, including Anderson Creek, Bagley Creek, and Wells Creek. Thus, the potential for brook trout hybridization with bull trout and Dolly Varden is likely greatest in the North Fork Nooksack River, particularly since this portion of the watershed contains the coolest water refugia habitat where co-occurrence between the two species is most frequent. The magnitude of hybridization is expected to increase over time if habitat continues to be degraded in the system, and migratory life history forms of bull trout remain in low abundance. Brook trout appear to adapt better to degraded habitats than bull trout (MBTSG 1996 p. all). Because elevated water temperatures and sediments are often indicative of degraded habitat conditions, bull trout may be subject to stresses from both interactions with brook trout and degraded habitat (MBTSG 1996 p. all). The low numbers of adult bull trout observed at known spawning sites in the Nooksack River Basin may further allow brook trout to become more dominant within the core area.
- Researchers have confirmed the presence of *Flavobacterium columnare* (*Columnaris*), a pathogenic bacteria that occurs throughout the Pacific Northwest in warm water conditions has caused pre-spawn mortality of adult pink and Chinook salmon in the South Fork Nooksack River, although there are no documented cases of *Columnaris* in bull trout (Nooksack Natural Resources et al. 2005 p. 80). Ongoing seasonal warm water conditions in the South Fork Nooksack River suggest adult and subadult bull trout could be at risk from *Columnaris* outbreaks.

In addition to the climate change-related temperature threats to the South Fork Nooksack River described above, climate change is expected to negatively affect bull trout throughout the Nooksack River watershed via elevated water temperatures during migration, spawning, and rearing periods; redd scour due to increased peak flows; and decreased habitat quantity because of lower summer flows. Climate change will exacerbate the low flow issues and elevated water temperature problems currently existing in the watershed.

10.1.1.4 Recent Information

Based on threats assessment scoring, the North Puget Sound working group members rated the Nooksack River Core Area high (3.60) for demographic score and medium (2.91) for the habitat score (Winkowski 2024 p. all). The North Puget Sound regional working group rated five factors as high (4.0) within this core area: life history diversity, occupied local populations, genetic connectivity, abundance, and habitat quantity. The North Puget Sound regional working group rated this core area low on a single factor: water quality. The overall resiliency score for the Nooksack River Core Area was medium (3.25) (Winkowski 2024 p. all).

10.1.2 Lower Skagit River Core Area

The USFWS recognizes 20 local populations within the Lower Skagit River Core Area: Bacon Creek, Baker Lake, Sulphur Creek (Lake Shannon), Buck Lake, Cascade River, South Fork Cascade River, Downey Creek, Goodell Creek, Illabot Creek, Lime Creek, Milk Creek, Newhalem Creek, Forks of the Sauk River, Upper South Fork Sauk River, Straight Creek, Upper Suiattle River, Sulphur Creek, Tenas Creek, Lower White Chuck River, and the Upper White Chuck River (Figure 15) (USFWS p. A-148). The Lower Skagit Core Area comprises the Skagit River Basin downstream of the Gorge Dam, and includes mainstem reaches of Skagit, Cascade, Sauk, Suiattle, White Chuck, and Baker Rivers. This core area also includes habitat within the reservoirs on the Baker River (Baker Lake, Lake Shannon). The Lower Skagit River Core Area supports all four life history forms.

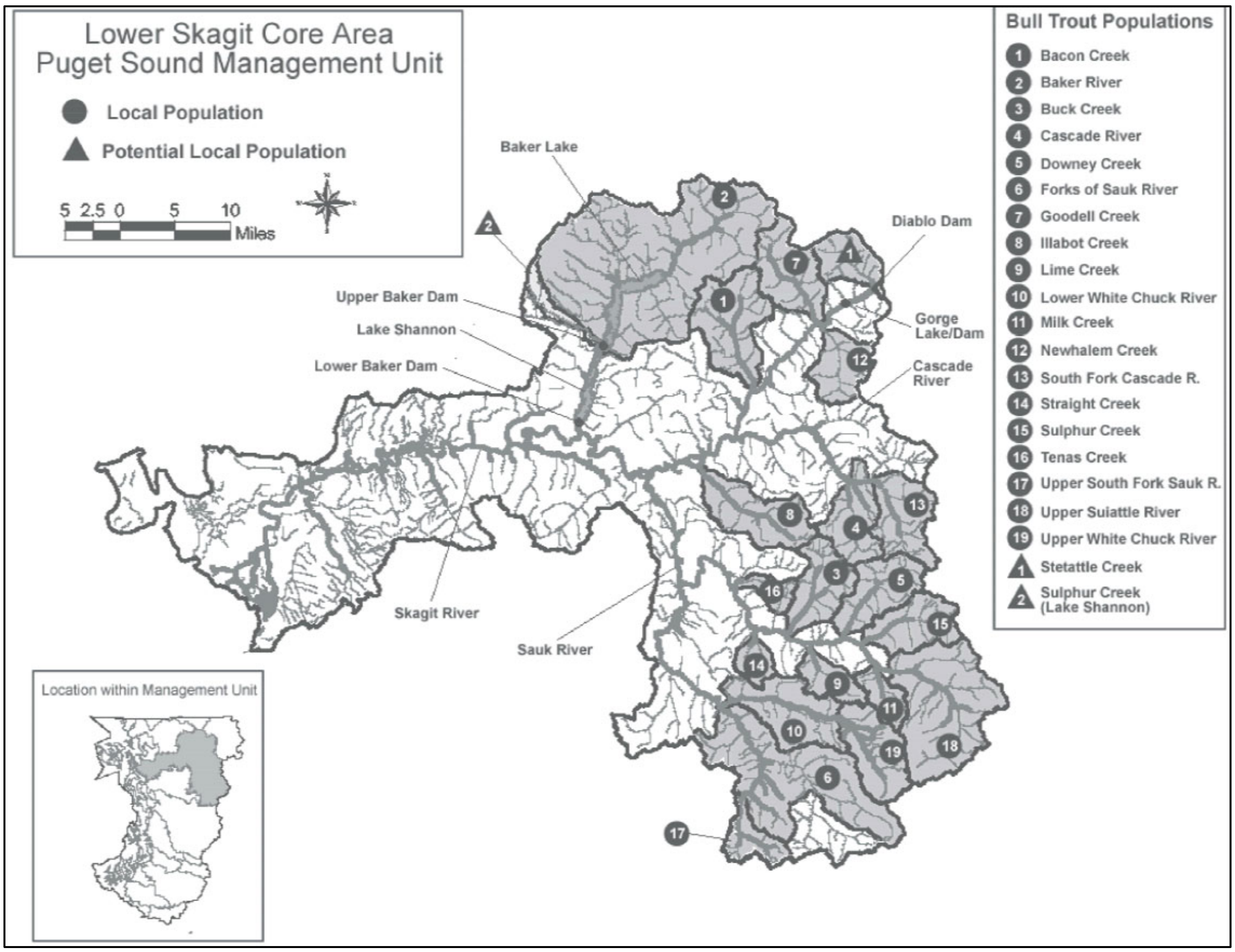

Figure 15. Local populations of bull trout in the Lower Skagit River Core Area. Highlighted streams are key freshwater habitat for recovery.

10.1.2.1 Abundance and Productivity

Based on the available information, the Lower Skagit River Core Area contains the largest spawning population of bull trout in Washington. In the 2008 5-year species status assessment

(SSA) review the USFWS estimated bull trout adult abundance to be between 5,000 individuals and 10,000 individuals based on partial spawner survey data from less than half of this core area (USFWS 2008 p. 35). Based on recent data collected within the core area, adult abundance in the Lower Skagit River was categorized as 'high' (more than 1,000 fish) (Winkowski 2024 p. all). While a comprehensive abundance estimate of bull trout in the Lower Skagit River may not be available, the data collected within the core area suggest that adult abundance has generally declined since 2008. We describe these data below.

More recent, new, and/or higher quality survey data for most local populations are critical to reach more confident conclusions regarding bull trout abundance throughout the CRU. Since 2002, the WDFW has conducted spawning ground surveys and bull trout redd counts in several index reaches within the Lower Skagit River Core Area (Figure 16) (USFWS 2009 pp. 1636–1639).

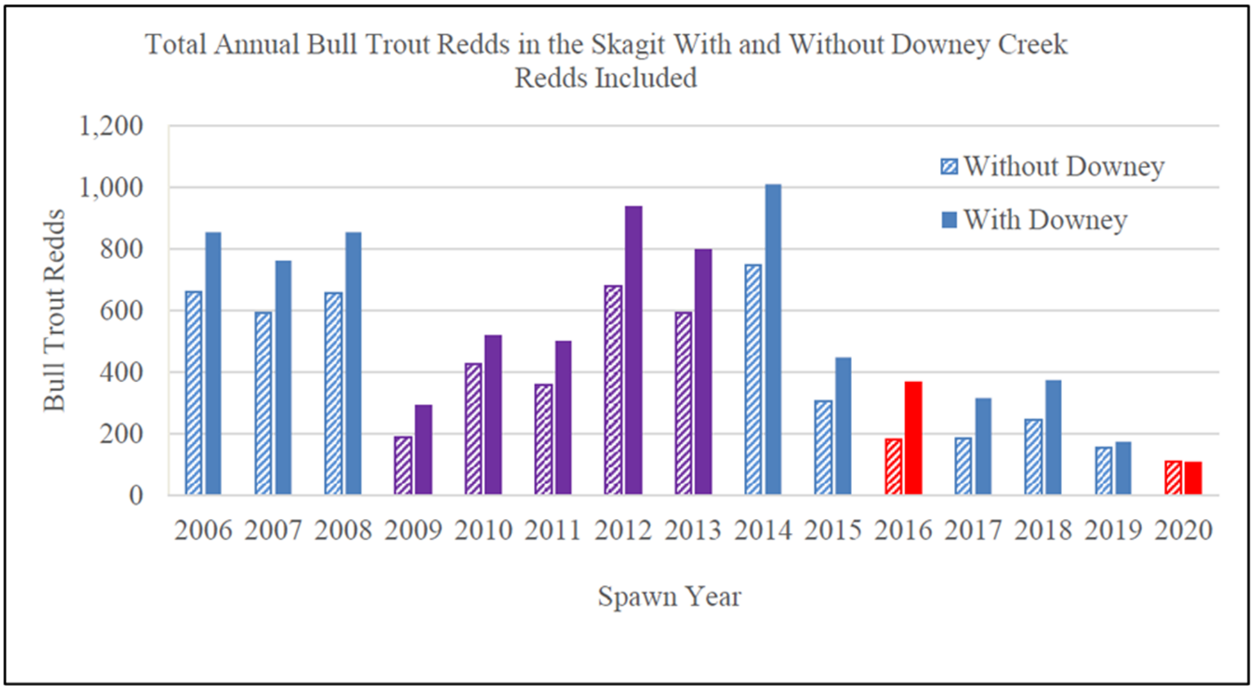

Figure 16. Annual Skagit River Basin bull trout redds from all monitored Skagit River spawning reaches from 2006 to 2020 (Fowler 2021 p. 7). In years in purple, the Illabot Creek spawning population was not monitored due to road washout. Bull trout redd surveys conducted during 2016 and 2020 (denoted in red) indicates years incomplete surveys years due to stream conditions and wildfire. Bull trout redd surveys conducted in 2020 do not include Goodell Creek.

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 six-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 2018 pp. 4–5, 2019 pp. 4–5, 2020 pp. 4–5, 2021 pp. 4–5). Based on these data, while habitat quality is generally satisfactory, bull trout abundance may be declining in the Lower Skagit River Core Area (Fowler 2018, 2019, 2020, 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, observations of juvenile bull trout have declined in the outmigrant smolt trap at RM 17 in the mainstem.

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 and observations of bull trout during spawning surveys indicate a decreasing trend in bull trout abundance and productivity in this core area and, thus, present concerns if these trends continue (USFWS ; Fowler 2018, 2019, 2020, 2021).

10.1.2.2 Connectivity

Puget Sound Energy (PSE) owns and operates hydropower facilities on the Baker River dams that are equipped with fish passage facilities. Local populations in Baker Lake and Lake Shannon are dependent on operation of the fish passage facilities, and thus, experience somewhat limited connectivity. In general, PSE has improved fish passage capabilities by constructing new passage infrastructure (i.e., an adult trap-and haul facility for upstream migrants and floating surface collectors for juveniles migrating downstream) and implementing enhanced fish passage protocols and monitoring. There are limitations preventing the passage measures from being fully effective in ensuring safe transport. This lack of connectivity puts the Baker Lake and Sulpher Creek (Lake Shannon) local populations at an increased risk of extirpation due to the low abundance and limited availability of spawning and rearing habitat. 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 p. all, 2020 p. all). 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).

10.1.2.3 Threats

The USFWS identified five primary threats to bull trout in the Lower Skagit River Core Area (USFWS p. A-11, A-12):

1. Upland/Riparian Land Management: Legacy Forest Management–associated sediment impacts, particularly from forest roads, have led to habitat degradation within key spawning and rearing basins (i.e., Sauk and Suiattle rivers).

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

3. Water Quality: Agricultural Practices and Residential Development and Urbanization–related activities have resulted in sediment and temperature impairment in major tributaries to the lower Skagit River and possibly upper Sauk River.

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

5. Connectivity Impairment: Fish Passage Issues–upstream and downstream connectivity at hydropower facilities [Baker River hydropower project] is directly tied to active fish passage measures under agreements with the Federal Energy Regulatory Commission.

10.1.2.4 Recent Information

Based on data from the core area populations and threats assessment scoring, the members of the North Puget Sound regional working group rated the Lower Skagit River Core Area high (4.00) for the demographic score and medium (2.91) for the habitat score (Winkowski 2024 p. all). The North Puget Sound regional working group rated this core area highest on abundance, occupied local populations, genetic connectivity (all rated 5.0). The North Puget Sound regional working group rated this core area low on two factors: growth rate (1) and water quality (1.5). The overall resiliency score for the Lower Skagit River Core Area was high (3.45) (Winkowski 2024 p. all).

10.1.3 Stillaguamish River Core Area

The Stillaguamish River is comprised of the North Fork and South Fork Stillaguamish Rivers and their tributaries (Figure 17).

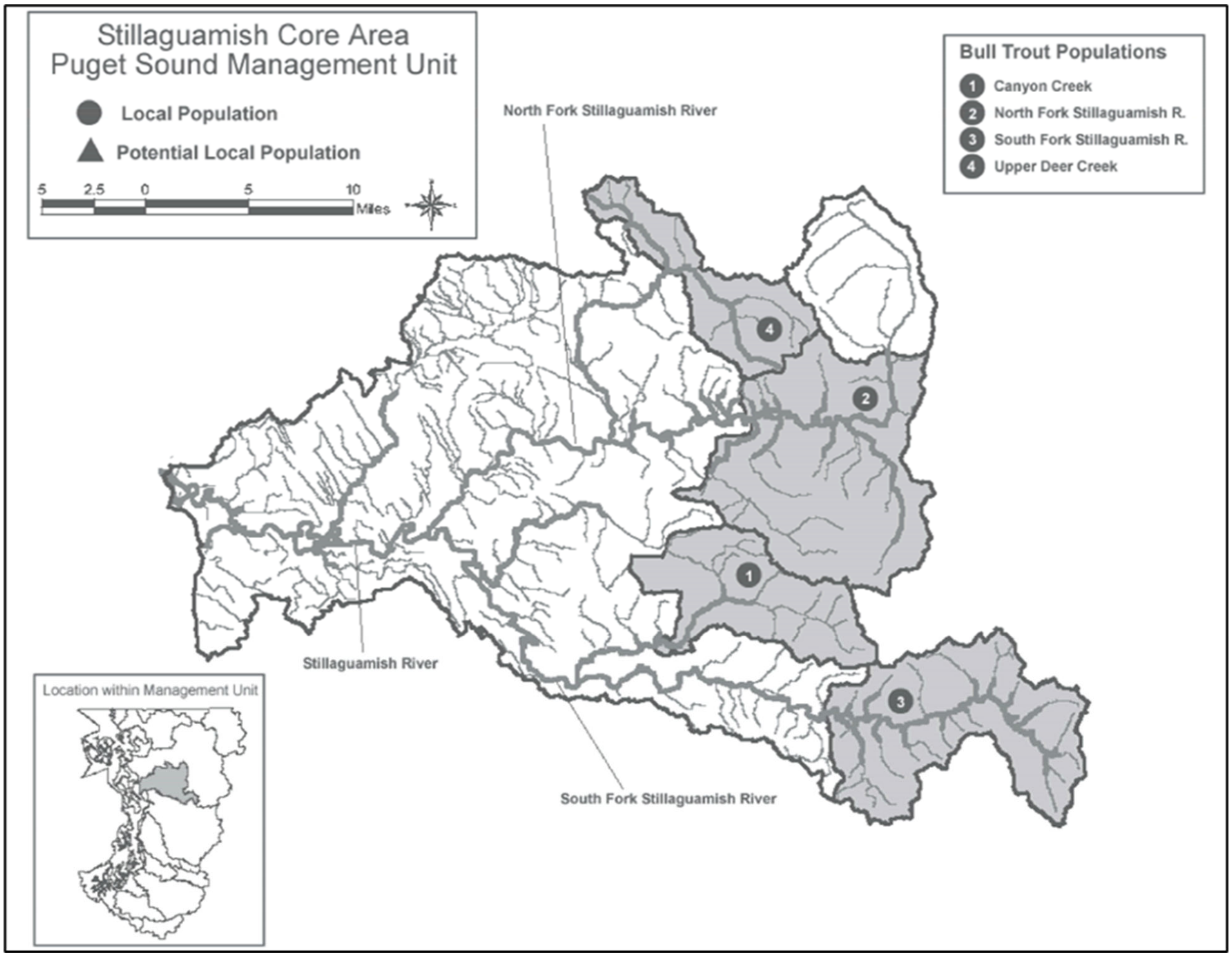

Figure 17. Local populations of bull trout in the Stillaguamish River Core Area. Highlighted streams are key freshwater habitat for recovery.

The USFWS recognizes three extant populations in the Stillaguamish River Core Area, including: Canyon Creek, the South Fork Stillaguamish River, and Upper Deer Creek (USFWS p. A-149). Three local populations are relatively well distributed throughout this core area. However, based on the paucity of historical observations of bull trout and more recent failures to detect bull trout the Upper Deer Creek local population may be extirpated (USFWS 2015a, p. A-13).

Status of the North Fork Stillaguamish River as a local population is somewhat uncertain. The USFWS initially recognized this local population based on snorkel surveys conducted from 1996 to 2003 (USFWS 2004 pp. 96–97). Although biologists observed numerous adult bull trout in this part of the Stillaguamish River during staging and spawning periods , none have been detected in subsequent years (USFWS 2015b, p. A-149). These are now thought to have been anadromous individuals from outside the Stillaguamish River Basin. Thus, the North Fork Stillaguamish River local population is considered to be composed of individuals from outside the Stillaguamish River Basin (USFWS 2015b, p. A-149). Because of the past adult detections in this area, the USFWS considers the North Fork Stillaguamish River a potential local population only.

Bull trout in the Stillaguamish River Core Area primarily consist of the anadromous and fluvial life-history forms (USFWS 2004, p. 96). Bull trout exhibiting a resident life history occur in the upper South Fork Stillaguamish River (USFWS 2004, p. 96; 2008, p.1). Recent research indicated that all char in Higgins Creek are resident Dolly Varden, not bull trout (DeHaan 2009 p. all), as was initially suspected in earlier reports.

10.1.3.1 Abundance and Productivity

The Stillaguamish River core area likely contains fewer than 100 adults, however survey data is limited (Winkowski 2024 p. all). Extremely low numbers of bull trout redds were observed between 2017 and 2019. The Stillaguamish River Core Area is identified as having low population abundance and has had only one bull trout redd identified between 2016 and 2019 (Figure 18).

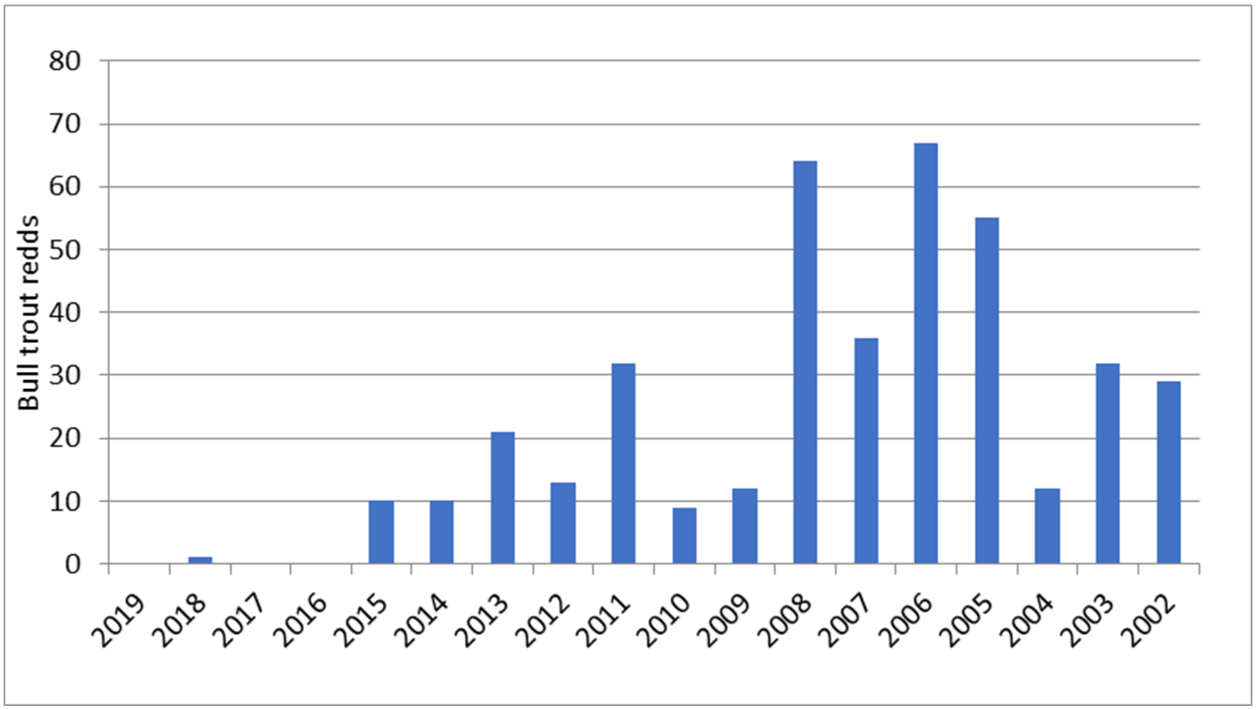

Figure 18. Number of bull trout redds enumerated by WDFW biologists in the South Fork Stillaguamish River and Palmer Creek spawning index reaches (WDFW 2019 p. all).

In 2014 and 2015, ten bull trout redds were found in the Stillaguamish River Core Area. The highest number of bull trout redds were found in 2006 with 67 redds, and in 2008 with 64 redds. Bull trout redd numbers within the Stillaguamish River core area have always been low, with less than 30 redds occurring 12 times between 2002 and 2019. Bull trout abundance within the Stillaguamish River Core Area is inferred to be extremely low based on redd counts. The Stillaguamish River Core Area populations were considered “at risk” for extirpation in 2008 (USFWS 2008 p. 35). Thus, the USFWS believes bull trout in the Stillaguamish River Core Area may be at greater risk of extirpation risk now due to lower abundance and declining productivity.

Spawning habitat is generally limited in the Stillaguamish River Core Area due to two primary issues: 1) there is a relatively limited amount of high elevation areas that provide the best thermal regimes for spawning, egg incubation, and early juvenile rearing; and, 2) historical land management practices, particularly related to timber harvesting, have degraded much of the available spawning and rearing habitat. In the North Fork Stillaguamish River Basin, migratory bull trout historically spawned in the upper reaches of the Deer Creek subbasin, including Upper Deer, Little Deer, and likely lower Higgins creeks (USFWS 2004, p. 96). In the Boulder River sub-basin, bull trout spawn below an anadromous barrier at RM 3. Adult bull trout have been observed in the North Fork Stillaguamish River upstream of the Boulder River confluence, including in the Squire Creek sub-basin (USFWS 2004, p. 97-98).

10.1.3.2 Connectivity

Apart from Granite Falls, the USFWS has not identified major barriers to connectivity within the Stillaguamish River. The South Fork Stillaguamish River upstream of Granite Falls has supported anadromous bull trout since the construction of a fishway in the 1950s (USFWS 2004 p. 97-98). Previously, the falls were impassable to anadromous fish. Anecdotal information from fish surveys in the 1920s and 1930s suggest that native char likely were present above Granite Falls prior to construction of the fishway (USFWS 2004 p. 97-98).

Upstream movement of bull trout from the lower river is currently dependent upon proper functioning of the fish ladder at Granite Falls. There has been no evaluation of bull trout passage upstream of this facility. The lack of available spawning habitat and spatial isolation of this habitat suggests local populations in the Stillaguamish River are somewhat isolated from each other. Therefore, improving connectivity between these local populations is essential to maintaining opportunities to improve the survival and recovery of bull trout in this core area.

10.1.3.3 Threats

The USFWS identified six primary threats to bull trout in the Stillaguamish River Core Area (USFWS p. A-13):

- Upland/Riparian Land Management: Forest Management. Legacy and ongoing impacts have exacerbated landslide activity in the watershed degrading salmonid habitat and water quality.
- Instream Impacts: Recreational Mining. Activities impact spawning and rearing tributary habitats.
- Water Quality: Forest Management, Residential Development and Urbanization. Legacy impacts result in seasonal high-water temperatures in the mainstem river, North and South Forks, and some local population tributaries; anticipated to be further exacerbated by climate change.
- Connectivity Impairment: Fish Passage Issues. Stillaguamish weir on Cook Slough impedes upstream fish passage and/or traps migratory spawners.

- Connectivity Impairment: Fish Passage Issues. Persistence of the migratory life history in the South Fork Stillaguamish River local population is reliant upon continued functionality of the fishway at Granite Falls.
- Small Population Size: Genetic and Demographic Stochasticity. Available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in the South Fork Stillaguamish and Upper Deer Creek local populations, in fact, the Upper Deer Creek local population may be extirpated.

Additional threats to the Stillaguamish River Core Area include the following:

- Estuarine nearshore foraging habitats have been severely diminished in quantity and quality (USFWS 2023, p. 40). In addition, declines in marine forage fish species, particularly surf smelt (*Hypomesus pretiosus*) and Pacific herring (*C. pallasii*), in the marine nearshore areas of the Salish Sea (Therriault et al. 2009 pp. 4–6; Greene et al. 2015 pp. 159–165) have resulted in part from degradation of habitats including natural beaches and eelgrass beds from water pollution impacts. Anadromous bull trout feed heavily on marine forage fish species in nearshore areas (Goetz et al. 2004 pp. 109–112). Declines in marine nearshore habitat quality and prey resources may limit the abundance of the anadromous life history form.
- The abundance of many species of anadromous salmonids in the Stillaguamish River Core Area has been in decline for many years (WDFW 2019 p. all).
- The long-term decline in abundance of live-spawning anadromous salmonids and the related decline in the prey base may limit the long-term abundance and productivity of local populations in the Stillaguamish River Core Area.
- Climate change is expected to cause similar negative effects on spawning and rearing of bull trout from elevated water temperatures during migration, spawning, and rearing periods as in other nearby core areas (e.g., Lower Skagit), redd scour due to increased peak flows, and decreased habitat quantity because of lower summer flows.
- Historical planting of Westslope cutthroat trout (O. *clarkii lewisi*) in the North and South Forks of the Stillaguamish River in areas overlapping bull trout spawning and rearing is a potential concern (USFWS 2008 p. 7).

10.1.3.4 Recent Information

Based on data from the core area populations and threats assessment scoring, the members of the North Puget Sound regional working group rated the Stillaguamish River Core Area low (2.60) for the demographic score and medium (3.24) for the habitat score (Winkowski 2024 p. all). The North Puget Sound regional working group rated this core area highest on life history diversity (4), instream quality (4.5), and riparian quality (4.5). The North Puget Sound regional working group rated this core area low on abundance (1), growth rate (1), and water quality factors (1.5). The overall resiliency score for the Stillaguamish River Core Area was medium (2.92) (Winkowski 2024 p. all).

10.1.4 <u>Snohomish/Skykomish Rivers Core Area</u>

The Snohomish/Skykomish River watershed is the second largest by area in the Puget Sound. The Snohomish/Skykomish Rivers Core Area includes the Snoqualmie River and its tributaries, in addition to both the Snohomish River and the Skykomish River (Figure 19).

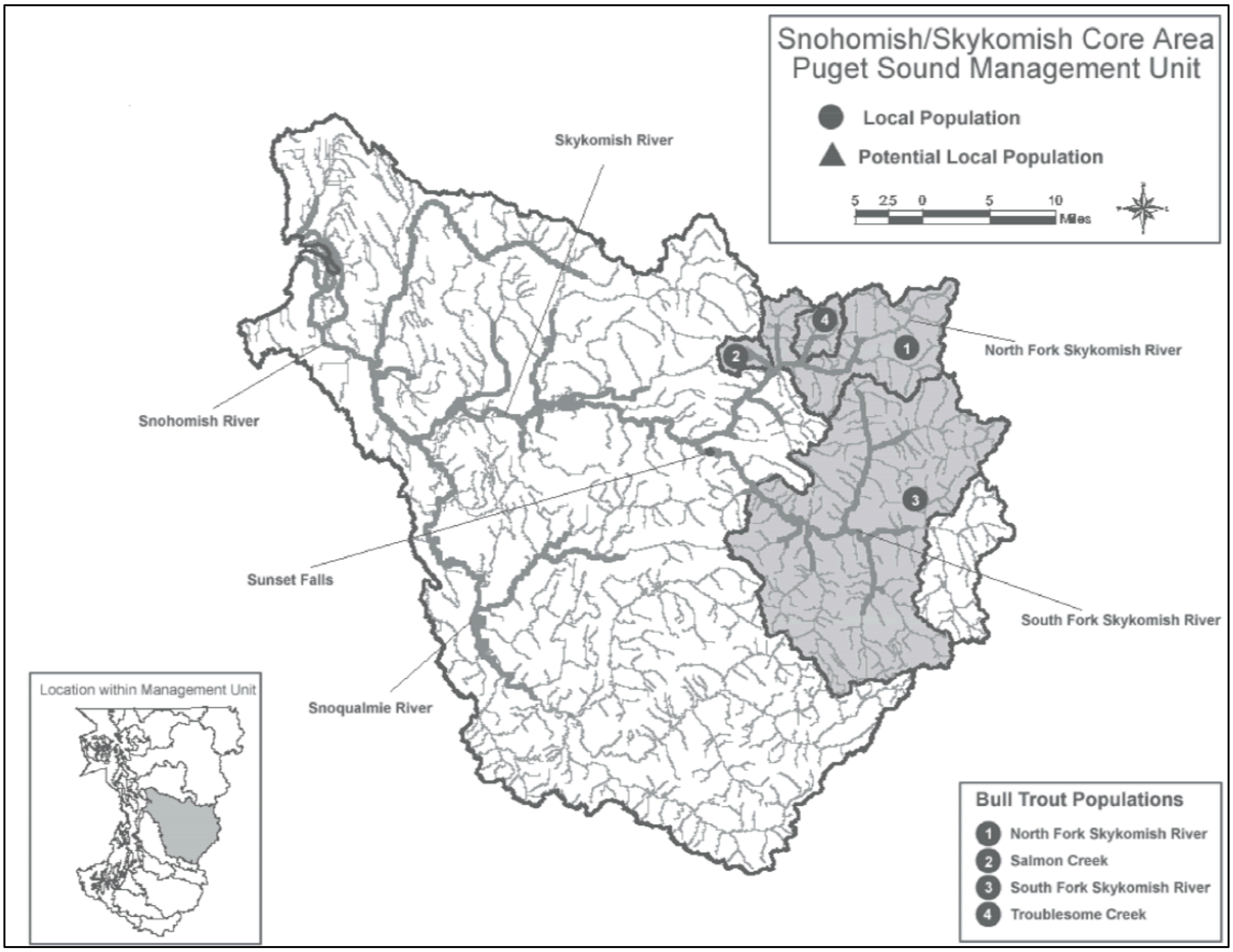

Figure 19. Local populations of bull trout in the Snohomish/Skykomish Rivers Core Area. Highlighted streams are key freshwater habitat for recovery.

The USFWS recognizes four local populations in the Snohomish/Skykomish Rivers Core Area, including the North Fork Skykomish River (including Goblin and West Cady Creeks), Troublesome Creek, Salmon Creek, and South Fork Skykomish River (USFWS p. A-149). Bull trout occur throughout the Snohomish/Skykomish watershed, except for the Snoqualmie River. In addition, bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, upstream of Deer Falls on the North Fork Skykomish River, or upstream of Alpine Falls on the Tye River.

The Snohomish/Skykomish Rivers Core Area contains other medium to large-sized tributaries, such as the Pilchuck, Tolt, and Wallace Rivers, although these are considered of secondary importance to bull trout (USFWS 2004, p. 239). The Snohomish/Skykomish Rivers Core Area supports fluvial, resident, and anadromous life history forms of bull trout. Biologists believe that a large portion of the Snohomish/Skykomish Core Area is anadromous.

*10.1.4.1 Abundance and Productiv*ity

In 2008, the USFWS estimated the Snohomish/Skykomish Rivers Core Areas supported just over 1,000 adults (USFWS 2008 p. 35). Abundance indices in the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have substantially declined. Observations of adult bull trout passed at the Sunset Falls Fishway Facility suggests abundance of bull trout in the South Fork Skykomish River is declining (Figure 20) (WDFW 2020 pp. 22–23; USFWS 2021 p. 4). The persistence of the South Fork Skykomish River local population is reliant upon ongoing operation of the trap and haul facility at Sunset Falls. The Sunset Falls Fishway facility consists of a series of 33 vertical slots which lead into a trap and haul facility at RM 51.5 (WDFW 2001 p. 4). The Sunset Falls Fishway facility provides bull trout with access to over 92 miles of spawning and rearing habitat in the upper South Fork Skykomish watershed.

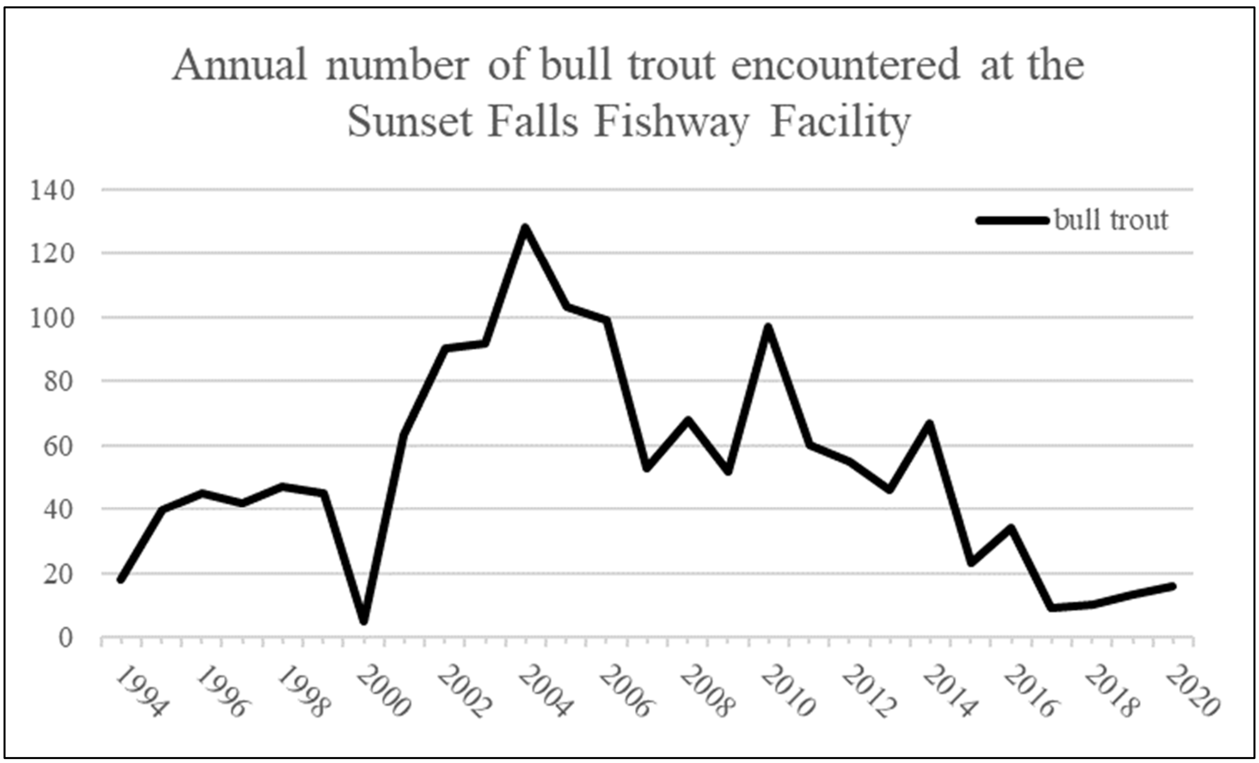

Figure 20. Annual number of bull trout encountered at the WDFW Sunset Falls Fishway Facility. (WDFW 2020 pp. 22–23; USFWS 2021 p. 4).

It is possible that migratory bull trout may occasionally migrate to the upper basin of the South Fork Skykomish River during high flow conditions that allow steelhead upstream access. The known spawning and early rearing areas in the Skykomish River Basin are all found at an elevation of 1,000 ft to 1,500 ft. Because of the topography of the basin, the amount of key spawning and early rearing habitat available is more limited than in some basins. Primary spawning and early rearing habitat for bull trout is found in the upper North Fork Skykomish River. The major areas of production include the North Fork Skykomish River between Bear

Creek Falls and Deer Falls, Goblin Creek, Troublesome Creek, and Salmon Creek. In addition, in the last several decades a migratory bull trout population has become established in the East Fork Foss and Beckler rivers on the South Fork Skykomish River. Bull trout spawn in the North Fork Skykomish River upstream of Bear Creek Falls to Deer Falls, as well as in Goblin Creek and West Cady Creek. This area supports as many as 500 migratory adults based on redd counts as well as a small number of resident fish (only occasionally observed). The Troublesome Creek local population is primarily a resident population with typically only resident fish found upstream of the natural barrier located approximately 0.4 km (0.25 miles) upstream from the mouth. The abundance of the resident population is currently unknown but is believed to be stable due to intact habitat conditions. Spawning and early rearing habitat is believed to be in good to excellent condition given the upper reaches of this system are within the Henry M. Jackson Wilderness.

10.1.4.2 Connectivity

The Snohomish/Skykomish Rivers Core Area contains three major, or potential barriers to migration relevant to bull trout. Sunset Falls is located at RM 51.5 and is the first of a series of large cascades that forms an anadromous barrier to migratory salmonids in the South Fork Skykomish River. The WDFW constructed a trap and haul facility in 1958 and has transported anadromous fish to the upper South Fork Skykomish River for several decades. Continued operation of the Sunset Falls trap and haul facility is necessary to maintain physical and genetic connectivity for bull trout in this portion of Snohomish/Skykomish River. The Tulalip Tribes and the City of Snohomish collaborated to remove the 110-year-old Pilchuck River Diversion Dam in July 2022. This restoration action increased access of 37 miles of stream habitat available to bull trout. The Seattle Public Utilities operates an earthen dam at RM 16 of the South Fork Tolt River. Connectivity between the Troublesome Creek local population and the rest of the Snohomish/Skykomish River is likely limited, but this is due to a natural barrier that maintains the historical condition of this local population.

10.1.4.3 Threats

The USFWS identified three primary threats to bull trout in the Snohomish/Skykomish Rivers Core Area (USFWS p. A-14):

- Instream Impacts:
    - Flood Control–flood and erosion control associated with agricultural practices, residential development and urbanization continues to result in poor structural complexity within lower river FMO habitats key to the persistence of the anadromous life history form.
    - Recreational Mining–activities impact spawning and rearing tributary habitats.
- Water Quality: Residential Development and Urbanization–associated impacts increase seasonal high-water temperature in lower mainstem river, a migration corridor key to the persistence of the anadromous life history form.

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

10.1.4.4 Recent Information

Based on data from the core area populations and threats assessment scoring, the members of the North Puget Sound regional working group rated the Snohomish/Skykomish Rivers Core Area medium (3.0) for the demographic score and high (3.74) for the habitat score (Winkowski 2024 p. all). The North Puget Sound regional working group rated this core area highest on life history diversity (4.0), abundance (4.0), water quality (4.5), instream quality (4.5) and riparian quality (4.5) factors. The North Puget Sound regional working group rated this core area low on growth rate (1). The overall resiliency score for the Snohomish/Skykomish Rivers Core Area was high (3.37) (Winkowski 2024 p. all).

10.2 Factors Responsible for the Condition of the Species

The USFWS identified threats to bull trout in the Nooksack River Core Area in its 2015 Recovery Plan (USFWS 2015a p. A-40 and A-42), which have affected the species through modification of the physical and biological habitat features that are necessary for survival and reproduction. The primary threats to bull trout are the result of: 1) legacy forest management and agricultural practices; and 2) water quality changes exacerbated by climate change. The USFWS also notes that presence of brook trout (*S. fontinalis*), a salmonid species known to compete with bull trout for habitat and food resources, may be a concern due to its wide distribution and overlap with key bull trout local populations in the Nooksack River Core Area. However, they are not considered a primary threat at this time due to uncertainty about their direct interaction(s) with bull trout. Below we discuss other factors that have contributed to the current condition of the species.

Good water quality is an essential component necessary for a healthy aquatic environment in freshwater and marine habitats. Water quality is generally defined by its biological, chemical, and physical features, in addition to prevailing streamflow or marine currents necessary to provide adequate habitat features for bull trout. In the Puget Sound, the climate and weather patterns are strongly influenced by the El Niño–Southern Oscillation and Pacific Decadal Oscillation patterns. These influence marine water circulations patterns and are characterized by sinking (i.e., downwelling) or rising (i.e., upwelling) currents. Prevailing water circulations patterns consist of downwelling flow patterns from fall through spring months, followed by upwelling flow patterns in the summer. Good water quality, and the continued functioning of marine water circulation are essential components that maintain suitable habitat features for bull trout throughout the action area.

Aquatic habitats throughout the action area receive pollutant loads from a few sources, including impervious surfaces, groundwater, and surface runoff. Aquatic animals in Puget Sound are therefore exposed to complex mixtures of thousands of chemicals that may impact their health and survival. Thousands of chemicals, known as contaminants of emerging concern, are unregulated by governments and might harm Puget Sound aquatic species but are less well known. Many of these substances are delivered to freshwater and marine ecosystems through impervious surfaces, such as roadways, roofs, and parking lots. Early surveys for contaminants in the Puget Sound were centered in marine industrial areas that were visibly contaminated with metals, polynuclear aromatic hydrocarbons, polychlorinated biphenyls, chlorinated pesticides, wood preservatives, and other toxic substances used in manufacturing (Mayer and Elkins 1990 pp. 215–219; Long et al. 2013 p. 1701). Marine industrial areas often contained highly contaminated sediments and hosted bottom-dwelling fishes with high incidences of lesions and tumors. Subsequent investigators have detected substances that include thousands of prescription pharmaceuticals, over-the-counter medicines, illicit drugs, nutritional supplements, diagnostic agents, shampoos, soaps, fragrances, and lotions. These substances, commonly referred to as pharmaceuticals and personal care products (PPCPs), are present in minute quantities either within the ranges or less than results reported outside of the action area and lower than those associated with acute toxicity in laboratory tests for individual chemicals (Long et al. 2013 p. 1708).

Changes in local climate and weather patterns during the recent decade have produced notable air and marine water temperature anomalies in the action area. Water temperatures during 2021 were generally above the climatological average, continuing a general pattern of warmer conditions since the 2014-2016 marine heatwave. These conditions may have contributed to substantial changes in marine plant and invertebrate communities; some species experienced more than 90 percent mortality (Hamilton et al. 2021 p. all; PSEMP 2022 p. 49). The 2021 marine heat wave spanned thousands of miles across the West Coast, while the Puget Sound experienced a record-breaking atmospheric heatwave in June 2021 that meteorologists estimated would occur once every thousand years (PSEMP 2022 p. xii). The 2021 heat wave coincided with seasonal low tides and exposed thousands of acres of intertidal marine habitat to extreme air temperatures that resulted in high mortality of intertidal communities (Puget Sound Partnership 2021 pp. 21, 39). Extreme heat during this weather event also caused extensive loss of snowpack, leading to below normal streamflow and drought conditions in late summer (Pelto et al. 2022 pp. 11–14). These weather conditions have yielded changes affecting water quantity and water quality that we will address in greater detail below.

Puget Sound tributaries are fed by rain, snow, glacial meltwater, and groundwater sources that provide suitable habitat features for bull trout. In terms of streamflow, a third of the freshwater supply to the Puget Sound comes from the region’s tributaries, particularly the Skagit, Snohomish, Puyallup, Nooksack, and Stillaguamish Rivers. Streamflow minimums in Puget Sound area tributaries have been declining in most rivers since the 1970s (Pelto et al. 2022 pp. 1–2). The Puget Sound region has experienced changes in climate and precipitation, manifested by alterations in streamflow, particularly in rivers unaltered by dams. The general trend since the 1970s for throughout the Puget Sound, particularly during summer low flow conditions when many species enter rivers in preparation for spawning, is characterized by declining streamflow.

Changes in streamflow in summer months results in a loss of fish habitat and is associated with regional trends of diminishing adult salmon returns. The lack of precipitation is causing a reduction in streamflow throughout the action area, with water use demands from municipal and residential uses increasing. For example, more than 67,000 wells were drilled in the Puget Sound region since 1980. Of these, 5,815 were built between 2015-2019, a 40 percent increase over the number of wells built during the previous five years (2010-2014) (Puget Sound

Partnership 2021 p. 23). The increasing rate of new well installations is likely to disproportionately affect instream flows and overall ecosystem health of freshwater tributaries throughout the region with substantial agricultural development.

Land ownership and land use in freshwater areas is an important factor affecting water quality, quantity, and availability because of the natural functions of the landscape. Differences in land ownership and land use are defining characteristics that affect water quality conditions because of the contribution of chemical contaminants, excess sources of nitrogen, and suspended sediment. The areas typically impacted most by chemical contaminants from non-point-source pollution are urban and residential developments. The lower and middle reaches of the Nooksack and Samish River basins are impacted by excess nitrogen from fertilizers from agricultural lands. Agricultural land use is important insofar as is often associated with increased water use, degraded riparian habitat, and use of animal or chemical amendments (i.e., high nitrogen) that degrade freshwater habitat features. As a result, these rivers typically receive the largest nutrient inputs from animal and agricultural fertilizers. Elevated nutrient concentrations from animal and agricultural fertilizer application can contribute to excessive growth of aquatic plants and reduced levels of dissolved oxygen in Puget Sound waterbodies, which can adversely affect fish (Embrey and Inkpen 1998 p. 9). These authors estimated the amount of nitrogen loading in the in the Samish River Basin at 6 tons of nitrogen per square mile per year from chemical fertilizers and 3 tons per square mile per year of nitrogen from animal fertilizers (Embrey and Inkpen 1998 p. 31). As a result of nutrient loading, numerous water bodies throughout the action area are designated as impaired based on fecal coliform, dissolved oxygen, temperature, pH, and ammonia levels (e.g., 303(d) listing) (Blake and Peterson 2005 p. 11). High nitrate levels in ground and surface water remain a concern for residents and the WDOE throughout the basin due to agricultural land use, permeability of the aquifer, and shallow water table (Blake and Peterson 2005 pp. 78–79). The middle and higher elevation reaches of the Nooksack River basin continue to support forestry land use that contribute excess sediment from timber harvest and road construction activities.

Researchers have documented the effects of nitrogen and chemical fertilizers for decades due to the ubiquitous use of these amendments in agriculture. More recently, researchers have identified numerous chemical contaminants broadly categorized as PPCPs throughout the action area (Mayer and Elkins 1990 pp. 217–220; Carey et al. 2023 pp. 27–36) that may also pose a risk to water quality. These chemicals are typically introduced through municipal wastewater treatment facilities and distributed throughout surface water and groundwater sources as well as the marine environment. Researchers have found presence of PPCPs in marine sediments, wastewater effluent, wells, tributaries, and estuaries within the action area. In combination with microplastics, PPCPs are highest near sewage treatment outfalls, and even though these chemicals persist in small quantities, they may cause disruption of endocrine systems and create physical deformities or decrease reproductive biology of individuals sufficient to alter population dynamics. Therefore, PPCPs are likely an additional stressor that degrades water quality features for bull trout near urban and residential areas.

Additional water quality degradation from agricultural land use has occurred due to the loss of riparian forest and the diking and draining and filling of wetlands. These impacts to the physical structure of streamside habitat have resulted in warmer water and increased phytoplankton growth, causing issues with water chemistry. We address the impacts of land use in the action area and its effect on water quality related to critical habitat features further in Section 10.3.

The health of streams and freshwater quality vary throughout the action area. In general, areas with less residential and urban development and impervious surfaces have better water quality. Benthic macroinvertebrate communities are effective indicators of water quality and habitat because they are sensitive to water quality characteristics. The PSP used an index of biological integrity (IBI) assessment to evaluate the health of freshwater benthic communities that are relevant to bull trout and other salmonids. These features affect habitat elements important to bull trout, such as benthic macroinvertebrates, upon which juvenile bull trout rely to grow and mature. The PSP collected 36 macroinvertebrate samples in the action area from 2018-2022 (https://www.pugetsoundinfo.wa.gov/Indicator/Detail/16/VitalSigns), noting 'excellent' or 'good' IBI conditions in the upper and middle reaches and 'fair' or 'very poor' in the lower reaches of watersheds within the action area.

The PSP also evaluated nine marine water quality indicators specific to Puget Sound. Scientists characterize water quality by the ability to support aquatic life and the presence of harmful substances that are known contaminants (i.e., toxic chemicals), which include heavy metals, flame retardants, petrochemical contaminants, and others. Only one of the nine indicators (marine sediment chemistry index) was considered to have met the improvement target, and only one indicator showed improvement (Puget Sound Partnership 2021 pp. 19–20). The sediment chemistry index indicator is the only indicator that was near its 2020 target. Exposure to toxic chemicals in sediment has generally been minimal throughout the past 20 years and has remained in good condition. Other signals for marine and freshwater water quality did improve in some places or at least stayed the same, namely the Water Quality Index for freshwater areas, the Benthic IBI, and indicators of contaminants in different fish species in different habitats. The PSP reports the level of contaminants in fish living within the Puget Sound is below 2020 targets for four groups of fish: English sole (*Parophyrys vetulus*), adult Chinook salmon, juvenile Chinook salmon, and Pacific herring (Puget Sound Partnership 2021 p. 19). The contaminants in Pacific herring and adult salmon indicators failed to meet their recovery targets because polychlorinated biphenyls exceed their health effect thresholds (Puget Sound Partnership 2021 p. 20). The PSP found all four groups of fish were below recovery targets. Thus, absorption of toxic chemicals into fishes spans large areas and many different habitat types. Ultimately, the health of benthic communities is necessary to support forage fishes and salmonids through intact and functional physical and chemical features. The physical features of CH are degraded in areas with poor circulation and slow water exchange and that are high in organic matter and low in oxygen, while chemical features are degraded by presence of heavy metals, flame retardants, and other petrochemical contaminants (Puget Sound Partnership 2021 p. 11). The Marine Water Condition Index is the only indicator that has steadily declined over the past few decades. Ultimately, good water quality conditions are necessary to support freshwater and marine life that bull trout rely upon throughout their life cycle.

Human development has also impacted physical features within freshwater habitats. The PSP reported that several major rivers within the action have lost over 60 percent of their floodplain function in the last 100 years (Puget Sound Partnership 2023 p. 1). All major river deltas in the Puget Sound have been modified by levee or diking, armoring, or to protect road or rail infrastructure (Hall et al. 2021 pp. 151–200) restricting floodplain habitat and tidal connectivity (Figure 21). Hall et al. (2021 pp. 151–200) noted that the Samish River watershed was among those most impacted, with approximately 80 percent complete restriction of floodplain and tidal connectivity areas. Levee and bank stabilization construction in freshwater has removed large portions of productive floodplain habitat that is important to bull trout as FMO habitat because floodplains provide refuge during high flow events and abundant forage resources. The loss of floodplain connectivity continues to restrict riverine processes that sort large wood and sediments, which increase habitat diversity necessary for bull trout to thrive. In addition, the loss of floodplain connectivity may further increase the intensity of flood events by constraining high flows within a limited portion of the stream channel. Human development has fundamentally changed the way that riverine systems function by channeling streams and reducing floodplain connectivity that has degraded the quality of bull trout habitat features.

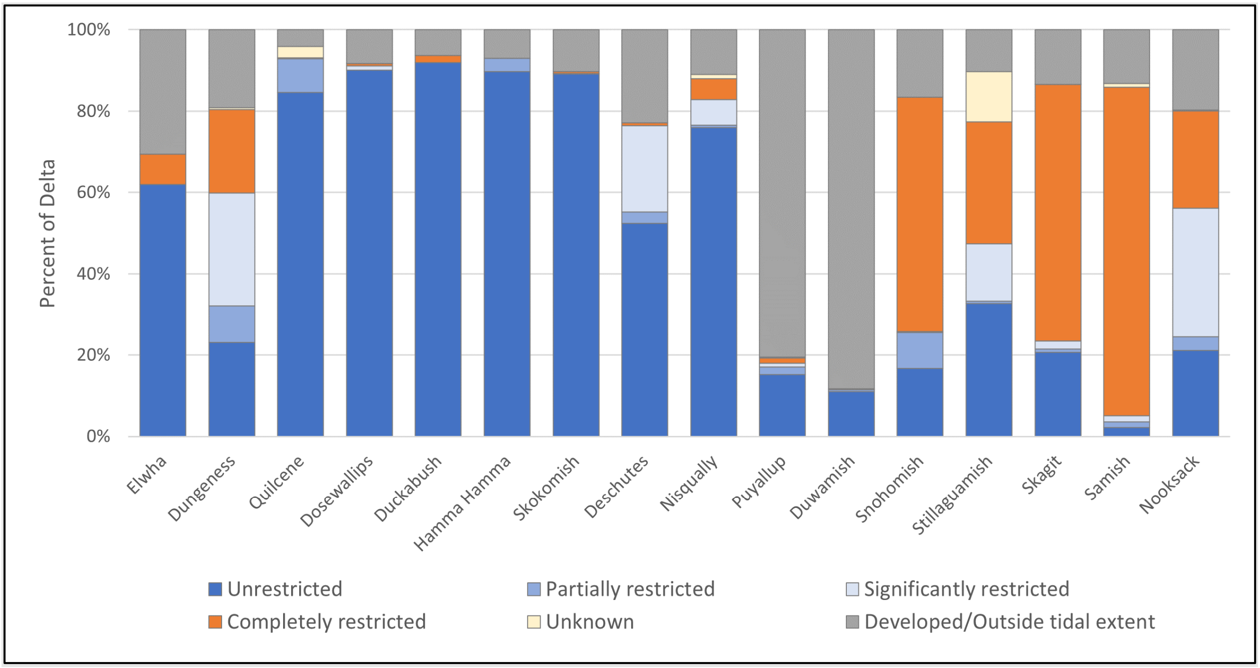

Figure 21. Proportion of restricted freshwater habitat in major rivers of the Puget Sound (Hall et al. 2021 pp. 151–200).

10.3 Current Condition of Habitat for the Bull Trout in the Action Area

The USFWS included approximately 2,737.3 km (1,700.8 miles) of streams; 17,890.5 hectares (44,208.3 acres) of lake surface area; and 911.9 km (566.6 miles) of marine shoreline designated as CH within the Puget Sound CHU (USFWS 2010, pp. 103-109, pp. 191-195). The USFWS further defined 13 CHSUs (i.e., based on bull trout abundance and distribution, connectivity, and general trends) that are essential to the survival, recovery, and conservation of bull trout: Nooksack River, Samish River, and Puget Sound Marine. The USFWS identified the Samish River and Puget Sound Marine CHSUs as areas that support only FMO habitat features.

The three CHSUs encompassing the action area are influenced by: agricultural uses; fisheries; resource extraction of timber and gravel resources; rail and roadway infrastructure; and development for commercial, industrial, and residential purposes. The USFWS identified two primary threats associated with CH in the Nooksack River: 1) legacy forest management and agriculture practices that channelized and degraded lower river FMO habitats; and 2) seasonal high water temperatures in the South Fork Nooksack River likely to be exacerbated by climate change that further degrade migratory habitat and reduce availability of spawning and rearing habitat. The USFWS also identified one primary threat associated with habitat in the Puget Sound Marine FMO habitat: 1) upland and riparian land management that degrades or eliminates nearshore marine and estuarine habitats and processes critical to the persistence of the anadromous life history form and their marine prey base. These factors are primarily the result of previous and ongoing land ownership and associated land management activities (Figure 22). Current and historical agricultural uses are on private land located adjacent to UGAs in the lower Nooksack River, whereas forestry occurs on private and federal lands. Most residential and urban growth is occurring within designated municipalities (e.g., Bellingham, Ferndale, Everson, Lynden).

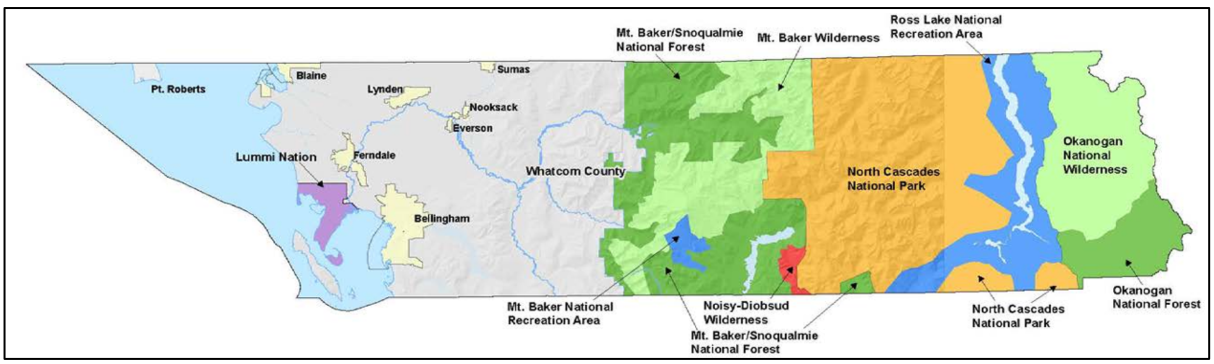

Figure 22. Land ownership in Whatcom County, Washington.

10.3.1 <u>Agriculture</u>

A large proportion of land ownership in the lower elevation areas of Nooksack and Samish River watersheds is devoted to agricultural use. Frequent use of fertilizers and lack of riparian corridor has contributed to water quality degradation in both watersheds. The Nooksack and Samish Rivers were reported to receive the largest nutrient inputs from animal manure and agricultural fertilizers. Elevated nutrient concentrations from animal manures and agricultural fertilizer application can contribute to excessive growth of aquatic plants and reduced levels of dissolved oxygen in Puget Sound waterbodies, which can adversely affect fish (Embrey and Inkpen 1998 p. 9). These authors estimated nitrogen contribution to the Samish River basin at 6 tons per mi^2 per year and 3 tons per mi^2 per year of nitrogen from animal manures (Embrey and Inkpen 1998 p. 31). In addition to excessive nutrient inputs, low elevation areas in the Nooksack and Samish watersheds devoted to agricultural use contain little to no riparian buffer and are heavily impacted through river diking, draining, and filling of wetlands. As a result of alterations to the physical and chemical features and nutrient , numerous water bodies throughout the action area are designated as impaired fecal coliform, dissolved oxygen, temperature, pH, and ammonia (e.g., 303(d) listing) (Blake and Peterson 2005 pp. 67–70). High nitrate levels in ground and surface water remain a concern for residents and the WDOE throughout the basin due to agricultural land use, permeability of the aquifer, and shallow water table (Blake and Peterson 2005 pp. 79–80).

10.3.2 Forestry

Much of the action area in the Nooksack River basin is affected by timber cutting and road construction necessary to facilitate timber removal. Large-scale forestry is not prevalent in other watersheds within the action area because most of the land area was cleared decades ago for residential or urban development, or agricultural uses. Approximately 19,878 acres of the Nooksack River basin lies within the Mt. Baker Wilderness and is not subjected to timber cutting (USDA 2006 p. 40). Most of the lower elevation area within U.S. Forest Service and private ownership is managed for timber production. The Middle Fork Nooksack River flows northwesterly through the southern part of Mount Baker Wilderness, other National Forest Land, and 14,817 acres of non-federal land.

Legacy impacts from road construction associated with recent history of logging remain in the Nooksack River basin. Road densities are generally high, especially in the Hutchinson, Skookum, Edfro, Cavanaugh, Deer, Roaring, Plumbago, and Howard Creek watersheds and along the middle reaches of the South Fork Nooksack River (Washington State Conservation Commission 2002 pp. 13–14). The high level of road construction has created considerable problems with sedimentation and mass wasting in the South Fork Nooksack River. More than 1,200 landslides have been identified with 37 percent associated with clearcuts and 32 percent related to roads. Similar conditions were reported by the Washington State Conservation Commission (2002 p. 14), although with somewhat less frequency (632 landslides; 36 percent originating from clearcut logging). Most landslides reported above occurred within ten years of intense timber harvest in a given area. In general, landslide frequency is highly correlated to forestry activity, both temporally and spatially. The density of landslides in the North Fork Nooksack River are especially high in the Cornell, Racehorse, Gallop, Boulder, and Coal Creek watersheds with generally high road densities in most of the watersheds downstream of Nooksack Falls (RM 65) (Washington State Conservation Commission 2002 pp. 14).

Forestry and road construction throughout the Nooksack River watershed and associated excess sedimentation has also contributed to the transport of large wood and a reduction in pool habitat (Washington State Conservation Commission 2002 pp. 14). Implementation of the Northwest Forest Plan (Dunham et al. 2023 p. 61) and identification of riparian restoration and RMAPs appear to have decreased the rate of fine sediment delivery in the North Cascades region associated with forestry activities (USFWS 2015b, p. A-40), leading to some improvement in bull trout spawning habitat. Dunham et al. (2023 p. 61) note that other long-term processes stream processes that are important components of bull trout habitat, such as large wood recruitment in upper watershed, are unknown. However, short-term improvements on primary threats related sedimentation in bull trout spawning and rearing habitat suggests overall improvement in forest and watershed conditions is occurring at a slow rate (Dunham et al. 2023 p. 89).

10.3.3 Gravel Mining

The Nooksack River was historically mined for river gravel, primarily between RM 14 and 22 (downstream of the town of Lynden to near Everson). Kerr Wood Leidal (2008) reported mean permitted gravel removal of 80,000 tons per year from 1964 to 1987, growing from 1960 to the early 1970s and then declining until the late 1980s. Gravel extraction increased significantly between 1990 and 1993 to an average of about 240,000 tons per year, but then declined and ultimately stopped in 1997. Much of the gravel mining during the previous 60 decades was completed on national forestland to support road construction. In addition, at the time natural resource managers thought that straightening the stream channels and removing large wood would benefit native salmonids.

10.3.4 Commercial, Residential, and Urban Development

The condition of habitat for bull trout in the action area is also affected by human development impervious surfaces consisting of roadways, parking lots, and rooftops from transportation infrastructure and commercial, residential, and urban development. In general, human development in the action area is centered around the cities of Bellingham, Ferndale, Lynden, and Everson. Except for Bellingham, all of these cities are located in the Nooksack watershed (Figure 11). The U.S. Census Bureau reported in 2020 the population growth in Whatcom County and surrounding areas at 1.7 percent annually (U.S. Census Bureau 2020 pp. 1–2). Whatcom County predicted over 40 percent of population growth will occur in the Bellingham UGA (Whatcom County Planning and Development Services 2020 p. 4).

Road and rail infrastructure crosses through lower elevation areas of all watersheds included in the action, with the exception of Orcas Island, which contains only two-lane surface roads. The most prominent among these Interstate 5 and the Burlington-Northern Sante Fe (BNSF) railroad line. Smaller state highways (highway 9, highway 539, and highway 542) connecting the South Fork Nooksack River to the Samish River valley extend east to the forks of the Nooksack River. The highway and rail transportation infrastructure occupies substantial area (300 ft of the corridor) adjacent to streams that is within the riparian buffer. Overall, roadway infrastructure contributes to the largest land area impacted by impervious surface within Whatcom County. The action area also contains small state highways and substantial county road infrastructure with numerous road crossings.

10.3.5 Invasive Species

EGC have been established along the northeast Pacific coast for three decades, and researchers reported the first live EGC in the San Juan Islands and Padilla Bay, Washington in 2016 (Mueller and Jefferson 2019 p. 5). In 2019 the Lummi Indian Tribe reported the first observation of several live EGC in Drayton Harbor, Whatcom County, Washington. The Lummi Tribe subsequently captured over 1,000 EGC in Portage Bay (located between Lummi Island and the city of Bellingham) and Lummi Bay, and included capture of EGC at the Lummi Bay Sea Pond hatchery facility (Mueller and Jefferson 2019 p. 5). As of 2019, the relative abundance of the Lummi Bay population was the second highest reported in the State of Washington (Mueller and Jefferson 2019 p. 32). The Tribe subsequently reported capturing more than 70,000 EGC in 2021 (Washington Sea Grant 2021 pp. 1–5).

10.3.5.1 Completed Habitat Restoration Projects

State, County, and Tribal governments have been active partners in restoration projects within the Nooksack River watershed. Numerous partners have completed several projects that have improved habitat and connectivity to bull trout populations in the Nooksack River watershed. Recently completed restoration projects designed to improve habitat conditions in the action area include:

- Smuggler's Slough Nooksack River Restoration Project – The Lummi Indian Tribe installed a self-regulating tide gate between the Nooksack River Delta and freshwater tidal wetlands associated with the old Smuggler's Slough, enhanced those wetlands, and raised the roadway to improve access during flooding. The project is anticipated to increase delta rearing habitat for salmon, restore delta hydraulics and water quality, and reduce flood hazards. The project reconnected 225.4 acres of freshwater tidal wetlands and beaver marsh, and improved flow along the 6.6-mile Smuggler's Slough.
- Cougar Creek Culvert and Floodgate Replacement – Proponents will modify or replace culverts, floodgates, and levees to restore fish access to 5.1 miles of Cougar Creek.
- Terrell Creek Habitat Restoration – Volunteers helped to restore 11.5 acres of riparian habitat by preparing and planting sites to establish a 100-foot buffer along 2,500 ft of the creek.
- Middle Fork Nooksack River Fish Passage Project – American Rivers and the City of Bellingham removed a diversion dam on the Middle Fork Nooksack River. Completion of the project in 2022 opened more than 20 miles of unobstructed habitat. This restoration project has opened up spawning areas in Clearwater (RM 9.1), Warm (RM 12.9), and Green (RM 15.3) Creeks. By removing the diversion, action proponents alleviated the primary connectivity impairment to bull trout in the action area (USFWS 2015b, p. A-41).
- Deming Floodplain Restoration Project – Whatcom County modified the City of Deming Levee to reduce property damage and restore a portion of the floodplain, including off channel wetlands associated with Marshall Hill Creek.
- Saxon Reach Engineered Log Jam (ELJ) Project – The Lummi Indian Nation installed ELJs on the Saxon Reach of the South Fork Nooksack River. The Tribe completed this action to improve connectivity to cool subsurface water flows and enhance 3.5 acres of rearing and refugia stream habitat to benefit salmonids.
- Landingstrip Creek Tributary Salmonid Habitat Improvement – The Nooksack Salmon Enhancement Association and the Whatcom Land Trust restored a 1,800-foot floodplain channel on the west bank of the South Fork Nooksack River. Contractors redirected the stream out of a ditch along a railroad right-of-way.
- Larson’s Reach Instream Restoration – The Lummi Indian Nation installed a series of ELJs in the South Fork Nooksack River to reconnect the river to its floodplain and restore complex pool habitat.

10.3.6 Factors Responsible for the Condition of the Critical Habitat

Designated CH 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 action area. 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 Samish River and lower reaches of the Nooksack River are channelized and have extensive bank armoring and levees, which reduces hyporheic connectivity and groundwater inflow. Portions of the South Fork Nooksack River have incised into the river bed and become entrenched within a set channel that is now isolated from its historic floodplain (Nooksack Indian Tribe 2017 pp. 41, 43). This appears to contribute to degraded hyporheic connectivity within the South Fork Nooksack River. Overall, this PCE is functioning throughout the action area.

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.

There are no barriers limiting access to spawning and rearing habitat or FMO habitat. Although biologists suspect that seasonally high temperatures that exceed 22 °C in the South Fork Nooksack River may limit connectivity during the summer months (Nooksack Indian Tribe 2017 p. 62). Except for the lower reaches of the South Fork Nooksack River during the summer months, this PCE is functioning adequately in all portions of the action area.

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

All three major watersheds in the action area (i.e., Nooksack, Whatcom, and Samish) support spawning populations of salmon. Thus, each watershed supports a seasonally augmented prey resource base from hatchery releases of juvenile salmon. The lack of riparian forest, channelized and armored streambank structure, and lack of large wood pieces in the Samish River and the lower reaches of the Nooksack River limit the productivity and availability of benthic macroinvertebrates that are important to juvenile bull trout. In comparison, these features are substantially better in the upper reaches of the Nooksack River, where rearing habitat for young bull trout occurs. The marine portions of the action area support abundant populations of forage fishes. The three most common marine forage fish species to bull trout are Pacific herring (*Clupea pallasii*), surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*). These species and their spawning habitats all commonly occur throughout the action area in the intertidal zone, and all three species use adjacent nearshore habitats as nursery grounds. The marine shoreline near Lummi Bay Sea Ponds is surrounded by the Cherry Point spawning population of Pacific herring, one the largest in the Puget Sound (Sandell et al. 2016 p. 66). Both surf smelt and Pacific sand lance are abundant with marine portions of the action area and contribute important forage resources to anadromous bull trout. This PCE is functioning adequately throughout the action area, except for highly modified areas in the Samish River and lower reaches of the Nooksack River. Hatchery production of juvenile salmon is an important component to maintaining seasonal productivity 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 large wood, side channels, pools, undercut banks, and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

Legacy forest management and agricultural practices have cause channelization and habitat degradation throughout the Nooksack and Samish River basins resulting in a loss of large wood and complex habitat features (large, deep pools, multi-thread channel structure, and undercut banks) (Nooksack Indian Tribe 2017 p. 78). Ongoing presence of dikes and riprap prevent accumulation of large wood pieces and hinder development of complex habitat features noted above in all 3 watersheds in the action area. Both banks of Whatcom Creek is surrounded by urban development. The adjacent riparian forest provides minimal large wood pieces to the floodplain and does not recruitment large wood pieces from Lake Whatcom. Therefore, habitat features in Whatcom Creek is simplified and function degraded. Overall, this PCE is substantially degraded throughout the action area due to legacy agricultural and forestry management practices, yet, is slowly improving due to completion of recent restoration projects as described above in Section 10.3.1.6.

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.

The hydrological and temperature regimes in the action area 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) in the upper portion of the Nooksack River during the summer months. Warm water temperatures are a critical problem in the South Fork Nooksack sub-basin because this sub-basin does not receive glacial meltwater. The South Fork Nooksack River experiences high temperatures during the summer months that exceed 22 °C, which is thought to be a limiting habitat factor to salmonids (Nooksack Indian Tribe 2017 p. 62). Many of the tributaries in the Nooksack River experiencing elevated water temperatures are also characterized by impaired riparian function, sedimentation issues, and/or impaired flow conditions. Neither Whatcom Creek, nor the Samish River currently present temperature exceedances (Beamer et al. 2000 p. 48). Within the action area, 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-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 amount of fine sediment suitable to bull trout will likely vary from system to system.

This PCE is only present in the Lower Middle Fork Nooksack River, Upper Middle Fork Nooksack River, Lower North Fork Nooksack River, Middle North Fork Nooksack River, Upper North Fork Nooksack River, Lower South Fork Nooksack River, Upper South Fork Nooksack River. Three tributaries also support suitable features for spawning and rearing habitat: Lower Canyon Creek, Glacier Creek, and Wanlick Creek. Sediment transport may be affected in the upper watersheds due alterations in flow resulting from climate change. Most suitable spawning and rearing habitat for bull trout is in higher elevation areas. Much of this habitat is contained within U.S. Forest Service land, or overlapping, wilderness and recreation areas and/or protected areas. Overall, this PCE is functioning adequately and continues to support abundant spawning and rearing for bull trout in the Nooksack River watershed.

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 hydrograph of the Nooksack River and Samish River watersheds are maintained with natural flow provided by seasonal changes in precipitation and snowmelt. Whatcom Creek is located at the outfall of Lake Whatcom, a natural lake with a small dam constructed at the outlet. The City of Bellingham to controls water flow to Whatcom Creek flow control to limit seasonal high flows during winter because Lake Whatcom is the City's domestic water source. Channel confinement, bank armoring, 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 bank armoring have resulted in the reduction, isolation, and general degradation of floodplain processes throughout the action area, but primarily in the Nooksack and Samish River watershed. In the action area, this PCE is impaired and functioning at reduced capacity.

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

As described in Section 10.3.2 water quality and quantity are generally sufficient throughout the action area to support normal reproduction, growth, and survival. Most tributaries in the action area that support spawning and rearing habitat currently meet Washington's surface water quality temperature criteria for the protection of salmonid spawning and incubation. Biologists have identified early summer warm water conditions in the South Fork Nooksack River as potential seasonal barriers to movement of salmonids. However, non-point source releases of chemical contaminants and petrochemicals within and near urban centers that are impacted by high road densities, poor riparian conditions, bank armoring, and floodplain development. The lower reaches of the Nooksack River and Samish River experience poor water quality due to excessive nutrient loading from agricultural runoff that reduces quality of FMO habitat. The upper reaches of the Nooksack River watershed are good, except for the South Fork Nooksack River, as previously noted. Overall, water quality and quantity are satisfactory and function adequately throughout the action area.

PCE 9: Sufficiently low levels of occurrence of nonnative predatory fish species (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 Nooksack River basin is the only known watershed within the action area that supports non-native fish species that are a risk to bull trout. Brook trout are present throughout the lower Nooksack River, the North Fork Nooksack River, and one tributary of the South Fork Nooksack River (Kopp 2022 p. 15). There are no reports indicating the number of this species is more than a sufficiently low level. 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.

10.4 Conservation Role of the Action Area

The action area encompasses the Nooksack River Core Area, which includes freshwater, estuary, and marine habitats. The Nooksack River watershed is the only portion of the action area that contains both FMO and spawning and rearing habitat: all the essential habitat features necessary for bull trout to complete their life cycle. This distinguishes the Nooksack River basin from other portions of the action area that contain FMO habitat features. Lower reaches of the Nooksack River provide: 1) a migratory corridor for bull trout moving between areas for spawning located in the upper reaches, 2) abundant and diverse forage resources in estuary and nearshore marine areas of the Nooksack, and 3) access to estuaries, marine nearshore areas, and neighboring watersheds (Skagit, Snohomish/Skykomish, and Stillaguamish watersheds). There are numerous small tributaries that support spawning and rearing of bull trout in the upstream reaches of the Middle, North, and South Forks of the Nooksack River (USFWS 2010 pp. 93–110). The action area also provides overwintering habitats in freshwater and marine areas that are important to adult and subadult bull trout.

Habitat features in the lower portions of the Nooksack River are moderately impaired by degraded water quality from agricultural, residential, and urban development and reduced floodplain connectivity. However, connectivity is sufficient and has recently improved due to removal of the Bellingham Water Diversion structure. Habitat features in the upper reaches of the Nooksack River are largely intact, but with reduced functionality as the result of sedimentation from upland forest management. High water temperatures in the South Fork Nooksack River remain the primary impediment to connectivity for bull trout within the watershed.

Small coastal tributaries such as the Samish River and Whatcom Creek do not support natal populations of bull trout but do provide important FMO habitat that is essential to anadromous bull trout and the viability of bull trout within the Puget Sound CHU. The Samish River does not provide habitat features necessary for spawning and rearing of bull trout. Whatcom Creek provides about one mile of relatively low-quality freshwater foraging and/or refugia habitat. This tributary does not support habitat for bull trout to spawn or rear young and is not designated as CH for the bull trout. The USFWS considers Whatcom Creek to provide limited incidental use to bull trout from the Nooksack River Core Area and the Lower Skagit River Core Area (USFWS 2004 p. 267). Given the proximity of Whatcom Creek to the Nooksack River estuary, it is most likely that bull trout from the Nooksack River Core Area population use this small tributary as FMO habitat. However, it is also likely that anadromous individuals from the Lower Skagit River, Snohomish/Skykomish, and Stillaguamish Core Areas may use the action area over the course of the proposed action.

The Samish River and Whatcom Creek watersheds provide seasonally important low elevation habitats for bull trout FMO purposes, particularly from the fall through spring months when water temperature and water quality conditions are favorable for bull trout. Habitat conditions within these tributaries are similar to those in low elevation areas of the Nooksack watershed and are characterized by moderate impairment and/or degradation as the result of sedimentation, temperature exceedances, low dissolved oxygen, and high levels of nutrients, as discussed in Section 10.

In general, the impairments described above are caused by agricultural, residential, and urban development, reduced floodplain connectivity, modification of tributary and marine nearshore areas, and sedimentation problems. In most cases, PCEs throughout the action area are functioning in the capacity needed to provide the conservation role for bull trout. Connectivity between spawning and rearing habitat and FMO habitat is intact, ensuring that the risk to anadromous and fluvial life history forms of bull trout is minimal. In core areas in which multiple bull trout local populations exist, maintaining connectivity (i.e., foraging, overwintering, rearing, and genetic exchange) among local populations through movement of anadromous individuals is critical in sustaining genetic diversity and recolonizing local populations that have become extirpated.

10.5 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 2014 pp. 119–120). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014 p. 119). Various types of changes in climate can have direct or indirect effects on species and CHs. 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 2014, pp. 64, 67-69, 94, 299). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change and its effects on species and their CHs. We focus in particular on how climate change affects the capability of species to successfully complete their life cycles, and the capability of CHs to support that outcome.

Recent analysis suggests that, like the adjacent Skagit watershed (Hamlet 2011; Lee and Hamlet 2011), the Nooksack watershed is highly vulnerable to climate change due to projected changes in streamflow from decreasing snowpack and increased winter precipitation. The USGS reported changes in streamflow and precipitation in the Nooksack River basin from 1981 to 2013. These authors noted monthly precipitation decreases at all four weather gauges in the Nooksack River basin in February and July and increased in the North Fork, Middle Fork, and South Fork basins in March (Anderson et al. 2019 pp. 32–34). These increases in streamflow represent a reduction in annual precipitation of about 2 inches per decade. Anderson et al. (2019 pp. 32–34) also found the number of days with less than 0.1 inches per day of precipitation increased from 1981 to 2013 at all four locations in March, representing a trend of increased rainfall in the late winter, but less rainfall over the year. These changes are consistent with predictions by meteorologists, who suggest that climate change will cause warmer temperatures and less precipitation during the spring and summer months.

Anticipated changes in vegetation occurring in the Mt. Baker-Snoqualmie National Forest (MB-SNF) and coastal lowland areas of the action area projected via www.climatedashboard.org suggest substantial changes in low-elevation coastal areas from coniferous forest to mixed forest (Figure 23). In comparison, the MB-SNF is likely to experience an increase in coniferous forest, likely as result of ice and snow cover recession in high elevation areas. The extent to which modification in forest cover directly affects bull trout is uncertain; these changes are more likely to reduce the functionality of CH features and stream function necessary to support bull trout. Researchers predicted that changes in air temperature will result in a loss of large habitat patches, rather than broad-scale reduction of thermally suitable area (Rieman et al. 2007 pp. 1558–1560). As a result, local populations of bull trout are likely to become more fragmented as the effects of climate change become more pronounced.

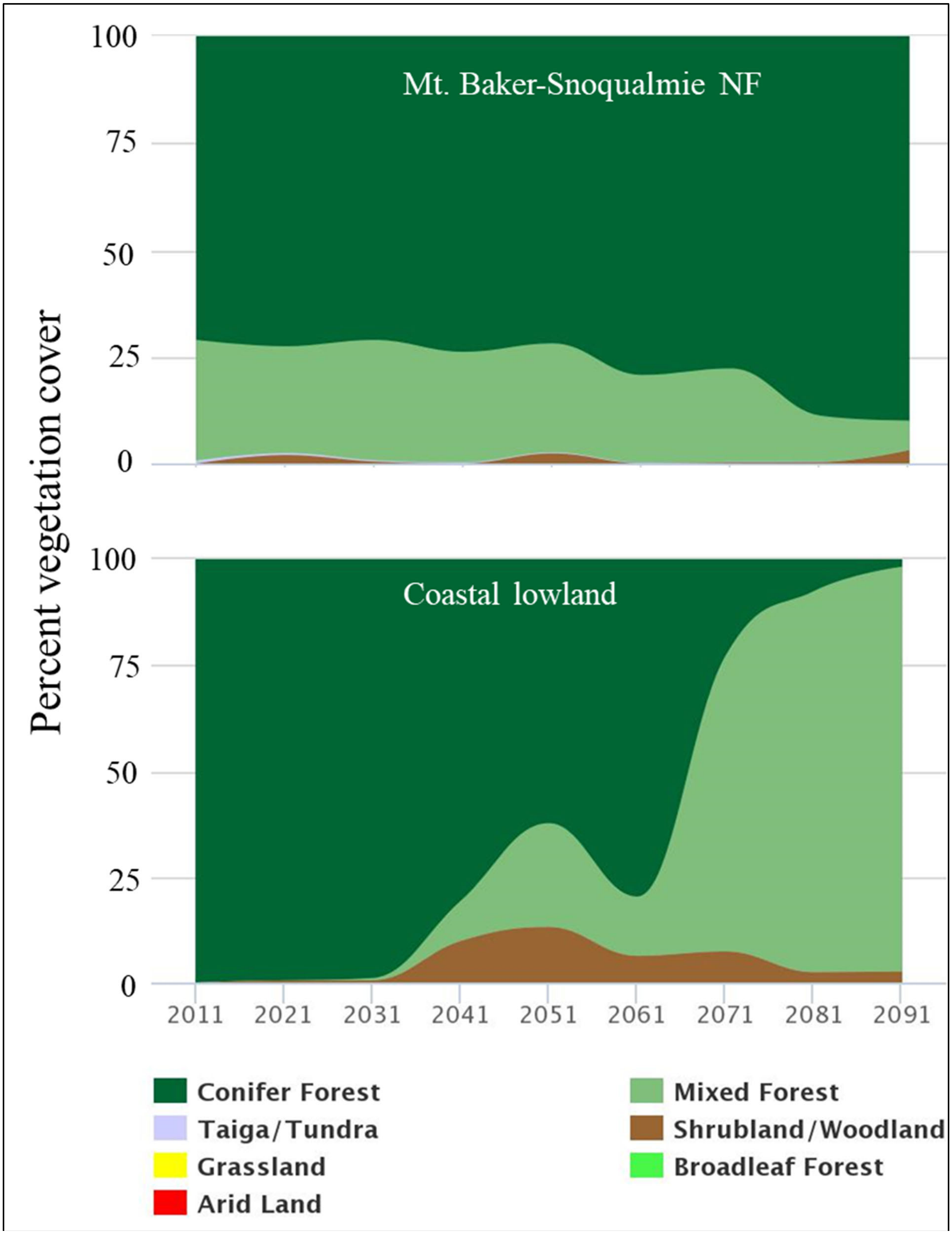

Figure 23. Predicted changes in vegetation cover in the MB-SNF and Coastal-Puget Lowlands resulting from climate change.

Climate change is likely to decrease the capacity of the action area to support spawning and rearing in the upper portions of the Nooksack River watershed. The effects of climate change will likely be disproportionately greater in the South Fork Nooksack River watershed. Reaches of the South Fork already experience seasonal high temperatures that exceed thermal tolerances for bull trout, which will likely be exacerbated by climate change. Because this portion of the South Fork Nooksack River does not contain glaciers, and has diminishing snowpack, this watershed will likely experience reductions in the quantity of spawning and rearing habitat for bull trout. We also expect these conditions may reduce connectivity to spawning and rearing habitats in the upper South Fork Nooksack River during the late spring through early fall. It is difficult to predict changes in the quantity and quality of spawning and rearing habitat in the Middle and North Forks of the Nooksack River over the course of the next 20 to 30 years. However, glacial meltwater in the Middle and North Forks of the Nooksack River will mitigate impacts of increased water temperature to some extent, maintaining connectivity to spawning and rearing habitat in the upper portions of these basins.

Bull trout are especially vulnerable to climate change because of their preference for cold water, complex habitats, and connected migration corridors. While many regions inhabited by the species are at increasing risk of habitat loss as the result of wildfires particularly in areas east of the Cascade Mountains (Eby et al. 2014 pp. 4–6; Falke et al. 2015 pp. 312–315), climate conditions in the Puget Sound region will likely be characterized by warmer and drier springs and summers that increase susceptibility to fire damage. These conditions will also further degrade habitat features in FMO habitat, particularly within smaller freshwater tributaries such as the Samish River, Whatcom Creek, and others in the action area flowing directly into the Puget Sound that are dependent on rainfall to supplement baseflow.

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

The effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

11.1 Effects on Bull Trout

11.1.1 Insignificant and Discountable Effects

Insignificant and discountable effects on bull trout resulting from the proposed action include: 1) migration delay; 2) impingement and entrainment at all facilities besides the Skookum Creek Hatchery; 3) water quantity/water withdrawals; 4) effluent discharge; 5) sediment and debris release; 6) herbicide use; 7) ecological interactions with hatchery-origin fish, including competition and predation; 8) underwater noise; 9) outdoor artificial lighting; and, 10) broodstock collection at the Glenwood Creek Hatchery.

11.1.1.1 Migration Delay

The USFWS expects that bull trout will experience a temporary migration delay of 12 hours and/or up to several days due to the use of mainstem weirs and holding ponds at specific hatchery facilities. The Kendall Creek Hatchery uses a permanent weir spanning the creek to direct all returning fish through a ladder and into the hatchery holding ponds, where they are sorted and non-target fish are released back to the river (WDFW et al. 2021, p. 13). Chinook salmon broodstock are collected the last week of May through September (WDFW et al. 2021, p. 12), and coho salmon are trapped at the hatchery from mid-October through the end of January (WDFW et al. 2021, p. 13). Kendall Creek Hatchery has had very few instances of bull trout retention in the holding pond (Co-managers, in litt., June 14, 2023). At the Skookum Creek Hatchery, fish voluntarily enter the hatchery outflow channel from the river and ascend a short fish ladder to enter the brood pond (WDFW et al. 2021, p. 12). Coho salmon are typically collected from October through November at this hatchery (WDFW et al. 2021, p. 12), and Chinook are typically collected from July 1 through October 10. There is no documented or known bull trout recruitment into the brood pond at the Skookum Creek Hatchery facility (Co-managers, in litt., June 14, 2023). The Samish River Hatchery, which is not located in a watershed with bull trout spawning habitat, operates a collapsible weir that directs fish into a ladder and holding pond, and broodstock are typically collected from September to late October (WDFW et al. 2021, p. 12). The weir has a fish ladder built into it, and a bypass tube allows for non-target fish to be passed upstream (Co-managers, in litt., June 14, 2023). The weir provides for bypass passage when not in use (Co-managers, in litt., June 14, 2023). At the Glenwood Springs Hatchery, all fish voluntarily enter a fish ladder and holding pond where broodstock are sorted and held until spawning, typically from early August to late October (WDFW et al. 2021, p. 12). At the Whatcom Creek Hatchery, fish volitionally enter the holding pond through a fish ladder, and there is no weir blocking the river or forcing fish to the trap (WDFW et al. 2021, p. 13). The ladder/trap typically operates from August 1 through December 15 (WDFW et al. 2021, p. 13).

While hatchery managers commonly use trapping infrastructure to obtain adult broodstock, a few studies have focused on how these structures affect non-target species (USFWS 2022, p. 54). The existing studies (Clements et al. 2002, all; Murauskas et al. 2014, all; USFWS 2022, p. 54) indicate that trapping infrastructure (e.g., adult trap), which blocks fish passage, can significantly affect bycatch such as bull trout via migration/passage delays, holding and avoidance, and severe and prolonged stress (USFWS 2022, p. 54). Prolonged captivity in trapping infrastructure may delay upstream migration of adult bull trout and require bull trout to spawn in suboptimal locations and/or habitats, which may reduce overall spawning success and loss of spawning opportunities (USFWS 2022, p. 54). Some bull trout 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, resulting in a migration delay migration of 12 hours to several days (WDFW et al. 2021, p. 40; USFWS 2022, p. 54). Fish that have undergone handling have been shown to move back downstream after release, delaying migration for up to five days (WDFW et al. 2021, p. 40; USFWS 2022, p. 54). Hatchery staff will remove broodstock from the pond once every four days (Co-managers, in litt., June 14, 2023). Therefore, any bull trout inadvertently captured in the adult trap at Kendall Creek Hatchery may be retained in the holding pond for up to four days until the subsequent trap assessment is conducted (Co-managers, in litt., June 14, 2023). Captured bull trout may also potentially experience an additional five days of migration delay if they move downstream upon release back into the river (WDFW et al. 2021, p. 40). Because upstream migration to spawning grounds occurs over a window of multiple months, the USFWS does not expect that delay of up to nine days will prevent bull trout from completing their migration to spawning grounds within the required biological timeframe.

Holding bull trout within hatchery ponds may expose them to stressful conditions for the four days of confinement. If bull trout experience severely stressful conditions during the four days in the holding/brood pond, they may become physiologically weakened to an extent that they cannot successfully reach their upstream spawning grounds upon release. Potential stressful conditions in the holding ponds include decreased water quality and fighting among the confined salmonids. Considering the severity and likelihood of these potential stressors, the USFWS does not anticipate that bull trout will experience stressful conditions in the ponds severe enough to inhibit their ability to successfully migrate upon release. During the summer months, minor warming may occur in the ponds (WDFW et al. 2021, p. 39), and thus bull trout captured in the ponds may be exposed to sub-optimal water temperatures for up to four days. However, water temperatures at the hatcheries must be maintained at temperatures cold enough to support the target salmonid species (WDFW et al. 2021, p. 39), and thus water temperatures at the hatcheries do not generally rise to levels that could be detrimental to salmonids. Additionally, some salmonids that are ready to spawn and are confined in a holding pond may fight for dominance as the density of confined fish increases, thus adding to the potential for stress and injury experienced by bull trout (USFWS 2022, p. 54). However, the USFWS expects that the frequency at which hatchery managers propose to check the holding pond will limit the density of salmonids captured in the pond, and thus minimize the risk of salmonid fighting to a degree considered discountable. In consideration of these factors, the USFWS does not expect bull trout trapped in holding/brood ponds for four days to experience sufficiently stressful conditions for a long enough period to impact their ability to successfully migrate upon release.

Additionally, hatchery staff will operate a rotary screw smolt trap in the South Fork Nooksack River from March 1 through June 30. Since there is bull trout spawning and rearing habitat in the South Fork Nooksack River, juvenile, subadult, or adult bull trout may be captured in the smolt trap. We expect that juveniles and subadults are more likely to be captured since adults are stronger swimmers and thus better able to escape the flows directing them into the trap. The South Fork smolt trap may be fished for up to 22 hours maximum at a time (Co-managers, in litt., December 1, 2023), and thus bull trout caught in the smolt trap will face a migration delay of up to 22 hours. Because migration to spawning grounds occurs over a period of months, the USFWS does not expect that a 22-hour delay will measurably alter the migration and spawning behavior of bull trout. However, if a smolt trap is not checked frequently enough, the trap will become densely packed with fish, exposing captured individuals to stressful and potentially injurious conditions if trapped fish become territorial and attack other fish in the trap. Prolonged exposure to these conditions in the smolt trap has the potential to stress or injure bull trout to an extent that they are unable to successfully migrate upon release. However, the USFWS expects that the frequency in which hatchery managers propose to check the smolt trap (e.g., once every 22 hours, at most) will prevent this effect from occurring, and thus the smolt trap is not expected to delay or prevent bull trout migration to a measurably adverse extent.

In consideration of these factors, the USFWS expects that migration delays from both holding/brood ponds and the South Fork Nooksack smolt trap will not measurably impact bull trout or their ability to successfully migrate. Therefore, the USFWS considers the effect of trapping infrastructure on bull trout to be insignificant.

11.1.1.2 Impingement and Entrainment (Excluding Skookum Creek Hatchery)

Water withdrawals and weir operation at hatchery facilities are known to entrain or impinge non-target fish such as bull trout. 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 (USFWS 2022, p. 41). 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 (USFWS 2022, p. 41). Both entrainment and impingement can lead to injury and/or mortality of bull trout (USFWS 2022, p. 41). Small subadult and juvenile bull trout are most likely to experience entrainment or impingement due to their small size (USFWS 2022, p. 42). Adult and larger subadult bull trout are less likely to experience entrainment and impingement because these individuals are typically large and strong swimmers capable of avoiding intakes entirely and/or escaping high velocity flows that could otherwise impinge them against screens or entrain them over weirs (USFWS 2022, p. 42).

Fish rearing at the McKinnon Pond, Kendall Creek, Skookum Creek, Samish River, Lummi Bay, Whatcom Creek, and Glenwood Springs facilities require water withdrawals from surface and/or groundwater sources. Surface water intakes can be a source of entrainment and/or impingement of bull trout if they are unscreened, poorly designed, and/or poorly placed (USFWS 2022, p. 41). Hatchery managers often use surface water intake screens to prevent fish from entering hatchery facilities through water intakes. Intake screens are designed to minimize risk of juvenile fish injury and mortality through entrainment and impingement, and they are generally required for surface water intakes where fish are present.

The McKinnon Pond facility is located on the Middle Fork Nooksack River near several streams identified as potential spawning and rearing habitat, including Peat Bog Creek, Porter Creek, unnamed tributaries, and Canyon Lake Creek (Figure 24; WDFW et al. 2021, p. 47, NWIFC 2023).

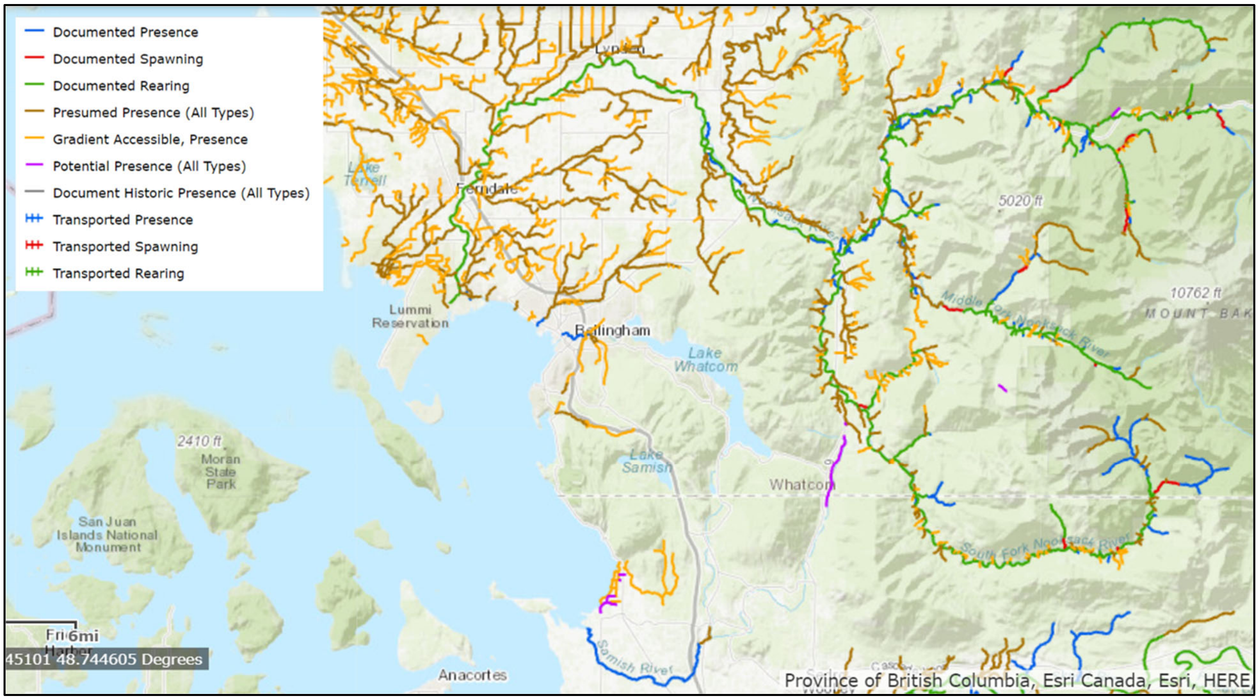

Figure 24. Map of bull trout/Dolly Varden/native char habitat usage in the action area. (NWIFC 2023)

Therefore, juvenile bull trout may be in the vicinity of the intake structures at this facility. However, the intake screens at the McKinnon Pond facility are compliant with NMFS' Anadromous Salmonid Passage Facility Design Criteria (NMFS 2022), which are designed to prevent salmonid entrapment from in-stream infrastructure. The USFWS therefore considers the risk of entrainment or impingement at the McKinnon Pond intake structures to be discountable due to their compliance with these Federal criteria.

Co-managers will construct one to two new modular acclimation/release ponds for off-station Chinook salmon releases near one to two of the following potential locations: 1) Glacier Creek; 2) Nooksack Falls; 3) Maple Creek; and, 4) Deadhorse Creek (Randy Mason, WDFW, personal communication, December 7, 2023. The acclimation pond will include intake structures for withdrawing water from the adjacent river or stream. There is bull trout spawning and/or rearing habitat relatively nearby these sites, so the USFWS expects that small subadult and juvenile bull trout will be in the vicinity of the new acclimation pond(s). However, we do not expect that small subadult and juvenile bull trout will become impinged or entrained at the acclimation pond intake structures. All intake structures will be properly screened following current guidelines for size, shape, and porosity to limit the risk of impingement and entrainment (Randy Mason, in litt., December 13, 2023). Intake screens will be compliant with NMFS' Anadromous Salmonid Passage Facility Design Criteria (NMFS 2022, all). Due to the compliance with Federal criteria, the USFWS therefore considers the risk of entrainment or impingement at the proposed new acclimation pond(s) to be discountable.

Other than the brood pond intake structures at the Samish River Hatchery, all other intakes at the Samish River Hatchery (i.e., aged surface water intake infrastructure on Friday Creek), the

Whatcom Creek Hatchery, the Glenwood Springs Hatchery, and the Lummi Bay Hatchery are not in compliance with the most recent Anadromous Salmonid Passage Facility Design Criteria (NMFS 2022). The surface water intake guidelines to prevent entrainment and impingement of juvenile salmonids are the same across the 2011 and 2022 versions of NMFS' Anadromous Salmonid Passage Facility Design Criteria (NMFS 2011, all; NMFS 2022, all). The four hatcheries that are out of compliance with these criteria are not in watersheds containing spawning and rearing habitat for bull trout (WDFW et al. 2021, p. 47). Bull trout in close proximity to these hatcheries are likely to be larger subadult and adult bull trout using the area for FMO purposes. As a result, it is unlikely that a juvenile bull trout small enough to become entrained or impinged will be near the intake structures at these hatcheries. Therefore, the USFWS considers the risk of entrainment or impingement to be discountable for the Samish River, Whatcom Creek, Glenwood Springs, and Lummi Bay hatcheries.

Additionally, intake screens at the Kendall Creek Hatchery are currently not compliant with Anadromous Salmonid Passage Facility Design Criteria (NMFS 2022) due to potential for fish to be entrained for long periods of time (Co-managers, in litt., June 14, 2023). The Kendall Creek Hatchery is located at RM 46 on the North Fork Nooksack River. There is documented bull trout rearing habitat in the immediate vicinity of the hatchery, as well as upstream and downstream from the hatchery (Figure 24; NWIFC 2023; WDFW et al. 2021, p. 47). There is also documented spawning in tributaries upstream of the hatchery (i.e., Boulder Creek, Canyon Creek, Hedrick Creek, Little Creek, Thompson Creek, etc.) (Figure 24; NWIFC 2023; WDFW et al. 2021, p. 47). The closest upstream spawning area is Boulder Creek, which drains into the North Fork Nooksack River at approximately RM 52 (WDOE 2023), about five RMs upstream of the Kendall Creek Hatchery. Due to the vicinity of both rearing and spawning habitat to the hatchery, the USFWS expects that juvenile bull trout will be in the vicinity of the hatchery. However, we anticipate that juvenile bull trout will not be able to access the stream reach in the immediate vicinity of the intake structures. Intake structures are located in Kendall Creek above the WDFW hatchery weir, which is intended to be a barrier to upstream passage (WDFW et al. 2021, p. 33). Since bull trout are unable to pass upstream of the weir near the mouth of Kendall Creek into the stream reach where the intake structures are located, the USFWS considers the risk of impingement and entrainment at the Kendall Creek Hatchery to be discountable.

In addition to intake structures, the presence and operation of weirs can also be a source of entrainment to bull trout, particularly during high flow events. High flows may wash bull trout over weirs, trapping them in potentially unsuitable habitat. At the Kendall Creek Hatchery, a permanent weir near the mouth of Kendall Creek directs fish into a ladder and subsequent concrete holding pond (WDFW et al. 2021, p. 12). Hatchery staff will release any bull trout encountered traveling up Kendall Creek back into the North Fork Nooksack River (see Section 11.1.2.1). Kendall Creek is not known as a suitable system for bull trout (Co-managers, in litt., June 14, 2023), and no bull trout have ever been observed above the weir in Kendall Creek (WDFW et al. 2021, p. 19). As a result, we do not anticipate that there will be any bull trout above the weir that could become entrained below the weir. Therefore, the USFWS considers the risk of entrainment due to the permanent weir at the Kendall Creek Hatchery to be discountable.

At the Samish Hatchery, a collapsible weir directs fish into a ladder and subsequent holding pond where broodstock are sorted and held until spawning (WDFW et al. 2021, p. 12). The weir has a ladder built into it, and thus does not pose an entrainment risk to bull trout (Co-managers, in litt., June 14, 2023). A bypass tube allows for non-target fish to be passed upstream, and the weir provides for bypass passage when not in use (Co-managers, in litt., June 14, 2023). Therefore, the risk of entrainment in the collapsible weir at the Samish River Hatchery is considered discountable.

At the Skookum Creek Hatchery, temporary weirs will be used for emergency broodstock collection and checked daily. The co-managers may use weirs to collect adult coho salmon in South Fork tributaries but will not locate these structures in areas where bull trout are expected to occur (WDFW et al. 2021, p. 13). Additionally, temporary weirs will be dismantled or left open when not in use (WDFW et al. 2021, p. 48), further precluding the risk of impingement or entrainment. Therefore, the risk of entrainment or impingement in temporary weirs at the Skookum Creek Hatchery is considered discountable. Impingement and entrainment risk at the Skookum Creek Hatchery water intakes is addressed below in Section 11.1.2.3, as the USFWS anticipates adverse effects from impingement and entrainment at that hatchery.

11.1.1.3 Water Quantity (Water Withdrawals)

Fish rearing at the hatchery facilities requires water withdrawals from surface and/or groundwater sources. The Kendall Creek Hatchery withdraws 22.36 cfs from Kendall Creek (typically October through April) and 35.5 cfs from five groundwater wells (WDFW et al. 2021, p. 15). The Samish Hatchery withdraws 25 cfs from the Samish River (September through October) and 23.13 cfs from Friday Creek (late November through May) (WDFW et al. 2021pp. 15-16). The Skookum Creek Hatchery withdraws up to 40 cfs from Skookum Creek and additional groundwater from wells (WDFW et al. 2021, p. 15). The Lummi Bay Hatchery withdraws 2.3 cfs of fresh water directly from the Nooksack River below the Marine Drive Bridge (WDFW et al. 2021, p. 15). The Lummi Bay Hatchery also withdraws 5.5 cfs of salt water from Lummi Bay and 0.2 cfs of groundwater from a groundwater well (WDFW et al. 2021, p. 15). The Whatcom Creek Hatchery withdraws 5.8 cfs from Whatcom Creek, the McKinnon Pond facility withdraws 2.23 cfs from Peat Bog Creek, and the Glenwood Springs Hatchery withdraws 0.95 cfs from an unnamed stream (WDFW et al. 2021, p. 15-16).

Withdrawing water from streams and rivers for hatchery operations may reduce water quantity in bull trout habitat, which results in secondary effects on water quality by concentrating contaminants and increasing water temperatures. Since bull trout require clean, clear, and cool water, exposure to reduced water quantity and related degradation in water quality causes bull trout to experience a stress response, and raised hormones from stress can lead to decreased feeding, growth, and competitive ability (Gregory and Wood 1998, p. 286; WDFW et al. 2021, p. 40).

Additionally, lowered water quantity can dewater stream sections and decrease available FMO, spawning, and rearing habitat for bull trout, potentially leading to reduced growth, survival, and reproduction.

However, hatchery facilities will return almost all withdrawn water (excluding a minimal amount of evaporated water) back to the stream near the points of withdrawal, resulting in no net loss in river or tributary flow volume (WDFW et al. 2021, p. 41). Hatchery facilities will not dewater stream segments used by bull trout for migration and rearing habitat (WDFW et al. 2021, p. 41). Therefore, the USFWS does not expect that hatchery operations will reduce water quantity to a degree that measurably impacts bull trout, and thus effects on bull trout resulting from water withdrawals are considered insignificant.

11.1.1.4 Effluent Discharge

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

- Discharge of hatchery effluent at the Kendall Creek Hatchery, Lummi Bay Sea Ponds, Skookum Creek Hatchery, and Samish Hatchery is consistently implemented within the "Upland Fin-Fish Hatching and Rearing" NPDES general permit (WDOE 2021, all; WDFW et al. 2021, p. 17);
- 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 are used at their lowest effective concentrations.

For the hatchery programs addressed in this Opinion, fish rearing requires the use and discharge of surface and/or well water into streams and rivers adjacent to the hatchery facilities. Hatchery water discharge (effluent) may negatively affect several water quality parameters in the associated river systems. Hatchery facility waste products discharged in effluent include uneaten food, fish waste products (e.g., fecal matter, mucus, excretions, proteins, and soluble metabolites such as ammonia), antibiotics, chemotherapeutic agents (e.g., Formalin, iodophor), cleaning agents (e.g., bleach, sodium sulfonate, and iodine), 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 effluent flows through the uncovered hatchery ponds and raceways. Chemical cues in effluent may also alter bull trout behavior by attracting them to effluent discharge sites. Each of these effluent impacts is addressed individually in the subsections below.

Chemical Cues

Bull trout may detect and/or be attracted to effluent (USFWS 2022, p. 46). Bull trout 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 (USFWS 2022, p. 46). Effluent discharged from the hatchery facilities likely contains relatively high concentrations of organic substances from hatchery salmon, which could attract bull trout to the immediate vicinity of the hatchery facilities and mixing zones at the discharge locations (USFWS 2022, p. 46). This behavior is most likely exhibited during the time of year when juvenile smolts are being released in the spring (USFWS 2022, p. 46).

Organic substances from hatchery salmon found in effluent discharge can alter bull trout foraging behavior and have the potential to reduce feeding efficiency compared to other natural cues and typical feeding responses or behaviors (USFWS 2022, p. 46). There is documentation of regular observations of bull trout below other fish hatchery facilities not covered within this Opinion during times of the year when hatcheries are releasing large numbers of juvenile salmonids (USFWS 2022, p. 46). 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 (USFWS 2022, p. 46).

Given the volume of effluent discharged from the hatchery facilities is small relative to the receiving waters used by bull trout, even during the lowest annual flow periods, it is likely that organic substances from hatchery salmon present in the effluent will be quickly diluted and will not be measurable beyond the mixing zone. Bull trout observations at hatchery facilities covered in this Opinion are limited to: 1) two individual bull trout encounters in 2000 and 2014 at the Kendall Creek Hatchery (WDFW et al. 2021, p. 14); 2) three subadult bull trout encounters in 2002 at the Whatcom Creek Hatchery (WDFW et al. 2021, p. 14); and, 3) five adult bull trout encounters in 2015 at the Skookum Creek Hatchery yearling pond outfall channel (WDFW et al. 2021, p. 45). The five bull trout encountered at the Skookum Creek Hatchery were presumably preying upon coho smolts that were being released from the ponds at the same time (WDFW et al. 2021, p. 45), and thus may have been drawn to the hatchery discharge site by chemical cues in the effluent. However, the observations occurred within a single year. No bull trout have been observed within the Skooku6m Creek Hatchery prior to, or since, 2015 (WDFW et al. 2021, p. 45). Given that little additional information is available about the five observations of bull trout at the Skookum Creek outfall, we are basing our analysis on the following two probable assumptions: 1) the five bull trout were observed during routine hatchery operations of the yearling pond (i.e., monitoring effort was consistent across the years in question); and, 2) hatchery operations have remained relatively consistent between 2015 and the preceding/following years in which bull trout were not observed at the hatchery (i.e., a significant change in hatchery operation in 2015 was not the underlying reason that five bull trout visited the hatchery). In consideration of these assumptions, it is our best professional judgement that the presence of five bull trout in one year at the Skookum Creek Hatchery was an uncommon event that is unlikely to happen again. Therefore, given the rapid dilution of chemical cues and the rarity of bull trout observations at the hatchery facilities, it is unlikely that bull trout will be exposed to elevated chemical cues to a degree that will alter their behavior. Therefore, the USFWS considers this impact insignificant.

Waste Products and Nutrients

Hatchery effluent will discharge organic matter such as uneaten food, fish waste products, and nutrients into receiving waterbodies inhabited by bull trout, which impacts water quality and nutrient cycling that supports bull trout and their prey species. Kendall Creek Hatchery, Lummi Bay Sea Ponds, Skookum Creek Hatchery, and Samish Hatchery are covered under NPDES permits and have abatement systems or abatement ponds to allow hatchery facility waste products to settle to the bottom before effluent is discharged. Skookum Creek Hatchery also has a filtration system to further treat effluent. Given the use of abatement and/or filtration systems, we do not expect effluent from these hatcheries to contain high enough concentrations of uneaten food, fish waste products, and nutrients to measurably impact bull trout at the point of discharge, particularly since effluent is likely to be quickly diluted in the receiving water body.

The Glenwood Springs Hatchery, McKinnon Pond facility, and Whatcom Creek Hatchery do not require NPDES coverage since they release less than 20,000 pounds of fish per year or feed fish less than 5,000 pounds of fish feed per year (WDFW et al. 2021, p. 17). These facilities do not have effluent treatment systems. However, due to their relatively low numbers of fish released and low fish feed use, we expect that a low amount of uneaten food, fish waste products, and nutrients effluent will be discharged into receiving waterbodies and will be quickly diluted.

In consideration of these factors, the USFWS anticipates that organic matter such as uneaten food, fish waste products, and nutrients in hatchery effluent will have no measurable impact on bull trout, and the effect is therefore considered insignificant.

Antibiotics

Effluent released from Skookum Creek and Kendall Creek hatcheries contains antibiotics from medicated food used to treat Chinook salmon and coho salmon. Prolonged exposure to sufficient concentrations of antibiotics can cause salmonids to experience suppressed immunity, nephrotoxicity, and suppressed growth and development (Maklakova et al. 2011, p. 1133). However, we do not anticipate that antibiotics will be discharged at high enough concentrations to measurably impact bull trout. Even though some medicated food may not be ingested, discharge of the antibiotic into the associated waterways will be minimal and intermittent, and the antibiotic will be quickly diluted before reaching receiving waters (Schmidt et al. 2007, p. 28; WDFW et al. 2021, p. 42). Therefore, the USFWS anticipates that antibiotic in the effluent from the Skookum Creek and Kendall Creek hatcheries will have no measurable impact on bull trout and is therefore considered to result in insignificant effects.

Chemotherapeutic Agents

The hatcheries analyzed in this Opinion use chemotherapeutic agents (e.g., iodophor and formalin) to suppress pathogens during rearing, and therefore these agents may be present in hatchery effluent. Eggs are treated once with an iodophor solution during water-hardening to suppress pathogens and are treated daily with formalin drip or iodophor throughout incubation until just prior to hatching to suppress *Saprolegnia* (WDFW et al. 2021, p. 43). While research on formalin and salmonids is limited, steelhead were found to experience hypertrophy and necrosis in the gills after treatment of 200 parts per million (ppm) of formalin (USFWS 2017b, p. 23). Buchmann et al. (2004) found that various concentrations of formalin (50 ppm to 300 ppm) increased the skin's mucous layer including damage to the epithelium (USFWS 2017b, p. 23).

However, we do not expect that bull trout will experience adverse effects resulting from exposure to chemotherapeutic agents. 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. Therefore, it is likely that chemotherapeutic agents will be undetectable within a few feet of the outfall due to the immediacy of effluent dilution (USFWS 2017b, p. 23). The USFWS thus expects that bull trout will not experience measurable impacts from chemotherapeutic agent exposure, and the effect is therefore considered insignificant.

Cleaning Agents

Cleaning agents that may be used during regular hatchery cleaning activities (i.e., bleach, sodium sulfonate, iodine) may be present in effluent discharged from the hatcheries. However, given that the volume of hatchery discharge is relatively low in comparison to the receiving water bodies even at the lowest annual flow periods, elevated levels of cleaning agents will be isolated to the immediate areas of discharge and will be quickly diluted. Therefore, it is unlikely that bull trout will experience measurable effects from exposure to cleaning agents, and the USFWS thus considers the effect insignificant.

Pathogens and Disease

Hatchery facilities may result in elevated levels of pathogens or disease downstream of effluent discharge sites WDFW et al. 2021, p. 42). The high densities of fish rearing in the hatchery are conducive to higher rates of disease transmission, producing greater disease and pathogen levels in the hatchery than under natural conditions (WDFW et al. 2021, p. 42). Some infectious fish pathogens (bacterial, viral, fungal, or parasitic) may be transmittable through waste discharged from the hatchery, potentially transmitting pathogens to bull trout inhabiting receiving waters (USFWS 2022, p. 46). 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, pp. 62-63; USFWS 2022, p. 46). The potential for pathogen transmission is not fully understood and can be confounded by the natural occurrence of many of these infectious organisms in salmonid populations (USFWS 2022, p. 46).

While disease and pathogen dynamics among hatcheries and naturally-reproducing fish are not well studied or understood (Naish et al. 2008, pp. 141-149, 166-167), the best available science suggests that hatchery operations managed in accordance with current science-based protocols (e.g., NWIFC and WDFW 2006, all) do not result in an increased risk of disease and pathogens to bull trout (USFWS 2017b, p. 24). Many disease transmission risks, including the most severe, are precluded when hatcheries follow good fish health protocols and do not transfer fish to or from distant watersheds (Naish et al. 2008, p. 141-149; USFWS 2017b, p. 24). For the hatcheries covered in this Opinion, the co-managers carry out fish pathogen prevention, diagnosis, treatment, and control procedures prescribed by the WDFW or Northwest Indian Fisheries Commission (NWIFC) consistent with the Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State (NWIFC and WDFW 2006, all; WDFW et al. 2021, p. 14). These are science-based protocols for pathogen prevention, diagnosis, treatment, and control, and corresponding best management practices (BMPs) for hatchery operations and sanitation practices (USFWS 2017b, p. 24). When implemented, these protocols help contain any pathogen outbreaks at hatchery facilities, minimize release of infected fish from hatcheries, and reduce the risk of fish pathogen transfer and amplification to natural-origin fish (USFWS

2017b, p. 24). Fish health is monitored daily by hatchery staff and at least monthly by state or tribal Fish Health Specialists (WDFW et al. 2021, p. 14).

Additionally, bull trout may be inherently resistant to some disease agents that commonly result in losses to hatchery-reared salmonids (USFWS 2022, p. 46). In controlled laboratory studies conducted by researchers from the Oregon State University on the Metolius River in central Oregon, 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 (USFWS 2022, p. 46). Further, rainbow trout exposed simultaneously in the study showed high infection prevalence and disease severity (USFWS 2022, p. 46). Similarly, no infections were detected in bull trout exposed to infection by *Ceratonova shasta* (a myxozoan parasite) (USFWS 2022, p. 46). Disease studies conducted on bull trout from the Deschutes River basin (which includes the Metolius River) illustrated that bull trout were relatively resistant to all strains of infectious Hematopeietic Necrosis Virus tested (USFWS 2022, p. 46). 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 (USFWS 2022, p. 46).

Given the proper implementation of fish health protocols, the USFWS does not expect that bull trout will experience a measurable increase in disease transmission due to pathogen exposure from hatchery effluent, and the effect is therefore considered insignificant.

Water Temperature

At the hatchery facilities, water temperature may increase as water flows through the uncovered hatchery ponds and outdoor, unshaded raceways via solar radiation and atmospheric conduction (WDFW et al. 2021, p. 49; USFWS 2022, p. 46), and warming will be most pronounced during the summer months. However, the USFWS expects that increases in water temperatures at the hatcheries will be minimal. For successful hatchery operations, water temperatures in the hatchery facilities and adjacent rivers and streams must be maintained at appropriate levels to support rearing salmonids (USFWS 2022, p. 45). Consequently, water temperature does not generally rise to levels that could be detrimental to salmonids. Water also travels quite rapidly through the hatchery and is thus exposed to solar radiation for a short amount of time, limiting the level of warming (WDFW et al. 2021, p. 49). Effluent discharge volumes are low relative to the receiving waterbodies, so waters warmed in the hatchery ponds and raceways are likely to be quickly diluted and cooled upon discharge into receiving waters.

All hatcheries and facilities covered in this Opinion either do not require an NPDES permit (McKinnon Pond, Whatcom Creek, and Glenwood Springs facilities) or operate under the "Upland Fin-Fish Hatching and Rearing" NPDES general permit (Kendall Creek, Lummi Bay Sea Ponds, Skookum Creek, and Samish River hatcheries) (WDOE 2021, all; WDFW et al. 2021, p. 17). Under this general permit, hatchery facilities discharging to water bodies impaired for temperature must continuously monitor water temperatures at the point of discharge between April 1 and November 30 and report the daily maximum water temperature (WDOE 2021, p. 17, p. 66). Hatcheries covered under this Opinion that discharge to temperature impaired waterbodies are the Kendall Creek Hatchery, which discharges to Kendall Creek, and the Samish

Hatchery, which discharges to the Samish River and Friday Creek (WDOE 2021, p. 62). These two hatcheries are thus required to monitor effluent temperature according to the requirements outlined in the general NPDES permit.

In consideration of these factors, the USFWS anticipates that increased water temperature resulting from hatchery operation will be minimal and will quickly cool upon dilution in the receiving water body. Therefore, increased water temperatures will have insignificant effects on bull trout.

11.1.1.5 Dissolved Oxygen

As water temperatures increase, dissolved oxygen levels in the water generally decrease. With the potential for a minimal amount of warming as water flows through the hatchery facilities, effluent may have slightly decreased levels of dissolved oxygen at the point of discharge into receiving water bodies. While research studies regarding the effects of low dissolved oxygen on bull trout are limited, studies conducted with other salmonid species such as Chinook salmon, coho salmon, and steelhead concluded that low levels of dissolved oxygen can have both lethal and sublethal (i.e., impacts to rate of embryonic development, time to hatch, and size of emerging fry) effects on embryonic and larval stages of development (Carter 2005, pp. 1-4; USFWS 2022, p. 45). Additionally, low dissolved oxygen levels can negatively impact growth, feed conversion efficiency, and swimming performance of adult and juvenile salmonids (Bjornn and Reiser 1991, p.85; USFWS 2022, p. 45).

However, the USFWS anticipates that dissolved oxygen will not decrease to a degree that measurably impacts bull trout. For successful hatchery operations, dissolved oxygen levels must be maintained at sufficient levels at all fish hatcheries to support rearing salmonids (USFWS 2022, p. 45). Thus, dissolved oxygen is not depleted to levels that would be detrimental to juvenile salmonids (USFWS 2022, p. 45). The USFWS also anticipates that any decreases in dissolved oxygen levels in the effluent will be restored near the point of discharge due to rapid dilution into the larger receiving waterbodies (USFWS 2022, p. 45). Falling water at the point of discharge may 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, all; USFWS 2022, p. 45). Furthermore, salmonids have been found to actively avoid areas with low dissolved oxygen levels (Carter 2005, p. 1; USFWS 2022, p. 45)

All hatcheries covered in this Opinion either do not require an NPDES permit (McKinnon Pond, Whatcom Creek, and Glenwood Springs facilities) or operate under the “Upland Fin-Fish Hatching and Rearing” NPDES general permit (Kendall Creek, Lummi Bay Sea Ponds, Skookum Creek, and Samish hatcheries) (WDOE 2021, all; WDFW et al. 2021, p. 17). Under this general permit, hatchery facilities discharging to water bodies impaired for dissolved oxygen must monitor effluent nutrient levels (phosphorus, orthophosphate, nitrogen, nitrate + nitrite nitrogen, ammonia), pH, dissolved oxygen carbon, and biochemical oxygen demand monthly during the time of year that fish feeding operations are occurring (WDOE 2021, pp. 17-18, p. 65). The only hatchery covered under this Opinion that discharges to waterbodies impaired for dissolved oxygen is the Samish Hatchery, which discharges to the Samish River and Friday Creek (WDOE 2021, p. 63).

In consideration of these factors, the USFWS anticipates that dissolved oxygen levels in hatchery effluent will not decrease to a level that has measurable effects on bull trout and will be quickly restored upon dilution in the receiving water body, and thus the effect on bull trout is considered insignificant.

11.1.1.6 Sediment and Debris Release

The USFWS expects that the following hatchery maintenance activities will increase turbidity in hatchery effluent and adjacent water bodies: 1) routine removal of minor debris accumulations from hatchery surface-water diversion structures and discharge outfall structures; 2) maintenance dredging at the Samish River Hatchery; and, 3) pond maintenance (i.e., vacuuming accumulated sediment). Bull trout are highly sensitive to sediment inputs and turbidity, particularly the embryonic and alevin development stages (Bash et al. 2001, p. 24; USFWS 2022, p. 45). 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, p. 1067; USFWS 2022, p. 45). Additionally, high turbidity can alter feeding strategies in adult and juvenile salmonids and can cause individuals to avoid impacted reaches (Bash et al. 2001, p. 8; USFWS 2022, p. 45).

Routine removal of minor debris accumulations from hatchery surface-water diversion structures and discharge outfall structures may temporarily elevate the level of debris such as wood, leaves, grass, and sediment in the stream directly below the structure (WDFW et al. 2021, p. 43). Any work of this kind that would require significant disturbance to the habitat adjacent to the facility structure (i.e., the need for heavy equipment) is not considered normal hatchery maintenance and is not considered in this Opinion (WDFW et al. 2021, p. 43). Therefore, USFWS anticipates that any increase in sediment and debris in the water column due to routine debris removal from hatchery structures would be temporary and limited in extent, and thus would be unlikely to measurably impact bull trout. We therefore consider this effect insignificant.

Hatchery staff propose to dredge sediment adjacent to the intake structure at the Samish River Hatchery on an annual or semi-annual basis between August 1 and September 15, removing a maximum of 1,200 cy of material no more than once per year during the state-approved in-water work window for the area (between August 1 and September 15). Hatchery staff propose to use an excavator equipped with a long-reach boom from an upland location adjacent to the Samish Hatchery surface water intake structure. Dredging activities will suspend sediments in the water column, temporarily increasing turbidity in occupied bull trout habitat. Although there is no known spawning in the Samish River basin, bull trout have been documented using the Samish River as FMO habitat (USFWS 2008), which limits use of the basin to older and larger bull trout including adults and subadults (WDFW et al. 2021, p. 29). Thus, there is the potential for adult and subadult bull trout to be present near the intake structure dredge site at the Samish River Hatchery.

However, dredging above and below the hatchery intake does not occur when there is a possibility of bull trout in the area (WDFW et al. 2021, p. 44). In western Washington, anadromous bull trout migrate to spawning grounds from approximately August into October (Brenkman et al. 2001, p. 981). Dredging will occur between August 1 and September 15 when bull trout are expected to be migrating to spawning grounds and are unlikely to still be in FMO habitat like the Samish River (Brenkman et al. 2001, p. 981; Goetz et al. 2021, p. 1073). Additionally, turbidity from dredging will be temporary, intermittent, and limited in extent, and hatchery staff will monitor sediment movement during dredging activities (WDFW et al. 2021, p. 43). In consideration of these factors, it is unlikely that bull trout will be exposed to turbidity from dredging in the Samish River, and the USFWS therefore considers the effect discountable.

Routine hatchery maintenance involves vacuuming ponds to remove accumulated sediment (WDFW et al. 2021, p. 44). This maintenance activity will suspend sediment in the water column, temporarily increasing turbidity and potentially discharging the suspended sediment downstream into bull trout habitat through hatchery effluent. Since NPDES requirements prohibit the discharge of accumulated sediment, hatcheries will monitor influent and effluent discharge during pond maintenance to ensure that accumulated sediment is not discharging downstream (WDFW et al. 2021, p. 44). The hatchery facilities also have pollution abatement structures, which act as settling chambers for the vacuumed sediment and water to further prevent discharging suspended sediment downstream (WDFW et al. 2021, p. 44). Hatchery staff remove the solids from the abatement structures and dispose of them elsewhere on the hatchery grounds or through commercial means so that the solids are not released into the river downstream (WDFW et al. 2021, p. 44). Precautions are also taken with pond level at the time of cleaning to reduce the risk of elevating the sediment level in the hatchery effluent (WDFW et al. 2021, p. 44). Given the adherence to NPDES requirements and associated precautions, any suspended sediment that may be discharged after pond maintenance is likely to be minimal and will quickly dilute in receiving waters. Therefore, it is highly unlikely that bull trout will be measurably impacted by sediment release from pond maintenance, so the USFWS considers the effect insignificant.

11.1.1.7 Herbicides

During ground maintenance, hatchery staff will apply Roundup, Rodeo, and Crossbow herbicides to manage vegetation at the hatchery facilities (WDFW et al. 2021, p. 44). Herbicides such as glyphosate (e.g., found in Roundup and Rodeo) 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 (USFWS 2022, p. 43). Furthermore, the use of glyphosate can lead to oxidative stress in fish (Faria et al. 2021, pp. 7-8), and herbicides at high doses can cause fish mortality (USFWS 2022, p. 43).

At the hatcheries considered in this Opinion, staff will apply glyphosate herbicide using a backpack pump sprayer as a part of regular hatchery maintenance activities. To ensure that herbicides are not released into the stream, hatchery staff will apply herbicide following the manufacturer's label, away from water, and only when conditions are dry with little to no wind to prevent runoff (WDFW et al. 2021, p. 44). Additionally, the volume of herbicide applied annually at the hatchery facilities is relatively 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, p. 93; USFWS 2022, p. 43).

Due to the relatively low herbicide use and the conservation measures 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.

11.1.1.8 Ecological Interactions

Competition

Competition for food and space among anadromous salmonids and bull trout may occur in spawning and rearing areas, migration corridors, and/or the marine environment (USFWS 2022, p. 47). Competition may result from direct interactions, in which hatchery-origin salmon may interfere with bull trout for access to limited resources, or indirect interactions, in which use of a limited resource (e.g., prey resource base) by hatchery-origin salmon reduces the amount available for bull trout (USFWS 2022, p. 47).

Progeny 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, but the extent to which this occurs is unknown. If there is overlap in spawning areas between bull trout and progeny of hatchery-origin fish, progeny of hatchery-origin fish may establish a redd in the same place as a previously established bull trout redd (e.g., redd superimposition), potentially killing, dislodging, or preventing development of bull trout eggs (Baker and Hand 2023, p. 4). In the action area, there is little spatial overlap between Chinook, coho, and chum salmon documented spawning areas and bull trout spawning areas, but there is some spatial overlap in rearing areas within the Nooksack River basin (NWIFC 2023). Increasing evidence suggests that, in areas where bull trout co-occur with naturally reproducing salmon, bull trout abundance is dependent on and directly correlated with naturally reproducing salmon (Copeland and Meyer 2011, pp. 936-940; USFWS 2022, p. 32, p. 47). This suggests that the benefits of abundant, naturally spawning salmon are greater than any deleterious competitive interactions (see Section 11.1.3 — Beneficial Effects; USFWS 2022, p. 48). Additionally, the abundance of naturally spawning Chinook, coho, and chum salmon are currently lower than historical levels, meaning that competition from these species for spawning and rearing habitat will be lower than what bull trout have experienced in the past (USFWS 2022, p. 48). The USFWS expects that any competition for spawning and rearing habitat between bull trout and progenies of hatchery-released salmon will be infrequent, limited in scope and scale, and not measurable. For these reasons, we consider the effects from competition for spawning and rearing habitat to be insignificant.

It is possible that a few adult hatchery-origin salmon may stray and spawn naturally in the lower portions of bull trout spawning areas. However, based on the available information on documented Chinook, coho, and chum salmon spawning areas and as discussed previously, there is little spatial overlap between areas used by Chinook, coho, and chum salmon and by bull trout for spawning (NWIFC 2023). The USFWS expects that most adult stray hatchery-origin salmon will spawn in lower areas of the watershed relative to bull trout (USFWS 2022, p. 48). Because of the separation between these species, the USFWS anticipates that relatively few, if any, hatchery-origin 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 have been observed spawning in do occasionally overlap with areas used by bull trout (Keeley and Slaney 1996, p. 12; USFWS 2022, p. 48). Even with this overlap in reach-scale spawning habitat between bull trout and other hatchery-reared salmonids, 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 salmon (USFWS 2022, p. 48). Therefore, the USFWS considers the effects of potential interactions related to competition and superimposition of redds between bull trout and hatchery-origin salmon in spawning areas to be discountable.

In freshwater environments, the USFWS expects limited competition for prey resources between hatchery-released salmon (Chinook, coho, and chum salmon) and bull trout due to the following factors: 1) the short residence time of hatchery-reared salmon in freshwater; and, 2) the differences in habitat selection, foraging behavior, and prey resource selection between bull trout and hatchery-released smolts (USFWS 2022, p. 48). The hatchery programs are designed to ensure that smolts rapidly out-migrate to marine waters within days of release. Therefore, any direct competitive interactions for prey resources would occur, if they occur at all, within a short timeframe. Differences in habitat selection and foraging behavior increase the likelihood of hatchery-origin fish and bull trout using different prey sources, further minimizing detrimental competitive interactions (USFWS 2022, p. 48). 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, p. 8; USFWS 2022, p. 48). Hatchery-released smolts also provide an additional prey resource for bull trout. Where bull trout co-occur with hatchery-released fish, larger subadult bull trout are likely to be feeding on hatchery-released juvenile salmonids (see Section 11.1.3 — Beneficial Effects; USFWS 2022, p. 48). Because there is no evidence to suggest that hatchery-origin fish in the action area deplete prey resources to the detriment of bull trout, the USFWS does not expect competitive interactions between bull trout and hatchery-released fish 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-released smolts and returning adults seasonally occupy waters at approximately the same time of the year as foraging adult and subadult bull trout. Therefore, 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 the upper Puget Sound relative to the abundance of salmonids and bull trout local populations in this area (USFWS 2022, p. 48). There are no data to suggest that there are negative competitive interactions between bull trout and hatchery- or natural-origin salmonids in the Puget Sound marine nearshore or in any other marine nearshore habitat that bull trout may occupy across their range (USFWS 2022, pp. 48-49). 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 (USFWS 2022, p. 49).

For these reasons, the USFWS considers the effects of the proposed action on competition for prey resources in marine waters to be insignificant.

Predation

Releasing hatchery-origin fish (Chinook, coho, and chum salmon) has the potential to result in predation on bull trout via the following pathways: 1) direct predation, whereby the hatchery salmon consume small, juvenile bull trout; 2) indirect predation, whereby large concentrations of released hatchery 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 salmon that spawn naturally in the Nooksack and Samish River basins (USFWS 2022, p. 49). Direct predation on bull trout by released hatchery-origin 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, p. 26; USFWS 2022, p. 49). The magnitude of, and vulnerability to, predation resulting from hatchery fish releases depend on a combination of prey and predator abundance, the size of hatchery salmon in relationship to the size of bull trout occupying the same area, the feeding habits of hatchery-origin salmon, and other factors (USFWS 2022, p. 49).

Hatchery-released salmon (Chinook, coho, and chum salmon) may directly predate on juvenile bull trout if the species overlap in time and space, and if the hatchery-released juveniles are much larger in body size than the bull trout juveniles. However, this type of direct predation on bull trout by hatchery-released salmon is extremely unlikely for several reasons. It is unlikely that most small juvenile bull trout (e.g., the life stage most vulnerable to predation) will encounter hatchery-origin juveniles because most bull trout spawning areas in the action area are upstream of hatchery release locations (WDFW et al. 2021, p. 45), and it is unlikely that hatchery-released juvenile Chinook, coho, or chum salmon would move upstream into areas where small juvenile bull trout are rearing. Bull trout rearing habitat spans much of the North Fork, Middle Fork, and South Fork Nooksack Rivers (Figure 24; NWIFC 2023), but juvenile bull trout will likely have grown to larger sizes less susceptible to predation by the time they reach rearing habitat lower in the system.

Additionally, the USFWS expects that most hatchery-origin salmon will outmigrate to the marine environment relatively quickly, minimizing freshwater residence (WDFW et al. 2021, p. 23). To encourage rapid outmigration, hatcheries covered in this Opinion will implement the following BMPs: 1) hatcheries will rear all spring and fall Chinook salmon and coho salmon released from Kendall Creek, Skookum Creek, Samish River and Glenwood Spring hatcheries to a size and physiological stage to ensure readiness for downstream migration; 2) hatcheries will release fish volitionally and immediately after a freshet when possible; and, 3) hatcheries will monitor juvenile out-migration annually to determine size, timing, and spatial and temporal overlap among fish species and their origins (WDFW et al. 2021, p. 47). Given the implementation of these BMPs, hatchery-released salmon are likely to emigrate to marine waters before becoming large enough to prey on any juvenile salmonids, including bull trout fry (USFWS 2022, p. 50). In general, salmonids become primarily piscivorous at lengths of 310 mm (12.2 inches) (Keeley and Grant 2001, p. 1128) after feeding mainly on invertebrates while rearing in freshwater (USFWS 2022, p. 50). Once they become piscivorous, hatchery-origin fish can prey on fish one half their length (WDFW et al. 2021, p. 45), but prefer fish one-third or less their length (WDFW et al. 2021, p. 45). Hatchery-origin coho are the largest in size of any hatchery-origin salmonids co-occurring with juvenile bull trout (WDFW et al. 2021, p. 46), making them the most likely hatchery-origin species to predate on juvenile bull trout. However, the average fork lengths for bull trout and hatchery-origin coho are very similar (WDFW et al. 2021, p. 46), suggesting that coho predation on bull trout is highly unlikely to occur due to their similarity in size. If hatchery-origin salmon were to return to their natal river or stream as adults in order to migrate upstream, they would likely be large enough to prey on juvenile bull trout, but returning adult salmon are not typically known to prey on fish once they enter freshwater and begin their upstream migration (USFWS 2022, p. 49). Given the spatial separation between bull trout spawning areas and hatchery release sites, the minimal freshwater residence of hatchery-released fish, and the small sizes of outmigrating hatchery fish, the USFWS does not anticipate that hatchery-origin salmon will directly prey on bull trout, and the effect is thus considered discountable. Despite this expectation, hatcheries will use information collected during annual monitoring of juvenile outmigration to implement mitigation measures to minimize predation risks to bull trout and other listed species (i.e., adjusted release time of hatchery fish) (WDFW et al. 2021, p. 47).

Regarding indirect predation, the second potential pathway for predation on bull trout, large concentrations of hatchery-origin juvenile Chinook, coho, and chum salmon may attract predators (e.g., piscivorous fish, birds, and mammals), which may also prey on natural-origin bull trout inhabiting the same area (Kostow 2009, p. 26; WDFW et al. 2021, p. 45; USFWS 2022, p. 49). Hatchery-released juvenile salmonids exhibit riskier behaviors, which make them more susceptible to predation than natural-origin fish (Olla et al. 1998, pp. 533- 538; USFWS 2022, p. 49). This risky behavior 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 (USFWS 2022, p. 49). Additionally, most of the release sites covered in this Opinion are located downstream of bull trout spawning areas (WDFW et al. 2021, p. 45). Bull trout in early life stages are most vulnerable to predation due to their small size, so the spatial separation between most release sites and bull trout spawning habitats further reduces the risk indirect predation on bull trout by fish, birds, and mammals. 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 (USFWS 2022, p. 49).

A third potential predation pathway for predation on juvenile bull trout is predation from the progenies of hatchery-origin adult salmon that spawn naturally in the action area. While bull trout are known to spawn throughout the Nooksack River basin, there is no bull trout spawning known in the Samish River basin (NMFS 2023, p. 29). Subadult and juvenile bull trout may feed in the Samish River basin (WDFW et al. 2021, p. 28), but are expected to have grown to a larger size less susceptible to predation after rearing for one to four years in their natal basin (Fraley and Shepard 1989, p. 138; Goetz 1989, pp. 17732-17733, p. 17746), making the risk of predation unlikely. In the Nooksack River basin, most Chinook, coho, and chum salmon spawning areas are located in lower areas of the watershed relative to the bull trout spawning areas (NWIFC 2023). While bull trout rearing habitat encompasses much of the North Fork, Middle Fork, and South Fork Nooksack Rivers (Figure 24; NWIFC 2023), juvenile bull trout are expected to have grown to larger sizes less susceptible to predation by the time they travel to downstream rearing habitat lower in the system where they may encounter progenies of hatchery-origin Chinook, coho, and chum salmon. Because there is little overlap in spawning areas between the three salmon species and bull trout, any progenies of hatchery-origin, naturally spawning Chinook, coho, or 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.

Additionally, the behavior that bull trout fry exhibit in their early rearing habitat further reduces their risk of predation. Due to their small size, the USFWS considers bull trout fry to be the most susceptible life history state to predation. Fry tend to be cryptic and hide in the substrate during the day, which helps them avoid predation (primarily by larger bull trout) (USFWS 2022, p. 50). Bull trout fry also typically remain in close proximity to where they hatched and within the interstitial spaces of gravel and cobble substrates to a much greater extent than other salmonids (Pratt 1992, pp. 5-6; Rieman and McIntyre 1993, p. 5), where the potential for predation by Chinook, coho, or chum salmon would be limited (USFWS 2022, p. 50). In general, juvenile bull trout occupy very different habitats than other, larger salmonids, which likely reduces their exposure to predation by these other species (USFWS 2022, p. 50).

Given the locations, life history stages, and timing of hatchery-origin smolt releases, as well as the rare spatial overlap between adult spawning areas and small, juvenile bull trout, the USFWS expects that an increase in predation on bull trout resulting from hatchery operations will be extremely unlikely, and therefore considers the effect discountable.

11.1.1.9 Underwater Noise

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 (Yelverton et al. 1975, p. 17; Nedwell et al. 2006, all; Popper and Hastings 2009, all; Popper and Hawkins 2019, all; USFWS p. 43). For bull trout that weigh 2 grams or less, in-water noise greater than 183 decibels (dB) sound exposure level (SEL), and, for bull trout that weigh greater than 2 grams, in-water noise greater than 187 dBSEL, can result in injury and/or mortality (USFWS 2022, p. 43). 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. Increased underwater noise may cause bull trout to avoid the immediate area while heavy equipment is being operated, but this effect is expected to be intermittent, temporary, and limited in extent. Therefore, we consider the direct effects to bull trout associated with short-term exposure to elevated levels of in-water noise resulting from hatchery maintenance activities to be insignificant.

11.1.1.10 Outdoor Artificial Lighting

Hatchery operations often rely on outdoor artificial lighting for carrying out hatchery-related activities. At the hatchery facilities considered in this Opinion, artificial lighting used at night has the potential to attract juvenile bull trout from the adjacent rivers or nearby tributaries

(USFWS 2022, p. 43). The artificial lighting will likely make the bull trout more visible to predators that hunt visually, potentially exposing bull trout to increased levels of predation (USFWS 2022, p. 43). 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 hatchery locations. Therefore, the USFWS expects that effects to bull trout associated with the artificial lights will be extremely unlikely and discountable.

Broodstock Collection at the Glenwood Springs Hatchery

The Glenwood Springs Hatchery operates an adult trap and holding pond in an unnamed stream on Orcas Island from early August to late October to collect Chinook salmon broodstock (WDFW et al. 2021, p. 12). All fish voluntarily enter the fish ladder and holding pond, and hatchery staff will release all non-target fish such as bull trout inadvertently encountered in the trap back to the Puget Sound (WDFW et al. 2021, p. 12).

At the Glenwood Springs Hatchery, collection of adult Chinook salmon for broodstock is unlikely to result in the incidental capture and handling of bull trout. While bull trout are known to use Puget Sound marine areas and nearshore areas of islands along the east Puget Sound as FMO habitat (USFWS 2010, p. 191), bull trout occurrence has not been documented off the San Juan Islands (NWIFC 2023), and no encounters of bull trout have been reported at the Glenwood Spring Hatchery (WDFW et al. 2021, p. 39). Given the rarity of bull trout around Orcas Island, the USFWS does not expect that bull trout will be present in the vicinity of the Glenwood Springs Hatchery during broodstock collection, and the risk of capture and handling associated with broodstock collection for the Glenwood Springs Hatchery is considered discountable.

11.1.2 Adverse Effects

Adverse effects on bull trout resulting from the proposed action include: 1) capture and handling via broodstock collection, fish isolation for annual dredging at the Samish River Hatchery, and the RM&E program; and, 2) impingement and entrainment at the Skookum Creek Hatchery. See Table 6 for a summary of all adverse effects.

Table 6: Chinook, coho, and chum salmon hatchery facility components and program activities and the resulting expected number of bull trout that will be adversely affected.

Hatchery Activity	Facility	Activity Sub-Type	Target Species	Location	Method	Timing	Maximum Number of Bull Trout Adversely Affected (Expected)	Maximum Number of Bull Trout Mortalities (Expected)
Broodstock Collection	Kendall Creek Hatchery	On-Site Hatchery Trap Broodstock Collection	Chinook salmon	Kendall Creek (RM 0.01)	Adult trap and holding pond	Last week of May through September	5 fish per year	1 fish per year
			coho salmon	Kendall Creek (RM 0.01)	Adult trap and holding pond	Mid-October to January 31		
			chum salmon	Kendall Creek (RM 0.01)	Adult trap and holding pond	November 1 to December 31		
		Emergency In-River Broodstock Collection	chum salmon	Kendall Creek (RM 46)	Weirs and seine nets	November 1 to December 31	2 fish in a five-year period	1 fish in a five-year period
	Skookum Creek Hatchery	On-Site Hatchery Trap Broodstock Collection	Chinook salmon	Skookum Creek (RM 14.3)	Adult trap and brood pond	July 1 to September 30	5 fish per year	1 fish per year
			coho salmon	South Fork Nooksack River (RM 14.3)	Adult holding/brood pond	October 1 to February 1		
		Emergency In-River Broodstock Collection	Chinook salmon	South Fork Nooksack River (RM 13-14.5)	2-3-inch mesh seine and/or tangle nets	July 1 to October 10	2 fish in a five-year period	1 fish in a five-year period
			Chinook salmon	South Fork Nooksack River tributaries	Temporary weirs	July 1 to October 10		
			coho salmon	Mainstem South Fork Nooksack River (RM 0.0 to 25.0)	Hook-and-line	November 1 to January 31		
			coho salmon	South Fork Nooksack River tributaries (Edfro, Cavanaugh, Fobes, Plumbago, Deer, and Roaring Creek and unnamed tributaries at	Weirs and/or seine nets	November 1 to February 1		

				RM 20.3, 21.3, and 22.2)				
	Lummi Bay Hatchery	On-Site Hatchery Trap Broodstock Collection	Chinook salmon	Kendall Creek Hatchery	Hatchery trap and holding pond	Last week of May to September 30	5 fish per year	1 fish per year
			coho salmon	Skookum Creek Hatchery (RM 14.3)	Hatchery trap	September 15 to November 15		
			chum salmon	Lummi Bay (RM 0.0)	Hatchery trap	October 1 to December 15		
		Emergency In-River Broodstock Collection	chum salmon	Independent streams (Chuckanut, Oyster, Colony, and Whitehall)	Block nets	October 1 to December 15	2 fish in a five-year period	1 fish in a five-year period
	Samish River Hatchery	On-Site Hatchery Trap Broodstock Collection	Chinook salmon	Samish River (RM 10.5)	Block nets, dipnets, electrofishing	September 1 to October 31	5 fish per year	1 fish per year
	Whatcom Creek Hatchery	On-Site Hatchery Trap Broodstock Collection	Chinook salmon	Whatcom Creek	Adult trap, fish ladder, and holding pond	August 1 to December 15	5 fish per year	1 fish per year
			chum salmon	Whatcom Creek	Adult trap, fish ladder, and holding pond	October 15 to December 15		
		Emergency In-River Broodstock Collection	chum salmon	North Fork Nooksack River		November 1 to December 31	2 fish in a five-year period	1 fish in a five-year period
			chum salmon	Independent streams (Chuckanut, Oyster, Colony, and Whitehall)	Block nets	November 1 to December 31		
Fish isolation for maintenance dredging	Samish River Hatchery	N/A	Chinook salmon	Above and below intake structures on Samish River (RM 1.3)	Block nets, dipnets, electrofishing	Between August 1 and December 15	5 fish in a five-year period	3 fish in a five-year period
Research, monitoring, and evaluation	Kendall Creek Hatchery, McKinnon Pond, Skookum	N/A	Juvenile Chinook salmon	South Fork Nooksack River (RM 8.7)	Rotary screw trap	March 1st to December 31st	100 fish per year	3 fish per year
				South Fork Nooksack River Basin	Beach seining	March 1st to December 31st		

	Creek Hatchery			North Fork Nooksack River Basin (all suitable locations within reaches accessible to adult Chinook are considered)	Seining	March 1st to December 31st		
				Middle Fork Nooksack River Basin (all suitable locations within reaches accessible to adult Chinook are considered)	Seining	March 1st to December 31st		
				North Fork or South Fork Nooksack Rivers (RM 0 to 25)	Electrofishing	March 1st to December 31st	50 fish per year	5 fish per year
Surface water intakes (impingement and entrainment)	Skookum Creek Hatchery	N/A	Chinook, coho salmon	Intake structures near mouth of Skookum Creek	Surface water intake structures with federally non-compliant intake screens	All year	5 fish per year per decade	5 fish per year per decade

*Pending co-manager use of an alternative stock

11.1.2.1 Capture and Handling

Hatchery activities will result in the incidental capture and handling of bull trout. When handled, bull trout experience physiological responses associated with stress. Researchers have broadly grouped fish physiological responses to stressors as primary, secondary, and tertiary (USFWS 2021, p. 26). Primary responses, which involve the initial neuroendocrine responses, include the release of catecholamines from chromaffin tissue (Reid et al. 1998, p. 1; USFWS 2021, p. 26), and hypothalamic-pituitary-interrenal axis stimulation culminating in the release of corticosteroid hormones (Wendelaar Bonga 1997, p. 597; Mommsen et al. 1999, p. 216; USFWS 2021, p. 26). Secondary responses include changes in plasma and tissue ion and metabolite levels, hematological features, and heat shock or stress proteins, all of which relate to physiological adjustments such as in metabolism, respiration, acid-base status, hydromineral balance, immune function, and cellular responses (Mommsen et al. 1999, p. 212; USFWS 2021, p. 26). Tertiary responses may also occur such as changes in growth, condition, overall resistance to disease, metabolic scope for activity, behavior, and ultimately survival (USFWS 2021, p. 26). The number, duration, and intensity of stressors are factors determining whether the fish's homeostatic response mechanisms are restored, or exceeded, which may cause a sustained reduction in fitness or death (USFWS 2021, p. 26).

The USFWS analyzed the effects on bull trout associated with capture and handling in the subsections below, categorized by: 1) on-site broodstock collection at the hatchery facilities; 2) in-river emergency broodstock collection; 3) fish isolation prior to maintenance dredging; and, 4) activities associated with the RM&E program, including seining, and electrofishing.

Broodstock Collection

Co-managers will conduct broodstock collection (i.e., the capture of live adult fish for use in the hatchery programs) of Chinook, coho, and chum salmon in the Nooksack and Samish River basins. Broodstock collection methods will involve either trapping fish on-site at the hatcheries using an adult trap/holding pond system or trapping fish off-site using in-river collection methods such as seining or netting. The following subsections summarize the expected direct impacts to bull trout as a result of ongoing broodstock collection activities at the hatchery programs and facilities covered in this Opinion.

Kendall Creek Hatchery

For collection of Chinook, coho, and chum salmon broodstock, the Kendall Creek Hatchery operates an adult trap and holding pond in Kendall Creek at RM 0.01. A permanent weir spanning Kendall Creek directs fish into a ladder and subsequent concrete holding pond, where broodstock is sorted (WDFW et al. 2021, p. 12). If any non-target fish such as bull trout enter the holding pond, hatchery staff will remove them with a dipnet, transport them in a tote, and release them downstream of the weir in Kendall Creek (150 yards downstream of brood pond) (Co-managers, in litt., June 14, 2023). The Kendall Creek Hatchery will operate the adult trap and holding pond from the last week of May through September for Chinook salmon, from mid-October through the end of January for coho salmon, and from November 1 to December 31 for chum salmon.

If the hatchery is unable to collect sufficient chum salmon broodstock via the hatchery trap, then hatchery staff will collect broodstock off-site using emergency in-river collection methods. If emergency broodstock collection is necessary, then hatchery staff will collect adult chum salmon using seine nets from North Fork sub-basin chum spawning grounds from November 1 to December 31 (WDFW et al. 2021, p. 14). Seine nets will be used in areas of high chum abundance and will allow for the release of all non-target species such as bull trout (WDFW et al. 2021, p. 14).

At the Kendall Creek Hatchery, collection of adult Chinook, coho, and chum salmon for broodstock is likely to result in the incidental capture and handling of bull trout, both during operation of the adult trap/holding pond system and the emergency in-river broodstock collection seining efforts. The physical presence of a trap, weir, or net located within or connected to a river where bull trout are either foraging, migrating/moving, overwintering, or rearing 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) causing 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 2022, pp. 53-54).

Although the permanent weir in Kendall Creek serves as an anadromous barrier to upstream migration, bull trout may be found below the weir in Kendall Creek and in the adjacent North Fork Nooksack River (NWIFC 2023). The Kendall Creek Hatchery has had a few instances of encountering bull trout within the hatchery holding ponds (Co-managers, in litt., June 14, 2023), but no documented instances of bull trout encountered during seining activities for emergency broodstock collection in the North Fork Nooksack River (WDFW et al. 2021, p. 13). Two adult bull trout have been documented at the Kendall Creek Hatchery, one in 2010 and one in 2014 (WDFW et al. 2021, p. 39). Given the prior encounters with bull trout in the holding ponds and the presence of bull trout throughout much of the North Fork Nooksack River, it is reasonable to expect that bull trout individuals will be incidentally captured during operation of the adult trap/holding pond system and during in-river broodstock collection associated with the Kendall Creek Hatchery. While all 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.

Hatchery staff will operate the adult trap and holding pond at the Kendall Creek Hatchery from May through the end of January to collect Chinook, coho, and chum salmon broodstock. Given this timing, the USFWS expects that adult and subadult bull trout are the most likely life stage to be incidentally captured in the holding ponds. Additionally, in-river emergency broodstock collection of chum salmon using seine nets will occur between November 1 and December 31 in Kendall Creek and the North Fork Nooksack River. Therefore, in-river broodstock collection activities will most likely affect adult and subadult bull trout that are either foraging in/adjacent to and/or migrating through the North Fork Nooksack River. 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.

Regarding capture of bull trout in the on-site adult trap/holding pond or during off-site seining, associated handling is expected to result in stress, injury, or death, either immediate or delayed, experienced by bull trout (USFWS 2022, p. 54). 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 (USFWS 2022, p. 54). During handling, bull trout may also suffer from thermal stress or experience injuries resulting from descaling and/or losing their protective slime layer (USFWS 2022, p. 54). Handling may also contribute directly or indirectly to disease susceptibility and transmission and/or increased predation, post-release (USFWS 2022, p. 54). Smaller bull trout that experience increased stress, regardless of the cause or source, are most vulnerable to predation (Mesa et al. 1994, pp. 86-91; USFWS 2022, p. 54).

If broodstock collection of chum salmon via the on-site adult trap system fails to supply sufficient broodstock, the Kendall Creek Hatchery chum salmon program will use seine netting in chum spawning grounds within the North Fork Nooksack sub-basin between November 1 and December 31. During this time, it is reasonable to assume that bull trout individuals will be incidentally captured in the North Fork Nooksack sub-basin and handled during seine netting efforts. Seine netting is likely to result in entanglement and handling of bull trout, leading to adverse effects on bull trout such as injury and delayed mortality. Bull trout may be injured in seines if they become tangled in the net or if they attempt to squeeze through the mesh and scrape their gills along the net (also referred to as "gilling"). The likelihood of injury via gilling depends on the seine net mesh size as well as the size of fish anticipated to be in the area. Some small juvenile fish may be small enough to slip through the mesh without their gills touching the net, and other larger subadults and adults may be too large to attempt to squeeze through the mesh.

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 (Kendall Creek Hatchery staff will not use gill nets, which are more injurious than seines). The authors concluded that the risk of immediate mortality is less than five percent when entanglement and handling times are short (Patterson et al. 2017, p. 78, p. 81; USFWS 2022, p. 55). Post-release mortality rates may increase to 17 percent, depending on the collection methodology, for slightly longer entanglement and handling times (USFWS 2022, p. 55). Kendall Creek Hatchery staff are experienced fish handlers (Co-managers, in litt., June 14, 2023) and will minimize handling time to the greatest extent possible when bull trout are encountered. They will record and report all bull trout encounters to the USFWS and will release all bull trout that are inadvertently captured during broodstock collection activities back into the river close to the collection site. Considering the seining methodology and measures to minimize handling times, 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 seine nets for in-river broodstock collection of adult chum salmon associated with the Kendall Creek Hatchery may be injured and/or killed. Since there is limited information regarding the extent of bull trout injury and mortality under a worst-case scenario for seining activities, we have used our best professional judgement to determine 25 percent as a conservative expectation.

Given the extensive migration patterns and movements of bull trout in the North Fork Nooksack River sub-basin, it is likely that adult and subadult bull trout will be present in the vicinity of the Kendall Creek Hatchery during the periods of on-site broodstock collection (last week of May through September for Chinook salmon, mid-October through the end of January for coho salmon, and November 1 to December 31 for chum salmon). A proportion of these bull trout could move into the adult trap and remain in the holding pond for up to four days. In consideration of this possibility and the co-managers' best professional judgment, the USFWS estimates that up to five adult and/or subadult bull trout per year will be adversely affected by the adult trap and holding pond at the Kendall Creek Hatchery (NMFS 2023, p. 40), and, of these, one bull trout per year will die (direct or delayed mortality from stress, injury, infection, etc.).

The USFWS expects up to a 25 percent mortality rate for bull trout bycatch resulting from in-river seine netting for chum salmon at the Kendall Creek Hatchery. Based on our best professional judgement, the USFWS expects that up to two adult bull trout per year will be captured during in-river broodstock collection seine netting efforts associated with the Kendall Creek Hatchery, and, of these, one adult bull trout will die as a result of immediate or delayed mortality.

Skookum Creek Hatchery

The Skookum Creek Hatchery operates an adult trap and brood pond on Skookum Creek, a tributary of the South Fork Nooksack River, from July 1 to September 30 for collection of Chinook salmon broodstock. The hatchery also operates the adult trap and brood pond from October through November, and potentially through February 1, for collection of coho salmon broodstock. Hatchery staff will check the holding pond every four days and will transport non-target fish in a tote back to the South Fork Nooksack at the Saxon Bridge (1 mile away) (Co-managers, in litt., June 14, 2023).

If on-site broodstock collection via the adult trap does not produce sufficient broodstock, the Skookum Creek Hatchery Chinook and coho programs will use in-river emergency broodstock collection methods. In-river broodstock collection for adult Chinook salmon will occur between July 1 and October 10 in the South Fork Nooksack River (from RM 0.0 to RM 25.0) and South Fork Nooksack River tributaries (Co-managers, in litt., June 14, 2023). Collection methods may include seine nets, block nets, tangle nets, weirs, or other traps (NMFS 2023, p. 12). The channel-spanning weir may be operated between RM 0.0 and RM 14.5 of the South Fork Nooksack River (Co-managers, in litt., June 14, 2023). In the event that emergency warrants restarting a captive brood program, hatchery staff may also collect juvenile Chinook using seine net varieties or tangle nets in the between South Fork Nooksack between RM 0.0 and RM 25.0 from March to June (Co-managers, in litt., June 14, 2023). Additionally, coho salmon in-river broodstock collection will occur between November 1 and January 31 in the mainstem South Fork Nooksack River (from RM 0.0 to 25.0) and in the South Fork Nooksack tributaries (Edfro, Cavanaugh, Fobes, Plumbago, Deer, and Roaring Creek and unnamed tributaries at RM 20.3, RM 21.3, and RM 22.2). In-river collection methods will include weirs, seine nets, or hook and line (WDFW et al. 2021, p. 13). For both Chinook and coho in-river broodstock collection, hatchery staff will decide the exact net type and set duration at the time of collection based on the fish abundance, river flow, and location, and weirs will be reserved for use only in the South Fork tributaries (WDFW et al. 2021, p. 12).

Broodstock collection of Chinook and coho salmon associated with the Skookum Creek Hatchery is likely to result in the incidental capture and handling of bull trout, both via the on-site adult trap and the in-river netting and weir operation. Bull trout have been sporadically observed in the South Fork Nooksack River sub-basin, but numbers are consistently low, suggesting limited abundance of bull trout in the area (WDFW et al. 2021, p. 29). Skookum Creek and the South Fork Nooksack River provide FMO habitat for bull trout, and upstream areas of Skookum Creek (upstream 3.5 km [2.2 mi]) provide bull trout spawning and rearing habitat (USFWS 2010, p. 91). At the Skookum Creek Hatchery, five bull trout were encountered in the holding ponds in 2015, presumably feeding on hatchery smolts (Co-managers, in litt., June

14, 2023). Given that all prior bull trout encounters at the Skookum Creek Hatchery were limited to a single year and that the South Fork Nooksack River sub-basin likely has a small population of bull trout overall, the USFWS anticipates that broodstock collection efforts in Skookum Creek and the South Fork Nooksack River will capture, injure, and/or kill a low number of bull trout. Given the timing of broodstock collection efforts, the USFWS anticipates that both broodstock collection via hatchery traps and holding/brood ponds as well as in-river broodstock collection via hook-and-line and netting are most likely to capture adult and/or subadult bull trout that are either foraging, migrating, and/or overwintering in the South Fork Nooksack River and associated tributaries.

While we expect that collection practices and protocols will minimize the risk of injury and delayed mortality, we anticipate a minimal level of incidental capture and handling of bull trout associated with Skookum Creek Hatchery Chinook and coho salmon broodstock collection, both via hatchery traps and holding/brood ponds as well as in-river collection via netting and hook-and-line. Similar to the adverse effects predicted at the Kendall Creek Hatchery (refer to prior subsection), potential adverse effects resulting from operation of the adult trap and holding/brood pond infrastructure at the Skookum Creek Hatchery include holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. Likewise, adverse effects of in-river emergency broodstock collection on bull trout in the South Fork Nooksack River and associated tributaries include entanglement and handling, resulting in injury and immediate and/or delayed mortality.

Given the likely low abundance of bull trout in the sub-basin and the limited number of previous bull trout observations at the hatchery, the USFWS expects a low number of adult and subadult bull trout will be present in the vicinity of the Skookum Creek Hatchery during the periods of broodstock collection for the two hatchery programs. A proportion of these bull trout could move into the adult trap and remain in the holding pond for up to four days. In consideration of this possibility, the USFWS estimates that up to five adult and/or subadult bull trout per year will be adversely affected by the adult trap and holding pond associated with the Skookum Creek Hatchery (WDFW et al. 2021, p. 40), and, of these, up to two bull trout will die due to direct or delayed mortality (i.e., from stress, injury, infection, etc.).

The USFWS expects up to a 25 percent mortality rate for bull trout bycatch resulting from in-river netting for Chinook and coho salmon associated with the Skookum Creek Hatchery programs. We expect a very low mortality rate associated with hook-and-line collection efforts, since bull trout will be quickly released close to the collection site. Considering the collection methods and low abundance of bull trout in the area, the USFWS expects that up to five adult and/or large subadult bull trout per year will be adversely affected by in-river netting and hook-and-line efforts and, of these, two bull trout will die (immediate or delayed mortality).

Samish River Hatchery

The Samish River Hatchery operates an adult trap and holding/brood pond on the Samish River (RM 10.5) from September 1 to October 31 for collection of Chinook salmon broodstock. A collapsible weir directs fish into a ladder and subsequent holding pond (WDFW et al. 2021, p.

12). The collapsible weir has a fish ladder built into it, and a bypass tube allows for non-target fish like bull trout to be passed 150 yards upstream (Co-managers, in litt., June 14, 2023).

At the Samish River Hatchery, collection of adult Chinook and coho salmon for broodstock is likely to result in the incidental capture and handling of bull trout. While no encounters of bull trout have been reported at the Samish River Hatchery, bull trout have been documented in the Samish River (WDFW et al. 2021, p. 39). There is no known bull trout spawning in the Samish River basin (WDFW et al. 2021, p. 29), but habitat is adequate for FMO use, limiting use to older and larger bull trout including adults and subadults (WDFW et al. 2021, p. 29). During September and October when broodstock collection will occur, bull trout will likely be in the process of migrating to spawning grounds in other nearby basins, so the number of bull trout remaining in the Samish River FMO habitat will likely be low. Thus, while we expect that collection practices and protocols will minimize the risk of injury and delayed mortality, the USFWS anticipates that broodstock collection efforts in the Samish River will capture, injure, and/or kill a low number of adult or subadult bull trout. Similar to the adverse effects predicted at the Kendall Creek Hatchery (see previous subsection for more detail), potential adverse effects of hatchery trap and holding/brood pond infrastructure at the Samish River Hatchery include holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality.

While bull trout abundance in the Samish River will likely be low during September and October, it is likely that some adult and subadult bull trout will be present in the vicinity of the Samish River Hatchery during the periods of broodstock collection. A proportion of these bull trout could move into the adult trap and remain in the holding pond for up to four days. In consideration of this possibility and our best professional judgment, the USFWS estimates that up to five adult and/or subadult bull trout per year will be adversely affected by the adult trap and holding pond associated with the Samish River Hatchery (WDFW et al. 2021, p. 40), and, of these, up to two bull trout per year will die (direct or delayed mortality from stress, injury, infection, etc.).

Whatcom Creek Hatchery

The Whatcom Creek Hatchery operates an adult trap, fish ladder, and brood pond on Whatcom Creek from August 1 to December 15 to collect Chinook salmon broodstock and from October 15 to December 15 to collect chum salmon broodstock. There is no weir blocking the river or forcing fish to the trap, and fish volitionally enter the holding pond through a fish ladder (WDFW et al. 2021, p. 13). If bull trout are inadvertently encountered in the trap, then hatchery staff will transport the fish in a portable fish tube and release them upstream of Whatcom Falls (200 yards upstream of brood pond) (WDFW et al. 2021, p. 14; Co-managers, in litt., June 14, 2023).

The Whatcom Creek Hatchery chum salmon program also includes in-river emergency broodstock collection. In the event that the number of broodstock collected at the Whatcom Creek Hatchery is not sufficient to meet program objectives, broodstock for this program may be collected from Kendall Creek Hatchery using the same methods and protocols used for the North Fork Nooksack Chum program (WDFW et al. 2021, p. 14). In-river natural origin broodstock may be collected using seine nets from North Fork sub-basin chum spawning grounds between early November and late December (WDFW et al. 2021, p. 13). Seine nets will be used in areas of high chum abundance and will allow for the release of all non-target species, including bull trout (WDFW et al. 2021, p. 13).

At the Whatcom Creek Hatchery, broodstock collection of adult Chinook and chum salmon via the on-sit adult trap and holding pond is likely to result in the incidental capture and handling of bull trout. The hatchery is situated close to the outlet of Whatcom Creek into Bellingham Bay, and bull trout originating from a variety of nearby core areas frequently use Bellingham Bay as FMO habitat (USFWS 2010, p. 191; USFWS 2023, p. 48-49). While Whatcom Creek does not have a population of bull trout nor any bull trout spawning areas (WDFW et al. 2021, p. 49), adult, subadult, and juvenile bull trout use Whatcom Creek as FMO habitat, and adults/subadults may enter Whatcom Creek to prey on hatchery-origin fry and smolts (WDFW et al. 2021, p. 28, p. 47). In 2002, three subadult bull trout, approximately 8 inches to 9 inches long, were captured in the adult pond at the Whatcom Creek Hatchery during chum salmon broodstock collection (WDFW et al. 2021, p. 39). These bull trout were the first seen at the hatchery in approximately a decade, and they were released into Whatcom Creek upstream of the cascades (WDFW et al. 2021, p. 39).

Additionally, in-river chum broodstock collection for the Whatcom Creek Hatchery via seine netting in the North Fork Nooksack River is likely to result in the incidental capture and handling of a low number of bull trout. The upper North Fork Nooksack River bull trout population has approximately 100 adults based on incidental redd counts and available spawning habitat (WDFW et al. 2021, p. 29), and the North Fork Nooksack River provides bull trout spawning and rearing habitat upstream of its confluence with Maple Creek at RM 49.6 (WDFW et al. 2021, p. 49). However, bull trout have not historically been encountered during chum broodstock collection using seine nets in the North Fork Nooksack River (WDFW et al. 2021, p. 13).

Given that bull trout use Whatcom Creek and the adjacent Bellingham Bay nearshore as FMO habitat, the USFWS anticipates that on-site broodstock collection via the adult trap and holding pond at the Whatcom Creek Hatchery will capture, injure, and/or kill bull trout. Additionally, the USFWS expects that in-river broodstock collection using seine nets in the North Fork Nooksack River will also capture, injure, and/or kill a low number of bull trout. Considering the timing of broodstock collection efforts, the USFWS anticipates that both on-site and in-river broodstock collection efforts will most likely affect adult and/or subadult bull trout that are foraging, migrating, and/or overwintering in Whatcom Creek and the North Fork Nooksack River. Similar to those adverse effects predicted at the Kendall Creek Hatchery (see previous subsection for more detail), potential adverse effects of hatchery trap and holding pond infrastructure at the Whatcom Creek Hatchery include holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. Adverse effects of in-river emergency broodstock collection on bull trout in the North Fork Nooksack River and associated tributaries include entanglement and handling, resulting in injury and immediate and/or delayed mortality.

Overall, the USFWS expects that adult and subadult bull trout will be in the vicinity of the Whatcom Creek Hatchery during broodstock collection, and a proportion of these bull trout could move into the adult trap and remain in the holding pond for up to four days. We thus estimate that up to five adult and/or subadult bull trout per year will be adversely affected by the adult trap and holding pond associated with the Whatcom Creek Hatchery (WDFW et al. 2021, p. 40), and, of these, up to two bull trout will die (direct or delayed mortality from stress, injury, infection, etc.).

The USFWS expects up to a 25 percent mortality rate for bull trout bycatch resulting from in-river netting for chum salmon in the North Fork Nooksack River associated with the Whatcom Creek Hatchery. Considering this mortality rate and the presence of bull trout in the North Fork Nooksack River, the USFWS expects that up to two adult and/or large subadult bull trout per year will be adversely affected by in-river netting and hook-and-line efforts and, of these, one adult and/or large subadult bull trout will die as a result of immediate or delayed mortality.

Lummi Bay Hatchery

The Lummi Bay Hatchery programs for Chinook, coho, and chum salmon collect their broodstock mainly via the operations of other hatchery facilities. For the Lummi Bay Hatchery Chinook salmon program, broodstock are collected annually at Kendall Creek Hatchery's adult trap and holding pond, typically from last week of May through September (WDFW et al. 2021, p. 12). For the Lummi Bay Hatchery's coho program, broodstock is captured at the Skookum Creek Hatchery from October through November (WDFW et al. 2021, p. 13). In the event that Skookum Creek Hatchery cannot collect enough broodstock to meet both programs' combined objectives, a portion or all coho broodstock collection may occur at Lummi Bay Hatchery from mid-September to mid- November via operation of an adult trap and holding pond (WDFW et al. 2021, p. 13). For the Lummi Bay Hatchery chum program, broodstock is currently collected from the Whatcom Creek or Kendall Creek hatcheries. As the number of returning adults increase to Lummi Bay Hatchery, broodstock will also be collected from Lummi Bay Hatchery from October 1 to December 15 (WDFW et al. 2021, p. 14).

All Chinook, coho, and chum salmon broodstock collection associated with the Lummi Bay Hatchery (i.e., at the Kendall Creek Hatchery, the Skookum Creek Hatchery, the Whatcom Creek Hatchery, and the Lummi Bay Hatchery) is likely to result in the incidental capture and handling of bull trout. However, anticipated bull trout captures from broodstock collection operations for the Kendall Creek Hatchery, the Skookum Creek Hatchery, and the Whatcom Creek Hatchery are accounted for in the respective analyses for each hatchery, so only anticipated adverse effects associated with coho and chum broodstock collection at the Lummi Bay Hatchery will be addressed in this section.

Bull trout have been documented in nearshore areas around Lummi Island (USFWS 2010, p. 191). Lummi Bay Hatchery is not located in a watershed containing spawning habitat for bull trout (WDFW et al. 2021, p. 49), limiting use of surrounding areas to adults and subadults. Although no encounters of bull trout have been reported at the Lummi Bay Hatchery (WDFW et al. 2021, pp. 39-40), the documented presence of bull trout in Lummi Bay leads the USFWS to expect that a low number of bull trout will be encountered during broodstock collection efforts at the Lummi Bay Hatchery. While we expect that collection practices and protocols will minimize the risk of injury and delayed mortality, we anticipate that there will be incidental capture and handling of bull trout resulting from on-site Lummi Bay Hatchery coho and chum salmon broodstock collection. Similar to those adverse effects predicted at the Kendall Creek Hatchery (see previous subsection for more details), potential adverse effects of broodstock collection at the Lummi Bay Hatchery include holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. Considering these factors, the USFWS estimates that up to five adult and/or subadult bull trout per year will be adversely affected by the adult trap and holding pond associated with the Lummi Bay Hatchery (WDFW et al. 2021, p. 40), and, of these, up to two bull trout will die (direct or delayed mortality from stress, injury, infection).

11.1.2.2 Fish Exclusion for Annual Dredging

At the Samish River Hatchery, hatchery staff will annually dredge above and below the hatchery intake on the Samish River for one day between August 1 and September 15 (WDFW et al. 2021, p. 43; Co-managers, in litt., June 14, 2023). Before beginning sediment removal, a fish exclusion team will exclude fish from the dredge area using a combination of crowding fish out (or herding) using block nets, creating an enclosure with the block nets, seining/dipnetting, and electrofishing to remove any remaining fish from the enclosure (WDFW et al. 2021, p. 43; Co-managers, in litt., June 14, 2023). Electrofishing will be employed only after all other means of fish capture and removal have been exhausted, and only after a qualified biologist determines that all or nearly all of the adult and subadult-sized fish have been effectively removed. Only biologists trained by qualified personnel and familiar with equipment handling, settings, maintenance, and safety may operate the electrofishing equipment. When operating electrofishing equipment, hatchery staff shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, and they shall measure water conductivity in the field before electrofishing in order to determine appropriate settings.

Due to the elevated potential for fish injury and mortality as compared to other fish exclusion techniques, electrofishing is typically used as a last resort to remove fish. The process involves passing an electrical current through water to immobilize fish and facilitate their capture and removal from the in-water work area (USFWS 2017a, p. 48). The process of running an electrical current through the water can cause a range of effects on fish, including annoyance, startle, or avoidance behavior; temporary immobility; physical injury; and, mortality (USFWS 2017a, p. 48). The amount of unintentional injury or mortality attributable to electrofishing can vary widely, depending upon the equipment used, settings used, waveform produced, site conditions (e.g., clarity of water and visibility), and the expertise of the operator (Dalbey et al. 1996, pp. 566-567; Dwyer and White 1997, p. 174; Sharber and Carothers 1988, p. 117; USFWS 2017a, p. 48). Accidental contact with the electrodes is a frequent cause for physical injury or mortality (USFWS 2017a, p. 48). When fish capture operations use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, shocked fish normally revive quickly (USFWS 2017a, p. 48). Continuous direct current or low frequency pulsed direct current (equal or less than 30 Hz) have been recommended for electrofishing because lower spinal injury rates, particularly in salmonids, have resulted from these waveforms (Dalbey et al. 1996, p. 568; USFWS 2017a, p. 48).

Due to their large size and surface area, adult salmon are more susceptible to severe impacts from electrofishing, such as injury and mortality (USFWS 2017a, p. 48). Injuries can include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns, and these injuries may cause delayed mortality (Dalbey et al. 1996, p. 560; Hollender and Carline 1994, pp. 646-648; Thompson et al. 1997, p. 144; USFWS 2017a, p. 48). Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. Most studies on the effects of electrofishing have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996, all; USFWS 2017a, p. 48). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish (USFWS 2017a, p. 48). Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988, p. 121) and may therefore experience lower injury rates (Dalbey et al. 1996, p. 567; Thompson et al. 1997, p. 151; USFWS 2017a, p. 48). McMichael et al. (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River (p. 901).

Although the long-term effects of electrofishing on adult and juvenile salmonids are not well understood, long experience with electrofishing indicates that most measurable effects occur at the time of fish capture operations and are of relatively short duration (USFWS 2017a, p. 48). Only a few studies have examined the long-term effects of electrofishing on salmonid survival and growth (Ainslie et al. 1998, all; Dalbey et al. 1996, all), and these studies indicate that although some fish suffer spinal injury, few die as a result (USFWS 2017a, p. 48). However, severely injured fish grow at slower rates and sometimes exhibit no growth at all (Dalbey et al. 1996, p. 567; USFWS 2017a, p. 48).

While adult salmonids face an increased risk of injury and mortality from electrofishing due to their large body size and surface area, it is possible that juvenile salmonids may also face increased risk of severe impacts since their small body size may allow them to seek refugia within the area of electrofishing instead of fleeing the area. Because of their small body size, small juveniles may be able to seek refugia by hiding in the gravel or in small crevices within features such as root mounds during electrofishing activities. Adult and subadult salmonids with larger body sizes (i.e., older than one year and larger than 150 mm; with variation dependent on species) are too large to seek refuge in gravels and are generally easier to detect, herd, seine, and/or net, although some adults and subadults may hide under vegetation or other cover (e.g., cut banks, rootwads, etc.) (USFWS 2017a, p. 49). Since juveniles can hide in the gravel, it is our best professional opinion that they may be more likely to go unnoticed by hatchery staff during fish exclusion efforts and may be more likely to be exposed to repeated electroshocks, thus increasing the risk of injury and mortality.

While the USFWS expects that fish exclusion protocols will minimize the risk of injury and delayed mortality, we anticipate that block netting, seining, dipnetting, and electrofishing prior to dredging are likely to result in the incidental capture and handling of bull trout, which will cause adverse effects such as holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. However, dredging and fish exclusion above and below the hatchery intake will occur at a time of year (from August 1 to September 15) when bull trout presence in the Samish River will be low (WDFW et al. 2021, p. 44). During August and September, most anadromous bull trout are likely to have migrated out of FMO habitat into rivers and streams with spawning habitat (Goetz et al. 2021, p. 1083). While the Samish River is adequate for FMO use, there is no known bull trout spawning habitat in the Samish River basin, limiting use to adult and subadult bull trout (WDFW et al. 2021, p. 29). Given the timing of dredging and the migration patterns of bull trout, the USFWS anticipates that most bull trout will have migrated out of the Samish River FMO habitat by August and September. However, a low number of adult and subadult bull trout may still be in the Samish River during fish exclusion and dredging. Considering this possibility, the USFWS estimates that up to five adult and/or subadult bull trout in a five-year period will be adversely affected by capture and handling associated with fish exclusion efforts for dredging in the Samish River, and, of these, up to three bull trout in a five-year period will die (direct or delayed mortality from stress, injury, infection, etc.).

11.1.2.3 Research, Monitoring, and Evaluation

Co-managers will carry out an RM&E program in the Nooksack River basin to monitor juvenile Chinook salmon released from the Kendall Creek Hatchery, the McKinnon Pond facility, and the Skookum Creek Hatchery. The RM&E program will include the following elements: 1) operation of a 5 ft rotary screw trap for smolt collection in the South Fork Nooksack River; 2) beach seining in the South Fork Nooksack River; 3) seining in the Middle Fork and North Fork Nooksack Rivers; and, as a last resort if seining is not feasible, 4) electrofishing in the Middle Fork and North Fork Nooksack Rivers (Co-managers, in litt., December 1, 2023).

In the South Fork Nooksack River, hatchery staff will operate the smolt trap at RM 8.7 from March 1 to December 31 annually, except when water temperatures exceed 19 °C (typically occurs between July 1 and August 30) (Lummi Indian Nation 2021, p. 20). Seining events are expected to occur in all portions of the South Fork Nooksack River sub-basin accessible to anadromous salmonids (Lummi Indian Nation 2021, p. 19). In the North Fork and Middle Fork Nooksack River basins, all suitable locations within reaches accessible to adult Chinook are considered for seining (Co-managers, in litt., Dec. 1, 2023). Since river geomorphology is prone to change on an annual basis, and because scientific understanding of Chinook distribution advances over time, exact seining locations in the North Fork and Middle Fork Nooksack may vary over time (Co-managers, in litt., Dec. 1, 2023). While juvenile Chinook monitoring will occur between March 1 and December 31 annually, nearly all collections will occur between March 1st and June 30th (Co-managers, in litt., Dec. 1, 2023).

Although juvenile Chinook salmon are the primary target of the RM&E program, all other salmonids endemic to the Nooksack River basin are will likely be encountered in their respective habitats and accessible reaches, including bull trout (Co-managers, in litt., Dec. 1, 2023). Since the Nooksack River basin is considered CH for bull trout, smolt trapping and seining efforts are likely to result in the incidental capture and handling of bull trout. Between 2007 and 2012, 129 bull trout were captured during RM&E seining activities in the Nooksack River basin (Morgan Robinson, in litt., November 29, 2023). The Nooksack River basin contains bull trout spawning and rearing habitat, and thus bull trout in any life stage may be encountered during smolt trapping and seining activities (Co-managers, in litt., Dec. 1, 2023). However, existing data show that small adults and large subadults are most likely to be encountered (Co-managers, in litt., Dec. 1, 2023). Juvenile bull trout have also been encountered during summer fish exclusion projects conducted in the North Fork Nooksack River by the Nooksack Tribe (Co-managers, in litt., Dec. 1, 2023). The bull trout encountered during these efforts were generally older juveniles (one year or older), though some young-of-year bull trout were observed in a North Fork project near the Maple Creek confluence (Co-managers, in litt., Dec. 1, 2023). In a project near the Kendall Creek Hatchery, only older juveniles were encountered (Co-managers, in litt., Dec. 1, 2023). While co-managers have not encountered bull trout in lower South Fork Nooksack projects, the area is considered foraging and migration habitat with spawning habitat located higher in the watershed, and the temperatures during the time of observation were warmer than optimal for bull trout (Co-managers, in litt., Dec. 1, 2023).

In general, capture and handling of bull trout will cause adverse effects on bull trout such as holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. Effects specific to operation of the rotary screw trap, seining activities, and electrofishing are discussed individually below.

Rotary Screw Trap

If bull trout are captured in the South Fork Nooksack smolt trap, the bull trout will likely experience stress if retained for a long period of time while crowded in the trap with a high density of other fish. However, co-managers will implement smolt trap operation protocols to reduce the time that fish are retained in a crowded trap. On-site field staff will monitor catch rates and adjust the frequency of trap checks, as needed, based on current catch observations. If catch rates are high based on the co-managers' best professional opinion, then hatchery staff will check the trap during the night every two hours or less. If catch rates are low based on the co-managers' best professional opinion, then hatchery staff will check the trap the following morning. Bull trout may be caught in the smolt trap for up to 22 hours, but this maximum length of entrapment would only occur when low densities of fish are in the trap. Entrapment of bull trout in the smolt trap could also delay their migration by up to 22 hours, potentially resulting in lost reproductive opportunities. Hatchery staff will have to handle bull trout to remove them from the trap, record their length, collect samples (tissue sample for genetic analysis, scale samples), and return them to the river. While hatchery staff will implement procedures to minimize handling time, bull trout caught in the smolt that undergo capture, handling, and sample collection will experience adverse effects such as holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. For fish handled at the trap, the co-managers anticipate ≥ 97.0 percent immediate survival (i.e., ≤ 3.0 percent mortality) and ≤ 1.0 percent immediate incidental mortality at the trap (Lummi Indian Nation 2021, p. 19).

Seining

Seining activities can injure fish if they become entangled in the net or if they attempt to squeeze through the net mesh and scrape their gills (also referred to as "gilling"). The likelihood of injury via gilling depends on the seine net mesh size as well as the size of fish anticipated to be in the area. Some small juvenile fish may be small enough to slip through the mesh without their gills touching the net, and other larger adults and subadults may be too large to attempt to squeeze through the mesh. However, a subset of fish may be small enough to attempt to squeeze through the mesh, but large enough that their gills scrape along the net as they exit, thus damaging their gills. The beach seines proposed for use during seining in the South Fork Nooksack River activities are 2 meters (m) by 9 m, 1/8-inch braided mesh (Lummi Indian Nation 2021, p. 19), and this mesh size is smaller than the body width (including gills) of any bull anticipated to be in the area during beach seining. Additionally, the seine nets proposed for use during seining in the Middle Fork and North Fork Nooksack Rivers are 1/8-inch braided mesh.

Regarding any bull trout captured during seining activities, trained hatchery staff will handle the bull trout in order to remove them from the seines, record their length, collect tissue and scale samples, and return them to the river. While hatchery staff will implement procedures to minimize handling time for fish caught in seines, capture, handling, and sample collection during seining activities will cause bull trout to experience adverse effects such as holding and avoidance, severe and prolonged stress, injury, and immediate and/or delayed mortality. For fish handled during RM&E seining activities, the co-managers anticipate ≥ 97.0 percent immediate survival (i.e., ≤ 3.0 percent mortality) and ≤ 1.0 percent immediate incidental mortality (Lummi Indian Nation 2021, p. 19).

Electrofishing

In tributaries where beach seining is not feasible, the co-managers propose to use electrofishing as a last resort for juvenile Chinook monitoring. As discussed previously in Section 11.1.2.1.2, electrofishing can injure and kill bull trout, and injuries may include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns (Dalbey et al. 1996, p. 560; Hollender and Carline 1994, pp. 646-648; Thompson et al. 1997, p. 144). Large adult bull trout may be particularly susceptible to severe injury from electrofishing due to their large body size and surface area (McMichael et al. 1998, p. 894; Snyder 2003, pp. 79-80), and small juveniles may also particularly susceptible to mortality due to their potential capacity to seek refugia within the gravels of the electrofishing site.

Based on our best professional opinion, the USFWS estimates that up to 100 juvenile, subadult, or adult bull trout per year will be adversely affected by the smolt trap operation and seining activities combined. Of these, we expect that up to three bull trout will die per year (direct or delayed mortality from stress, injury, infection, etc.). The USFWS also expects that up to 50 juvenile, subadult, or adult bull trout per year will be adversely affected by the RM&E electrofishing activities. Based on our best professional opinion, we anticipate that up to five bull trout will die per year as mortalities associated with electrofishing.

Impingement and Entrainment (Skookum Creek Hatchery)

As discussed in Section 11.1.1.2, surface water intakes can be a source of entrainment and/or impingement of bull trout if they are unscreened, poorly designed, and/or poorly placed (USFWS 2022, p. 41). Entrainment or impingement at a surface water intake can result in bull trout injury or mortality if strong flows pin an individual against an intake screen or other structure, or if an individual becomes trapped in an area unsuitable for survival. Small subadult and juvenile bull trout are most likely to become impinged or entrained, as their small size makes it more difficult to escape from strong flows (USFWS 2022, p. 42).

Intake screens are designed to minimize the risk of juvenile fish injury and mortality through entrainment and impingement. However, intake screens at the Skookum Creek Hatchery, which is located at RM 14.3 on the South Fork Nooksack River, are currently not compliant with Anadromous Salmonid Passage Facility Design Criteria (NMFS 2022) due to potential for duration of entrainment before being able to swim back to stream (Co-managers, in litt., June 14, 2023). There is documented bull trout rearing habitat in the immediate vicinity of the hatchery, as well as upstream and downstream from the hatchery (Figure 24; NWIFC 2023; WDFW et al. 2021, p. 47). There is also documented spawning habitat downstream (Hutchinson Creek) and upstream of the hatchery (e.g., Howard Creek, Wanlick Creek, unnamed tributary) (Figure 14; NWIFC 2023; WDFW et al. 2021, p. 47; USFWS 2010, pp. 90-91). The spawning area nearest to the hatchery is Hutchinson Creek, which is approximately four to five RMs downstream (NWIFC 2023). Because there are both rearing and spawning habitats in relatively close proximity to the hatchery, there is potential for juvenile bull trout to be near the intake structures at the Skookum Creek Hatchery. Since the intake screens at the Skookum Creek Hatchery are not compliant with Federal standards, they pose a heightened entrapment risk for nearby juvenile salmonids. Therefore, the USFWS expects that juvenile bull trout will become impinged or entrained at the Skookum Creek Hatchery intake structures.

Five adult bull trout were observed at the Skookum Creek Hatchery yearling pond outfall channel in 2015, and no bull trout have been observed within the hatchery prior to, or since, 2015 (WDFW et al. 2021, p. 45). While bull trout observations at the Skookum Creek Hatchery are limited to a single year and the adult life stage, juvenile bull trout near the hatchery may go unnoticed due to their small size. In consideration of these factors, the USFWS expects that up to five small subadult and juvenile bull trout per year will be impinged or entrained at the Skookum Creek Hatchery intake structures.

11.1.3 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 Nooksack and Samish River basins limit the contribution of nutrients in the Nooksack and Samish Rivers and associated tributaries. Hatchery-origin Chinook and coho carcasses could provide some of these aforementioned ecosystem services. Despite low bull trout populations levels in comparison to historical levels in the action area, the USFWS expects to see modest beneficial effects to bull trout resulting from increased salmonid biomass.

Hatchery-released fish may produce a limited, direct forage benefit to adult and subadult bull trout in the Nooksack and Samish River basins. In freshwater, adult and subadult bull trout are likely to consume hatchery released salmonids. However, the hatchery programs are designed to ensure that released smolts rapidly outmigrate to marine waters. Thus, the temporal availability of hatchery smolts as prey for bull trout is somewhat limited given the rapid outmigration, since most hatchery-released salmonids emigrate seaward within a few weeks of release (USFWS 2022, p. 59).

Returning hatchery-origin Chinook and coho salmon that spawn naturally in the Nooksack and Samish River basins 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, p. 937; Zimmerman and Kinsel 2010, p. 24; USFWS 2022, p. 59). 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, pp. 734-735).

According to the information provided in the BA (WDFW et al. 2021, pp. 9-10), the hatchery programs will collectively produce approximately 14,100,000 Chinook salmon, 3,500,000 coho salmon, and 17,000,000 coho salmon, which will be annually released into rivers and streams throughout the Nooksack and Samish River basins and into the Puget Sound. These hatchery-released juveniles will provide additional prey resources for bull trout, thereby positively contributing to their overall survival, growth, and reproductive success, and ultimate recovery.

11.2 Effects on Designated Critical Habitat for the Bull Trout

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 CH for bull trout uses the term PCE. The new CH regulations (81 FR 7214) replace this term with 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 CH.

The proposed action will result in insignificant or discountable effects to springs/seeps/groundwater (PCE 1), habitat complexity (PCE 4), thermal refugia (PCE 5), spawning habitat (PCE 6), natural hydrograph (PCE 7), and water quality (PCE 8) in the action area; adverse effects on the migratory corridor (PCE 2); and, beneficial effects on the availability of forage fish (PCE 3). The proposed action will have no effect the lack of non-native predators and competitors (PCE 9).

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.

The twelve hatchery programs and facilities will use water non-consumptively. All water used by the hatcheries is returned to the river within 1,000 ft from the point of withdrawal (WDFW et al. 2021, p. 47). All water used by the Kendall Creek and Samish hatcheries is returned to the river within approximately 400 ft to 500 ft of the points of withdrawal, while at McKinnon Pond water is released 250 ft from the intake location (WDFW et al. 2021, pp. 47-48). At the Skookum Creek Hatchery, all water is returned to the South Fork Nooksack adjacent to the junction of Skookum Creek and the South Fork Nooksack River (WDFW et al. 2021, pp. 47-48). Since all 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 40 cfs), then water use from these streams will have no measurable effect on groundwater recharge. No stream reaches will be dewatered to the extent that natural-origin fish spawning, migration, and rearing would be impaired, and there will be no net loss of water quantity in river or tributary flows (WDFW et al. 2021, pp. 47-48). Because water use at hatchery facilities is lower in the late summer and early fall, there are no large areas of stream dewatering associated with these facilities during seasonal low flows (WDFW et al. 2021, pp. 47-48). 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.

Traps and weirs used for on-site broodstock collection at the hatchery facilities can serve as permanent or temporary barriers to fish movement and block connectivity to spawning, rearing, overwintering, and freshwater and marine foraging habitats (PCE 2). The Kendall Creek, Samish River, Skookum Creek, Glenwood Springs, Lummi Bay, and Whatcom Creek hatcheries all have on-site hatchery trap and pond systems to collect broodstock. At the Skookum Creek, Glenwood Springs, Lummi Bay, and Whatcom Creek hatcheries, there is no weir blocking the river or forcing fish to the trap (WDFW et al. 2021, p. 13), and thus no temporary or permanent barrier to fish passage. However, a permanent weir spanning the river at the Kendall Creek Hatchery permanently obstructs fish passage, and a collapsible weir at the Samish River Hatchery temporarily obstructs fish movement when it is open (WDFW et al. 2021, p. 12). All weirs and traps, when operated, are checked at least daily (WDFW et al. 2021, p. 48). Any bull trout encountered are released immediately so that migration is not physically impeded for more than 24 hours (WDFW et al. 2021, p. 48). Temporary weirs, when not operated, are dismantled or open to allow for not obstructed migration (WDFW et al. 2021, p. 48). Because the two weirs present a permanent barrier (Kendall Creek Hatchery) and a temporary, seasonal barrier (Samish River Hatchery) to migration and will preclude the PCE from functioning either permanently or during the time of use, the USFWS considers that weirs used for on-site broodstock collection have adverse effects on this PCE.

Nets (tangle/block nets, seines) and temporary weirs used for in-river emergency broodstock collection activities can also serve as temporary barriers to fish movement and block connectivity. The co-managers will use nets and/or temporary weirs in Kendall Creek, the North Fork Nooksack River, the South Fork Nooksack River, tributaries of the South Fork Nooksack River (Edfro, Cavanaugh, Fobes, Plumbago, Deer, and Roaring Creek and unnamed tributaries at RM 20.3, 21.3, and 22.2), and independent streams (Chuckanut, Oyster, Colony, and Whitehall). Depending on the 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. In-river collection methods involving the use of nets, seines, and temporary weirs will partially preclude bull trout movement and migrations throughout the areas where fish will be captured for use in the 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.

Use of rotary screw traps and channel-spanning seine nets during RM&E activities can also serve as temporary barriers to fish movement and block connectivity. The co-managers will set up a rotary screw traps in South Fork Nooksack River (RM 8.7) and will operate the traps from March 1 to December 31 annually. Screw traps will be checked as frequently as every two hours when catch rates are high or as infrequently as every 22 hours when catch rates are low. Any bull trout encountered during checks will be immediately released within the immediate vicinity where captured. While the trap does not block fish passage along the river, it does present a partial, temporary migration barrier as it delays the migration of any bull trout captured in the trap by up to 22 hours. Additionally, co-managers will operate beach seines in the South Fork Nooksack River and seine nets in the Middle Fork and North Fork Nooksack River from March 1 to December 31 annually to monitor outmigrating hatchery smolts. Seining activities will create a temporary, intermittent, and/or seasonal barrier to fish migration in these rivers. Because the seining activities and smolt trap operation preclude the PCE from fully functioning during the time when they are in use, the USFWS considers the effects of RM&E evaluation 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.

The release of hatchery-origin smolts is likely to have a positive effect on bull trout by increasing the prey base in a variety of ways (WDFW et al. 2021, p. 48). Fish released from the hatcheries evaluated in this Opinion provide an addition of food to the forage base for adult and subadult bull trout (WDFW et al. 2021, p. 48). In addition, returning adult hatchery fish provide a source of marine derived nutrients after spawning when their carcasses decay (WDFW et al. 2021, p. 48). These nutrients benefit primary productivity, contributing to diversification of and enhancement at the lower levels of the food web, and provide for both direct and indirect food sources for juvenile bull trout (WDFW et al. 2021, p. 48). While hatchery staff will use herbicide to remove vegetation at the required distance from water bodies, routine maintenance activities required to operate and maintain hatchery facilities do not involve the removal of riparian vegetation or in-water work to a degree that could measurably affect terrestrial or aquatic macroinvertebrates, a prey resource for bull trout.

Overall, given the influx of available prey from hatchery-released smolts as well as the nutrient additions from decaying hatchery fish, the USFWS expects that the proposed action could contribute positively to 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 large wood, 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 hatchery facilities will alter or measurably affect habitat complexity in or near the hatchery facilities. Hatchery facilities affected the site-specific complexity of habitat when they were built (WDFW et al. 2021, p. 48). Protective armoring of banks and construction of weirs has occurred, which affect natural processes that provide complex habitat (WDFW et al. 2021, p. 48). However, the continued operation and maintenance of the facilities will not have any effect on habitat complexity (WDFW et al. 2021, p. 48). 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 all the hatchery facilities addressed in this Opinion, water temperatures must be cold enough to support rearing juvenile salmonids. Thus, the USFWS anticipates that temperatures in the hatchery facilities will 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. Any increase in temperature caused by water moving through the hatchery is generally undetectable as the water travels rapidly through the hatchery and is exposed to solar radiation for a short amount of time (WDFW et al. 2021, p. 48). Additionally, the USFWS expects that ground and surface water withdrawals for hatchery use will not measurably alter water temperature in the source water bodies, as water withdrawn is returned to the river in close proximity (WDFW et al. 2021, p. 48). For these reasons, effects on this PCE will not be measurable and are thus considered insignificant.

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

Operation and maintenance of the hatchery facilities being evaluated in this Opinion will have no effect on bull trout spawning substrate (WDFW et al. 2021, p. 49). The Samish, Whatcom Creek, Glenwood Springs, and Lummi Bay hatcheries are not located in watersheds containing spawning habitat for bull trout (WDFW et al. 2021, p. 49). The Kendall Creek, McKinnon Pond, and Skookum Creek facilities are located in watersheds with bull trout spawning habitat.

The closest bull trout spawning habitat to the Kendall Creek Hatchery is located approximately 3.6 miles (5.8 km) upriver from the facility. The North Fork Nooksack River provides spawning and rearing habitat upstream of its confluence with Maple Creek at RM 49.6 (WDFW et al. 2021, p. 49), and the Kendall Creek Hatchery is located downstream of this confluence at RM 46

(WDFW et al. 2021, p. 49). The upstream spawning and rearing areas are unaffected by downstream hatchery activities (WDFW et al. 2021, p. 49).

The McKinnon Pond facility (RM 4.4 on the Middle Fork Nooksack River) is located relatively near several streams identified as important streams for migratory bull trout foraging, and which are considered "potential" spawning and rearing habitat (WDFW et al. 2021, p. 47). These streams include Peat Bog Creek, Porter Creek, unnamed tributaries, and Canyon Lake Creek (WDFW et al. 2021, p. 47). However, these potential spawning and rearing areas are all upstream of the hatchery and are unaffected by downstream hatchery activities (WDFW et al. 2021, p. 47, 49).

Skookum Creek Hatchery is located at RM 14.3 on the South Fork Nooksack River. The South Fork Nooksack River from its confluence with the mainstem Nooksack River upstream approximately 64.4 km (40.0 mi) to its headwaters provides spawning and rearing habitat upstream of Wanlick Creek and combined spawning, rearing, and FMO habitat in its reaches downstream of Wanlick Creek (USFWS 2010, p. 91). Most bull trout spawning habitat in the South Fork Nooksack River sub-basin is upstream of the Skookum Creek Hatchery and will be unaffected by hatchery activities, but there is one spawning site downstream of the hatchery above the mouth of Hutchinson Creek (Figure 24; NWIFC 2023). However, any returning hatchery-origin salmon are likely to return to their release sites and are unlikely to disturb spawning substrates in Hutchinson Creek.

Considering these factors, the USFWS expects that hatchery operations at the three facilities in the Nooksack River basin are unlikely to result in measurable impacts to bull trout spawning habitat, and effects to this PCE are thus considered insignificant.

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.

Hatchery facilities will return almost all withdrawn water (excluding a minimal amount of evaporated water) back to the stream near the points of withdrawal, resulting in no net loss in river or tributary flow volume (WDFW et al. 2021 2023, p. 41). 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 will 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 effects of hatchery effluent discharge on bull trout are adequately minimized through compliance with federal and state permit requirements and the fact that the effluent is diluted before it enters the receiving waters (WDFW et al. 2021, p. 49). The area affected by hatchery discharges is relatively small and will not measurably impair water quality in CH or waterbodies that drain into CH. 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 twelve hatcheries 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.

Additionally, the USFWS expects that water withdrawals for use in hatchery operations will result in insignificant effects on water quantity. All water used by the hatcheries will be returned to the watercourses near the points of withdrawal (WDFW et al. 2021, p. 49). No stream reaches will be dewatered to the extent impairing natural-origin fish migration and rearing, and there will be no net loss in river or tributary flow volume (WDFW et al. 2021, p. 49). Thus, the USFWS expects that surface water used for hatchery programs and effluent discharges will have insignificant effects on water quality or quantity.

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

The 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.

11.3 Summary of Effects

11.3.1 Effects on Bull Trout

Since bull trout will be present in the action area during hatchery operations, the USFWS expects that adult, subadult, and juvenile bull trout will be exposed to hatchery activities. Insignificant or discountable effects to bull trout include migration delay, impacts to water quantity from water withdrawals, impacts to water quality from effluent discharge, sediment/debris release, herbicide use, ecological interactions with hatchery-origin fish (i.e., competition, predation), underwater noise, and outdoor artificial lighting. These effects are not likely to result in measurable impacts to bull trout or are unlikely to occur. Impingement and entrainment are considered discountable at each hatchery facility besides Skookum Creek Hatchery, where adverse effects to bull trout will occur due to the use of federally non-compliant intake screens and the facility's proximity to bull trout spawning and rearing habitat. Handling and capture associated with broodstock collection at the Glenwood Springs Hatchery is considered discountable due to the rarity of bull trout around Orcas Island. However, handling and capture associated with broodstock collection at all other hatchery facilities analyzed in this Opinion will result in adverse effects on bull trout, including injury and immediate/delayed mortality. Additionally, handling and capture associated with fish exclusion efforts (including herding, block netting, seining/dipnetting, and electrofishing) prior to dredging at the Samish River Hatchery and the RM&E program for juvenile Chinook monitoring (e.g., operation of a smolt trap, seining, and electrofishing) will also result in adverse effects on bull trout, including injury and immediate/delayed mortality. Adverse effects resulting from hatchery operation may minimally reduce the abundance of bull trout in the CRU. The effects of the action are not expected to be detectable at a scale larger than the impacted local populations.

11.3.2 Effects on Bull Trout Critical Habitat

The proposed action will result in temporary effects on springs/seeps/groundwater (PCE 1), thermal refugia (PCE 5), and water quality (PCE 8), but these effects are not anticipated to adversely affect the ability of bull trout to use the action area for spawning, rearing, foraging, migrating, and overwintering. Hatchery operations will have no effect on spawning and rearing habitat (PCE 6), the natural hydrograph (PCE 7), or populations of non-native predators and competitors (PCE 9). Habitat complexity (PCE 4) will be maintained in its current state. The proposed action will have adverse effects on the migratory corridor (PCE 2) and beneficial effects on the availability of forage fish (PCE 3).

The hatchery programs and facilities will use water non-consumptively and will return all water close to the point of withdrawal (excluding a minimal amount of water lost through evaporation), so the action will have no measurable impact on springs, seeps, or groundwater (PCE 1). The use of adult traps/holding ponds, permanent and temporary weirs, channel-spanning nets, and a rotary screw trap will serve as serve as permanent or temporary barriers to fish movement and block connectivity to spawning, rearing, overwintering, and freshwater and marine foraging habitats (PCE 2). The release of hatchery-origin smolts is likely to positively impact the availability of forage fish for bull trout (PCE 3), since bull trout may feed directly on the smolts, and the decaying carcasses of hatchery-origin fish provide nutrient inputs to the ecosystem. Habitat complexity (PCE 4) at hatchery sites was negatively impacted upon hatchery construction, but the continued operation and maintenance of the facilities will not have any effect on habitat complexity. Minor warming of the water may occur in rearing ponds prior to the water being discharged, but warming will be limited to a small mixing zone around the discharge point, and thus will not impact the presence of thermal refugia (PCE 5). Hatchery operations are unlikely to impact bull trout spawning and rearing habitat (PCE 6), as hatchery facilities are either located in basins that do not support bull trout spawning and rearing or are mainly located upstream of hatchery facilities in basins with spawning/rearing habitat. Hatchery facilities will return almost all withdrawn water (excluding a minimal amount of evaporated water) back to the stream near the points of withdrawal, and so will not impact the natural hydrograph (PCE 7) in the action area. While hatcheries will discharge substances in their effluent, the effects of hatchery effluent discharge on water quality (PCE 8) are adequately minimized through compliance with federal and state permit requirements, and reductions in water quality will be limited to a small mixing zone around the discharge point. Hatchery operations will not result in the introduction of, and/or measurable changes in, populations of non-native predatory, interbreeding, or competitive species (PCE 9).

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

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. We anticipate increased human population in the action area will result in further degradation on the physical and biological habitat features bull trout need to achieve recovery. We expect most of these effects will increase proportional to increasing residential and urban development.

Development trends in the Puget Sound have been remarkably consistent over the past 50 years. The average annual loss of farmland in the Puget Sound region from 1950 to 2007 was nearly 14,000 acres per year, with Whatcom County losing more than 100,000 acres of farmland during that period (Canty et al. 2012 p. 15). Most of this land has been developed for urban uses and rural estates. However, is likely to occur within UGAs managed by cities and municipalities. Increases in impervious surfaces, and their associated effects, will occur proportionally with the expected increases in residential and urban development. As a result, habitats close to urban areas will be slow to recover habitat conditions necessary for bull trout and are most likely to experience further reduction in habitat use by the species.

Human population growth will affect recovery of bull trout and CH for the bull trout. In general, population growth in the action area is likely to continue within UGAs of Bellingham, Everson, and Ferndale and surrounding areas. Whatcom County predicts growth will occur primarily in the Bellingham UGA (44 percent) and non-UGA areas (16 percent) (Whatcom County Planning and Development Services 2020 pp. 3–4). Predicted population growth is most likely to yield changes in water quality and stormwater delivery from increased impervious surfaces and transportation.

The Bellingham UGA is the most extensively developed portion of the action area. A large portion of the Bellingham UGA covers the lower Whatcom Creek watershed and is adjacent to Bellingham Bay. Habitat conditions are not only more degraded within UGAs as these areas become more developed and impervious surface increases. Thus, habitats within and adjacent to UGAs are most likely to experience further degradation in the future. Low-density residential growth near the Bellingham UGA is most likely to occur surrounding Lake Whatcom. The effects of residential sprawl in the Whatcom Creek watershed are most likely to manifest in degraded water quality from nutrient loading, increased water temperature, and altered hydrography. While water quality conditions in the Whatcom Creek watershed will be degraded throughout the year, increased growth in the Bellingham UGA is likely to increase and prolong the intensity of degradation during late spring to early fall months, when there is little precipitation. Water quality degradation will continue to decrease FMO habitat for bull trout in this portion of the action area.

As noted above, Whatcom County predicts growth in non-UGA areas within the Nooksack watershed will occur at slower rates than urban areas of the action area. Measured population growth in non-UGA zones is also likely to occur in other portions of the action area, such as the Samish River watershed and coastal areas. Population growth in non-UGA areas will yield increased water withdrawal and overallocation of groundwater sources. Adequate groundwater supply has been and is likely to remain an issue in the action area (e.g., Whatcom County *v* Western Washington Growth Management Hearings Board) (Washington State Supreme Court 2016).

Numerous partners are working to reduce water quality degradation in the action area. These include Washington State's departments of Agriculture and Health; the PSP; Skagit County's departments of Health, Planning, and Public Works; Skagit Conservation District; Tribal governments; and non-profit organizations. In particular, the WDOE and regional organizations is working to address degraded water quality conditions in the Samish River and other freshwater streams that flow into Samish Bay (WDOE 2010 pp. 1–4). The combined efforts of these partners have resulted in gradual, localized, and modest improvements in water quality within the Nooksack and Samish watersheds and nearshore marine habitats. However, it is uncertain whether the rate of water quality improvements will compensate for degradation from additional residential and urban development.

The aforementioned cumulative effects associated with increased human population in the action area will affect bull trout and habitat features for the species in several ways. State and county governments have slowly revised construction code that provide improved stormwater management (e.g., bioswales, stormwater collection facilities) for new residential and urban construction, most of which will occur within UGAs. We anticipate that newer stormwater management systems will reduce degraded water quality conditions and moderate stormwater delivery to some extent. However, improvements in stormwater treatment are likely to be offset by increasing quantities of nutrients and chemical contaminants resulting from human population growth, particularly associated with areas characterized by substantial existing development (e.g., Bellingham Bay and Whatcom Creek). State and county efforts to reduce fertilizers delivered from agricultural and residential uses in the lower Nooksack watershed and Samish River will slightly improve water quality.

Overall, we anticipate that changes in water quality will be mixed. Small-scale actions by local watershed enhancement groups and conservation districts will play an important role in improving baseline conditions in the future. The Washington State Conservation Commission, and its partner entities in the county conservation districts work directly with farmers and landowners to improve riparian conditions and nutrient loading, both which contribute to primary threats for bull trout in the action area. This will slightly improve water quality conditions throughout the action area related to reduction in nitrates from agricultural use. Yet, we anticipate improvement in water quality conditions will be offset in residential and urban areas where most of human growth is predicted to occur (i.e., UGAs). Thus, current water quality conditions will continue to constrain the functionality of ecosystem processes that support small stream habitats used by bull trout for FMO because improvements are dependent on changes from non-point-source pollution that are not subject to regulation. Moreover, water quality conditions will be further hampered by climate change, which will generally decrease streamflow and increase stream temperature (Dickerson-Lange and Mitchell 2013, p. 5236). The effects of water quality changes are most likely to occur in small, low elevation tributaries that provide FMO habitat for bull trout as reduced streamflow and warm water concentrates pollutants during periods that are suboptimal for bull trout. Individual bull trout are likely to restrict their use of low elevation tributary habitats as water quality conditions degrade each season. It is possible that some individuals may compensate for the reduction in availability of freshwater FMO habitat through increased use of marine FMO habitat, but there is no data (that we are aware of) to support such changes in habitat use in response to altered water quality conditions. Affected core areas are likely to experience a slight decrease in the availability/productivity of FMO.

Habitat connectivity within the Nooksack River basin and surrounding watersheds have improved over the past 20 years. Project proponents addressed the primary threat to connectivity within the action area by removing the Bellingham Water Diversion on the Middle Fork Nooksack River. Although the primary benefit from this restoration project is now established (i.e., diversion structure removal is complete), bull trout will continue to experience benefits from increased connectivity in perpetuity as individuals are now able to access productive habitats in marine waters of Puget Sound and freshwater habitats of the Nooksack watershed. This restoration action will also increase access to spawning and rearing habitat, which will improve genetic diversity and resiliency of the Nooksack River Core Area. Benefits also include increased access to marine derived nutrients, which will improve foraging resources for bull trout for all life stages and overall improvement in FMO features. Thus, we anticipate that the completed restoration project will continue to provide ongoing benefits to the local bull trout population as bull trout re-establish their migratory movements within the Middle Fork Nooksack River, with full re-establishment of migratory movements requiring a period of at least one full reproductive cycle of 5 to 7 years (Dunham and Rieman 1999 p. 3).

We also expect gradual improvement in connectivity and FMO habitat in the action area resulting from replacement of culverts that currently block fish passage. Data from Whatcom County Public Works initially estimated that more than 60 percent of existing culverts on fish bearing streams were barriers to migration (Blake and Peterson 2005 pp. 110–111). Replacing a small proportion of culverts by the state and county governments will represent substantial improvement in small and medium-sized tributaries throughout the action area. One example in the Samish River watershed is the Parson Creek Fish Passage Barrier Removal project, in which biologists replaced an undersized culvert with a bridge allowing fish unrestricted access to approximately 0.5 miles of habitat. Future culvert replacement projects are most likely to benefit salmon, as these species spawn and rear in low elevation streams. Improved spawning and rearing habitat for salmon will yield additional prey resource availability and enhanced FMO habitat for bull trout. Fish passage improvement projects are likely to proceed slowly, with few projects completed each year, but will improve conditions for adult, subadult, and juvenile life stages. Because the rate of the number of projects implemented annually is likely to be low and the area improved will be limited, we expect this will result in modest improvements to the Nooksack River Core Area. Completion of fish passage projects will be too small to result in meaningful improvements when analyzed at the CRU and DPS scale.

As noted in the Environmental Baseline (Section 9.1), small-scale construction actions for streambank protection (dikes and levees), irrigation infrastructure, and river restoration will continue to improve habitat conditions in the action area. Regarding future projects in the action area, all State, Tribal, local, and private construction or excavation actions are required to obtain a U.S. Army Corps of Engineers permit for work conducted in, over, or under navigable waters under the authority of Section 10 of the Rivers and Harbors Act and/or for the discharge of dredged or fill material under Section 404 of the Clean Water Act. Therefore, new actions involving construction or excavation within the action area will require section 7 consultation with the USFWS. These include large-scale, multi-stage projects proposed by Floodplains by Design (FbD) designed to address systemic need for reducing flooding and habitat improvement in the Nooksack watershed (Floodplains by Design 2018 pp. 1–2) in addition to projects by state and tribal governments intended for improving anadromous fish habitat. Smaller-scale restoration actions are likely to receive ESA coverage under Programmatic Opinions (e.g., Fish Passage and Habitat Restoration Programmatic Biological Opinion) (NMFS and USFWS 2008).

While state, federal, tribal, and non-governmental organizations (NGOs) are making limited progress on habitat improvements, bull trout and CH for bull trout will likely face threats from continued urban development, non-native species such as the brook trout (i.e., hybridization in the Nooksack watershed), and EGC (i.e., degradation of estuary and marine habitats in the action area) (Grosholz et al. 2000 pp. 1214–1221; Kulhanek et al. 2011 pp. 194–200). Local conservation organizations and NGOs will play an important role in limiting damage to species and habitat features caused by invasive species.

Overall, restoration actions are improving habitat features within the action area that are vital to the survival and recovery of bull trout. However, project proponents have limited resources and, thus, must patiently and strategically and address the types and locations of projects to achieve the maximum potential conservation benefit.

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

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action and the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: 1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or, 2) result in the destruction or adverse modification of critical habitat.

13.1 Bull Trout

The proposed action involves the operation of twelve hatchery programs in the Nooksack River, Lummi Bay, Samish River, Whatcom Creek and San Juan basins. Proposed activities include broodstock collection, hatchery rearing (egg incubation, fish rearing, and release), operation and maintenance of hatchery facilities, and the RM&E programs. These activities will result in capture and handling of bull trout, as well as mortality via impingement and entrainment in intake screens.

Bull trout are listed throughout the coterminous U.S., where their populations range from the Rocky Mountains west to the Pacific Ocean. The range-wide status of bull trout is negatively affected by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, and grazing; the blockage of migratory corridors by dams or diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced nonnative species (64 FR 58910). Similarly, within the other RUs associated with the DPS, the abundance, productivity, connectivity, and genetic diversity of bull trout in the action area have been degraded by timber harvest, construction of dams, land conversion, and agricultural development, among other stressors.

The proposed action is limited to areas accessible to hatchery-origin (HOR) Chinook, coho, and chum salmon. This includes all anadromous habitat in the Nooksack River, Samish River, and Whatcom Creek watersheds and nearshore marine areas within Lummi Bay and East Sound where salmon hatchery programs are located. Bull trout in the action area express adfluvial, anadromous, fluvial, and resident life histories. The action area is used primarily by bull trout from the Nooksack River Core Area, but it is also used by bull trout from neighboring core areas in the Lower Skagit River, Snohomish/Skykomish, and Stillaguamish River Core Areas since a majority of bull trout from these core areas exhibit an anadromous life history and move/migrate long distances. However, the Nooksack River Core Area also supports individuals exhibiting fluvial and perhaps resident life history stages.

With some minor exceptions (i.e., Baker River and upper Skagit River watershed), connectivity within the north Puget Sound region is relatively unimpaired. The Nooksack River Core Area consists of ten local populations. Anadromous bull trout from the three neighboring core areas may also occupy the action area and contribute individuals from, at minimum, an additional 27 local populations from neighboring watersheds. Abundance of bull trout within the north Puget Sound is generally considered among the highest within the CRU.

The USFWS determined that effects from capture, handling, and release associated with broodstock collection and RM&E activities will expose a limited number of bull trout from four of the most abundant core areas in the CRU. While exposure is more likely to impact bull trout originating from the Nooksack River Core Area, some individuals from neighboring core areas may also be exposed to adverse effects from capture and handling as described above. Most activities where bull trout will be exposed to adverse effects are associated with handling and release occurring within freshwater habitats. Bull trout do not to exhibit anadromy until they reach the adult life stage, therefore subadult and juvenile bull trout encountered during RM&E and in-river broodstock collection activities; these individuals will be from the Nooksack River core area. In contrast, adult bull trout are likely to be encountered within the Nooksack River, as well as locations in Samish River, Whatcom Creek, and other small coastal tributaries where in-river broodstock collection activities may occur. Thus, adult bull trout from neighboring core areas (Lower Skagit, Snohomish/Skykomish, Stillaguamish) may also be encountered during broodstock collection activities.

Implementation of the proposed action will result in effects on bull trout that are insignificant and/or discountable, adverse, or beneficial. The USFWS concluded that effects to bull trout from the following activities were considered insignificant or discountable: migration delay; impingement and entrainment at all facilities besides the Skookum Creek Hatchery; water quantity/water withdrawals; effluent discharge; sediment and debris release; herbicide use; ecological interactions with hatchery-origin fish, including competition and predation; underwater noise; outdoor artificial lighting; and, broodstock collection at the Glenwood Creek Hatchery. Adverse effects on bull trout resulting from the proposed action include capture and handling (via broodstock collection, fish isolation for annual dredging at the Samish River Hatchery, and the RM&E program), as well as impingement and entrainment at the Skookum Creek Hatchery. The USFWS concluded that beneficial effects on bull trout resulting from the proposed action include increased nutrients and prey resources.

In summary, the USFWS conservatively estimates that up to 25 bull trout per year may be incidentally captured and handled during on-site hatchery trap broodstock collection activities, and we expect up to five of those bull trout captures per year to result in mortality. Additionally, the USFWS expects that, across all the hatchery programs, eight bull trout in a five-year period will be incidentally captured during emergency broodstock collection activities, and four of those bull trout captures in a five-year period will result in mortality. We expect that up to five fish in a five-year period will be captured and handled during fish isolation for maintenance dredging at the Samish River Hatchery, and three of those bull trout captures in a five-year period will result in mortality. The USFWS anticipates that the RM&E programs will result in the capture and handling of up to 100 bull trout per year, and up to three of those bull trout captures per year will result in mortality. We also expect the intake structures at the Skookum Creek Hatchery will result in impingement or entrainment of up to five bull trout per year for up to ten years, with all incidences of impingement or entrainment resulting in mortality.

Overall, the number of bull trout adversely impacted by the proposed action is low compared to the abundance of bull trout in the impacted core areas. Limited spawning surveys conducted by the Nooksack Indian Tribe suggest adult abundance of the Nooksack River Core Area is 250 to 1,000 individuals (Currence 2008 p. 4). The USFWS believes that the Snohomish/Skykomish River Core Area contains 1,000 to 2,500 adult bull trout, and that the Stillaguamish River Core Area contains 250 to 1,000 adult bull trout (USFWS 2008 p. 35). The Lower Skagit River Core Area is consistently monitored by WDFW and is thought to consist of 2,500 to 10,000 adults (USFWS 2008 p. 35).

Because the proposed action will result in adverse effects to a very small subset of bull trout across four core areas, the foreseeable adverse effects will thus have a minor impact at the scale of the four impacted core areas. While the projected bull trout mortalities associated with the proposed action will affect individuals and minimally reduce local population abundance at the core area scale, the anticipated effects of the action, combined with the cumulative effects associated with future state, tribal, local, and private actions, are not expected to limit nor reduce bull trout distribution, and will not measurably reduce the likelihood of persistence or recovery at the scale of the local populations or core area. The USFWS concludes that the proposed action is not likely to appreciably reduce the survival, resiliency, and recovery of bull trout at the scale of the CRU or across their coterminous range. Additionally, the proposed action is likely to increase prey resources for bull trout in the action area since bull trout may feed on hatchery-released smolts, and the action is thus likely to result in a minor beneficial effect to bull trout productivity.

13.2 Bull Trout Critical Habitat

The action area supports a diverse suite of CH features for the bull trout. The action area contains the northernmost freshwater FMO habitat in lower and mid-elevation reaches of the Nooksack River, Samish River, and Whatcom Creek watersheds, as well as connectivity to upper reaches of the Nooksack River. Lower elevation reaches of the Nooksack River, in addition to the Samish River and Whatcom Creek, provide FMO habitat for adult and subadult bull trout to grow and seek refuge. The action area provides adult and subadult bull trout with access to nearby watersheds and large and productive FMO habitats in estuaries and nearshore marine areas. The action area also includes important FMO habitat in the Samish River, Whatcom Creek, and North Puget Sound nearshore marine habitat that connect the action area to adjacent core areas (e.g., Skagit, Snohomish/Skykomish, and Stillaguamish Core Areas).

The upper reaches of the Nooksack River basin are the only part of the action area that supports spawning and rearing habitat for 10 local populations of bull trout. The functionality of all CH types (freshwater FMO, marine FMO, and spawning and rearing) are important to achieving the recovery of bull trout in the action area.

The current condition of CH is generally poorer at low elevations in comparison to upper elevations where bull trout spawn and rear. The Samish River, Whatcom Creek, and lower reaches of the Nooksack River are all degraded from dikes, levees, and bank armoring, loss of riparian cover, and urban and residential development. Physical habitat features in the upper reaches are somewhat better due to comparatively lesser amounts of development and roadway infrastructure. However, the loss of forest canopy cover from forestry activity has reduced recruitment and retention of large wood is contributing to seasonally warm water conditions in portions of the action area that do not receive glacial runoff (i.e., the South Fork Nooksack River). Thus, the physical habitat features are functioning at reduced capacity. In addition, the chemical features of water quality in the lower reaches of the action area are also degraded from legacy agricultural development and urban and residential non point-source pollution that contribute excessive amounts of nitrates, petrochemical contaminants, and PCPPs. However, restoration proponents have completed several habitat restoration actions that have improved floodplain connectivity, increased the number of large wood features, and removed a barrier to migration in the Middle Fork Nooksack River. Removal of the Bellingham Water Diversion dam on the Middle Fork Nooksack River addressed one of three factors limiting recovery of bull trout in the Nooksack River Core Area. Overall, habitat features in the action area are functional, but degraded by nearly a century of habitat degradation from agricultural development and forestry management actions.

The action area provides nearly all of the PCEs of designated CH for the bull trout. The USFWS found the proposed action will have no measurable effect on PCE 9. The USFWS found that most PCEs (1, 4, 5, 6, 7, and 8) are minimally affected by the proposed action. The USFWS found only PCE 2 (i.e., migration habitats) will be adversely affected by broodstock collection involving the use of hatchery traps, weirs, and/or nets will partially preclude bull trout movement/migrations while adult salmon are migrating to their spawning grounds the proposed action. The USFWS found effects to PCE 3 will be beneficial.

We considered the overall effect of the implementing the proposed action by taking into account the magnitude, scope, and intensity of effects relative to the current environmental baseline and cumulative effects of non-federal actions to form or conclusion. The proposed hatchery programs provide a substantial amount of seasonally available forage items and nutrients that support primary productivity. The beneficial effects from additional prey resources will be distributed within all portions of freshwater CH in the action area and will support all life stages of bull trout. Abundant prey resources are critical to the continued persistence of bull trout in the action area given the lack of juvenile salmon of natural-origin. Implementing the hatchery programs will result in a slight degradation to water quality from effluent discharge, removal of sediment and debris from the Samish Hatchery intake, and limited, though non-consumptive water withdrawal. These activities will have a negligible effect on CH features in the action area and will not compound existing effects to CH features. However, the operation of hatchery surface water intakes poses a risk of entrainment and/or impingement of juvenile bull trout because these individuals may not be able to escape flow velocities immediately next to the intake screen.

Overall, the USFWS found beneficial effects of implementing the hatchery programs will be pervasive, widespread, and necessary to support adequate prey resources. The USFWS found discountable, insignificant, and adverse effects from implementing hatchery programs occurred adjacent to, or within close proximity to, the hatchery facilities. Thus, most effects of the action that may reduce CH features, if only minimally, are extremely limited in geographic scope immediately adjacent to the hatchery facilities. Given the widespread and essential beneficial effects and geographically limited adverse effects to CH features the implementation of the proposed action will not meaningfully reduce the function of CH for the bull trout.

14 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 Nooksack-Samish Hatchery Program or HGMP and the cumulative effects, it is the USFWS' biological opinion that the proposed action, is not likely to jeopardize the continued existence of the bull trout and is not likely to destroy or adversely modify designated critical habitat**.**

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

16 AMOUNT OR EXTENT OF TAKE

The USFWS anticipates 175 bull trout per year will be taken as a result of on-site hatchery trap broodstock collection and RM&E activities (Table 7). The USFWS also anticipates that five bull trout will be taken per year for up to ten years as a result of impingement and/or entrainment at the Skookum Creek Hatchery surface water intake structures (Table 7). The USFWS expects that 13 bull trout in a five-year period will be taken as a result of emergency in-river broodstock collection and fish isolation for maintenance dredging (Table 7). The incidental take is expected from the capture, handling, and release as noted below. The USFWS categorizes incidental take from RM&E activities involving electrofishing as harm. The USFWS also categorizes direct take from electrofishing during fish salvage operations at the Samish River Hatchery as harm although engaging in fish salvage will minimize the incidental take of individual bull trout from dredging adjacent to the Samish River Hatchery surface water intake.

Table 7. Bull trout take and mortalities resulting from broodstock collection, fish isolation for maintenance dredging, surface water intake operations, and RM&E.

Activity	Facility	Broodstock Origin	Form of Take	Bull Trout Taken	Bull Trout Mortalities	Life History Stage
Broodstock collection	Kendall Creek Hatchery	On-site broodstock collection at the Kendall Creek Hatchery	capture, handling, and release	5 fish per year	1 fish per year	adult, juvenile, sub-adult
		Emergency in-river broodstock collection in the North Fork Nooksack River	capture, handling, and release	2 fish in a five-year period	1 fish in a five-year period	adult, juvenile, sub-adult
	Skookum Creek Hatchery	On-site broodstock collection at the Skookum Creek Hatchery	capture, handling, and release	5 fish per year	1 fish per year	adult, juvenile, sub-adult
		Emergency in-river broodstock collection in the South Fork Nooksack River and tributaries (Edfro, Cavanaugh, Fobes, Plumbago, Deer, and Roaring Creek and unnamed tributaries at RM 20.3, RM 21.3, and RM 22.2)	capture, handling, and release	2 fish in a five-year period	1 fish in a five-year period	adult, juvenile, sub-adult
	Lummi Bay Hatchery	On-site broodstock collection at the Lummi Bay Hatchery	capture, handling, and release	5 fish per year	1 fish per year	adult, sub-adult
		Emergency in-river broodstock collection in independent streams* (Chuckanut, Oyster, Colony, and Whitehall) associated with Lummi Bay	capture, handling, and release	2 fish in a five-year period	1 fish in a five-year period	adult, sub-adult

		Hatchery broodstock collection				
	Samish River Hatchery	On-site broodstock collection at the Samish River Hatchery	capture, handling, and release	5 fish per year	1 fish per year	adult, sub-adult
	Whatcom Creek Hatchery	On-site broodstock collection at the Whatcom Creek Hatchery	capture, handling, and release	5 fish per year	1 fish per year	adult, sub-adult
		Emergency in-river broodstock collection in independent streams* (Chuckanut, Oyster, Colony, and Whitehall) associated with Whatcom Creek Hatchery broodstock collection	capture, handling, and release	Two fish in a five-year period	One fish in a five-year period	adult, sub-adult
Fish isolation for maintenance dredging (direct take)	Samish River Hatchery	N/A	capture, handling, and release	Five fish in a five-year period	Three fish in a five-year period	adult, sub-adult
Surface water intake operation(s)	Skookum Creek Hatchery	N/A	impingement and/or entrainment	5 fish per year per decade	5 fish per year per decade	adult, juvenile, sub-adult
Research, monitoring, and evaluation	Nooksack River and tributaries	N/A	capture, handling, and release	100 fish per year	3 fish per year	adult, juvenile, sub-adult
			electrofishing	50 fish per year	5 fish per year	adult, juvenile, sub-adult

*Creeks/tributaries draining directly into Bellingham Bay or Samish Bay (e.g., Chuckanut, Oyster, Colony, and Whitehall).

17 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.

18 REASONABLE AND PRUDENT MEASURES

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

1. Minimize entrapment and impingement of bull trout on surface water intake at Skookum Creek Hatchery.
2. Monitor and minimize adverse effects on bull trout resulting from in-river broodstock collection.
3. Monitor and minimize adverse effects on bull trout resulting from fish isolation prior to maintenance dredging at the Samish Hatchery.
4. Monitor and minimize adverse effects on bull trout resulting from implementation of RM&E activities.

19 TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the NMFS 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.

1. To implement RPM 1 the NMFS and the co-managers shall:
    a. Ensure intake screens are performing optimally be completing monthly inspections for damage and/or debris that may compromise water intake functionality.
    b. Following NMFS' guidance, within 10 years of issuance of this Opinion, the appropriate co-managers shall modify and/or replace surface water intakes at Skookum Creek Hatchery to be consistent with the most up-to-date NMFS' compliance standards. The co-managers 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.
2. To implement RPM 2 the NMFS and the co-managers shall:
    a. Ensure that buckets and/or tanks for fish containment have sufficient water volume to accommodate adult bull trout during holding and transport.

   b. Ensure use of aerators to provide for the circulation of clean, cold, well-oxygenated water during fish capture, temporary holding, and release, to minimize the risks associated with prolonged holding.
   c. When engaging in hook and line angling:
      i. Ensure that individuals engaged in hook and line angling that may handle bull trout be trained and knowledgeable in bull trout identification and safe bull trout handling procedures.
      ii. Do not remove bull trout from the water.
      iii. Remove the hook and release the fish as soon as possible and as close as possible to the point of capture.
      iv. If a hook is swallowed by a bull trout or the hook appears to be lodged in or penetrate critical areas, such as the esophagus and stomach, cut the line as close as possible to the hook and release the fish as soon as possible.

3. To implement RPM 3 the NMFS and the co-managers shall:
   a. Comply with terms and conditions described above in 2a and 2b.
   b. When engaging in electrofishing:
      i. Employ electrofishing only after all other means of fish capture, handling, and removal have been determined impracticable.
      ii. Use electrofishing equipment and methodologies that comply with the electrofishing guidelines outlined by the NMFS (2000 p. all).
      iii. Use the minimum voltage, pulse width, and rate settings necessary to immobilize fish.
   c. Include encounters and tissue sample information in annual report referenced below in Term and Condition 5.
4. To implement RPM 4 the NMFS and the co-managers shall:
   a. Employ electrofishing only after all other means of fish capture, handling, and removal have been determined impracticable.
   b. Include all observations of bull trout in the annual report referenced below in Term and Condition 5.
5. To implement RPMs 2 – 4 the NMFS and the co-managers shall:
   a. Provide an annual report to the USFWS listing all bull trout encountered while implementing activities described in the terms and conditions listed above. The NMFS and the co-managers shall include, to the extent possible, the following information in their annual report to the USFWS: date and location of capture, capture method, approximate size of the fish, condition of the fish at release (including any obvious injuries or descaling, whether these were the result of incidental capture and handling), and whether the fish was released alive or died.

b. Submit annual report referenced above in 5a to the USFWS via e-mail by no later than May 1 to:

    Scott Sebring
    Fisheries and Wildlife Biologist
    U.S. Fish and Wildlife Service
    scott_sebring@fws.gov

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take requires reinitiation of consultation and review of the reasonable and prudent measures provided. The federal agency must immediately provide an explanation of the causes of the taking and review with the USFWS need for possible modification of the reasonable and prudent measures.

The USFWS is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest USFWS 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 USFWS Law Enforcement Office at (425) 883-8122, or the USFWS's Washington Fish and Wildlife Office at (360) 753-9440.

20 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.

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

1. Consider working with state co-managers to process tissue samples collected from bull trout for genetic analysis on an annual or semi-annual basis and report the results of this analysis to the USFWS. Genetic analysis should include the date and location of tissue collection and, to the extent possible, a determination of core area lineage for each tissue sample collected. The core area lineage determination is important for the USFWS to establish a baseline information on genetic diversity of bull trout within the Nooksack River Core Area.

21 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 where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

22 LITERATURE CITED

Ainslie, B.J., J.R. Post, and A.J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. North American Journal of Fisheries Management 18:905-918. 14 pp.

Anderson, S. W., C. P. Konrad, E. E. Grossman, and C. Curran. 2019. Sediment Storage and Transport in the Nooksack River Basin, Northwestern Washington, 2006-15. U.S. Geological Survey, Scientific Investigations Report 2019–5008, Reston, Virginia. 56 pp.

Arlinghaus, R., S. J. Cooke, J. Lyman, D. Policansky, A. Schwab, C. Suski, S. G. Sutton, and E. B. Thorstad. 2007. Understanding the Complexity of Catch-and-Release in Recreational Fishing: An Integrative Synthesis of Global Knowledge from Historical, Ethical, Social, and Biological Perspectives. Reviews in Fisheries Science 15(1–2):75–167. 95 pp.

Baker, J., and B. K. Hand. 2023. Impacts of redd superimposition on the spawning success of listed tule fall Chinook salmon in the White Salmon River, Washington. Columbia River Fish and Wildlife Conservation Office, Vancouver, Washington. 28 pp.

Bash, J., Berman, C. H., and Bolton, S. (2001). Effects of turbidity and suspended solids on salmonids. University of Washington Water Center. 80 pp.

Beamer, E., T. Beechie, B. Perkowski, and J. Klochak. 2000. River Basin Analysis of the Skagit and Samish Basins: Tools for Salmon Habitat Restoration and Protection. Skagit Watershed Council, Mount Vernon, WA. 86 pp.

Bentley, K. T., D. E. Schindler, J. B. Armstrong, R. Zhang, C. P. Ruff, and P. J. Lisi. 2012. Foraging and growth responses of stream-dwelling fishes to inter-annual variation in a pulsed resource subsidy. Ecosphere 3(12). 17 pp.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication. 55 pp.

Blake, S., and B. Peterson. 2005. Watershed Resources Inventory (WRIA 1) - Watershed Management Plan - Phase 1. 437 pp.

Bottom, D. L., C. A. Simenstad, J. Burke, A. M. Baptista, D. A. Jay, K. K. Jones, E. Casillas, and M. H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, Technical Memorandum NMFS-NWFSC-68. 246 pp.

Bowerman, T., Neilson, B.T., and P. Budy. 2014. Effects of fine sediment, hyporheic flow, and spawning site characteristics on survival and development of bull trout embryos. Canadian Journal of Fisheries and Aquatic Sciences 71:1059-1071. 13 pp.

Brenkman, S. J., Larson, G. L., & Gresswell, R. E. 2001. Spawning migration of lacustrine-adfluvial bull trout in a natural area. Transactions of the American Fisheries Society, 130(5), 981-987. 7 pp.

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

Brenkman, S. J., S. C. Corbett, and E. C. Volk. 2007. Use of Otolith Chemistry and Radiotelemetry to Determine Age-Specific Migratory Patterns of Anadromous Bull Trout in the Hoh River, Washington. Transactions of the American Fisheries Society 136(1):1–11. 11 pp.

Buchmann, K., Bresciani, J., & Jappe, C. (2004). Effects of formalin treatment on epithelial structure and mucous cell densities in rainbow trout, *Oncorhynchus mykiss* (Walbaum), skin. Journal of Fish Diseases, 27(2), 99-104. 6 pp.

Canty, D., A. Martinsons, and A. Kumar. 2012. Losing Ground: Farmland Protection in the Puget Sound Region. 34 pp.

Carey, A., A. Gipe, W. Hobbs, and S. O'Neill. 2023. Investigating the Source of PBDE Contaminant Exposure in Steelhead Trout within the Major Tributaries of the Nisqually River Basin. Washington Department of Ecology and Washington Department of Fish and Wildlife, Final Contract Report Submitted to the Nisqually Indian Tribe WDFW Report Number FPT 23-02. 55 pp.

Carter, K. 2005. The effects of dissolved oxygen on steelhead trout, coho salmon, and Chinook salmon biology and function by life stage. California Regional Water Quality Control Board. San Francisco, California, 10 pp.

Cederholm, C. J., M. D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific Salmon Carcasses: Essential Contributions of Nutrients and Energy for Aquatic and Terrestrial Ecosystems. Fisheries 24(10):6–15. 10 pp.

Clements, S. P., Hicks, B. J., Carragher, J. F., & Dedual, M. 2002. The effect of a trapping procedure on the stress response of wild rainbow trout. North American Journal of Fisheries Management, 22(3), 907-916. 10 pp.

Copeland, T., and K. A. Meyer. 2011. Interspecies Synchrony in Salmonid Densities Associated with Large-Scale Bioclimatic Conditions in Central Idaho. Transactions of the American Fisheries Society 140(4):928–942. 16 pp.

Creutzburg, M. K., R. M. Scheller, M. S. Lucash, S. D. LeDuc, and M. G. Johnson. 2017. Forest management scenarios in a changing climate: trade-offs between carbon, timber, and old forest. Ecological Applications 27(2):503–518. 16 pp.

Currence, N. 2007. Nooksack Tribe bull trout surveys within the Nooksack basin - final report. Nooksack Tribe, Final Report Cooperative Agreement Number 134513J008. 7 pp.

Currence, N. 2008, July 30. Email from Ned Currence, Biologist, Nooksack Tribe Natural Resource Department, to Jeffrey Chan, Fish Biologist, USFWS. 20 pp.

Dalbey, S.R., T.E. Mcmahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury on long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16(3):560-569. 10 pp.

Davis, R.J., Hollen, B., Hobson, J., Gower, J.E., and D. Keenum. 2016. Status and Trends of Northern Spotted Owl Habitats. U.S. Department of Agriculture, U.S. Forest Service, Pacific Northwest Research Station. Portland, Oregon. 62 pp.

Davis, R.J., D.B. Lesmeister, Z. Yang, B. Hollen, B. Tuerler, J. Hobson, J. Guetterman, and A. Stratton. 2022. Northwest Forest Plan—the first 25 years (1994–2018): status and trends of northern spotted owl habitats. Gen. Tech. Rep. PNW-GTR-1003. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 38 pp.

DeHaan, P. 2009. Species Identification Results. Microsoft Excel spreadsheet table. 1 p.

Dickerson-Lange, S. and R. Mitchell. 2014. Modeling the effects of climate change projections on streamflow in the Nooksack River basin, Northwest Washington. Hydrological Processes 28(20):5236-5250.

Dugger, K.M., E.D. Forsman, A.B. Franklin, R.J. Davis, G.C. White, C.J. Schwarz, K.P. Burnham, J.D. Nichols, J.E. Hines, C.B Yackulic, P.F. Doherty, Jr., L. Bailey, D.A. Clark, S.H. Ackers, L.S. Andrews, B. Augustine, B.L. Biswell, J. Blakesley, P.C. Carlson, M.J. Clement, L.V. Diller, E.M. Glenn, A. Green, S.A. Gremel, D.R. Herter, J.M. Higley, J. Hobson, R.B. Horn, K.P. Huyvaert, C. McCafferty, T. McDonald, K. McDonnell, G.S. Olson, J.A. Reid, J. Rockweit, V. Ruiz, J. Saenz, and S.G. Sovern. 2016. U.S. Geological Survey, Oregon Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University. Corvallis, Oregon. 60 pp.

Dunham, J. B., and B. E. Rieman. 1999. Metapopulation Structure of Bull Trout: Influences of Physical, Biotic, and Geometrical Landscape Characteristics. Ecological Applications 9(2):642–655. 14 pp.

Dunham, J., C. Hirsch, S. Gordon, R. Flitcroft, N. Chelgren, M. Snyder, D. Hockman-Wert, G. Reeves, H. Andersen, S. Anderson, W. Battaglin, T. Black, J. Brown, S. Claeson, L. Hay, E. Heaston, C. Luce, N. Nelson, C. Penn, and M. Raggon. 2023. Northwest Forest Plan—the first 25 years (1994–2018): watershed condition status and trends. Report number PNW-GTR-1010. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, PNW-GTR-1010, Portland, OR. 184 pp.

Dwyer, W.P., and R.G. White. 1997. Effect of electroshock on juvenile arctic grayling and Yellowstone cutthroat trout growth, 100 days after treatment. North American Journal of Fisheries Management 17:174-177. 4 pp.

Eby, L. A., O. Helmy, L. M. Holsinger, and M. K. Young. 2014. Evidence of Climate-Induced Range Contractions in Bull Trout Salvelinus confluentus in a Rocky Mountain Watershed, U.S.A. PLoS ONE 9(6):1-8. 8 pp.

Embrey, S. S., and E. L. Inkpen. 1998. Water-quality assessment of the Puget Sound basin, Washington, nutrient transport in rivers, 1980-93. U.S. Geological Survey, Water-Resources Investigations Report 97–4270, Tacoma, Washington. 35 pp.

Falke, J. A., R. L. Flitcroft, J. B. Dunham, K. M. McNyset, P. F. Hessburg, and G. H. Reeves. 2015. Climate change and vulnerability of bull trout (*Salvelinus confluentus*) in a fire-prone landscape. Canadian Journal of Fisheries and Aquatic Sciences 72(2):304–318. 15 pp.

Faria, Melissa, Bedrossiantz, J., Ricardo Rosas Ramírez, J., Mayol, M., Heredia Garcia, Gerargo, Bellot, M., Prats, E., García-Reyero, N., Gómez-Canela, C., Manuel Gómez-Olivan, L., and D. Raldúa. 2021. Glyphosate targets fish monoaminergic systems leading to oxidative stress and anxiety. Environment International 146:106253. 10 pp.

Flagg, T.A., Berejikian, B.A., Colt, J.E., Dickhoff, W.W., Harrell, L.W., Maynard, D.J., Nash, C.E., Strom, M.S., Iwamoto, R.N., and C.V.W. Mahnken. 2000. Ecological and Behavioral Impacts of Artificial Production Strategies on the Abundance of Wild Salmon Populations: A Review of Practices in the Pacific Northwest. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, Washington. 98 pp.

Floodplains by Design. 2018. Floodplains that Work Phase 1. 2 pp.

Fowler, A. 2018. Bull Trout Population Monitoring Field Study in the Skagit River Basin in 2017. Report to Seattle City Light WDFW #16-07206. 12 pp.

Fowler, A. 2019. Skagit Bull Trout Spawning Population Index Monitoring Field Study in the Skagit River Basin in 2018. Washington Department of Fish and Wildlife, Report to Seattle City Light. 13 pp.

Fowler, A. 2020. Bull Trout Spawning Population Index Monitoring Field Study in the Skagit River Basin in 2019. Washington Department of Fish and Wildlife. 14 pp.

Fowler, A. 2021. Skagit Bull Trout Spawning Population Index Monitoring Field Study in the Skagit River Basin in 2020. Washington Department of Fish and Wildlife, Report to Seattle City Light 16–07206. 13 pp.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. Northwest Science 63(4):133-143. 11 pp.

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

Goetz, F., E. Beamer, E. Connor, E. Jeanes, C. Kinsel, J. Chamberlin, C. Morello, and T. Quinn. 2021. The timing of anadromous bull trout migrations in estuarine and marine waters of Puget Sound, Washington. Environmental Biology of Fishes. 104 pp.

Goetz, F., E. Jeanes, and E. Beamer. 2004. Bull Trout in the Nearshore. Technical Report to the U.S. Army Corps of Engineers. 156 pp.

Greene, C., L. Kuehne, C. Rice, K. Fresh, and D. Penttila. 2015. Forty years of change in forage fish and jellyfish abundance across greater Puget Sound, Washington (USA): anthropogenic and climate associations. Marine Ecology Progress Series 525:153–170. 18 pp.

Gregory, T. R., and C. M. Wood. 1998. The effect of chronic plasma cortisol elevation on the feeding behavior, growth, competitive ability, and swimming performance of juvenile rainbow trout. Physiological and Biochemical Zoology 72(3): 286-295. 11 pp.

Grosholz, E. D., G. M. Ruiz, C. A. Dean, K. A. Shirley, J. L. Maron, and P. G. Connors. 2000. The Impact of a Non-Indigenous Marine Predator in a California Bay. Ecological Society of America 81(5):1206–1224. 19 pp.

Hall, J., S. Burgess, K. Ross, D. Small, R. Gatchell, T. Beechie, C. Greene, J. Chamberlin, O. Stefankiv, and B. Timpane_Padgham. 2021. Mapping Tidal Restrictions and Tidal Wetlands to Support Identification and Evaluation of Restoration Opportunities in Puget Sound. Cramer Fish Sciences. 225 pp.

Hamilton, S. L., V. R. Saccomanno, W. N. Heady, A. L. Gehman, S. I. Lonhart, R. Beas-Luna, F. T. Francis, L. Lee, L. Rogers-Bennett, A. K. Salomon, and S. A. Gravem. 2021. Disease-driven mass mortality event leads to widespread extirpation and variable recovery potential of a marine predator across the eastern Pacific. Proceedings of the Royal Society B: Biological Sciences 288(1957):10. 10 pp.

Hamlet, A. F. 2011. Assessing water resources adaptive capacity to climate change impacts in the Pacific Northwest Region of North America. Hydrology and Earth System Sciences 15(5):1427–1443. 16 pp.

Hayes, M. C., S. P. Rubin, R. R. Reisenbichler, F. A. Goetz, E. Jeanes, and A. McBride. 2011. Marine Habitat Use by Anadromous Bull Trout from the Skagit River, Washington. Marine and Coastal Fisheries 3(1):394–410. 17 pp.

Hildebrand, L.D., Sullivan, D.S., and T.P. Sullivan. 1982. Experimental studies of rainbow trout populations exposed to field applications of Roundup herbicide. Archives of Environmental Contamination and Toxicology 11:93-98. 6 pp.

Hollender, B.A., and R.F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:636-649. 7 pp.

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

Jones, L. A., C. C. Muhlfeld, L. A. Marshall, B. L. McGlynn, and J. L. Kershner. 2014. Estimating Thermal Regimes of Bull Trout and Assessing the Potential of Climate Warming on Critical Habitats. River Research and Applications 30(2):204–216. 13 pp.

Keeley, E.R. and J.W.A. Grant. 2001. Prey size of salmonid fish in streams, lakes, and oceans. Canadian Journal of Fisheries and Aquatic Sciences 58:1122-1132. 11 pp.

Keeley and P.A. Slaney. 1996. Quantitative Measures of Rearing and Spawning Habitat Characteristics for Stream-Dwelling Salmonids: Guidelines for Habitat Restoration, Watershed Restoration Project Report No. 4. University of British Columbia and the Watershed Restoration Program, Ministry of Environment, Lands, and Parks. British Columbia, Vancouver, Canada. 32 pp.

Kopp, S. 2022. Nooksack eDNA Project. Presentation from North Sound Trout Unlimited and 4th Corner Fly Fishers. Available on the internet at: https://www.northsoundtu.org/edna-project.html. 20 pp.

Kostow, K. 2009. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Reviews in Fish Biology and Fisheries 19(1):9-31. 23 pp.

Kraemer, C. 2003. Lower Skagit Bull Trout Age and Growth Information Developed from Scales Collected from Anadromous and Fluvial Char. Washington Department of Fish and Wildlife, Management Brief. 17 pp.

Kulhanek, S. A., A. Ricciardi, and B. Leung. 2011. Is invasion history a useful tool for predicting the impacts of the world's worst aquatic invasive species? Ecological Applications 21(1):189–202. 14 pp.

Lee, S.-Y., and A. F. Hamlet. 2011. Skagit River Basin Climate Science Report, a summary report prepared for Skagit County and the Envision Skagit Project by the Department of Civil and Environmental Engineering and The Climate Impacts Group at the University of Washington. 226 pp.

Long, E. R., M. Dutch, S. Weakland, B. Chandramouli, and J. P. Benskin. 2013. Quantification of pharmaceuticals, personal care products, and perfluoroalkyl substances in the marine sediments of Puget Sound, Washington, USA. Environmental Toxicology and Chemistry 32(8):1701–1710. 10 pp.

Lorenz, T. J., Raphael, M. G., Young, R. D., Lynch, D., Nelson, S. K., & Mclver, W. R. 2021. Status and trend of nesting habitat for the marbled murrelet under the northwest forest plan, 1993 to 2017. 72 pp.

Lowery, E. D., and D. A. Beauchamp. 2015. Trophic Ontogeny of Fluvial Bull Trout and Seasonal Predation on Pacific Salmon in a Riverine Food Web. Transactions of the American Fisheries Society 144(4):724–741. 15 pp.

Lummi Indian Nation. 2021, August 30. Hatchery and Genetic Management Plan (HGMP): Skookum Creek Hatchery Chinook Program. 53 pp.

Maklakova, M. E., Kondratieva, I. A., Mikhailova, E. S., Stupin, R. V., Khapchaev, S. Y., & Kasumyan, A. O. 2011. Effect of antibiotics on immunophysiological status and their taste attractiveness for rainbow trout *Parasalmo* (*Oncorhynchus mykiss*) (*Salmoniformes, Salmonidae*). Journal of Ichthyology, 51, 1133-1142. 10 pp.

Mayer, J. R., and N. R. Elkins. 1990. Potential for agricultural pesticide runoff to a Puget Sound estuary: Padilla Bay, Washington. Bulletin of Environmental Contamination and Toxicology 45(2):215–222. 8 pp.

McMichael, G.A., A.L. Fritts, and T.N. Pearson. 1998. Electrofishing injury to stream salmonids; Injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management 18:894-904. 11 pp.

Mesa, M.G., T.P. Poe, D.M. Gadomski, and J.H. Petersen. 1994. Are all prey created equal? A review and synthesis of differential predation on prey in substandard condition. Journal of Fish Biology 45:81-96. 16 pp.

Mommsen, T. P., M. M. Vijayan, and T. W. Moon. 1999. Cortisol in teleosts: dynamics, mechanisms of action, and metabolic regulation. Rev. Fish Biol. Fish. 9:211–268. 58 pp.

MBTSG (Montana Bull Trout Scientific Group). 1996. Assessment of methods for removal or suppression of introduced fish to aid in bull trout recovery. Prepared for by the Montana Bull Trout Restoration Team, c/o Montana Fish, Wildlife, and Parks, Helena, Montana. 37 p.

Mueller, K. W., and N. T. Jefferson. 2019. First detection of the invasive European green crab *Carcinus maenas* (Linnaeus, 1758) on Lummi Nation reservation tidelands. Lummi Nation Natural Resources Department, Bellingham, Washington. 88 pp.

Murauskas, J.G., Fryer, J.K., Nordlund, B., and J.L. Miller. 2014. Trapping effects and fisheries research: A case study of sockeye salmon in the Wenatchee River, USA. Fisheries 39(9):408-414. 7 pp.

Naish, K. A., Taylor III, J. E., Levin, P. S., Quinn, T. P., Winton, J. R., Huppert, D., and Hilborn, R. 2008. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in marine biology, 53, 61-194. 134 pp.

Naman, S.W. and C.S. Sharpe. 2012. Predation by hatchery yearling salmonids on wild subyearling salmonids in the freshwater environment: A review of studies, two case histories, and implications for management. Environmental Biology of Fishes 94:21-28. 8 pp.

Nedwell, J., A. Turnpenny, J. Lovell, and B. Edwards. 2006. An investigation into the effects of underwater piling noise on salmonids. The Journal of the Acoustical Society of America 120:2550–4. 5 pp.

Nelson, M. C., and J. D. Reynolds. 2014. Time-Delayed Subsidies: Interspecies Population Effects in Salmon. PLOS ONE 9(6):9. 9 pp.

NMFS (National Marine Fisheries Service). 2000. Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. June 2000. 5 pp.

NMFS. 2011. Anadromous Salmonid Passage Facility Design. Pp. 140. NMFS, Northwest Region, Portland, Oregon. 140 pp.

NMFS. 2022. NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual. NMFS, West Coast Region. 182 pp.

NMFS, and USFWS (U.S. Fish and Wildlife Service). 2008. Washington State Fish Passage and Habitat Enhancement Restoration Programmatic. U.S. Fish and Wildlife Service, Biological Opinion 13410-2008-FWS # F-0209, Lacey, Washington. 172 pp.

Nooksack Indian Tribe. 2017. South Fork Nooksack River Watershed Conservation Plan. Nooksack Indian Tribe Natural Resources Department, Watershed Conservation Plan. 143 pp.

Nooksack Natural Resources, Lummi Natural Resources, and Whatcom Public Works. 2005. WRIA 1 Salmonid Recovery Plan. Whatcom County Public Works, Bellingham, Washington. 323 pp.

NWIFC (Northwest Indian Fisheries Commission), and WDFW (Washington Department of Fish and Wildlife). 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. 38 pp.

NWIFC. 2023. Statewide Integrated Fish Distribution (SWIFD) Web Map. https://geo.nwifc.org/swifd/?_gl=1*rs3ork*_ga*NDU5Njg3NTU5LjE3MjY2ODE1ODg.*_ga_XGZ6DS8QV6*MTcyNzI4NjI5My40LjAuMTcyNzI4NjI5My4wLjAuMA. Accessed September 25, 2024.

Nysewander, D. R., Evenson, J. R., Murphie, B. L., & Cyra, T. A. 2005. Report of marine bird and marine mammal component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 period. Washington Department of Fish and Wildlife, Olympia. 194 pp.

Olla, B.L., M.W. Davis, and C.H. Ryer. 1998. Understanding how the hatchery environment represses or promotes the development of behavioral survival skills. Bulletin of Marine Science 62: 531-550. 20 pp.

O'Neill, S. M., A. J. Carey, L. B. Harding, J. E. West, G. M. Ylitalo, and J. W. Chamberlin. 2020. Chemical tracers guide identification of the location and source of persistent organic pollutants in juvenile Chinook salmon (*Oncorhynchus tshawytscha*), migrating seaward through an estuary with multiple contaminant inputs. Science of The Total Environment 712:1–16. 16 pp.

Patterson, D.A., Robinson, K.A., Lennox, R.J., Nettles, T.L., Donaldson, L.A., Eliason, E.J., Raby, G.D., Chapman, J.M., Cook, K.V., Donaldson, M.R., Bass, A.L., Drenner, S.M., Reid, A.J., Cooke, S.J., and S.G. Hinch. 2017. Review and Evaluation of Fishing-Related Incidental Mortality for Pacific Salmon. Fisheries and Oceans Canadian Science Advisory Secretariat Research Document, 2017/010. Ottawa, Ontario, Canada. 164 pp.

Pelto, M. S., M. Dryak, J. Pelto, T. Matthews, and L. B. Perry. 2022. Contribution of Glacier Runoff during Heat Waves in the Nooksack River Basin USA. Water 14(7):1145. 15 pp.

Popper, A. N., and M. C. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology 4(1):43–52. 10 pp.

Popper, A. N., and A. D. Hawkins. 2019. An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. Journal of Fish Biology 94(5):692–713. 22 pp.

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

PSEMP (Puget Sound Ecosystem Monitoring Program). 2022. Puget Sound Marine Waters 2021 Overview. PSEMP Marine Waters Workgroup. 84 pp.

PSE (Puget Sound Energy). 2019. Upstream Fish Passage 2018 Annual Report, Baker River Hydroelectric Project, FERC No. 2150. Annual Report, Olympia, Washington. 13 pp.

PSE. 2020. Upstream Fish Passage 2019 Annual Report, Baker River Hydroelectric Project, FERC No. 2150. Puget Sound Energy, Annual Report, Olympia, Washington. 13 pp.

PSP (Puget Sound Partnership). 2013. 2013 State of the Sound. https://pspwa.app.box.com/s/vr2e2349jqsvhvruq9w1. 179 pp.

PSP. 2021. State of the Sound. 62 pp.

PSP. 2023. Puget Sound Vital Signs. Streams and Floodplains Report. 2 pp.

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

Rieman, B. E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, and D. Myers. 2007. Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin. Transactions of the American Fisheries Society 136(6):1552–1565. 14 pp.

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

Roni, P., C. Johnson, T. De Boer, G. Pess, A. Dittman, and D. Sear. 2016. Interannual variability in the effects of physical habitat and parentage on Chinook salmon egg-to-fry survival. Canadian Journal of Fisheries and Aquatic Sciences 73(7):1047–1059. 13 pp.

Sandell, T., A. Lindquist, P. Dionne, and D. Lowry. 2016. 2016 Washington State Herring Stock Status Report. Washington Department of Fish and Wildlife, Fish Program Technical Report FPT 19-07, Olympia, Washington. 90 pp.

Schmidt, L. J., Gaikowski, M. P., Gingerich, W. H., Dawson, V. K., & Schreier, T. M. 2007. An environmental assessment of the proposed use of oxytetracycline-medicated feed in freshwater aquaculture. US Geological Survey, Biological Resources Division. 97 pp.

Sharber, N.G., and S.W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122. 6 pp.

Smith, A. B., Kissling, M., Capuano, A. M., Lewis, S. B., & Mooney, T. A. 2023. Aerial hearing thresholds and ecoacoustics of a threatened pursuit-diving seabird, the marbled murrelet *Brachyramphus marmoratus*. Endangered Species Research, 50, 167-179. 13 pp.

Snyder, D. E. 2003. Electrofishing and its harmful effects on fish. Information and Technology Report USGS/BRD/ ITR-2003-0002: U.S. Government Printing Office, Denver, CO, 149 pp.

Therriault, T. W., D. E. Hay, and J. F. Schweigert. 2009. Biologic overview and trends in pelagic forage fish abundance in the Salish Sea (Strait of Georgia, British Columbia). Marine Ornithology (37):3–8. 6 pp.

Thompson, K.G., P. Bergersen, and R.B. Nehring. 1997. Injuries to brown trout and rainbow trout induced by capture with pulsed direct current. North American Journal of Fisheries Management 17:141-153. U.S. Census Bureau. 2020. Statistics for Whatcom County, Washington. 2 pp.

USDA (U.S. Department of Agriculture). 2006. Upper Middle Fork and South Fork Nooksack Rivers Watershed Analysis. Mt. Baker - Snoqualmie National Forest, Watershed Analysis, Sedro-Woolley, Skagit County, Washington. 150 pp.

USFWS (U.S. Fish and Wildlife Service). 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Draft Recovery Plan, Portland, Oregon. 409 pp.

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

USFWS. 2009. Bull Trout Core Area Status Assessment Template. Draft report. 1895 pp.

USFWS. 2010. Bull Trout Final Critical Habitat Justification: Rationale for why Habitat is Essential, and Documentation of Occupancy. U.S. Fish and Wildlife Service, Boise, ID. 1035 pp.

USFWS. 2015a. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentu*s). 179 pp.

USFWS. 2015b. Coastal Recovery Unit Implementation Plan for Bull Trout (*Salvelinus confluentus*). Prepared by U.S. Fish and Wildlife Service Washington Fish and Wildlife Office and Oregon Fish and Wildlife Office, Lacey, Washington and Portland, Oregon. 160 pp.

USFWS. 2015c. State Route 542 - Warnick Bluff Roadway Re-alignment Emergency Project. 8 pp.

USFWS. 2017a. Biological Opinion for the Index-Galena Road Relocation Project. 206 pp.

USFWS. 2017b. Biological Opinion for the NMFS 4(d) Rule Determinations for WDFW, Muckleshoot Indian Tribe, and Suquamish Tribe Salmon and Steelhead Hatchery Operations in the Green River Watershed, including Elliott Bay and Des Moines Net Pens. 94 pp.

USFWS. 2021. Operation and Maintenance of the Sunset Falls Trap-and-Haul Facility and Integrated Skykomish River Summer Steelhead Program. U.S. Fish and Wildlife Service, Biological Opinion 01EWFW00-2020-F-1607, Lacey, Washington. 122 pp.

USFWS. 2022. Biological Opinion for the Chum Salmon Hatchery and Genetic Management Plans in the Skagit River Watershed. 145 pp.

USFWS. 2023. Biological Opinion for the Port of Bellingham, Bellingham Shipping Terminal Marine Infrastructure Maintenance and Rehabilitation Project. 98 pp.

USFWS, and NMFS. 1998. Endangered Species Consultation Handbook. 315 pp.

USGS (U.S. Geological Survey). 2023a. Surface water and surface-water-quality records: Cascade Creek NR Glacier, WA.

USGS. 2023b. Surface water and surface-water-quality records: Skookum Creek Above Diversion Near Wickersham, WA.

USGS. 2023c. Surface water and surface-water-quality records: Nooksack River Overflow at Highway 544 at Everson, WA.

Wang, Y., Han, Y., Zhou, X., Liang, M., and P. Chu. 2020. Study on the treatment of livestock farm wastewater by falling water aeration constructed wetland. IOP Conference Series: Materials Science and Engineering 780: 062052. 5 pp.

Washington Forest Practices Board. 2001. Washington Forest Practices Board Manual. Practices and Procedures, Chapter 222-08 WAC. Washington Department of Natural Resources, Olympia, Washington. 214 pp.

Washington Sea Grant. 2021. What Does the Invasion at Lummi Mean for the Salish Sea? 5 pp.

Washington State Conservation Commission. 2002. Salmon and steelhead habitat limiting factors: water resources inventory area 1. 325 pp.

Washington State Supreme Court. 2016. Whatcom County *v* Western Washington Growth Management Hearings Board. 74 pp.

WDFW (Washington Department of Fish and Wildlife). 2001. Salmonid Screening, Habitat Enhancement and Restoration Section (SSHEAR). Environmental Restoration Division Habitat Program. 58 pp.

WDFW. 2019. North Puget Sound total season bull trout redds 2006-2019. 1 pp.

WDFW. 2020. Application for issuance from the National Marine Fisheries Service (NMFS), Sustainable Fisheries Division, of a section 10(a)(1)(A) research/enhancement permit under the Endangered Species Act (ESA) of 1973. March 27, 2020. 24 pp.

WDFW. 2021. Hydraulic Project Approval, WDFW Hatchery Maintenance, Permit Number 2019-9-6+02. Washington Department of Fish and Wildlife, Application ID: 18299. 10 pp.

WDFW, Lummi Nation, and Nooksack Indian Tribe. 2021. Biological Assessment for Bull Trout: For the Nooksack River, Lummi Bay, Whatcom Creek, Samish River and San Juan Islands Hatchery Programs. 65 pp.

WDOE (Washington State Department of Ecology). 2010. Focus on the Clean Samish Initiative. Washington Department of Ecology, 09-10–020, Olympia, Washington. 4 pp.

WDOE. 2021. Upland Finfish Hatching and Rearing General Permit. Washington Department of Ecology, A National Pollutant Discharge Elimination System and State Waste Discharge General Permit, Olympia, Washington. 79 pp.

WDOE, and King County. 2011. Control of Toxic Chemicals in Puget Sound: Assessment of Selected Toxic Chemicals in the Puget Sound Basin, 2007-2011. Washington State Department of Ecology and King County Department of Natural Resources, 11-03–055, Lacey, Washington. 297 pp.

WDOE. 2023. Washington Geospatial Open Data Portal: River Miles – USGS & WDFW. https://geo.wa.gov/datasets/waecy::river-miles-usgs-wdfw/explore?location=48.936219%2C-122.054652%2C12.44.

Wendelaar Bonga, S. E. 1997. The stress response in fish. Physiological reviews. 77(3), 591-625. 35 pp.

Whatcom County Planning and Development Services. 2020. Population Growth and Monitoring Report. 8 pp.

Williams. 1975. A Catalog of Washington Streams and Salmon Utilization (Nooksack Basin). Volume 1: Puget Sound Region, Olympia, Washington. 54 pp.

Winkowski, M. 2024, May 31. Personal communication (via email) from M. Winkowski to M. Good and S. Sebring regarding Species Status Assessment citations for Biological Opinion. Page 1.

Yelverton, J. T., D. R. Richmond, W. Hicks, H. Saunders, and E. R. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Lovelace Foundation for Medical Education and Research, Topical Report DNA 3677T, Albuquerque, New Mexico. 42 pp.

Zimmerman, M., and C. Kinsel. 2010. Migration of Anadromous Juvenile Bull Trout in the Skagit River, 1990-2009. FPT 11-01. 59 pp.

In Litteris

Co-managers. 2023. Document addressing questions/additional information requests for co-managers. Topic: June 14, 2023, document included additional information on broodstock collection, hatchery facilities, fish handling, intake screens, and dredging.

Co-managers. 2023. Document addressing co-manager responses to additional USFWS questions about RM&E activities. Topic: December 1, 2023, document included additional information on RM&E activities including operation of the South Fork Nooksack smolt trap, beach seining in the South Fork Nooksack, and seining for juveniles in the Middle Fork/North Fork Nooksack

Mason, R. 2023. Email to Scott Sebring, Chanice Davies, Brian Missildine, and Linnea Gullikson. December 13, 2023, email from Randy Mason included confirmation that acclimation pond intake structures will follow current guidelines for size, shape, and porosity to ensure that they are up to code.

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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 (USFWS) identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011, p. 18). Based on a recommendation in the USFWS' 5-year review of the species' status (USFWS 2008a, p. 45), the USFWS 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 USFWS applied relevant factors from the joint USFWS 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 USFWS' 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 two historically occupied core areas and one research needs area. The Mid-Columbia RU is recognized as an area where bull trout have co-evolved with salmon, steelhead, lamprey, and other fish populations. Reduced fish numbers due to historic overfishing and land management changes have caused changes in nutrient abundance for resident migratory fish like the bull trout. The recovery unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. Major drainages include the Methow River, Wenatchee River, Yakima River, John Day River, Umatilla River, Walla Walla River, Grande Ronde River, Imnaha River, Clearwater River, and smaller drainages along the Snake River and Columbia River (USFWS 2015c, p. C-1).

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

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

Lower Mid-Columbia Region

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

Upper Mid-Columbia Region

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

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

Lower Snake Region

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

Middle Snake Region

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

Columbia Headwaters Recovery Unit

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Upper Snake Recovery Unit

The Upper Snake Recovery Unit includes portions of central Idaho, northern Nevada, and eastern Oregon. Major drainages include the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and the Weiser River. The Upper Snake Recovery Unit contains 22 bull trout core areas within 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).

LITERATURE CITED

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Spruell P., A.R. Hemmingsen, P.J. Howell, N. Kanda1 and F.W. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4: 17–29. 14 pp.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix B
Status of Designated Critical Habitat: Bull Trout

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

Current Legal Status of the Critical Habitat

Current Designation

The U.S. Fish and Wildlife Service (USFWS) published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (USFWS 2010, entire); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on the USFWS’ 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 USFWS 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 USFWS 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 (ESA), 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 USFWS; 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 USFWS 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 USFWS' evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, Ch. 4 p. 39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (USFWS 2010, pp. 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (USFWS 2010, pp. 63898:63943).

Current Critical Habitat Condition Rangewide

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

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

Effects of Climate Change on Bull Trout Critical Habitat

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

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

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

LITERATURE CITED

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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