In Reply Refer To:
FWS/IR09/IR12/AES/01EWFW00-2017-F-1650

July 24, 2020

Frances E. Coffey, Director, Programs
Department of the Army
U.S. Army Corps of Engineers
Northwestern Division
Portland, Oregon 97208-2870

Subject: Transmittal of the Biological Opinion addressing Operations and Maintenance of the Columbia River System in Washington, Oregon, Idaho, and Montana

Dear Ms. Coffey:

This letter transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion on the proposed operations and maintenance of the 14, multiple use dam and reservoir projects in the Columbia River System located in Washington, Oregon, Idaho, and Montana, and its effects on the bull trout (*Salvelinus confluentus*), Kootenai River white sturgeon (*Acipenser transmontanus*), and critical habitat for the bull trout and the Kootenai River white sturgeon. Formal consultation on the proposed action was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). We received your January 23, 2020 request for formal consultation and a Biological Assessment (BA) on January 24, 2020.

The enclosed Biological Opinion is based on information provided in the BA, dated January 24, 2020, the February 2020 Columbia River System Operations Draft Environmental Impact Statement, an April 2, 2020 clarification letter, many informational exchanges, and other sources of information cited in the Biological Opinion. A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Spokane, Washington. An electronic copy of this Biological Opinion will be available to the public approximately 14 days after it is signed. A list of Biological Opinions completed by the Service since October 1, 2017, can be found on the Service Environmental Conservation Online System (ECOS) website at https://ecos.fws.gov/ecp/report/biological-Opinion.html.

The BA also included a request for Service concurrence on "not likely to adversely affect" determination(s) for certain listed resources. The enclosed document includes a section separate from the Biological Opinion that addresses your concurrence requests. Service concurrence is provided for the streaked horned lark (*Eremophila alpestris strigata*), Columbian white-tailed deer (*Odocoileus virginianus leucurus*), grizzly bear (*Ursus arctos*), Ute ladies tresses (*Spiranthes diluvialis*) and the western yellow-billed cuckoo (*Coccyzus americanus*), and its designated critical habitat. The rationales for the concurrences are included in the concurrence section.

If you have any questions regarding the enclosed Biological Opinion, our response to your concurrence request(s), or our shared responsibilities under the Act, please contact Eric Hein (Eric_Hein@fws.gov), Columbia Pacific Northwest Regional Office, Portland, Oregon or Erin Kuttel (erin_brittonkuttel@fws.gov), Washington Fish and Wildlife Office, Spokane, Washington.

Sincerely,

Robyn Thorson

Regional Director

Enclosure

cc:
BOR, Boise, ID (R. Springer)
BPA, Portland, OR (B. Zelinsky)
NMFS, Portland, OR (M. Tehan)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2017-F-1650

Columbia River System Operations and Maintenance of 14 Federal Dams and Reservoirs

Washington, Oregon, Idaho, and Montana

Federal Action Agency:

Army Corps of Engineers
Bonneville Power Administration
Bureau of Reclamation

Consultation Conducted By:

U.S. Fish and Wildlife Service
Columbia Pacific Northwest Regional Office
Portland, Oregon

Robyn Thorson

July 24, 2020

Robyn Thorson, Regional Director
Interior Region 9: Idaho, Oregon, Washington, Western Montana
Interior Region 12: Hawaii & Pacific Islands

Date

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ACRONYMS AND ABBREVIATIONS

ac	acre
ac-ft	acre-feet
AEM	Action Effectiveness Monitoring
AIF	Adaptive Implementation Framework
BA	Biological Assessment
Bonneville	Bonneville Power Administration
CBP	Columbia Basin Project
CEERP	Columbia Estuary Ecosystem Restoration Program
cfs	cubic feet per second
CHSU	critical habitat subunit
CHU	Critical Habitat Unit
Corps	U.S. Army Corps of Engineers
CRS	Columbia River System
CRSO	Columbia River System Operations
CRU	Coastal Recovery Unit
CSKT	Confederated Salish and Kootenai Tribes
CTWSRO	Confederated Tribes of the Warm Springs Reservation
CWA	Clean Water Act
DDT	dichlorodiphenyltrichloroethane
DO	dissolved oxygen
DPS	Distinct Population Segment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency

ACRONYMS AND ABBREVIATIONS

ERTG	Expert Regional Technical Group
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FMO	foraging, migratory, and overwintering
FPC	Fish Passage Center
FPOM	Fish Passage Operations and Maintenance
FPP	Fish Passage Plan
FRM	flood risk management
ft	feet
ft/day	feet per day
ft/s	feet per second
FWCAR	Fish and Wildlife Coordination Act Report
GBT	gas bubble trauma
GIS	geographic information system
ha	hectare
HCP	Habitat Conservation Plan
HIP	Habitat Improvement Programmatic
Hz	Hertz
ICF	initial controlled flow
IDFG	Idaho Department of Fish and Game
IFP	improved fish passage
IJC	International Joint Commission
ITS	Incidental Take Statement
JBS	Juvenile Bypass Systems
JWKIII	John W. Keys III Pump/Generating Plan
kcfs	thousands of cubic feet per second
km	kilometer
km^2	square kilometer
KTOI	Kootenai Tribe of Idaho
LSRCP	Lower Snake River Compensation Plan
LW	large wood
m	meter
m/s	meter per second
maf	million acre feet
maf/year	million acre-feet per year
MCRU	Mid-Columbia Recovery Unit
MFWP	Montana Fish, Wildlife and Parks
mi^2	square mile
MIP	Minimum Irrigation Pool
mm	millimeter
MOP	Minimum Operating Pool
MPG	major population group
MSL	mean sea level
N	nitrogen

ACRONYMS AND ABBREVIATIONS

NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NMFS	National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
NWR	National Wildlife Refuge
Opinion	Biological Opinion
P	phosphorus
PBF	Primary Biological Factor
PCB	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PIT	passive integrated transponder
ppm	parts per million
PRCC	Priest Rapids Coordinating Committee
PTAGIS	Columbia River Basin Passive Integrated Transponder Information System
PUD	Public Utility District
Reclamation	Bureau of Reclamation
RIOG	Regional Implementation Oversight Group
RKM	river kilometer
RM	river mile
RM&E	research, monitoring, and evaluation
RNA	Research Needs Area
RPA	Reasonable and Prudent Alternative
RPM	Reasonable and Prudent Measure
RSW	removable spillway weir
SCT	Systems Configuration Team
Service	U.S. Fish and Wildlife Service
Services	National Marine Fisheries Service and U.S. Fish and Wildlife Service
SKQ	Sèliš Ksanka Qĺispè Dam
SMP	Smolt Monitoring Program
SRWG	Studies Review Working Group
TDG	total dissolved gas
THSC	Tributary Habitat Steering Committee
TMDL	total maximum daily load
TMT	Technical Management Team
TSS	total suspended solids
U.S.	United States
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VARQ	Variable-Flow Flood Control
VDL	Variable Draft Limit
WCM	Water Control Manual
WDFW	Washington Department of Fish and Wildlife
WECC	Western Electricity Coordinating Council
WSF	water supply forecast

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1 INTRODUCTION

This document represents the U. S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) and concurrence based on our review of the proposed operation and maintenance of the Columbia River System (CRS), previously known as the Federal Columbia River Power System (FCRPS). The Proposed Action includes the ongoing operation and maintenance of 14 federal dams located in the states of Washington, Oregon, Idaho, and Montana by the Army Corps of Engineers (Corps), Bonneville Power Administration (Bonneville) and the Bureau of Reclamation (Reclamation) for the next fifteen years. The Opinion addresses effects to bull trout (*Salvelinus confluentus*) and Kootenai River white sturgeon (*Acipenser transmontanus*) and critical habitat for the bull trout and Kootenai River white sturgeon. The Concurrence section reviews effects to Ute ladies'-tresses (*Spiranthes diluvialis*), grizzly bear (*Ursus arctos horribilis)*, Yellow-billed cuckoo (*Coccyzus americanus*), streaked horned lark (*Eremophila alpestris strigata*), Columbian white-tailed deer (*Odocoileus virginianus leucurus*) and critical habitat for the streaked horned lark and western yellow-billed cuckoo (yellow-billed cuckoo) in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). We received your January 23, 2020 request for formal consultation on January 24, 2020.

This Opinion is based on information provided in the January 2020 Biological Assessment (BA), the February 28, 2020 draft Environmental Impact Statement (EIS), the April 2, 2020 clarification letter, telephone conversations, meetings, email exchanges, and other sources of information as detailed below. A complete record of this consultation is on file at the Eastern Washington Field Office in Spokane, Washington.

2 CONSULTATION HISTORY

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

- The Service consulted on the FCRPS December 20, 2000, which resulted in a jeopardy conclusion for Kootenai River white sturgeon and no jeopardy conclusion for bull trout. The Opinion was amended slightly on January 25, 2001.
- On February 18, 2006, the Service issued a separate final Opinion for proposed operations of Libby Dam and its effect on Kootenai River white sturgeon and bull trout.
- In September 2008, the Center for Biological Diversity, the Service, Corps, Bonneville, Kootenai Tribe of Idaho and State of Montana entered into a settlement agreement regarding operations of Libby Dam. As a result, the Service issued a clarification of the 2006 Reasonable and Prudent Alternative (RPA) for Kootenai sturgeon in 2008.
- On October 18, 2010, the Service published revised designated critical habitat for the bull trout, triggering the need for the Action Agencies to reinitiate consultation on the 2000 FCRPS and 2006/2008 Libby Dam Opinions.

- On June 1, 2011, the Service received a letter from Reclamation, on behalf of Reclamation, Corps, and Bonneville, indicating the Action Agencies' assertion that the ongoing implementation of the 2000 FCRPS Operations and Maintenance Opinion and the 2006/2008 Libby Dam operations Opinion would not result in an irreversible commitment of resources concurrent to the Action Agencies' effort to prepare a reinitiation package.
- Between 2011 and 2014, the Service, Bonneville, Corps, and Reclamation exchanged numerous correspondence and conducted meetings to discuss the draft revised BA, timelines for consultation, and scope of the analysis.
- In May 2016, the United States (U.S.) District Court for the District of Oregon invalidated the National Marine Fisheries Service's (NMFS) 2008 FCRPS Opinion, as supplemented in 2010 and 2014. The court held that NMFS did not provide an adequate explanation for its analysis in the Opinion that FCRPS operations and maintenance were not likely to jeopardize the continued existence of ESA-listed salmon and steelhead species. In addition, the 2016 Court ruling found that the National Environmental Policy Act (NEPA) (42 U.S.C. §§ 4321 et seq. 1969) coverage for CRS operations was inadequate. The Court ordered the Action Agencies to conduct comprehensive NEPA analysis of CRS operations to be completed by September 2021 (Corps et al. 2020 p. 1-6).
- On May 6, 2016, the Action Agencies and Department of the Interior received a 60-day Notice of Intent to sue from Alliance for the Wild Rockies for failure to consult on bull trout critical habitat. On July 11, 2016, Alliance for the Wild Rockies filed a complaint for declaratory and injunction relief against the Action Agencies.
- The Action Agencies began developing the Columbia River System Operations (CRSO) EIS on September 30, 2016.
- Throughout 2016, the Service met and emailed regularly with the Action Agencies to discuss content and provide feedback on portions of the revised draft BA. The Action Agencies sent a letter to the Service dated December 5, 2016 requesting initiation of formal consultation for operation and maintenance of the 14 Federal Multiple-use Projects in the CRS, including a draft BA dated December 6, 2016, plus appendices.
- On December 20, 2016, the Service sent a letter to the Action Agencies that initiated the consultation with the understanding that the Service and Action Agencies would continue to clarify the Proposed Action.
- On February 22, 2017, District Judge Hernandez issued his Opinion and order indicating that the Alliance for Wild Rockies complaint was dismissed since the formal consultation had already been initiated.

- Throughout 2017, the Service and Action Agencies met and emailed regularly to clarify the Proposed Action and a clarified BA was received on November 17, 2017 from the Action Agencies. During the remainder of 2017 and into 2018, the Service and Action Agencies coordinated regularly on clarifications of the Proposed Action. In addition, the Corps and the Service developed a scope of work to complete a Fish and Wildlife Coordination Act Report (FWCAR) under the Fish and Wildlife Coordination Act of March 10, 1931, as amended (16 U.S.C. §§ 661-667e).
- Reclamation submitted a memorandum to the Service indicating their intent to consult formally with the Service on the Columbia Basin Project on August 30, 2018.
- On October 19, 2018, President Trump signed a Presidential Memorandum *Promoting the Reliable Supply and Delivery of Water in the West*. One provision of that memorandum was to complete the EIS and Opinions for the Columbia River System Operations by 2020. The Council on Environmental Quality approved the revised schedule proposed by the Action Agencies, NMFS and the Service (through their respective Departments) to release a final EIS and the associated Opinions from NMFS and the Service by June 2020.
- On February 14, 2019, the Action Agencies submitted to the Service a letter indicating the Proposed Action would likely change as a result of the EIS process and requested the Service issue a final Opinion in June 2020.
- On December 20, 2019, the Service received a draft revised BA with an updated Proposed Actionfrom the Corps for review along with a request to initiate consultation.
- The Service provided comments on the draft BA on January 12, 2020 to the Action Agencies via email. On January 14, 2020, the Service provided the Action Agencies with a draft FWCAR for inclusion with the draft EIS.
- A final BA and consultation initiation package was received by the Service on January 24, 2020 (dated January 23, 2020).
- In response to the Service's comments on the draft BA, the Action Agencies provided a summary of responses and clarifications via email on February 19, 2020.
- On March 10, 2020, the Service initiated formal consultation with the intent to continue to work with the Action Agencies to further clarify the action and complete a final Opinion by the end of June 2020.
- On April 2, 2020, the Service received a letter from the Corps (dated April 1, 2020) clarifying several elements of the Proposed Action for NMFS and the Service.
- The Service provided the Action Agencies with the Draft Opinion for the Operations and Maintenance of the CRS for review on May 13, 2020. The Service received comments on May 29, 2020 and addressed them in this final Opinion.
- On June 24, 2020, he Council on Environmental Quality approved request by the Action Agencies to to change the signing date of the Biological Opinions from the current due date (June 30) to the last day of July. The request was granted, altering the signature date to July 24, 2020.

3 CONCURRENCE

The Proposed Action for the Operations and Maintenance of the CRS includes coordinated water management to meet the Action Agencies' authorized purposes, such as fish and wildlife conservation, flood risk management (FRM), irrigation, navigation, hydropower generation, recreation, and water supply (Corps et al. 2020a). The Action Agencies concluded the Proposed Action is not likely to adversely affect a suite of terrestrial species and associated critical habitat (Corps et al. 2020a Table 1-1). The following sections provide the Service's concurrences for species under our jurisdiction.

3.1 Grizzly Bear

The Service concurs that future operation and maintenance of the CRS may affect but is not likely to adversely affect the threatened grizzly bear (Corps et al. 2020a). This concurrence is based on the following rationale:

- Project activities will overlap or occur adjacent to grizzly bear recovery zones or are within proximity of known grizzly bear distribution outside of recovery zones. Hungry Horse Reservoir is located within the North Continental Divide Recovery Zone, reaches of the Kootenai River downstream of Libby Dam flow through the Cabinet-Yaak Recovery Zone, and the Pend Oreille and Clark Fork rivers flow adjacent to the Selkirk Recovery Zone. Lake Koocanusa is located adjacent to recurring grizzly bear use areas, and the Flathead River and Flathead Lake are within the current distribution of grizzly bears. In addition, grizzly bears have been documented upstream of reaches that may be seasonally inundated by Dworshak Reservoir. Although the Service does not consider the North Fork Clearwater Basin occupied by grizzly bears at this time, movement through this area has been documented and may occur during the life of the project.
- The Proposed Action may affect grizzly bears though modifications to varial zones (areas of periodic inundation), and changes in riparian habitat components. However, effects to grizzly bear are expected to be insignificant or discountable because much of the Action Area occurs at low-elevation in highly modified and fragmented habitats with frequent human disturbances that make these areas largely unsuitable for grizzly bears. The Proposed Action will not result in changes to riparian habitat that would significantly reduce existing cover or forage for grizzly bear, or preclude its use as travel corridors. Habitat restoration activities that improve riparian habitat quality may be a benefit for grizzly bears. The Proposed Action does not include road development and is not expected to result in an increase in human presence in or near grizzly bear habitat. In addition, the Proposed Action is not expected to impact any high-quality foraging, denning, or other security habitats frequently used by grizzly bear.

3.2 Ute ladies' tresses

The Service concurs that the future operation and maintenance of the CRS may affect, but is not likely to adversely affect Ute ladies' tresses based on the following rationale:

- Ute ladies' tresses is a long-lived perennial orchid that grows in wetland and riparian areas, seeps, mesic to wet meadows, river meanders, and floodplains. Human-altered areas like irrigation canals, berms, levees, drainages, and gravel pits can also be suitable and potentially occupied habitats (Fertig et al. 2005, p. 21). Ute ladies' tresses usually blooms from late July through August, although in some locations it may bloom in early July or into early October (Jordan 1999, p. 1). The species exhibits prolonged dormancy and may not bloom or even emerge above ground every year. Vegetative and reproductive Ute ladies'-tresses individuals can also revert to a prolonged, below ground dormancy for one to four or more growing seasons before re-emerging with new above ground shoots (Arft 1995, p. 34; Heidel 2001, p. 12). Therefore, it is extremely difficult to observe new individuals or even relocate already documented individuals because Ute ladies' tresses individuals are generally found within dense riparian understory vegetation and may be dormant for one to several years at a time.
- The Service listed Ute ladies' tresses based primarily on habitat loss and modification, although small population size and low reproductive rates were also listed as increasing the species' vulnerability to other threats (USFWS 1992). Specifically, modification of riparian habitat and destruction of wetland habitat in occupied habitat had resulted in several population extirpations. The Service also listed hydrologic and floodplain alteration, and other landscape-level threats (levee construction and maintenance, water diversions, road and bridge development, bank stabilization and armoring, channel dredging, and housing developments).
- Within the Action Area in Washington, Ute ladies' tresses occurs along the Rocky Reach Reservoir on gravel bars adjacent to the Columbia River in Chelan and Douglas counties (Fertig et al. 2005, p. 21). Potentially suitable habitat occurs on stabilized gravel bars and/or shoreline areas along the Columbia River that are moist throughout the growing season and inundated early in the growing season. Soil moisture must be at or near the surface through the growing season, and for most populations in Washington, individuals grow along the shoreline within the high-water inundation zone. Ute ladies' tresses has been found at relatively low elevations in Washington (1,000 to 1,800 ft). Ute ladies'-tresses tolerates periodic flooding; in fact, natural flooding cycles are important for creating new alluvial habitat and for reducing cover of competing plant species throughout their range, including along the Columbia River (Fertig et al. 2005, p. 82).
- As stated above, within the Action Area, Ute ladies' tresses occurs along the Columbia River in the Rocky Reach Reservoir, which is owned and managed by the Chelan County Public Utility District. Downstream flows could be influenced by discharge from Grand Coulee and Chief Joseph dams; however, the water surface elevation in Rocky Reach reservoir is primarily controlled by the operation of Rocky Reach Dam. The Action Agencies propose that those operations will not change from current operations, so flows and flooding cycles will be maintained at existing levels. In low flow years, water may

drop below normal levels. Conservation actions benefiting salmon and bull trout will minimize any effects through summer water releases from Grand Coulee Dam. Therefore, overall the effects to Ute ladies' tresses are expected to be insignificant.

3.3 Streaked Horned Lark and Designated Critical Habitat

The Service concurs that future operation and maintenance of the CRS may affect but is not likely to adversely affect the threatened streaked horned lark or designated streaked horned lark critical habitat (Corps et al. 2020a).

- In 2019, the Corps reinitiated consultation with the Service on the Columbia River Navigation Channel and the effects of the ongoing maintenance of channel dredging and dredge material placement on streaked horned larks and their critical habitat. That biological opinion concluded no jeopardy and not likely to destroy or adversely modify designated critical habitat (USFWS 2019a, Service reference 01EOFW00-2019-F-0350). The current Proposed Action does not expect any changes to navigation channel dredging timing, quantity, location, or frequency. If changes are needed, the Corps would reinitiate consultation on proposed dredging activities.
- The BA explains that most existing lark habitat is unlikely to be exposed to high water events, therefore the Proposed Action is not likely to influence early successional habitat conditions preferred by streaked horned larks. The BA also states that dams are operating more closely to mimic historic conditions, thus maintaining habitat conditions that streaked horned lark prefer, which could result in a beneficial effect to larks and their critical habitat. Finally, we do not expect that any individual streaked horned lark, at any life-history stage, is expected to be exposed to any other aspect of the management of the CRS. Therefore, we expect effects to be discountable, insignificant, or beneficial for the streaked horned lark and its designated critical habitat.

3.4 Western Yellow-Billed Cuckoo

The Service concurs that future operation and maintenance of the CRS may affect but is not likely to adversely affect the threatened yellow-billed cuckoo (USFWS 2014a) and its proposed designated critical habitat (Corps et al. 2020a). This concurrence is based on the following rationale:

- Few observations of yellow-billed cuckoo in the region and Action Area have been made, indicating they are more likely to visit or temporarily inhabit the Action Area rather than breed or reside there long-term. For instance, yellow-billed cuckoos are extremely rare in Washington; since 2000, only a few birds have been observed in the State: on the Little Pend Oreille National Wildlife Refuge (NWR) in northeastern Washington, and near Mazama, Washington (USFWS 2017a). In 2019, Little Pend Oreille NWR staff also documented these birds on the refuge. Incidental sightings of yellow-billed cuckoo have been noted in Oregon, however, based on limited data from recreationists, there are no clear patterns of cuckoo occurrence. In some parts of Idaho, the yellow-billed cuckoo is a rare visitor while, in northern Idaho, the few recorded sightings of cuckoos are most likely of transient, nomadic, or migrant individuals (USFWS 2017b).

- Currently, the Action Area is unlikely to include much suitable habitat that supports consistent, long-term breeding, rearing, and foraging of yellow-billed cuckoo. Yellow-billed cuckoo rely heavily on stringers or large blocks of riparian habitat, including willow dominated vegetation cover and cottonwood gallery forests, for successful nesting and to carry out other life history stages (USFWS 2017a; USFWS 2017b). If riparian habitats were to increase in quantity and quality throughout the Action Area, then it is possible yellow-billed cuckoo occurrence could also increase, especially during critical breeding and foraging periods. In the Action Area, hydropower development has significantly changed the timing, magnitude, and pattern of water levels, water velocities, and the processes that support the structure and function of riparian habitats (Hough-Snee et al. 2015; see Appendix U in Corps et al. 2020b). Thus, the baseline conditions for habitat in the Action Area are degraded and unlikely to support breeding, migratory, or resident yellow-billed cuckoo. Operations and maintenance of the CRS, coupled with a changing climate, are likely to maintain these baseline conditions, potentially limiting improvements in habitat quality in the future (USFWS 2017a; USFWS 2017b). However, since yellow-billed cuckoo are unlikely to spend much time in the Action Area and unlikely to be exposed to CRS impacts, effects are expected to be discountable.
- The Service proposed designation of critical habitat for the western U.S. Distinct Population Segment (DPS) of the yellow-billed cuckoo on August 15, 2014 (79 FR 48548; USFWS 2014b). In total, approximately 546,335 acres (ac) were proposed for designation in Arizona, California, Colorado, Idaho, Nevada, New Mexico, Texas, Utah, and Wyoming. On February 27, 2020 (85 FR 11458), the Service revised the proposed designation of critical habitat for the yellow-billed cuckoo. Now, approximately 493,665 ac (a reduction of 56,184 ac from the 2014 proposal) have been proposed for designation in the same states except New Mexico and Wyoming. Under both rulings, a few Critical Habitat Units (CHU) were proposed for designation along the Snake River and in tributaries (e.g., Henry's Fork) in Idaho. These units provide suitable breeding habitat for yellow-billed cuckoo, but they occur outside of the Action Area. No other critical habitat was proposed for designation within or near the Action Area and, thus we expect no impacts to yellow-billed cuckoo critical habitat as a result of future CRS operations and maintenance.
- Conservation recommendations specific to yellow-billed cuckoo are included later in this Opinion, which, if considered, could benefit existing riparian habitat like riparian forests and cottonwood galleries, or even create more habitat availability suitable for yellow-billed cuckoo. Additional conservation recommendations aimed at restoring or mimicking components of natural hydrological regimes, which can create improved natural conditions for successful riparian vegetation growth and survival that also supports yellow-billed cuckoo, are included in the Service's draft FWCAR (Corps et al. 2020b Appx U).

3.5 Columbian White-tailed deer

The Service concurs that future operation and maintenance of the CRS may affect but is not likely to adversely affect the threatened Columbian white-tailed deer (Corps et al 2020a). Critical habitat has not been designated for Columbian white-tailed deer, and therefore, will not be affected. This concurrence is based on the following rationale:

- Most existing Columbian white-tailed deer habitat is unlikely to be inundated by high water events because of existing levees, dikes, and upstream dams; therefore, the Proposed Action is not likely to influence habitat conditions preferred by Columbian white-tailed deer. While the Action Area contains suitable habitat that supports consistent, long-term breeding, rearing, and foraging populations of Columbian white-tailed deer, the closest known subpopulation is roughly 50 miles from any of the dams included in this consultation.
- Columbian white-tailed deer swim between islands in the Columbia River intermittently with no clear dispersal routes. While the deer may be exposed to navigation traffic, these effects are part of existing conditions and impacts from the Proposed Action are likely insignificant or discountable.
- The Proposed Action may affect Columbian white-tailed deer though changes in riparian habitat components and human disturbance factors. The Bonneville Power Administration consulted with the Service on the Columbia River Basin Habitat Improvement Program and the effects on Columbian white-tailed deer of the on-going aquatic and wildlife habitat restoration projects designed and implemented to restore or enhance stream and riparian function as well as upland wildlife habitat. That biological opinion concluded no jeopardy to the species, and recommended conservation measures (USFWS 2013a; 01EWOF00-2013-F-0199). Habitat restorations activities that improve riparian habitat quality may be beneficial for Columbian white-tailed deer.

4 BIOLOGICAL OPINION

5 DESCRIPTION OF THE PROPOSED ACTION

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02).

This ESA section 7(a)(2) consultation evaluates the effects of an ongoing federal action: the operations and maintenance of the 14 federal dam and reservoir projects in the Columbia River System that are managed as a coordinated system for multiple congressionally authorized public purposes by the Action Agencies (Corps et al. 2020a). The Proposed Action includes operational actions (e.g., FRM, navigation, fish passage, and hydropower generation) and non-operational actions (e.g., support for conservation hatchery programs, predation management, habitat improvement actions, and research, monitoring, and evaluation [RM&E] programs). The Biological Assessment Proposed Action is summarized here and highlights actions that are proposed to change over historical operations.

The Corps operates and maintains 12 of the 14 federal Columbia River System projects: Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, Dworshak, Chief Joseph, Albeni Falls, and Libby Dams. The Corps operates and maintains these projects for FRM, navigation, hydropower generation, fish and wildlife conservation, irrigation, recreation, water quality, and municipal and industrial water supply, though not every project is authorized for each of these purposes.

Reclamation operates and maintains the remaining two of the 14 federal Columbia River System projects: Grand Coulee and Hungry Horse Dams. Reclamation operates these projects to support multiple legally mandated authorizations including irrigation, hydropower generation, FRM, navigation, and municipal and industrial water supply.

Bonneville markets and distributes power generated at these 14 federal projects on the Columbia River and its tributaries. Transmission facilities owned and operated by Bonneville interconnect and integrate electric power generated at the federal projects to the regional transmission grid.

The Action Agencies also fund or implement substantial mitigation, enhancement, and RM&E programs. While considered in the Proposed Action, most of these programs have separate consultations with the Service and are discussed more in the Environmental Baseline. These programs include: salmon and steelhead hatchery programs (including kelt reconditioning programs), Kootenai River white sturgeon hatcheries, tributary habitat and estuary habitat restoration programs, predator management programs, and RM&E programs (including fish status monitoring).

This section focuses on those aspects of the Proposed Action which most affect ESA-listed species considered in this consultation. Additional specificity and a more detailed description of the Proposed Action can be found in the BA (Corps et al. 2020a) and in the associated BA clarification letter (Corps 2020a). The BA, and associated clarification letter, is hereby incorporated by reference.

5.1 System Operations and Maintenance for Congressionally Authorized Project Purposes

The Action Agencies propose to continue operating and maintaining the 14 federal Columbia River System projects to meet congressionally authorized purposes: FRM, fish and wildlife conservation, power system management, irrigation/water supply, navigation, recreation, system maintenance, water quality, and municipal and industrial water supply, though not every project is authorized for each of these purposes.

5.1.1 Operations for Flood Risk Management

The Action Agencies propose to continue operating the CRS storage projects for local FRM objectives in some locations and as a coordinated system to meet regional FRM objectives to protect life and property by minimizing flood consequences or risk of damages, regardless of the conditions presented in any given water year. CRS storage projects include Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak. John Day Dam has some limited storage space but generally is operated as a run-of-river project. Operations for these projects are developed collaboratively by Action Agency water managers and are described in the Water Control Manual (WCM) for most projects. Coordinated operation of these projects for FRM can best be described in terms of seasonal operations.

5.1.1.1 Fall Operation: September ─ December

Fall operations (from September to December period) at specific water storage projects are affected by a variety of factors, but projects generally are operated to reach end-of-December target reservoir elevations to create flood storage space, which usually results in operations to lower (draft) reservoir levels during this period. Operational purposes other than FRM may bring reservoir levels lower than the end-of-December FRM requirements. Grand Coulee (Lake Roosevelt) does not have a fall FRM requirement.

5.1.1.2 Storage Evacuation Operation: January ─ April

During the January to April period, the CRS storage projects operate to the storage reservation diagram unique to each dam. The storage reservation diagrams determine the maximum allowable elevation, or required minimum storage space, for each reservoir based on a given water supply forecast. Water supply forecasts at locations in the basin used to determine FRM space requirements are updated monthly from January through April (within the first 10 days of the month). Every year, the federal storage reservoirs are operated to maximize available water, while also ensuring that FRM objectives are met.

One of the analytical tools used to determine whether a storage reservoir can be drafted during the winter and maintain a high probability of meeting project refill objectives is development of a Variable Draft Limit (VDL). Grand Coulee and Hungry Horse utilize VDLs during the months of January through March; and a VDL will be developed for Dworshak reservoir to help inform water management decisions during the months of January through March. The concept is to increase the use of the reservoir for power generation during winters with high runoff forecasts and avoid drafting the reservoir during the spring months at rates that would produce total dissolved gas (TDG) levels that would pose a risk to aquatic life downstream in the Clearwater River.

5.1.1.3 Refill Operation: May ─ July

During the May to July period, the CRS storage projects are operated to target refill, limited by system and local FRM guidance. The projects on the Columbia River operate together to meet the initial controlled flow (ICF) at The Dalles Dam, while refilling reservoirs during the refill period. The ICF is a calculated flow, used in conjunction with the forecasts and available reservoir storage, to determine when to start refill to ensure a high probability of achieving total refill while managing flood risks. The probability of achieving total refill varies by project and timing, ranging from 75 percent to 95 percent. During the refill period, the outflow from the reservoir is kept lower than the inflow to the reservoir, allowing the water level in the reservoir to reach its targeted refill elevation when the risk of flooding has decreased significantly.

5.1.2 Proposed Changes to Storage Project Operations

The proposed changes to storage project operations include:

- Hungry Horse Dam:
  - A new sliding scale for drafting will be implemented at Hungry Horse Dam. Corps and Reclamation will determine the summer draft from the Hungry Horse project for the purposes of delivering flow augmentation for downstream fish based on a local water supply forecast. Additionally, this modified elevation objective would be incrementally adjusted over a range of water supply conditions. These changes would allow water managers to balance local resident fish priorities in the upper basin with downstream flow augmentation for the Columbia River downstream of Chief Joseph Dam.

- Libby Dam
  - Similar to Hungry Horse Dam, a new sliding scale for drafting is included in the Proposed Action for implementation at Libby Dam. *Refer to the bullet above for details.*
  - The Proposed Action would modify draft rates at Libby to provide water managers more flexibility to incorporate local conditions in the upper basin and alter flow management so that local flood durations and start of refill operations are tied to Kootenai Basin runoff. Draft targets remain the same as current operations in December and for forecast greater than 6.9 million acre feet (maf) at Libby Dam. During refill (generally April or May to July), the Variable-Flow Flood Control (VARQ) refill flow calculation will be adjusted to real-time local water conditions and account for planned releases, such as the sturgeon volume release. Implementing this action would improve water management flexibility to respond to local FRM conditions in the upper basin. It would also allow greater flexibility to provide suitable temperature and flow conditions to benefit resident fish.

    The Proposed Action would begin influencing reservoir elevations after December 31, and its effects are best understood by looking at the spring, when the lowest reservoir elevation typically occurs. The modified draft rate at Libby causes the spring reservoir elevation to be lower when the seasonal water supply forecast is less than 6.9 maf at Libby Dam. One benefit of the deeper draft is to help the reservoir warm faster in the spring so that warmer water will be available for flows to benefit Kootenai River white sturgeon (the Sturgeon Pulse) that starts in mid-May. See Section 2.3.2.1 of the BA for additional details on this action as it relates to the Sturgeon Pulse, outflows at Libby and flows at Bonners Ferry.

- Grand Coulee Dam
  - An additional 45,000 acre-feet (ac-ft) could be pumped from Lake Roosevelt at Grand Coulee above previous operations. Additionally, this operation would

change the delivery timing of recently developed water supplies for the Odessa Subarea of the Columbia Basin Project (CBP) (164,000 ac-ft for irrigation and 15,000 ac-ft for municipal and industrial or M&I of the current supplies) from September and October to when the water is needed, on demand. The 45,000 ac-ft water supports near-term additional development of authorized project acres. Water pumped from Lake Roosevelt would be delivered as the demand arises during the irrigation season (from March to October). Grand Coulee refill will be adjusted to offset this additional water supply impacts to spring flows; impacts to summer flows will be negligible.

- A modified fall operation to increase flexibility for hydropower at Grand Coulee Dam is included in the Proposed Action. Lake Roosevelt is refilled after summer flow augmentation for the benefit of resident; the project typically refills through October to prepare the project for winter Power operations and to support chum spawning and rearing below Bonneville Dam. The Proposed Action modifies the Lake Roosevelt minimum refill elevation of 1,283 feet (ft) from the end-of-September to the end-of-October to allow more operational flexibility for power generation while also meeting downstream flow objectives including Priest Rapids minimum flows and Lower Columbia River minimum flows for navigation. This Proposed Action may result in lower end of September Lake Roosevelt elevations when compared to previous operations, particularly in low water years. Short-term operations would continue to be coordinated with the tribes.
- A modified *Storage Reservation Diagram* would include a planned draft rate of 0.8 feet per day (ft/day); this would not change the draft rate limit of 1.5 ft/day or the deepest FRM elevation, typically on April 30. This Proposed Action changes the planned timing and rate of the draft to satisfy the FRM requirements. FRM space requirements are determined by water supply forecasts and upstream storage reservoir capacity. FRM space requirements are determined by water supply forecasts and upstream storage reservoir capacity, this calculation methodology has been updated including changes to how Grand Coulee space requirements respond to changes in upstream storage. The reduced draft rate would reduce the risk of erosion along the shoreline and may reduce spill in some years. This action will maintain the same level of flood risk and allow water managers to better manage drafts for Grand Coulee under a wide range of hydrologic conditions.
- This Proposed Action could expedite the maintenance schedule for the power plants and spillways of the Grand Coulee Project. The proposed changes to maintenance operations could result in additional spill in limited situations; changes to total outflows are not expected. The maintenance on the power plants could reduce the number of generating units available, requiring additional spill in some situations. The project could keep 27 of the 40 regulating gates and/or 8 drum gates in service and take the others out of service to perform spillway maintenance activities. This action could improve safety, reliability, and the capacity of power plants and spillways at Grand Coulee Dam.

- Dwörshak Dam
    - Slightly deeper reservoir drafts at Dworshak Dam would be calculated in-season to improve FRM operations, reduce spring spill at Dworshak, and increase hydropower generation in the January to March timeframe when market demand is higher. These modifications would result in a reduction of non-fish passage spill in the spring, resulting in reduced TDG exposure to fish in the Clearwater River below Dworshak Dam, and in particular, the salmon and steelhead raised at Dworshak National Fish hatchery downstream of the dam. This action would be implemented in a manner to limit the risk of the reservoir not refilling later in the year. The Corps would define a rule curve through further coordination with Bonneville to operate Dworshak.

- John Day Dam
    - The Proposed Action would remove current restrictions on seasonal pool elevations at John Day project in the winter, allowing more operating flexibility for hourly and daily shaping of hydropower generation. The Proposed Action would allow for operation of the reservoir across the full range possible, between 262.0 ft to 266.5 ft elevation outside of fish passage season, except as needed for FRM. The Proposed Action will maintain a minimum elevation of 262.5 ft during the irrigation season, generally March 15 through November 15.
    - The John Day reservoir elevation will be held to deter Caspian terns from nesting in the Blalock Islands Complex from about April 10 to June 1 (see Reservoir Operations (section 5.1.3.4) for additional details).

5.1.3 Operations for the Conservation of Fish and Wildlife

The operation of the 14 CRS projects is managed to minimize impacts to ESA-listed anadromous (e.g., salmon and steelhead) and resident species (e.g., Kootenai sturgeon, and bull trout), as well as other non-listed species (e.g., salmonids, burbot, and lamprey), while achieving other project purposes.

5.1.3.1 Storage Project Operations

The Action Agencies manage water and reservoir operations for both anadromous and resident fish using the specific operations described earlier and in the BA. These operations consider seasonal spring and summer flow objectives for migrating juvenile salmon and steelhead at several representative locations in the Columbia and Snake rivers, and fall and winter flows for spawning and incubating chum salmon below Bonneville Dam. While projects vary, in general, this includes the following:

- Operate Libby, Hungry Horse, Grand Coulee, and Dworshak to be at their elevation objectives in early April (for example Grand Coulee attempts to be at the elevation objective on April 10th, the exact date to be determined during in-season management) to maximize flows for the spring out-migration of juvenile salmon.

- Refill the storage projects by the end of June/early July (exact date to be determined during in-season management) to provide summer flow augmentation consistent with available water supply, spring operations, and FRM requirements.
- Draft storage projects to their August 31 or September 30 elevation targets based on water-supply volume forecast to support summer flow augmentation for juvenile fall Chinook salmon migration.
- Provide fall and winter tailwater elevations/flows to support chum salmon spawning and incubation in the Ives Island area below Bonneville Dam, and to provide access for chum spawning in Hamilton and Hardy Creeks.
- Balance the consideration of these priorities with all authorized project purposes.

The Corps and Reclamation will determine the summer draft from the Libby and Hungry Horse projects for the purposes of delivering flow augmentation for downstream fish based on a local water supply forecast. Additionally, this modified elevation objective would be incrementally adjusted over a range of water supply conditions. These changes would allow water managers to balance local resident fish priorities in the upper basin with downstream flow augmentation for the Columbia River downstream of Chief Joseph Dam.

- The Proposed Action would modify draft rates at Libby to provide water managers more flexibility to incorporate local conditions in the upper basin and alter flow management so that local flood durations and start of refill operations are tied to Kootenai Basin runoff. Draft targets remain the same as current operations in December and for forecast greater than 6.9 maf at Libby. During refill (generally April and May to July), the VARQ refill flow calculation will be adjusted to real-time local water conditions and account for planned releases, such as the sturgeon volume release. Implementing this action would improve water management flexibility to respond to local FRM conditions in the Upper Basin. It would also provide greater flexibility to provide suitable temperature and flow conditions to benefit resident fish. As this operation is implemented, adjustments to provide more space in the reservoir may be made with input from interested parties if new information emerges about nutrient dynamics and temperature impacts in the reservoir and river that could not be captured with the current modeling tools.

  The Proposed Action would begin influencing reservoir elevations after December 31, and its effects are best understood by looking at the spring, when the lowest reservoir elevation typically occurs. The modified draft rate at Libby causes the spring reservoir elevation to be lower when the seasonal water supply forecast is less than 6.9 maf at Libby Dam. A benefit of the deeper draft is to help the reservoir warm faster in the spring so that warmer water will be available for flows to benefit Kootenai River white sturgeon (the Sturgeon Pulse) that starts in mid-May.

  The Proposed Action adjusts the refill equations for all years, which results in increased likelihood of reservoir refill in all but the lowest 5 percent of years. The change in refill shaping is most notable prior to the Sturgeon Pulse, and then again after it. The Sturgeon Pulse shape and volume is expected to remain unchanged (i.e., from current CRS operations), which can commence as soon as early April in some years and continue through June depending on the required volume to be released. Action Agencies estimate that the peak reservoir elevation would usually be achieved in July or early August; there would be a 4 percent increased chance of the reservoir reaching elevation 2,454 ft NGVD29 or higher (within 5 ft of the full pool elevation of 2,459 ft NGVD29) by July 31. In August and September, the reservoir elevation would generally be about 1 ft to 4 ft higher than current CRS operations.

The Proposed Action will also increase the peak refill elevation in combination with a sliding scale end-of-September target elevation dependent on the water supply forecast at Libby and Hungry Horse dams, rather than the system wide water supply forecast at The Dalles. The Sliding Scale at Libby and Hungry Horse action targets a higher elevation than used in previous operations, specifically in the wettest 25 percent of years. These changes can carry over into October and November in some years.

The reservoir levels are expected to be higher in the months of July, August and September. In July, this is attributable to the modified draft rate at Libby Dam, which tends to increase the peak refill elevation. In August, the higher reservoir levels are attributable to a combination of the Modified Draft at Libby and Sliding Scale at Libby and Hungry Horse actions. In September, the higher reservoir levels are attributable to the Sliding Scale at Libby and Hungry Horse actions, which has fewer years drafting to 2,449 ft NGVD29 than under past operations (due to the change in forecast location), and many more years with elevations above 2,452 ft NGVD29 then under past operations.

- Libby Dam Outflow. The Proposed Action includes modified draft and refill and "sliding scale" operations at Libby Dam, which affect drafting and refill operations and have a direct effect on outflows throughout the year. Notably, in dry years, water releases may be lower in late April and May and higher flows in June, July and August. In wet years water releases may be higher in late April and lower flows in late June, July and August. Monthly average outflow from Libby Dam in average to dry years is expected to increase in January, February, and March, followed by a reduction in outflow in April and May as refill begins (caused primarily from the modified draft rate) (Corps et al 2020b Table 7-7). However, the Sturgeon Pulse volume and shape will remain unchanged, which happens in all but the 20 percent driest years, because the reduction in outflows in those years happens prior to the start of the Sturgeon Pulse. The shape of the Sturgeon Pulse volume will continue to be adaptively managed in season by the Flow Plan Implementation Protocol. The Sturgeon Pulse continues through sometime in June depending on the water supply forecast. In dry years, the summer outflows are expected to be 2000 to 3000 cubic feet per second (cfs) higher due to the higher refill elevations resulting from the modified draft rate. After the annual Sturgeon Pulse is completed, changes in outflow occur as a result of the proposed sliding scale at Libby and Hungry Horse dams and modified draft rate at Libby Dam (i.e., modified operations target a higher end-of-September elevation in the wettest 25 percent of years based on the Libby Dam water supply forecast).

- Bonners Ferry Flow. The Proposed Action would also affect flows at Bonners Ferry. In general, the flows would differ in much the same way as at Libby Dam, though to a smaller degree due to dilution effects of major tributaries downstream of the dam and effects of backwater from Kootenay Lake. The reason for the changes seen at Bonners Ferry are the same as those described for Libby Dam outflow (Corps et al 2020b, Table 7-8).

  Changes to operations of storage projects will result in small changes in Lake Roosevelt inflow as compared to previous CRS operations. Increases in flow are more prevalent in the winter months and decreases in flow within one percent may occur in the spring and summer months. The change in upstream flow accounts for much of the change seen in the Grand Coulee outflow and influences reservoir elevations at Lake Roosevelt.

The Action Agencies also propose to continue to pursue agreement with Canada, through the 1964 Columbia River Treaty annual agreements (up to 1.0 maf) released within the May to July period) or long-term Non-Treaty Storage Agreements (up to 0.5 maf released in the spring to benefit juvenile migrants in the lowest 20th percentile of water conditions (Dry Year Strategy), if not used in the prior year.

5.1.3.2 Spring Juvenile Fish Passage Spill Operations

Spring spill operations will occur from April 3 to June 20 at the four Lower Snake River projects, and from April 10 to June 15 at the four Lower Columbia River projects or as defined in the Fish Passage Plan (FPP). Daily spill caps to meet tailrace TDG targets will be coordinated with NMFS and adjusted daily as necessary, and will be within state TDG water quality standards and implementation guidelines. Target spill levels for spring 2021 at each project are defined in Table 1.

The intent of the flexible spring juvenile fish passage spill operation is to: (1) provide fish benefits (increasing spill levels to improve juvenile passage conditions and survival rates and adult returns), (2) provide federal power system benefits, (3) ensure operational feasibility, and (4) evaluate the biological effectiveness of the spring spill operation. As described in the Action Agencies' Proposed Action, spring spill levels will follow the flexible spill concept (Corps et al. 2020a). Beginning in the spring of 2021, the four Lower Snake River and McNary dams will all operate up to 125 percent TDG Gas Cap spill for a minimum of sixteen hours per day, and each project may operate under "performance spill" for up to eight hours per day. The Dalles Dam will spill to 40 percent spill. John Day Dam will spill to 120 percent TDG gas cap spill for 16 hours per day with 32 percent spill occurring during 8 hours of performance spill. Bonneville Dam will spill up to 125 percent TDG (with a 150 kcfs [thousands of cubic feet per second] spill constraint), for 16 hours and eight hours of performance spill at 100 kcfs per day. Typically, the eight hours of performance spill may be split into two separate blocks with one beginning in the AM hours, and one in the PM hours or used over a consecutive period of time, not to exceed 8 hours. There is one exception to this operation at Little Goose Dam. When the adult fish passage trigger of 25 spring Chinook salmon is met counted passing upstream of Lower Monumental Dam, performance spill must be implemented in the morning hours at Little Goose Dam and continue for eight consecutive hours of to reduce the risk of adult Snake River spring/summer Chinook salmon passage delay.

In general, performance spill blocks are intended to provide more flow through turbine units. Higher daytime powerhouse flow is intended to provide power marketing flexibility and benefit passage conditions for adult migrants that can have difficulty passing during high spill at some projects. The Gas Cap spill periods are intended to increase spillway passage, reduce forebay residence time, and reduce powerhouse encounter rates for downstream migrating juvenile salmonids. Attempts will be made to minimize in-season changes to the proposed spill operations, but if substantial impacts are observed (e.g., potential delays to adult migration, gas bubble trauma [GBT] above water quality agency biological thresholds for salmonids and non-salmonid fish, increased river flows, transmission reliability, spill due to lack of market, lack of turbine capacity, or effects on navigation), operations may be adjusted. The Corps will coordinate these changes and decisions through the established Regional Forum. Existing GBT monitoring and adaptive management protocols for juvenile salmon will be used to determine if GBT thresholds have been exceeded. If thresholds have been exceeded, and if river conditions allow, the Action Agencies may reduce spill, where appropriate, in accordance with Oregon[1] and Washington[2] water quality standards and implementation guidance.

Table 1. Summary of proposed spring spill levels at lower Snake and Columbia River projects.

PROJECT	FLEX SPILL (16 hours per day)	PERFORMANCE STANDARD SPILL (8 hours per day)
Lower Granite	125% Gas Cap	20 kcfs
Little Goose	125% Gas Cap	30%
Lower Monumental	125% Gas Cap (uniform spill pattern)	30 kcfs (bulk spill pattern)
Ice Harbor	125% Gas Cap	30%
McNary	125% Gas Cap	48%
John Day	120% TDG target	32%
The Dalles	40%	40%
Bonneville	125% Gas Cap (150 kcfs maximum spill constraint)	100 kcfs

(Source: Corps et al 2020a, Tables 2-9 and 2-13)

[1] The Oregon Environmental Quality Commission approved the Order Approving a Modification to the Oregon's Water Quality Standard for Total Dissolved Gas in the Columbia River Mainstem at the January, 24, 2020 meeting. The Order was signed on February 11, 2020 by the Oregon Department of Environmental Quality director.

[2] On July 31, 2019, Washington Department of Ecology proposed amendments to Chapter 173-201A WAC Water Quality Standards for Surface Waters of the State of Washington (AO # 19-02). On December 30, 2019, Ecology adopted the final rule amendments. U.S. EPA approved the rule on March 5, 2020. The amendments adopted into rule include the numeric criteria for total dissolved gas or TDG in the Snake and Columbia rivers at WAC 173-201A-200(1)(f)(ii).

The process for adaptive management of the flexible spill component of the CRS operations (Adaptive Implementation Framework or AIF) is attached to the draft EIS Appendix R (Part 2), released on February 28, 2020 for public review and comment. As part of the requirements by the Washington State Department of Ecology, the Action Agencies will investigate the feasibility of native non-salmonid fish collection at the current Juvenile Bypass Systems (JBS) locations and explore the practicality of native non-salmonid fish collection and GBT monitoring through the Northern Pikeminnow Removal Program index sampling that currently exists downstream of a dam project where 125 percent TDG gas cap spill occurs.

During the 2020 spring spill season, the first year when some dams will be spilling at 125 percent TDG gas cap spill, GBT monitoring of juvenile salmonids will continue using the primary established protocols. The unpaired fins and eyes will be examined for the presence of bubbles and the area covered with bubbles will be quantified at five of the CRS dams (Lower Granite, Little Goose, Lower Monumental, McNary and Bonneville dams). Native non-salmonid fish collected in the JBS, or through other locations in-river or at the dam, will be monitored using the same methods applied to salmonids. The data will be reported to fisheries management entities and the water quality agencies of Washington and Oregon on a daily basis. The data will be made available to other interested parties through Fish Passage Center (FPC) weekly reports and when postings are made to the FPC web site during the season. The 2020 sampling methodologies and data collected will be used to develop biological monitoring plans required for the 2021 spring spill season[3]. If feasible, the Action Agencies will also explore the practicality of secondary native non-salmonid fish collection and GBT monitoring through the Northern Pikeminnow Removal Program index sampling that is carried out downstream of dam's when/where 125 percent TDG gas cap spill is being occurring.

5.1.3.3 Summer Juvenile Fish Passage Spill Operations

Summer spill operations will occur from June 21 to August 31 at the four Lower Snake River projects, and from June 16 to August 31 at the four Lower Columbia River projects or as defined in the annually updated FPP. The Proposed Action describes that summer spill will be divided into two periods, an initial summer spill period occurring from the end of spring spill until August 14, and a late summer spill period which begins on August 15 and ends on August 31 (Corps et al. 2020a). Target summer spill levels at each project are defined in Table 2. The Action Agencies may reduce spill, where appropriate, in accordance with Oregon and Washington water quality standards and implementation guidance.

The Action Agencies will operate Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams at Minimum Operating Pool (MOP) with a 1.5 ft operating range from April 3 until August 14 unless adjusted on occasion to meet authorized project purposes, primarily navigation (Table 1.3-4). Except for the John Day Project, the Lower Columbia River projects (Bonneville, The Dalles, and McNary) will be operated within the normal forebay operating

[3] Many activities in 2020 were disrupted by travel restrictions and social distancing recommendations to reduce the risk of unintentionaly spreading the coronavirus, COVID-19. Therefore, it is possible that some of these activities will be revisited in 2021 for implementation.

range for each project (Table 3). The John Day reservoir will maintain a minimum elevation of 262.5 feet during the irrigation season, generally March 15 through November 15, except as needed for FRM.

Table 2. Summary of proposed summer target spill levels at lower Snake and Lower Columbia River projects.

PROJECT	Initial Summer Spill Operation	Late Summer Transition Spill Operation (August 15-August 31)
Lower Granite	18 kcfs	Removable Spillway Weir (RSW) or 7 kcfs
Little Goose	30%	Adjustable Spillway Weir or 7 kcfs
Lower Monumental	17 kcfs	RSW or 7 kcfs
Ice Harbor	30%	RSW or 8.5 kcfs
McNary	57% (with no spillway weirs)	20 kcfs
John Day	35%	20 kcfs
The Dalles	40%	30%
Bonneville	95 kcfs	50 kcfs

(Source: Corps et al 2020a, Tables 2-10 and 2-14)

5.1.3.4 Reservoir Operations

From April 10 to June 1 (or as feasible based on river flows), the John Day reservoir elevation will be held between 264.5 ft and 266.5 ft to deter Caspian terns from nesting in the Blalock Islands Complex during this period. The Action Agencies intend to begin increasing the forebay elevation prior to initiation of nesting by Caspian terns to avoid take of tern eggs; operations may begin earlier than April 10 (when the reservoir is typically operated between 262.0 ft and 266.5 ft). The operation may be adaptively managed due to changing run timing; however, the intent is to begin returning to reservoir elevations within the Minimum Irrigation Pool (MIP) range (262.5 to 264.5 feet) from June 1 (but no later than June 15), which generally captures 95 percent of the annual juvenile steelhead migration. John Day will operate within the MIP range (262.5 to 264.5 feet) through August 31 to support juvenile fish migration. The results of this action would be monitored and communicated with the Service and NMFS (collectively the Services) in appropriate forums (i.e., Technical Management Team [TMT], Fish Passage Operations and Maintenance [FPOM], and Studies Review Work Group or SRWG). During the operation, safety-related restrictions would continue, including but not be limited to maintaining ramp rates for minimizing project erosion and maintaining power grid reliability.

Table 3. Minimum Operating Pool, Minimum Irrigation Pool (MIP), and Normal Operating Elevation Range for CRS projects.

Project	Normal Operating Elevation Range		1.5 ft MOP/2.0 ft MIP Restricted Elevation Range	
	Minimum	Maximum	Minimum	Maximum
Lower Granite	733.0	738.0	733.0	734.5
Little Goose	633.0	638.0	633.0	634.5
Lower Monumental	537.0	540.0	537.0	538.5
Ice Harbor	437.0	440.0	437.0	438.5
McNary	337.0	340.0	N/A	N/A
John Day	262.0	266.5	262.5	264.5
The Dalles	155.0	160.0	N/A	N/A
Bonneville	71.5	76.5	N/A	N/A

(Source: Corps et al. 2020a, Tables 2-8, 2-11, and 2-12)

5.1.3.5 Transport Operations

The start of juvenile transport operations at Lower Granite, Little Goose, and Lower Monumental dams will target April 24 (collection starting on April 23), but may start as early as April 15. Prior to 2018, juvenile transport generally began on May 1. The earlier transport date is intended to provide additional flexibility to adjust to earlier juvenile migration timing, increase transport rates for spring migrants (which would otherwise decrease substantially as a result of the proposed Flexible Spill Operations), and evaluate the value of transporting fish earlier in the season. The decision to initiate transport will be made annually and will be coordinated through the TMT and the Regional Implementation Oversight Group (RIOG), but transport will begin no later than May 1. This is consistent with operations in 2018-2020, when transport began on April 24. In 2020, transport operations will continue through the end of October at Lower Granite and Little Goose Dams and through the end of September at Lower Monumental Dam, regardless of when spill ends. As part of ongoing discussions between parties of the 2019 to 2021 *Flexible Spill Operation Agreemen*t, cessation of transport operations between June 21 and August 15 may occur (Action Agency letter to NMFS dated December 19, 2018). Allowances for adaptive management through established regional forum processes may lead to further modifications to the transport program.

5.1.4 Operations for Power System Management

The Action Agencies propose to continue operating the 14 federal CRS projects to generate electricity to meet regional load (demand). Power will be generated using any remaining flexibility to manage water flow, and to meet the daily and seasonal demand for electricity (Corps et al. 2020a). This includes balancing electricity demand and supply, managing the system to address or avoid emergencies, and integrating renewable resources. Bonneville must also manage and provide operating reserves based on required reserve obligations using dispatchable energy generation[4] to ensure that generation within the balancing authority area matches load at all times through the deployment of balancing reserves, and maintains the safety and reliability of the transmission grid by dispatching contingency reserves during unplanned, emergency events (e.g., failed generator event). See the biological assessment (Corps et al. 2020a), Section 2.3.3, and the April 2020 clarification letter for more details (Corps 2020a).

5.1.4.1 Fall Operational Flexibility for Hydropower

The Proposed Action modifies the Lake Roosevelt minimum refill elevation of 1,283 ft from the end-of-September to the end-of-October to allow more operational flexibility for power generation while also meeting downstream flow objectives, including Priest Rapids minimum flows and Lower Columbia River minimum flows for navigation. This Proposed Action may result in lower Lake Roosevelt elevations at the end of September. Based on 80 years of historical records and modeling results, the end-of-September elevation was below 1,283 ft in approximately 40 percent of years and in October the elevation is projected to be below 1,283 ft in approximately 10 percent of the days. For comparison, under the previous operation, the reservoir elevation was modeled to be at or above 1,283 ft by the end of September each year; however, during dry years refilling to this elevation impacted power generation flexibility.

5.1.4.2 Turbine Operations Above ±1 Percent Peak Efficiency Range

As one component of the Proposed Action, the Action Agencies will have the flexibility to operate turbines above the ±1 percent of peak efficiency range at all 14 dams, including the four Lower Snake River and four Lower Columbia River dams. Generally, for power, the best operating range for turbines is within ±1 percent of peak efficiency, where the most power is produced for a given volume of water; however, there are some conditions that can be advantageous to operate at higher levels. This element of the Proposed Action would occur under limited conditions, frequencies, and durations to provide grid reliability, flexibility to incorporate other resources (such as wind, solar, other hydro projects, gas, coal, and nuclear), and additional power generation when demand and market is available.

During the months of April to August, the Action Agencies intend to meet all required fish passage spill operations (beginning April 3 on the Lower Snake River and April 10 on the Lower Columbia River or as described in the FPP), before operating turbines above the 1 percent efficiency range, as described in the biological assessment (Corps et al. 2020a). During spring and summer fish passage, the Action Agencies will operate as a soft constraint within 1 percent peak efficiency and as a hard constraint of within and above 1 percent peak efficiency when implementing the use of emergency, contingency reserves, mitigating TDG during high flow events, and carrying balancing reserves. Action Agencies will continue to assemble project

[4] Dispatchable generation refers to sources of electricity that can be dispatched (generation is increased or decreased) at the request of power grid operators or of the plant owner to meet fluctuations in demand or supply. Often, baseload power plants, such as nuclear or coal, cannot be turned on and off in less than several hours. The time periods in which a dispatchable generation plant may be turned on or off may vary in time frames of seconds, minutes or hours.

specific summaries on a monthly basis. These summaries will report incidences where operations exceed ±1 percent of peak efficiency range, as outlined in Appendix C of the FPP (reporting requirements in Section 5, Quality Control). During the rest of the year, September 1 to April 3 on the lower Snake River and April 10 on the lower Columbia River, the same soft constraints will be implemented; however, turbines may also be operated within normal range (including above and below 1 percent peak efficiency range).

- Contingency reserves will be used to meet energy demands caused by unexpected events such as transmission interruption or failure of a generator. The exact timing, magnitude, and the location of the need to deploy contingency reserves cannot be predicted, which makes pre-coordination for each individual event impossible. These events are rare and, when they occur, Action Agency system operators will strive to cover the contingencies without temporarily operating above the ±1 percent of peak efficiency range. On average, contingency reserves at each project are estimated to be deployed once per month for up to 35 minutes and are limited in duration (not to exceed 90 minutes). Carrying contingency reserves above the 1 percent peak efficiency range would provide operating flexibility and if an event is large enough to require action for greater than 90 minutes (e.g., loss of generation from nuclear plant), Bonneville will find other tools to maintain grid reliability. As currently defined in the FPP, any operations above ±1 percent of peak efficiency range that are deployed per project for contingency reserves will be reported.

- Periods of high spring run-off may result in TDG production above State water quality standards of 125 percent saturation. In those instances, the Action Agencies may operate turbines above the ±1 percent of peak efficiency range to mitigate for TDG. The purpose of mitigating TDG production is to reduce the duration and magnitude of water quality standards exceedances in the tailraces of each project due to lack of market, lack of turbine capacity spill levels at high river flow levels. While TDG management may occur at lower flows, if there are a high number of turbine outages, the Proposed Action would occur when minimum flow levels reach 160 kcfs on the Lower Snake River and 340 kcfs on the Lower Columbia River. During these high flow conditions, the Action Agencies intend to operate all available turbines before exceeding the upper ±1 percent of peak efficiency range.

  The Action Agencies will coordinate with the Regional Forum, in this case Fish Passage Operations and Maintenance, a forum that includes NMFS, the Service, and regional partners, to implement a priority list of TDG mitigation operations by project. Coordination will aid in the development of a prioritized operation that minimizes negative impacts to fish and considers fish condition and survival metrics, gatewell hydraulics, unit design and project capacity. As currently defined in the Fish Passage Plan, any operations above ±1 percent of peak efficiency range that are deployed per project for TDG mitigation will be reported.

- Bonneville is responsible for electrical grid reliability, which requires the use of balancing reserves to follow sub-hourly power demand and supply fluctuations. Because supply must equal demand for power second-by-second, power generation must increase and decrease automatically as demand for power changes. Furthermore, to integrate the use of other renewable power sources, balancing reserves assist in compensating for within-hour changes (e.g., due to changes in wind and solar availability). More specifically, Bonneville assigns a share of balancing reserves to Grand Coulee, Chief Joseph, and each of the four lower Snake and four lower Columbia projects according to the amount of operating flexibility each project has for the prevailing water conditions.

To meet expected power demand, an hourly basepoint of target megawatts is allocated to available generating units at each project. If actual within hour generation is different from the set basepoint, then the project is deploying reserves to either increase generation (deploy reserves upward) or decrease generation (deploy reserves downward) to preserve the balance of supply and demand. Basepoint departures would have increased risk of generating above ±1 percent of peak efficiency range if the basepoint was set near the upper 1 percent limit. There must be flow thresholds met and a positive market (i.e., net demand for power) to acquire enough load to set a basepoint near the upper 1 percent limit. During these high flow conditions, the Action Agencies intend to operate all available turbines before exceeding the upper ±1 percent of peak efficiency range.

As part of the Proposed Action, Bonneville intends to set all hourly basepoints for expected power demand within ±1 percent of peak turbine efficiency at all dams. As part of the Proposed Action, Bonneville intends to set all hourly basepoints for expected power demand with in ± 1 percent of peak turbine efficiency at the lower Snake and Columbia River dams. The application of balancing reserves at across multiple and up to all eight projects is expected to result in a reduction in magnitude of departures from basepoint within each hour. The Action Agencies anticipate this proposed operation will result in a frequency and magnitude of events that, on average, does not exceed a 30 hours per month, per project. Actual use of the Proposed Action is expected to be lower with the application of basepoint restrictions within ±1 percent of peak efficiency ranges, (over 50 percent of the time balancing reserves would be below the upper ±1 percent of peak efficiency). Additionally, there must be flow thresholds met and a positive market (i.e., net demand for power) to acquire enough load to set a basepoint near the upper 1 percent; during high flow conditions, markets can be negative and therefore Bonneville would not want to operate the turbines above ±1 percent of peak efficiency ranges.

Bonneville will continue to assemble and provide monthly summaries of project specific excursions from ±1 percent of peak efficiency operating ranges to the Corps, as outlined in Appendix C of the FPP (reporting requirements in Section 5, Quality Control). The Corps will continue to provide annual reports to NMFS of reportable excursions from ±1 percent operating range during fish passage season, which include codes associated with excursions (e.g., code 13, TDG reduction and code 7, emergency conditions or system failures associated with system reliability for contingency reserves) (Appendix C, Table C-1 of the FPP). Action Agencies will coordinate with the Services on future reporting requirements prior to the initiation of the Proposed Action. After three years of the proposed operation, the Action Agencies will produce a summary of frequency and duration of operations that occurred above ±1 percent of peak efficiency turbine operating range by project during spring and summer spill operations (as prescribed in Appendix C of the FPP) and will coordinate with the Services on future operations.

5.1.4.3 Extension of Zero Generation Operations

In the Pacific Northwest, energy demands have typically peaked in the wintertime as the need for heating increases. Ensuring a sufficient supply of electricity in the winter can be a challenge, particularly when demand increases dramatically region-wide and little or no electricity is available in the wholesale market during cold temperature events. Because most renewable resources generate when the wind blows or the sun shines, regardless of when residents and businesses in the Northwest need the electricity, other generators (typically hydropower and gas-fired power plants) must adjust their power generation to compensate for fluctuations in energy produced by these variable resources (i.e., to integrate the renewable power sources). Within normal operating limits and other project requirements, Bonneville uses the capacity of the CRS projects to support the integration of these additional carbon-free energy resources into the regional and western electrical grid. This ancillary service provided by the CRS is becoming increasingly important as more wind and solar power sources come online in the Pacific Northwest. A component of how wind and solar power resources are integrated into the CRS includes the flexibility to cease power generation when there is little demand.

Between October 15 and February 28, when power market conditions warrant and when river conditions make it feasible, power generation at Snake River projects may cease, and water stored, during nighttime hours, most commonly implemented between 2300 and 0500 hours when demand for power is lowest and other renewable resources are generating surplus power (or both). During this time, river flow occurs through operation of passage facilities only. This operation will end no later than 2 hours before dawn between October 15 and November 30. During the operation between December 15 and February 28, daytime hours will no longer be excluded from this operation, and up to 3 hours of daytime cessation will be part of the Proposed Action.

This shift in current operation would allow operators to save water in low demand periods to use for hydropower generation during higher demand periods. The timing and need for ceasing power generation during this period of time is difficult to predict. However, based on previous operations between December 15 and February 28 and during nighttime hours only, Bonneville estimates the use of this operation may occur one out of every 3 to 5 days at each project. See the biological assessment (Corps et al. 2020a) and Water Management Plan for additional details.

5.1.5 Operations for Irrigation/Water Supply

Reclamation and Corps propose to continue to store and divert water for irrigation and water supply (Corps et al. 2020a, Section 2.3.5). This includes the operation of the CBP and the mainstem hydrologic effects of several Reclamation irrigation projects that are not coordinated with the CRS (The Dalles Project; Chief Joseph Dam Project; Umatilla Projects, including Phase I and Phase II; Yakima Project; Deschutes Project; and Crooked River Project are included in this consultation). Depletions from these non-CRS irrigation projects are included in the Columbia River hydrologic models for the CRS.

The Corps manages some CRS reservoir levels to allow for irrigation on private agricultural lands. The Corps' Northwestern Division Reservoir Control Center coordinates and modifies operations to maintain water levels for incidental (non-federal and federal) irrigation projects in both John Day and McNary Reservoirs. The Lower Snake River projects also provides irrigation water by maintaining stabilized reservoir levels that enable the installation and operation of pumping stations.

5.1.6 Operations for Navigation

The Action Agencies propose to continue operating the eight projects on the lower Columbia and lower Snake rivers for navigation (Corps et al. 2020a Section 2.3.4). This includes managing reservoir elevations, filling and draining navigation locks, and maintaining navigation locks. Adjustments in spill or reservoir operating ranges may be required at any of the lower Snake or Lower Columbia River projects to address navigation safety concerns and to maintain the authorized depth in the federal navigation channel. This may include changes in spill patterns, reductions in spill, including short-term spill cessation, or adjustments to MOP operations. These adjustments may sometimes be necessary during the spring or summer fish passage season and possibly during periods of low or high flows.

5.1.7 Operations for Recreation

The Action Agencies propose to continue the operation of the 14 CRS projects to support recreational activities (Corps et al. 2020a, Section 2.3.6). This includes managing reservoir elevation and river flows. Both recurring and one-time requests for special operations to support recreation are considered, within normal operating limits and other project requirements including FRM and fish conservation operations.

5.1.8 System Maintenance

The Action Agencies propose to continue to maintain the 14 CRS projects (Corps et al. 2020a, Section 2.4). This includes scheduled, or routine, maintenance of fish facilities, spillway components, navigation locks, generating units, and supporting systems to ensure project reliability and to comply with North American Electric Reliability Corporation (NERC)/Western Electricity Coordinating Council (WECC) regulatory requirements.

Routine maintenance includes actions to reduce or contain the releases of oils and greases from federal dams into the Snake or Columbia rivers. For equipment in contact with the water, the Corps has developed best management practices to avoid accidental releases and to minimize the adverse effects in the case of an accidental release. The Corps has also begun using, where feasible, "environmentally acceptable lubricant" greases and in some cases has replaced greased equipment with greaseless equipment. The Corps has also developed and are implementing oil accountability plans with enhanced inspection protocols and are reporting annually for the four lower Snake River and four lower Columbia River projects to comply with the Clean Water Act (CWA).

At Bonneville Dam, periodic dredging in the forebay is required to ensure reliable operation of fishways. The area near the Bradford Island Fish Ladder exit is surveyed annually and is dredged every year or two. Similar work is done near the turbine units that supply attraction water to the Washington Shore Fish Ladder. A barge-mounted suction or clamshell dredge is used to remove material for eventual upland disposal and standard turbidity control actions are employed. The operation takes one week to complete and would continue to be conducted during the in-water work period (December to March), in accordance with the Fish Passage Plan.

Spill operations at Bonneville Dam routinely pull large rock material onto the spillway apron. This material must be removed to prevent structural damage and disruption to spill operations and minimize impacts on fish. Rock removal is generally needed every year that spill exceeds 150 kcfs, approximately 7 years out of 10. Hydrosurveys will continue to be conducted annually, usually in September, and will typically take one day to complete. Rock material removal would occur during the in-water work period (December to March), in accordance with the FPP and in coordination with FPOM. Rock material is typically removed using a clamshell dredge mounted on a barge then placed at upland disposal sites.

At Dworshak Dam, there are three generating units, which discharge into the North Fork of the Clearwater River. From September 15 through the end of February, units are taken down, one at a time, to perform annual inspection and maintenance. One of the generating units is brought down for six weeks for cavitation repair. This outage is scheduled because the turbines must be dewatered to provide access. Each of the remaining units is typically out of service for 2 weeks to 4 weeks during this annual inspection and maintenance period. Similar to turbine maintenance at Chief Joseph Dam, fish protection protocols have been developed for turbine dewaterings at Dworshak Dam in response to past events which resulted in the loss of adult B-run steelhead. These protocols began being implemented in 2017, are included in the FPP, and coordinated through the FPOM coordination team. Fish protection protocols for unit operation testing will continue to be developed by the Corps in coordination with the Services. To further minimize and avoid Snake River Basin injury and mortality, the Corps will continue to implement and improve protocols regarding Dworshak Dam turbine unit operations and maintenance, and associated FPOM coordination, consistent with the 2020 FPP.

System maintenance also includes unscheduled maintenance. Unscheduled maintenance can occur any time there is a problem or unforeseen maintenance issue or emergency that requires a project feature, such as a generator unit, to be taken offline in order to resolve. Unscheduled maintenance occurring in combination with ongoing scheduled maintenance can significantly reduce the generating capability and hydraulic capacity of the project. The timing, duration, and extent of these events are unforeseeable. These events are communicated through the appropriate teams under the Regional Forum, such as the FPOM coordination team and TMT, to minimize negative effects on fish.

Maintenance that is planned but is not performed at regular intervals (e.g., unit overhauls, major structural modifications, or rehabilitations) is non-routine maintenance. Non-routine maintenance is not performed at a regular pre-determined frequency, and includes tasks that are more significant than routine scheduled maintenance. Non-routine maintenance includes power plant modernization and major rehabilitations of CRS project features, described below.

During the expected timeframe of this consultation, improved fish passage (IFP) turbines will be installed at 3 out of 6 turbine units at Ice Harbor Dam. At McNary Dam, the status of turbine replacement is near the completion of the design phase and is expected to begin replacement within the next 15 years. At John Day Dam, initiation of the design phase has begun and the likelihood of completion during this consultation is uncertain. The Action Agencies, in coordination with NMFS and the Service, will consider cessation of turbine intake bypass screen installation at these projects if direct fish passage survival studies demonstrate a neutral or beneficial effect.

The Corps will repair the existing jetty and retaining wall located near the north shore adult ladder entrance at Little Goose Dam where significant erosion has occurred. During unusually high flows in 2011, the jetty rock was severely degraded, which led to the ladder entrance flow to be somewhat degraded by the tailrace eddy flow when spill exceeds 30 percent. Replacing the jetty with large rock and/or large coffer cells will restore passage conditions to pre-2011 levels at the north shore ladder entrance when spill exceeds 30 percent at Little Goose Dam.

5.2 Non-Operational Conservation Measures to Benefit ESA-listed Salmon and Steelhead

In addition to the operational actions described above, the Action Agencies propose to continue non-operational conservation measures to address uncertainty regarding the effects of further increases in spring spill, and to help offset any residual adverse effects of system management. These non-operational actions include support for conservation hatchery programs, predation management, and habitat improvement actions in the Columbia River Estuary and various tributaries. The Action Agencies' approach to mitigating the effects of CRS management on ESA-listed salmon and steelhead is consistent with conservation strategies established in regional salmon and steelhead recovery planning processes.

5.2.1 Structural Modifications at Mainstem Dams

The Action Agencies propose to implement several structural modifications at the lower Snake and Columbia River dams. These modifications are described in more detail in the biological assessment (Corps et al. 2020a, Section 2.6.1.1). At Lower Granite Dam, the Corps will monitor follow-on modifications to the juvenile bypass separator which were implemented to reduce delay, injury, and stress to salmon and steelhead, bull trout, and non-target species. Where beneficial and feasible, the Corps will develop and implement operational or structural solutions to address. The Corps will design and implement cost effective structural modifications to the Lower Granite Dam adult fish trap to reduce delay and stress for adult salmonids.

Consistent with the recommendations presented in NMFS' 2015 Adult Sockeye Salmon Passage Report (NMFS 2016), the Corps will continue monitoring and reporting all mainstem fish ladder temperatures and identify ladders that have substantial temperature differentials (> 1.0 °C). Where beneficial and feasible and in coordination with FPOM (or other appropriate Regional Forum), the Corps will develop and implement operational or structural solutions to address maximum temperatures and temperature differentials in adult fish ladders at mainstem lower Snake and Columbia dams identified as having these problems.

The Corps will implement enhanced debris management at Lower Snake River and McNary projects. Seasonally, pulses of woody debris can accumulate on turbine unit trash racks and enter bypass systems and can injure ESA-listed salmonids and cause considerable maintenance challenges for dam operators. In recent years, Lower Granite Dam's debris boom used in conjunction with the RSW have effectively passed large amounts of debris, increasing debris loads at downstream Lower Snake River dams and at McNary Dam. In response, the Corps has begun to identify potential new operational or structural solutions for managing debris. The Corps will continue to investigate potential operational or structural solutions for effective forebay debris management at McNary Dam and the Lower Snake River dams. Where necessary and feasible and in coordination with FPOM, the Corps will design and implement solutions designed to minimize and reduce ESA-listed salmonid injury and mortality associated with debris accumulation.

5.2.2 Conservation and Safety Net Hatchery Actions

To support ESA-listed salmon and steelhead species affected by CRS management, the Action Agencies will continue to fund the operation and maintenance of safety net and conservation hatchery programs that preserve and rebuild the genetic resources of ESA-listed salmon and steelhead in the Columbia and Snake River basins. The purposes of conservation programs are to rebuild and enhance naturally reproducing ESA-listed fish in their native habitats using locally adapted broodstock, while maintaining genetic and ecological integrity, and supporting harvest where and when consistent with conservation objectives. Safety net programs are focused on preventing extinction and preserving the unique genetics of a population using captive broodstock to increase the abundance of the species at risk.

5.2.2.1 Conservation and Safety Net Hatcheries

The Action Agencies note the continued existence of their respective independent, congressionally-authorized hatchery mitigation responsibilities, including, but not limited to, Grand Coulee mitigation, John Day mitigation and programs funded and administered by other entities, such as Lower Snake River Compensation Plan (LSRCP), which is administered by the Service. Similar to the conservation and safety–net programs and where appropriate, the Action Agencies will conduct separate consultations addressing effects to ESA-listed species from the operations and maintenance, as well as associated monitoring and evaluation (including tagging) for these programs. Most of these programs have been previously consulted on by the Service and are discussed in Section 9.4.7.

5.2.3 Conservation Actions for Lamprey

The Action Agencies propose to implement several structural measures designed to improve passage and survival of Pacific lamprey (*Entosphenus tridentatus*) as funding becomes available. Any structural or operational changes intended to improve passage conditions for Pacific lamprey will be coordinated with the Services to assure neutral to beneficial effects on ESA-listed species. The Action Agencies propose the following structural measures to improve lamprey survival:

- Modify turbine intake bypass screens that cause juvenile lamprey impingement. The Corps will replace existing extended-length bar screens with screens designed to reduce juvenile lamprey entanglement at Little Goose and Lower Granite dams. The upgrades would occur when existing screens need replacement;
- Expand network of Lamprey Passage Structures in fish ladders at Bonneville, The Dalles and John Day dams, and modify existing structures;
- Modify turbine cooling water strainer systems to safely exclude juvenile lamprey; and,
- Modify existing fish ladders, incorporating lamprey passage features and criteria into ladder modifications at lower Snake and Columbia River dams. Modifications may include ramps to submerged weir orifices, diffuser plating to provide attachment surfaces, diffuser grating with smaller gaps, refuge boxes, wetted walls, rounded weir caps and closure of floating orifice gates.

5.2.4 Predator Management and Monitoring Actions

The Action Agencies propose to continue actions to reduce the ESA-listed salmon and steelhead eaten by predators (Corps et al. 2020a Section 2.6.1.3) through the following actions:

- Pinniped Management at Bonneville and The Dalles Dams
  - Installation and potentially improve sea-lion exclusion devices in ladder entrances at Bonneville Dam;
  - Provide dam access and, as practicable, other support (e.g., crane support) for land- and water-based harassment and trapping efforts by state and tribal agencies;
  - The Corps will fund dam-based hazing (focusing on deterrence from fishway entrances) and haul out dissuasion of pinnipeds from March 31 through May 31 and from August 15 through October 31 at Bonneville Dam. Hazing season start and end dates may be adjusted, in coordination with NMFS, based on factors such as the number of animals present and hazing effectiveness;
  - Develop and implement, in coordination with NMFS, a revised Bonneville Dam pinniped predation monitoring plan that reflects current and near-future management needs. The Corps will continue to provide monthly and annual reports to NMFS and FPOM; and,
  - Haze pinnipeds observed in the vicinity of fish ladder entrances at The Dalles Dam as needed.

- Pikeminnow Predation Management
  - Implementation of the Northern Pikeminnow Management Program, including the Sport Reward Fishery (May through September) and Dam Angling programs (May through October);
  - Work with partners to understand and develop new management opportunities (i.e., revised sampling methods to replace electrofishing);
  - Adaptively manage the Dam Angling Program component to address new site-specific predation using test fisheries along Snake River hydroelectric projects; and,
  - Coordinate with the Services locations of future actions within the Dam Angling Program, especially if new site-specific predation locations become a priority.

- Avian Predation Management
  - Im0plementation of Inland Avian Predation Management Plan. The Corps will monitor presence or absence of Caspian terns (once during the breeding season) on Crescent Island indefinitely. Reclamation will continue to monitor, passively and actively dissuade Caspian terns, and (optionally) lethally take up to 200 tern eggs (all sites combined) on Goose Island and other areas in the North Potholes Reservoir until permanent and sustainable nesting deterrents achieve the metric thresholds outlined in the Inland Avian Predation Management Plan: less than 40 breeding pairs per site, and less than 200 breeding pairs all sites combined within reservoir. At the conclusion of the Synthesis Report, and informed by preliminary information from the 2020 studies funded by Bonneville and the Priest Rapids Coordinating Committee (PRCC), the Action Agencies will coordinate with the Services through the appropriate Regional Forum workgroup (e.g., FPOM) to determine need for and scope of future Action Agency-sponsored inland avian predation management and monitoring in the Columbia Plateau;
  - Implementation of the Caspian Tern Management Plan. On East Sand Island, the Corps will continue to implement management actions, including preparing 1.0 ac of suitable tern nesting habitat and passive and active dissuasion outside the 1.0 ac tern nesting area. The Action Agencies will monitor peak colony size (nesting pairs) and predation rate (on passive integrated transponder [PIT]-tagged juvenile salmon) until actions achieve the management goal: less than 4,375 breeding pairs (3-year average). To date, this management goal has been met in 2017 and 2019. Afterwards, the Caspian tern East Sand Island peak colony size and predation impact/rates on PIT-tagged juvenile salmonids will be monitored, as warranted by study findings and regional coordination. At the estuary dredge material placement islands (Rice, Miller, Pillar and other locations as warranted), the Corps will conduct active and passive dissuasion, potentially lethally take up to 100 tern eggs, and monitor tern presence or absence, per commitments under a separate 2012 NMFS Opinion. Further, if warranted at the alternative (constructed) sites in Oregon and Northern California, the Corps will maintain nesting habitat to attract and retain terns until those islands are legally transferred to Oregon, Washington or the Service. At the conclusion of the Synthesis Report, and informed by preliminary information from the 2020 studies funded by Bonneville and the PRCC, the Action Agencies will work with the

Services through the appropriate Regional Forum workgroup (e.g., FPOM) to determine need for and scope of future Action Agency-sponsored Caspian tern management and monitoring in the Columbia Plateau; and,

- Implementation of East Sand Island Double-Crested Cormorant Management Plan. On East Sand Island, the Corps will continue to implement Phase 2 management actions, including active and passive dissuasion and (optionally) lethally take up to 500 Double-Crested Cormorant eggs, as warranted. The Action Agencies will monitor peak colony size and predation rate (on PIT-tagged juvenile salmon) through 2020 and as needed thereafter. In the Columbia River Estuary, the Corps will also monitor dispersal, disposition (e.g., roosting, nesting, etc.) and colony size through 2020 and as needed thereafter. On the estuary dredge material placement Islands (Rice, Miller, Pillar and other locations as warranted), the Corps will conduct passive and active dissuasion, (optionally) lethally take up to 250 Double-Crested Cormorant eggs, and monitor cormorant presence or absence, per commitments under a separate 2012 NMFS Opinion. Finally, at the conclusion of the Synthesis Report, and informed by preliminary information from the 2020 studies funded by Bonneville and the PRCC, the Action Agencies will work with the Services through the Regional Forum workgroup (e.g., FPOM) to determine need for and scope of future Action Agency-sponsored double-crested cormorant management and monitoring on East Sand Island and the larger Columbia River Estuary.
- The Action Agencies will complete:
    - A synthesis of avian predation data collected through implementation of the three avian management plans to assist in assessing the effectiveness of these actions on a basinwide scale. In 2020, Bonneville intends to fund an analysis of presence or absence, abundance, and colony-specific information, and predation rates of piscivorous waterbird colonies (including unmanaged sites) within the Lower Columbia River, from McNary Dam downstream through the Columbia River Estuary (Corps et al 2020a);
    - An avian predation deterrence at Lower Columbia and Lower Snake River dams. The Corps will continue avian predation deterrence and monitoring activities at all eight lower Columbia and Lower Snake River dams. At each dam, bird numbers will continue to be monitored, birds foraging in dam tailraces will be hazed (to include, in some circumstances, lethal take) and passive predation deterrents; and
    - An avian predation deterrence operation of John Day Reservoir. As described in the CRSO EIS, the Action Agencies propose to increase the the reservoir elevation up to 2 feet above the MIP range during the spring. This operation would deter Caspian terns from nesting at Blalock Island Complex. The intent is to decrease rates of Caspian tern predation on ESA-listed juvenile salmon and steelhead in the Lower Columbia River.

5.2.5 Estuary Habitat Actions

The Action Agencies propose to continue implementing the Columbia Estuary Ecosystem Restoration Program (CEERP) to increase the capacity and quality of estuarine ecosystems, and improve the opportunity for access by juvenile salmonids. This element of the Proposed Action will help address uncertainty related to any residual effects of the Proposed Action from the CRS, including uncertainty regarding such effects in the face of climate variability.

The Action Agencies propose to prioritize habitat improvement sites by identifying regions with the greatest potential to benefit yearling and subyearling life-history types of ESA-listed salmon and steelhead. Examples of potential actions include: reconnecting floodplains, recreating wetland channels, enhancing riverine habitat, removing fish passage barriers, reducing non-native species, and restoring native vegetation. The Action Agencies will continue to use the Expert Regional Technical Group (ERTG) to provide technical information and analysis of issues to the Action Agencies regarding the most effective types of actions to pursue in the estuary (i.e., what actions will result in the greatest benefit), assist the Action Agencies in developing project prioritization criteria, (i.e., where will we get the greatest benefit), and reviewing completed projects.

The Action Agencies propose to reconnect an average of 300 acres per year of floodplain habitat for the first 10 years of this consultation. After the first five years of this consultation, the Action Agencies' will work with the NOAA Fisheries to evaluate the cumulative effectiveness of these and past projects in the estuary, and evaluate additional opportunities and needs. They note that because project cancellations and delays have sometimes occurred years into project development, there is uncertainty in forecasting into the future. The Action Agencies therefore propose to include a "5-year rolling review," which will evaluate the acreage restored to date and projects available for the next 5-year period in their annual CEERP restoration and monitoring plan. The CEERP will continue to include action effectiveness monitoring and research using a three-level approach, to improve the estuary habitat program over time as information becomes available that addresses current and future uncertainties. Several efforts are already underway:

- Synthesis Memorandum. Every five years or so, the Action Agencies will reevaluate the state of the science, their accomplishments to date, and the effects and trends of estuary habitat improvement actions. The latest memorandum was finalized in August June 2018;
- ERTG's Landscape Perspectives. The Action Agencies, NMFS, and ERTG continue to consider landscape ecology concepts and principles that can refine and direct where to focus future restoration efforts; and,
- Uncertainties research. With the development of additional landscape criteria, ERTG will revisit and rank the critical uncertainties that require new or continued attention. These recommendations, along with lessons learned and key findings from the Action Agencies' RM&E program, will guide future research objectives and study designs.

The intent of each of the undertakings listed above is to refine and learn a more effective approach to restoring estuary habitat. The Action Agencies describe these proposed endeavors, and their continued on-the-ground habitat improvement, as a commitment and willingness to analyze the outcomes and results of these actions to improve their understanding and the effectiveness of habitat improvement in the estuary.

5.2.6 Tributary Habitat Actions

The Action Agencies propose to implement targeted tributary habitat improvement actions as offsite mitigation to help address uncertainty related to residual adverse effects of CRS management on the listed salmon and steelhead that migrate through the CRS, including uncertainty regarding such effects in the face of climate change (Corps et al. 2020a, Section 2.6.1.4 and Appendix D; Corps 2020a).

5.2.6.1 Implementation Approach

The Action Agencies commit that their tributary habitat improvement actions will be informed by recovery plans and other best available information and science; will build adaptively on the science-based strategies and research and monitoring information developed during implementation of tributary habitat improvement actions under the 2008/2010/2014 FCRPS biological opinions and the 2019 CRS biological opinion; and will maintain the extensive network of collaboration with local experts and implementing partners developed under those biological opinions.

Implementation will be guided by the Tributary Habitat Steering Committee (THSC), which was established under the 2019 CRS Opinion. In addition, a Tributary Technical Team will be formed to provide scientific guidance to support implementation of the program and to help ensure that program goals and objectives are achieved.

The Action Agencies will focus implementation of tributary habitat improvement actions on priority populations. Initially, these will be the priority populations identified in the 2008 FCRPS Opinion, but the Action Agencies will work with NMFS to refine population priorities. The Action Agencies will prioritize actions based on locally developed implementation strategies that prioritize actions based on assessments of limiting factors and, eventually, of habitat capacity by species and life stage. Such assessments will identify watersheds and action types believed to offer the greatest potential to contribute to species viability. Action prioritization will also consider climate impacts as relevant to action locations and types. Input from the Tributary Technical Team will also inform action prioritization. In general, the Action Agencies intend that actions to improve habitat complexity will be the primary effort under this Proposed Action, with a corresponding focus on larger and more complex actions.

5.2.6.2 Implementation Commitments: Actions, Metrics, and Plans

For the period covered by this consultation, the Action Agencies will complete, or have in process, habitat improvement actions for three major population groups (MPGs) within the Snake River spring/summer Chinook salmon Endangered Species Unit, for four MPGs within the Snake River steelhead DPS, and for Upper Columbia River spring Chinook salmon and Upper Columbia River steelhead.

In addition, the Action Agencies may implement habitat improvement actions for Mid-Columbia River steelhead and for the populations of Columbia River chum, Lower Columbia River coho, Lower Columbia River Chinook, and Lower Columbia River steelhead that have been affected by CRS management. The Action Agencies will develop, with input from NMFS, a series of prospective 5-year implementation plans that outline the specific actions the Action Agencies intend to implement in that timeframe.

5.2.6.3 Implementation Reporting

The Action Agencies will provide NMFS with information sufficient to ensure that implementation is consistent with the level of effort committed to in the Proposed Action, and to evaluate the implementation and effectiveness of the tributary habitat improvement program both quantitatively (e.g., through life-cycle modeling) and qualitatively. During the first year of the Proposed Action, the THSC, in collaboration with the Tributary Technical Team, will coordinate the final requirements for implementation reporting, and will assure that reporting objectives are met.

The Action Agencies will report annually on implementation, with a more comprehensive report on, and analysis of, implementation at 5-year intervals.

5.2.6.4 Climate Change

Many of the habitat improvement actions planned, designed, funded, and implemented by the Action Agencies will help support resilient habitats and flexibility to adjust to climate change. For example, actions to enhance riparian areas, stream complexity, and stream flow will help to ameliorate streamflow and temperature changes and increase habitat diversity and population resilience.

5.2.6.5 Research, Monitoring and Evaluation

The Action Agencies will continue to monitor habitat status and trends information, including stream temperature and flow, to conduct implementation and compliance monitoring to ensure that habitat improvement actions are implemented as planned, to support effectiveness monitoring related to their habitat mitigation efforts at a range of scales, including the site and watershed scales, and to fund fish and habitat research projects with regional partners as funding and priorities allow.

The Action Agencies will implement a tributary habitat RM&E program to assist in regional efforts to assess tributary habitat conditions, limiting factors, and habitat-improvement effectiveness and to address critical uncertainties associated with offsite habitat mitigation actions. The Action Agencies' RM&E efforts are intended to work in concert with similar efforts funded by other federal, state, tribal, utility, and private parties that, when combined will contribute to basin-wide RM&E data and analyses.

The Action Agencies have also committed to engaging in a collaborative process with NMFS, the Service, the Northwest Power and Conservation Council (NPCC), Tribes, and other regional partners to develop and implement a Columbia River Basin tributary habitat research, monitoring, and evaluation strategy that will align with and directly support project documentation and project effectiveness to meet the needs of the THSC and Tributary Technical Team. Further, the Action Agencies will coordinate with NMFS, the Service, the THSC, and other regional partners to identify core habitat data objectives, to evaluate the success of the Action Agencies' program, and to support adaptive management. During the development of this habitat RM&E strategy, the Action Agencies will continue to fund tributary habitat RM&E to address interim needs and habitat management applications during the term of this consultation.

5.3 Conservation Measures for Kootenai River White Sturgeon

As part of the Proposed Action, Bonneville will provide funding and/or technical assistance to support implementation of a variety of activities to benefit Kootenai sturgeon, including conservation aquaculture, habitat, and other actions, as described further below. Planning and implementation for the habitat and nutrient enhancement actions occur in 5-year phases using an adaptive management approach to inform decisions regarding performance of these actions in addressing physical limiting factors for sturgeon. Funding of conservation measures for Kootenai sturgeon after 2025 will be subject to Bonneville's prioritization of available funds; investments in fish and wildlife by Bonneville for protection, mitigation and enhancement will be prioritized based on biological and cost-effectiveness and their connection to mitigating for the impacts of the CRS. A brief description of the various activities undertaken for the conservation of Kootenai sturgeon is as follows.

5.3.1 Conservation Aquaculture

As part of the Proposed Action, Bonneville will provide funding in accordance with the terms outlined in the Memorandum of Agreement between Bonneville and the Kootenai Tribe of Idaho (KTOI) for the KTOI's Kootenai River Native Fish Conservation Aquaculture Program for sturgeon (Bonneville and KTOI 2013). The conservation aquaculture program incorporates both short- and long-term objectives, with production strategically determined annually based on RM&E and in coordination with regional partners. Restoration opportunities will be identified by a variety of means, including: analysis of limiting factors; expert knowledge of specific conditions; field assessments; interpretation of aerial imagery to identify land use, open water features, current tributary alignments, and existing stands of vegetation; and analysis of spatial data layers, including land cover classification mapping, modern and historical wetland distribution within the floodplain, soil characteristics, floodplain elevations relative to current bank-full flows, and parcel ownership.

5.3.2 Habitat Improvement Actions

As part of the Proposed Action, Bonneville will continue to implement habitat actions in the Kootenai River to benefit Kootenai sturgeon, using a tiered, reach-specific restoration strategy to help guide identification and development of site-specific habitat restoration actions. The Action Agencies will work with implementation partners, including the KTOI, Idaho Department of Fish and Game (IDFG), and existing advisory teams (e.g., Co-Manager Advisory Team and Peer Review Advisory Team), to identify and prioritize restoration opportunities in the Braided Reach and Meander Reach during the first 5 years of the period covered by this consultation.

Each restoration opportunity incorporates a number of different restoration treatments and is designed to address reach-specific limiting factors and restoration strategies, which are grouped together into restoration nodes. An initial prioritization of these restoration nodes is complete; however, the details of the specific actions to be implemented in 2021 through 2025 will be determined based on a two-tiered approach to project categorization, with priority given to Tier 1 actions over Tier 2 actions, as described further below. The Action Agencies expect to initiate, on average, one comprehensive Tier 1 action per year in the near term (2021 to 2025) of this action to benefit Kootenai sturgeon.

Tier 1 and Tier 2 actions are described below:

- Tier 1 Action Categories
  - Floodplain restoration and enhancement. Restoration of floodplain habitat in the Meander Reach will improve overall ecosystem health for a range of species present in the Kootenai River, including white sturgeon. These actions are the highest priority for funding because they will contribute the most to improving ecosystem function. Large cottonwood plantings and wetland riparian revegetation discussed in the CRSO EIS are considered part of the Kootenai sturgeon Tier 1 actions for floodplain restoration and enhancement.
  - Maintenance of existing habitat projects. To assure that previously completed habitat actions continue to benefit Kootenai sturgeon, it may be necessary to conduct maintenance actions at these existing habitat projects (i.e., replacing woody material, replanting, and pool deepening). When these maintenance activities are necessary to maintain or return functionality, then these actions will count toward the one project per year target during the first 5 years of this consultation.
  - Restoration of kokanee spawning habitat. Habitat enhancement actions within the tributaries of the Kootenai River may increase kokanee spawning potential, and further promote juvenile to adult survival of kokanee salmon. Kokanee salmon serve as an important prey species for sturgeon and bull trout. Actions of enhancement may include improving tributary confluence areas by increasing their depth, adding complexity and cover, reducing sediment deposition, and reestablishing the floodplain and the native vegetation upon it.

- Tier 2 Action Category
    - Supplemental spawning gravel. Placement of suitable substrate materials (for instance, clean rock) near known sturgeon spawning areas may occur as a Tier 2 action. If enacted, gravels of approximately 3 inches to 8 inches may be placed on the river bottom in layers representing a gravel mat of up to 1 ft of thickness. These gravels may further promote egg attachment, reduce potential for egg suffocation, and provide cover for larval sturgeon.

The coming years will provide important additional data about whether ecosystem-based improvements are effective at spurring changes in sturgeon reproductive behavior in the wild. Therefore, following the initial 5-year commitment, the Action Agencies will work with the Service and implementation partners to evaluate the current conservation status and needs of Kootenai sturgeon to determine scope and scale of actions appropriate to consider implementing for the remainder of the period covered by this action. The Action Agencies therefore commit to work collectively with the Service, implementation partners, and technical advisory teams to evaluate progress in 2025 and assess whether adaptive management changes are warranted in this ecosystem-based approach.

The Action Agencies expect these prospective actions, combined with the comprehensive improvements in spawning and rearing habitat already implemented as well as continued nutrient additions and Libby Dam operations designed to cue spawning behavior, will be sufficient to establish conditions favorable for enabling sturgeon reproduction and carrying capacity when these long-lived species reach sexual maturity.

Site-specific effects on bull trout, Kootenai sturgeon, and their designated critical habitat from implementation of future restoration actions under the Kootenai River Habitat Restoration Program will be addressed through the Service's 2013 programmatic Opinion for the program (USFWS 2013b; 01EIFW00-2013-F-0278) or Project-specific consultations.

5.3.2.1 Adaptive Management

Throughout the duration of the Proposed Action, implementation of habitat actions to conserve Kootenai sturgeon will be periodically reviewed and adaptively managed in 5-year cycles, with an existing commitment to initiate at least one Tier 1 habitat project per year from 2021 to 2025. During this time, the Action Agencies, in coordination with the Service and other relevant regional stakeholders, will use a process of regional coordination to develop a 5-year implementation plan(s). Because of climate change vulnerabilities, Kootenai sturgeon population status, and density dependence concerns, conservation priorities may change in scale, scope, sequencing, or focus as more individuals in the river become sexually mature and previously completed actions mature, potentially resulting in more ecological benefits being fully realized.

The 5-year plan(s) will focus on the following activities:

- Identify and prioritize actions for implementation, and seek potential for refinement in methods used for identification and prioritization of actions based on Kootenai sturgeon conservation needs;
- Use the best available science at a watershed and reach scale to identify and prioritize actions to address key limiting factors for Kootenai sturgeon;
- Implement high-priority, strategic habitat restoration projects that produce measurable results;
- Maintain a collaborative prioritization framework that demonstrates objectivity, transparency, and accountability, and manage the prioritization framework and associated project implementation adaptively to assure maximum biological benefit; and,
- Generate a set of scored and ranked criteria, developed and approved by local and regional fish research and habitat biologists, ecologists, geomorphologists, and engineers, that facilitates the ranking of conceptual restoration opportunities based on their biological benefits.

An adaptive conservation approach acknowledges the changing nature of the factors that may drive our understanding of which actions will provide the greatest benefits. The management approach has to remain nimble enough to respond to new and evolving information (Corps et al 2020a, Appendix D).

5.3.2.2 Nutrient Enhancement

The construction of Libby Dam and the closure of the fertilizer mine upstream in British Columbia altered the availability of nutrients in the Kootenai River below Libby Dam, and downstream into Kootenay Lake in British Columbia. Lake Koocanusa, the reservoir created by Libby Dam in Montana, acts as a nutrient sink, retaining approximately 63 percent of total phosphorus (P) and 25 percent of total nitrogen (N), although levels of dissolved inorganic N have been increasing recently above and below Libby Dam. The low levels of P and N have resulted in oligotrophic (i.e., having a deficiency of plant nutrients) and ultra-oligotrophic conditions in most reaches of the Kootenai River. These effects are also evident in Kootenay Lake, because the Kootenai River provides approximately 60 percent of the inflow to Kootenay Lake. Altered N and P ratios (in combination with other factors) in Kootenay Lake have been shown to limit food web and fisheries development. The productivity of both Kootenay Lake and the Kootenai River are important to the growth and health of sturgeon.

To mitigate the reduced nutrient availability and associated biological productivity in the Kootenai River and Kootenay Lake, the International Kootenai Ecosystem Recovery Team recommended a 5-year experimental nutrient restoration effort in the Kootenai River in 2003, and extended the program to Kootenay Lake in 2004. Both programs continue today and are briefly summarized below.

5.3.2.2.1 Kootenai River nutrient enhancement

The nutrient supplementation consists of finely measured additions of liquid P to the Kootenai River near the Idaho-Montana border. If the ambient N:P ratio drops below a predetermined level, then N may be added, as happened briefly in 2009. Generally, application of nutrients is metered out over time through an automated apparatus. Nutrient addition since 2013 occurs from March 15 to October 31 annually. The Action Agencies will continue to support the existing nutrient addition program during the period of this consultation.

The RM&E component of the project collects water quality and algal, macroinvertebrate, and fish data. Results of this monitoring found statistically significant responses of fish productivity over baseline measures during the first 5 years of the program. These results, coupled with other reported findings from the lower trophic levels, demonstrate a significant positive benefit and provide support for continued nutrient addition as an ongoing management activity in the Kootenai River. Based on these results, Bonneville proposes to continue funding this action through fiscal year 2025 and will continue to use RM&E results to inform future management decisions.

5.3.2.2.2 Kootenay Lake Nutrient Addition

Experimental annual nutrient additions to the South Arm of Kootenay Lake began in 2004. Under this program, fertilizer is added each year from June through August. Kootenay Lake nutrification occurs via releases from boat-mounted tanks, with application carried out over a predetermined course or courses. These actions have been implemented and monitored by the British Columbia Ministry of Forests, Lands and Natural Resource Operations, with Bonneville funding.

Since nutrient addition began in the South Arm of Kootenay Lake in 2004, numbers of native kokanee salmon, a significant food source for adult and juvenile Kootenai sturgeon, have tripled and rainbow trout biomass has doubled; this trend may have declined in recent years. Additionally, significant numbers of kokanee salmon have begun to return to South Arm Kootenay Lake tributaries in British Columbia and Kootenai River tributaries in Idaho. This indicates that, in combination with the physical habitat restoration work on the tributaries, nutrient mitigation actions in the Kootenay Lake are working together to benefit the larger ecosystem. Based on this successful response to Kootenay Lake nutrient additions, Bonneville proposes to continue funding this action through fiscal year 2025 and will continue to use monitoring and evaluation results to inform management decisions regarding future actions.

5.3.2.3 Monitoring and Evaluation for Kootenai Sturgeon

Monitoring and evaluation activities funded by Bonneville are intended to achieve the following goals: (1) determine if actions are being implemented as proposed; (2) determine whether actions are effective in addressing the limiting factors they were intended to address (physical and biological); and (3) identify critical uncertainties. Overall, the monitoring and evaluation activities are intended to improve Kootenai sturgeon conservation by carrying out the following:

- continued monitoring of sturgeon behavior into the Braided Reach and beyond to evaluate sturgeon response to completed habitat actions and the flow regime implemented to encourage spawning;
- continued biological monitoring to better understand natural reproduction and juvenile survival;
- continued biological and chemical monitoring associated with nutrient enhancement activities; and
- monitor existing (constructed) habitat structures to assure they maintain their designed purpose.

More specifically, monitoring and evaluation involves conducting assessments of spawning activity (e.g., substrate mat sampling), collecting information about the population and health of juveniles and adults (e.g., mark-recapture and telemetry tracking of individuals), assessing completed habitat actions, and data management and reporting (KTOI 2005). Monitoring and evaluation involves the continued collection of water quality data, including samples of algae, zooplankton, and macroinvertebrates. Additionally, fish are collected and monitored to determine their distribution, abundance, and other factors that help managers make additional decisions.

These monitoring and evaluation studies build upon on an existing body of knowledge. Additional priority information needed in this consultation and gathered through monitoring and evaluation will be used to inform and modify existing actions, as well as design future actions as part of Bonneville's overall adaptive management approach. These monitoring and evaluation studies are subject to modification based on the new scientific information, project results, or other factors.

5.4 Conservation Measures for Bull Trout

Action Agencies propose the actions outlined in this section to provide direct and indirect benefits to bull trout.

5.4.1 Albeni Falls Actions to Benefit Bull Trout

The Corps, in coordination with Bonneville, Service, and the Kalispel Tribe, completed and approved a planning document regarding the construction, operation, and maintenance of an upstream bull trout passage facility at the Albeni Falls project (Corps 2018). The goal is to allow upstream migration past Albeni Falls Dam for bull trout entrained by the dam or for populations that would be reintroduced to the lower Pend Oreille River. The planning document addresses project authority, cost-effectiveness, and technical feasibility, among other issues (Corps 2018). On January 11, 2018, the Service issued an Opinion to the Corps on the construction, operation, and maintenance of an upstream fish passage facility at Albeni Falls Dam (USFWS 2018a; 01EIFW00-F-0259). The Corps received $6.5 million in the FY20 Work Plan for final design of the upstream fish passage facility at Albeni Falls Dam (Corps 2020a). Additional details regarding the Corps design process (e.g., geo-tech analysis, value engineering process, etc.) and milestones to complete construction of the fish passage facility were outlined in a separate letter (Corps 2020b). The funds will enable final design work to be initiated in 2020 completed by 2024. We believe that securing Congressional funding for final design demonstrates reasonable certainty of the Corps' continued support for this project. The Corps will continue to seek funding to complete construction of the proposed upstream "trap and haul" fish passage facility, and plans on continuing coordination with federal, state, and tribal agencies throughout this process.

5.4.2 Kootenai River Perched Tributary Actions

Delta formations at tributaries of Kootenai River downstream of Libby Dam may be causing upstream fish passage barriers to bull trout seeking spawning grounds in tributaries during summer months. In 2021, Action Agencies will contribute funding for an initial assessment of blocked passage to bull trout key spawning tributaries identified by the Service. The assessment may cover a range of water year types but must include a dry water year to adequately understand the problem. Upon completion of the initial assessment, Action Agencies, in collaboration with local stakeholders and the Service, will develop an action plan and prioritization process for tributaries identified as having blocked passage. Action Agencies will work with the Service and stakeholders to identify and initiate a process to address two restoration and/or improvement projects benefitting upstream passage opportunities over the period from 2021 to 2026. Any additional improvement opportunities to benefit bull trout passage in Kootenai River tributaries will be evaluated based on biological priorities and available funding.

5.4.3 Lower Columbia and Lower Snake River Actions to Benefit Bull Trout

Many of the proposed structural and operational passage improvements for salmon and steelhead are expected to benefit bull trout. The BA provides additional detail and specificity regarding proposed non-routine maintenance measures (including new IFP turbines at Ice Harbor, McNary and John Day dams) and other proposed structural measures.

5.4.4 Bull Trout Monitoring at Lower Columbia and Lower Snake River Dams and Adaptive Management Actions

The Action Agencies will continue to monitor for bull trout at the lower Columbia and Lower Snake River dams. The primary means of monitoring bull trout will be through the Corps' adult fish counts program, PIT detection arrays in fish ladders and JBSs, and through the Smolt Monitoring Program (SMP). Currently, all fish ladders at the eight Corps-operated dams on the lower Columbia and lower Snake River are equipped with dual-readers (full-duplex and halfduplex). Pacific States Marine Fisheries Commission, with Bonneville funding, is currently exploring feasibility of converting downstream passage PIT systems (full flow bypass PIT readers in juvenile bypass systems). While fish passage monitoring is discussed below, specific bull trout monitoring objectives include the following:

- Continue to visually count bull trout passing lower Columbia and Lower Snake River dam fish ladders. Visual counts will be posted on the adult ladder count website and documented in the Corps' Annual Fish Passage reports. To minimize the risk of missing observations of bull trout in fish ladders, reported daily and annual counts will include both total net passage past count windows (i.e., typical window counts) and the number of sightings (total number of observations, whether individuals were moving upstream or downstream).
- Continue monitoring for migratory bull trout incidentally collected/handled in SMP samples. Specific objectives are to:
    - Record size and condition (e.g., descaling, injury, GBT) of all bull trout when encountered in SMP samples, consistent with protocols for salmon and steelhead;
    - Scan all bull trout encountered in SMP samples for PIT tags. If untagged, PIT-tag and collect and store genetic samples (fin clips) of tagged bull trout to support annual abundance estimates and spatial distribution monitoring. The Action Agencies will make the genetic samples available to the Service upon request; and,
    - Record and report bull trout observations, condition information, and any other incidental sightings of bull trout in juvenile bypass facilities (e.g., at adult separator bars) to the FPC web page (http://www.fpc.org/bulltrout/bulltrout_home.html).
- In coordination with the Service, use existing PIT detection sites at mainstem dam fish ladders to track the movements and passage behavior of PIT-tagged bull trout.
- Document incidental recovery of bull trout PITs at mainstem nesting colonies within the scope of current East Sand Island management plans or Bonneville-funded avian predation studies of salmon and steelhead.
- Record and report bull trout observations during condition sampling for transport of juvenile fish.

While there is limited understanding of bull trout passage behavior at mainstem dams, the relative rarity of bull trout in the lower Columbia and Lower Snake Rivers makes direct passage evaluations (e.g., active telemetry, acoustic imaging) infeasible. The Action Agencies will continue to rely on passage studies elsewhere (for example, mid-Columbia Public Utility District dam passage studies), incidental PIT detections at traps, weirs and electrofishing, visual counts, and evaluations of passage behavior of other salmonids when considering the potential effects of various structural or operational changes on bull trout.

Monitoring objectives will be refined as priorities evolve and the state of knowledge advances. Action Agencies will continue to emphasize monitoring that fulfills mitigation requirements and directly informs management needs.

5.4.5 Downstream Passage (off season) for Bull Trout On Mainstem

The Corps will continue to refine and implement a multi-year research study (Section 5.7.4) to determine the frequency, timing, and duration of off-season surface spill needed to effectively pass adult steelhead downstream of McNary Dam. The Action Agencies assume that modifications to operations or structures designed to safely and effectively pass adult steelhead via surface spill will also benefit bull trout attempting to migrate downstream past McNary Dam.

5.4.6 Tributary Habitat Improvements for Bull Trout

As described in in the BA, the Action Agencies propose to continue prioritized tributary habitat actions that provide biological benefit for the interior Columbia River Basin ESA-listed anadromous salmonid species in this consultation. Implemented throughout the interior Columbia River Basin, these projects improve habitat through a variety of actions. Examples may include the following:

- fish passage and barrier removal,
- fish screening,
- instream flow acquisition,
- habitat protection through easement and acquisition,
- river, floodplain and wetland habitat improvements,
- riparian planting and fencing, and
- watershed enhancement including road removal and addressing invasive plants.

These actions have incidental benefits to bull trout in the targeted area where bull trout and anadromous salmon and steelhead coexist. When developing tributary habitat projects for salmon in areas where bull trout are present, the Action Agencies will proactively engage with the Service to leverage benefits for bull trout where feasible.

5.4.7 Spawning Habitat Augmentation at Lake Roosevelt

In Lake Roosevelt, changes in elevation would result in higher rates of kokanee and burbot egg dewatering in winter (which are prey species for bull trout), and lower reservoir levels in spring would decrease access to tributary spawning habitat for redband rainbow trout. Increased flexibility of refilling Lake Roosevelt that may occur through the month of October, depending on the annual water conditions, may impact the spawning success of kokanee, burbot and redband rainbow trout. In 2019, Bonneville funded year one of a three year study to determine potential impacts of modifications in Lake Roosevelt refill to resident fish spawning habitat access. Other evaluations will be conducted to determine potential impact areas. If study evaluations and other available data indicate resident fish spawning habitat areas are impacted by changes in reservoir elevations, the co-lead agencies will work with regional partners to determine where to augment spawning habitat at locations along the reservoir and in the tributaries (up to 100 acres).

5.5 Status and Trends of Habitat and Fish

Bonneville will support the annual collection of stream temperature and flow across the Columbia River Basin. The Action Agencies will continue to implement regional habitat data collection to support existing long-term habitat monitoring efforts in a subset of watersheds within the Snake River, Upper Columbia and Mid-Columbia evolutionarily significant units. The Action Agencies will also continue to support fish status and trend monitoring for one population per MPG for multiple life stages using a variety of sampling methods within the Snake River, Upper Columbia, and Mid-Columbia evolutionarily significant units.

Additional monitoring for habitat or fish status and trends will be considered in the forthcoming Columbia River Basin habitat RM&E strategy, developed with regional collaboration and scheduled for completion within two years of the release of the 2020 Opinion.

5.6 Implementation, Compliance and Effectiveness Monitoring

The Action Agencies will fund ongoing implementation and compliance monitoring for completed habitat actions to ensure that habitat improvement actions are implemented as planned.

The Action Agencies will support effectiveness monitoring related to their habitat mitigation efforts at a range of scales including the site and watershed scales. Bonneville will continue to fund site and project-scale action effectiveness monitoring through completion of the Action Effectiveness Monitoring (AEM) project study design through 2023 to monitor and evaluate the Action Agencies' salmon and steelhead tributary habitat improvement actions. The AEM project was developed in 2013 to establish a comprehensive, consistent, and cost effective programmatic approach to monitor and evaluate the large quantity of salmon and steelhead habitat improvement actions implemented by Bonneville throughout the Columbia River Basin with program partners including Tribes, Federal agencies, states, and non-profit organizations.

The Action Agencies will support the completion of a summary analysis and synthesis report for the Columbia Habitat Monitoring Program to guide management decisions on habitat priorities funded by Bonneville. The Action Agencies will continue to support fish status and trend monitoring within the Entiat, Lemhi, and John Day basins.

5.7 Research

The Action Agencies intend to articulate future research priorities consistent with regional critical uncertainties within the forthcoming habitat RM&E strategy. In collaboration with NMFS and when necessary to inform management decisions, the Action Agencies will fund fish and habitat research projects with regional partners. To address the continued uncertainty around the biological effects of increased spill associated with the Proposed Action, the Action Agencies may implement a study (or studies) to test the biological effects of increased spill. Accordingly, the Action Agencies will work with NMFS and other interested regional sovereigns (including the Service) to develop and implement a test of the relative influence of system operations on any effects from delay, fallback, and re-ascension.

5.7.1 Juvenile Salmonid Monitoring at Lower Columbia and Lower Snake River Dams

The Action Agencies propose to implement the following juvenile fish monitoring actions:

- Continue to annually fund and implement the Smolt Monitoring Program
- Continue to implement and maintain the Columbia River Basin Passive Integrated Transponder Information System or PTAGIS.
- Implement improvements to PIT detection capability to support the development of in-river juvenile salmon and steelhead survival estimates with specific improvements at or near Bonneville Dam.
- Further investigate juvenile fish survival if additional needs are developed through the Adaptive Implementation of the Flexible Spill Operation Process (Appendix X in Corps et al. 2020a).

5.7.2 Adult Salmonid Monitoring at Lower Columbia and Lower Snake River Dams

The Action Agencies propose to implement the following adult fish monitoring actions:

- Visually count and report adult salmon, steelhead, and bull trout passage. In addition to reporting net upstream passage, the Corps will report presence of bull trout in fish count windows to ensure the relatively rare sightings are recorded;
- Maintain PIT detection capability in adult fishways as needed to support monitoring of adult survival through fishway re-ascension rates;
- Monitor adult ladder counts and PIT-based re-ascension rates to identify any potential delay or fallback issues associated with temperatures in the exit sections of fishways;
- Monitor pinniped activity at Bonneville Dam, consistent with the monitoring plan to be developed in coordination with NMFS;
- Provide ongoing cost share to research the effects of nearshore ocean conditions on adult returns; and,
- Further investigate adult fish survival if additional needs are developed through the Adaptive Implementation of the Flexible Spill Operation Process (Corps et al. 2020a, Appx X).

5.7.3 Shad Deterrence

The Corps will investigate the feasibility of deterring adult shad from approaching and entering the Lower Granite Dam adult fish trap, alleviating the need to remove shad from the trap while processing adult salmon, steelhead and bull trout, and thereby reducing stress and delay for ESA-listed target species. Actions for consideration will be developed in coordination with NMFS and may include acoustic deterrents and operational changes, such as instituting plunging flows or blocking overflow weirs.

5.7.4 Off-season Surface Spill for Downstream Passage of Adult Steelhead

Each year, a portion of Mid-Columbia River steelhead migrate upstream past McNary Dam, overshooting tributaries. These fish then migrate back downstream through McNary Dam during months when there is no scheduled juvenile fish passage spill. In fall 2019, the Corps began an initial evaluation of off-season surface spill (24 hours per week) as a means of providing safe and effective downstream passage for adult steelhead and other fish, at McNary Dam. The Corps will continue to refine and implement a multi-year evaluation to determine the frequency, timing, and duration of the off-season surface spill needed to effectively pass adult steelhead downstream of McNary Dam. Pending results of the evaluation, the Action Agencies will, in coordination with NMFS, develop and implement an off-season surface spill operation at McNary Dam. The Corps will use existing information and, if warranted, targeted studies to determine whether other lower Columbia or Lower Snake River dams should be considered for similar offseason surface spill operations. The Action Agencies may also investigate potential structural modifications to spillway weirs that would allow reduced off-season spill volumes, while providing effective and safe passage of adult steelhead.

5.7.5 Biological Testing of Improved Fish Passage Turbines and Screen Deployment Cessation

In 2019, the Corps funded a study at Ice Harbor Dam's Unit 2 (an IFP turbine unit outfitted with fixed blades) to estimate direct injury and survival of juvenile Chinook salmon passing through the new turbine runner. As additional turbine unit runners are replaced at Ice Harbor, McNary, and John Day dams, the Corps may need to conduct additional direct injury and survival studies or other evaluations to inform turbine designs and verify their biological effectiveness. Particular study objectives and needs would be developed with NMFS, Service, and other regional sovereigns through the Studies Review Work Group.

The Action Agencies propose consideration of cessation of deployment of turbine intake bypass screens at Ice Harbor, McNary, and John Day dams following replacement of existing turbine unit runners with new IFP designs. In addition to further coordination with NMFS, the Action Agencies agree that any proposed changes in the configurations or operations at these dams requires biological monitoring and evaluations. If the study results demonstrate a neutral or beneficial effect, and NMFS concurs, the Action Agencies will consider cessation of turbine intake bypass screen installation. The Action Agencies anticipate that acoustic telemetry studies (beginning with Ice Harbor Dam) would be needed to evaluate dam passage and survival. Additionally, the Action Agencies may need to conduct biological studies to assess the effects on adult salmon and steelhead passage through JBSs and impacts on the SMP and PIT-based system survival analyses. Particular study objectives and needs would be developed with NMFS, Service, and other regional sovereigns through the Studies Review Work Group.

5.7.6 Adult Salmon and Steelhead Passage Response to Pacific Lamprey Modifications

As proposed adult Pacific lamprey passage improvements are implemented, radio-telemetry, video, or acoustic imaging studies may be needed to verify that structural or operational changes have a neutral to beneficial effect on adult salmon and steelhead. Particular study objectives and needs would be developed with NMFS, Service, and other regional sovereigns through the Studies Review Work Group.

5.8 Reporting, Adaptive Management, and Regional Coordination

The Action Agencies propose to use the best available scientific information to identify and carry out actions that are expected to provide immediate and long-term benefits to listed fish, while continuing to operate for other authorized purposes set forth by Congress. To that end, the Action Agencies propose to coordinate with NMFS, the Service, and other regional partners to inform and signal appropriate adaptations to changing circumstances (Corps et.al, 2020a, Section 2.7).

5.8.1 Annual Biological Opinion Implementation Reporting

The Action Agencies propose to report annually to NMFS and the Service the following information:

- Configuration or operational changes at the dams;
- Operations for juvenile fish (e.g., the placement of screens, the start and end of spill operations);
- Transport operations (start and end of transport operations, number of fish transported);
- Operations for adult fish;
- Predation management actions;
- Results from monitoring operations, such as:
    - Adult fish counts;
    - Pinniped numbers and predation estimates at Bonneville Dam;
    - Juvenile fish in-river system survival estimates[5]; and
    - Adult fish upstream conversion estimates.
- Tributary habitat improvements
    - See the Action Agencies Proposed Action Section 2.6.1.4 (Tributary Habitat Reporting and Evaluation) for details on tributary habitat improvement reporting.

[5] NOAA Fisheries has historically produced estimates of juvenile in-river system survival and adult fish conversion rates. The Action Agencies provide tagged fish, detection capability at dams, and maintain the PITagis database, while NOAA analyzes the data, generates the estimates and delivers them to the Action Agencies for inclusion in annual Biological Opinion reporting. The Action Agencies assume this collaborative arrangement will continue.

- Estuary habitat improvements –
  - Acres of estuary floodplain improved; and
  - Miles of estuary riparian area improved.

5.8.2 Adaptive Management and Regional Coordination

The Action Agencies propose to continue to use an adaptive management framework to manage system operations and guide implementation of the additional non-operational measures to benefit ESA-listed salmon and steelhead. The Action Agencies propose to continue to work collaboratively with regional sovereign parties to adaptively manage the implementation of system operations related to fish through various policy and technical teams, collectively referred to as the Regional Forum,[6] and to implement year-round system operations related to fish and adaptively manage operations, as necessary.

The process for adaptive management of the flexible spill component of the CRS operations (AIF), is attached to the draft EIS Appendix R (Part 2), released on February 28, 2020 for public review and comment. This AIF appended to the draft EIS replaces the previous draft version shared with the Services on January 23, 2020.

During the 2020 spring spill season, the first year when some dams will be spilling at 125 percent TDG gas cap spill, GBT monitoring of juvenile salmonids will continue using the primary established protocols. The unpaired fins and eyes will be examined for the presence of bubbles and the area covered with bubbles will be quantified at five of the CRS dams (Lower Granite, Little Goose, Lower Monumental, McNary and Bonneville dams). Native non-salmonid fish collected in the JBS will be monitored using the same methods applied to salmonids. The data will be reported to fisheries management entities, Corps, Resource Coordination Committee, Bonneville TMT representatives, Corps TMT representatives, and the water quality agencies of Washington and Oregon on a daily basis. The data will be made available to other interested parties through FPC weekly reports and when postings are made to the FPC website during the season. The 2020 sampling methodologies and data collected will be used to develop biological monitoring plans required for the 2021 spring spill season.

5.8.3 Contingencies

The 2009 Adaptive Management Implementation Plan included triggers for: (1) unexpected declines in adult abundance, and (2) environmental disasters or environmental degradation (either biological or environmental) in combination with preliminary abundance indicators. The Action Agencies propose to work with NMFS and other salmon managers, and will coordinate with other appropriate parties in any region wide diagnostic effort, such as life-cycle models if

[6] This includes the Regional Implementation Oversight Group; (RIOG); Technical Management Team; (TMT); Systems Configuration Team (SCT); Studies Review Work Group (SRWG); Fish Facility Design Review Work Group (FFDRWG); and Fish Passage Operations and Maintenance coordination team. (FPOM).

the early warning or significant decline triggers are tripped as defined in the NMFS's 2014 biological opinion (i.e., five-year abundance trends, rolling four-year averages of abundance, and where those metrics fall relative to particular percentiles).

5.9 Action Area

The Action Area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the Action Area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. The Action Area for this proposed federal action is based on the geographic extent of flow management effects throughout the Columbia River Basin. Therefore the Action Area for this Opinion includes the U.S. portions of the following:

- The mainstem Columbia River, from the uppermost extent of river affected by Lake Roosevelt, down to and including the Columbia River Estuary and plume (i.e., near-shore ocean adjacent to the mouth);
- Hungry Horse Reservoir and the South Fork Flathead River downstream of Hungry Horse Dam to the confluence with the mainstem Flathead River; Flathead Lake;
- Lake Pend Oreille and the Pend Oreille River, including Albeni Falls Dam, to its confluence with the Columbia River;
- Libby Reservoir (Lake Koocanusa) and the Kootenai River downstream of Libby Dam to its confluence with the Columbia River;
- The Snake River below its confluence with the Salmon River, to the Snake River's confluence with the Columbia River;
- Dworshak Reservoir and the North Fork Clearwater River downstream of Dworshak Dam, To its confluence with the Clearwater River, and the Clearwater River to its confluence with the Lower Snake River;
- All stream reaches and land areas permanently or seasonally inundated by Hungry Horse, Libby, Albeni Falls, Grand Coulee, Chief Joseph, Dworshak, Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, The Dalles, and Bonneville Dams within the high-water mark.

6 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

6.1 Jeopardy Determination

In accordance with policy and regulation, the jeopardy determination in this Opinion relies on the following components:

1. The *Status of the Species*, which evaluates the species' range-wide condition relative to its reproduction, numbers, and distribution, the factors responsible for that condition, and its survival and recovery needs.

2. The *Environmental Baseline*, which evaluates the condition of the species in the Action Area relative to its reproduction, numbers, and distribution without the consequences caused by the Proposed Action, the factors responsible for that condition, and the relationship of the Action Area to the survival and recovery of the species.

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

4. *Cumulative Effects*, which evaluates the consequences of future, non-Federal activities reasonably certain to occur in the Action Area on the species, and how those impacts are likely to influence the survival and recovery role of the Action Area for the species.

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

6.2 Adverse Modification Determination

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

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

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

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

2. The *Environmental Baseline*, which refers to the condition of critical habitat in the Action Area (without the consequences to critical habitat caused by the Proposed Action), the factors responsible for that condition, and the conservation value of critical habitat in the Action Area for the conservation/recovery of the listed species;

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

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

For purposes of making the destruction or adverse modification determination, the Service evaluates if the effects of the proposed Federal action, taken together with cumulative effects, are likely to impair or preclude the capacity of critical habitat as a whole to serve its intended conservation function for the conservation of the listed species. The key to making this finding is clearly establishing the role of critical habitat in the Action Area relative to the value of critical habitat as a whole, and how the effects of the Proposed Action, taken together with cumulative effects, are likely to alter that role.

7 STATUS OF THE SPECIES

7.1 Rangewide Status of Kootenai River White Sturgeon

On June 11, 1992, the Service received a petition from the Idaho Conservation League, North Idaho Audubon, and the Boundary Backpackers to list the Kootenai River white sturgeon (Kootenai sturgeon) as threatened or endangered under the ESA. The petition cited lack of natural flows affecting juvenile recruitment as the primary threat to the continued existence of the wild Kootenai sturgeon population. Pursuant to section 4(b)(A) of the ESA, the Service determined that the petition presented substantial information indicating that the requested action may be warranted, and published this finding in the Federal Register on April 14, 1993 (58 FR 19401).

A proposed rule to list the Kootenai sturgeon as endangered was published on July 7, 1993 (58 FR 36379), with a final rule following on September 6, 1994 (59 FR 45989).

7.2 Reasons for Listing

The Kootenai sturgeon is threatened by habitat modifications that primarily stem from a significantly altered annual hydrograph. Significant levels of natural recruitment ceased after 1974, which coincides with commencement of Libby Dam operations. Changes in the hydrograph, particularly from Libby Dam and the Corra Linn Dam (in Canada), have altered Kootenai sturgeon spawning, egg incubation, and rearing habitats, and reduced overall biological productivity of the Kootenai River. These factors appear to be adversely affecting the early life stages of the Kootenai sturgeon. Other potential threats to the Kootenai sturgeon include removal of side-channel habitats (important early-life stage habitats) and a loss/reduction of ecosystem functions such as riparian function and nutrient inputs from flooding. Paragamian (2002, pg. 375) reported that "Reduced productivity because of [a] nutrient sink effect in Lake Koocanusa, river regulation, the lack of flushing flows, power peaking and changes in river temperature may have led to changes in fish community structure." Changes in the fish community structure may have favored an increase in fish species that prey on Kootenai sturgeon eggs and free-embryos.

7.3 Species Description

Kootenai sturgeon are included in the family Acipenseridae, which consists of 4 genera and 24 species of sturgeon. Eight species of sturgeon occur in North America with Kootenai sturgeon being one of the five species in the genus *Acipenser*. Kootenai sturgeon are a member of the species *Acipenser transmontanus*.

White sturgeon were first described by Richardson in 1863 from a single specimen collected in the Columbia River near Fort Vancouver, Washington (Scott and Crossman 1973, as cited in NPCC, 2005, pg. 371). White sturgeon are distinguished from other *Acipenser* by the specific arrangement and number of scutes (bony plates) along the body (Scott and Crossman 1973, as cited in NPCC, 2005, pg. 371). The largest white sturgeon on record, weighing approximately 1,500 pounds was taken from the Snake River near Weiser, Idaho in 1898 (Simpson and Wallace 1978, pg. 51). The largest white sturgeon reported among Kootenai sturgeon was a 159 kilogram (350-pound) individual, estimated at 85 to 90 years of age, captured in Kootenay Lake during September 1995 (RL&L 1999, pg. 8). White sturgeon are generally long-lived, with females living from 34 to 70 years (PSMFC 1992, pg. 19).

7.4 Life History

Kootenai sturgeon are considered opportunistic feeders. Partridge (1983, pgs. 23-28) found Kootenai sturgeon more than 70 centimeters (28 inches [in]) in length feeding on a variety of prey items including clams, snails, aquatic insects, and fish. Andrusak (pers. comm., 1993) noted that kokanee (*Oncorhynchus nerka*) in Kootenay Lake, prior to a dramatic population crash beginning in the mid-1970s, were considered an important prey item for adult Kootenai sturgeon.

In the spring, reproductively active Kootenai sturgeon respond to increasing river depth and flows by ascending the Kootenai River. Historically (prior to Libby Dam construction and operation), spawning areas for Kootenai sturgeon were reported to be in the roughly one mile stretch of the Kootenai River below Kootenai Falls (river mile [RM] 309.7) (Corps 1971; MFWP 1974). However, Kootenai sturgeon monitoring programs conducted from 1990 through 1995 revealed that during that five year period, sturgeon spawned within an 11.2 mile reach of the Kootenai River, from Bonners Ferry downstream to below Shorty's Island (RM 143.0). As river flow and stage increase, Kootenai sturgeon spawning tends to occur further upstream, near the gravel substrates which now occur at and upstream of Bonners Ferry (Paragamian et al. 1997, pg. 30). Kootenai sturgeon have spawned in water temperature ranging from 37.3 °F to 55.4 °F. However, most Kootenai sturgeon spawn when the water temperature is near 50 °F (Paragamian et al. 1997, pg. 30). Until recently, only about one-third of Kootenai sturgeon in spawning condition migrated upstream to the Bonners Ferry area annually, with few remaining there to spawn (Paragamian et al. 1997; Rust and Wakkinen 2013). However, with the construction of multiple large-scale habitat projects in the mainstem Kootenai River and management of Libby

Dam flows during the sturgeon spawning season, an increasing proportion of spawning sturgeon have been migrating to areas upstream of Bonners Ferry, including nearly 40 percent of tagged spawners in 2018 (IDFG 2018, pgs. 13-14). Additionally, during the 2018 spawning season a fertilized egg was collected in the reach upstream of Bonners Ferry, marking the first documentation of sturgeon spawning in that area (IDFG 2018, pg. 15).

The size or age at first maturity for Kootenai sturgeon in the wild is quite variable (PSMFC 1992, pg. 11). In the Kootenai River system, females have been estimated (based upon age-length relationships) to mature at age 30 and males at age 28 (Paragamian et al. 2005, pg. 525). Only a portion of Kootenai sturgeon are reproductive or spawn each year, with the spawning frequency for females estimated at 4 to 6 years (Paragamian et al. 2005, pg. 525). Spawning occurs when the physical environment permits egg development and cues ovulation. Kootenai sturgeon spawn during the period of historical peak flows, from May through July (Apperson and Anders 1991, pg. 50; Marcuson 1994, pg. 18). Spawning at near peak flows with high water velocities disperses and prevents clumping of the adhesive, demersal (sinking) eggs.

Following fertilization, eggs adhere to the rocky riverbed substrate and hatch after a relatively brief incubation period of 8 to 15 days, depending on water temperature (Brannon et al. 1985, pgs. 58-64). Here they are afforded cover from predation by high near-substrate water velocities and ambient water turbidity, which preclude efficient foraging by potential predators.

Upon hatching the embryos become "free-embryos" (that life stage after hatching through active foraging larvae with continued dependence upon yolk materials for energy). Free-embryos initially undergo limited downstream redistribution(s) by swimming up into the water column and are then passively redistributed downstream by the current. This redistribution phase may last from one to six days depending on water velocity (Brannon et al. 1985, pgs. 58-64; Kynard and Parker 2005, pg. 3). The inter-gravel spaces in the substrate provide shelter and cover during the free-embryo "hiding phase".

As the yolk sac is depleted, free-embryos begin to increase feeding, and ultimately become free-swimming larvae, entirely dependent upon forage for food and energy. Because the larvae are free-swimming, they are less dependent upon rocky substrate or high water velocity for survival (Brannon et al. 1985, pgs. 58-64; Kynard and Parker, 2005, pg. 3). The timing of these developmental events is dependent upon water temperature. With water temperatures typical of the Kootenai River, free-embryo Kootenai sturgeon may require more than seven days post-hatching to develop a mouth and be able to ingest forage. At 11 or more days, Kootenai sturgeon free-embryos would be expected to have consumed much of the energy from yolk materials, and they become increasingly dependent upon active foraging.

The duration of the passive redistribution of post-hatching free-embryos, and consequently the linear extent of redistribution, depends upon near substrate water velocity, where free-embryos enter the hiding phase earlier when river currents are higher (Brannon et al. 1985, pg. 58). This adaptive behavior prevents prolonged exposure of free-embryos to potential predators (Brannon et al. 1985, pg. 58). Working with Kootenai sturgeon, Kynard and Parker (2005, pg. 3) found that under some circumstances this dispersal phase may last for up to 6 days. A prolonged dispersal phase among free-embryos would increase the risk of predation on the embryo and diminish energy reserves, whereas entering the hiding phase earlier would reduce these risks. Multiple years of field sampling of juveniles and adults indicates that juvenile and adult Kootenai sturgeon primarily rear in the lower Kootenai River and in Kootenay Lake (USFWS 2011, pg. 16).

7.5 Population Dynamics and Viability

In 2019, an interim progress report from IDFG estimated that the wild adult Kootenai sturgeon population abundance had declined from approximately 2,072 individuals in 2011 to 1,744 individuals (confidence interval 1,232 to 2,182) in 2017 (Hardy and McDonnell 2019). Annual survival rates (estimated by mark-recapture analysis) are estimated to be approximately 96 percent.

Beamesderfer et al. (2014, pg. 40) estimated natural recruitment to the wild population to be 13 new juveniles per year. However, the same analysis indicated that the number of naturally produced recruits are inadequate (i.e., too low) to accurately assess the number of wild juveniles produced annually. Applying sampling efficiencies of hatchery sturgeon to wild sturgeon, based on cumulative annual capture of wild juveniles between 3 and 24 years old, Ross et al. (2015) and Hardy et al. (2019) estimated that an average of approximately 85 new juvenile Kootenai sturgeon are naturally reproduced in the Kootenai River annually. Both estimates suggest that high levels of mortality are occurring in the population and natural reproduction at either level cannot be expected to provide any population level benefits (Anders 2017, pg. 6), nor would reproduction at either level have been adequate to sustain the population of 6,000 to 8,000 sturgeon estimated to exist in 1980 (Anders 2017, pg. 16). The last year of significant natural recruitment was 1974.

To address recovery and fill the demographic and genetic gaps left by limited natural reproduction, hatchery-origin Kootenai sturgeon have been spawned from wild broodstock and released into the Kootenai River (throughout the range of Kootenai sturgeon) annually beginning in 1992. Since 1992, the KTOI's Kootenai sturgeon aquaculture program has released over 300,000 hatchery-origin juvenile Kootenai sturgeon into the Kootenai River Basin (KTOI 2018, pg. 7). Dinsmore et al. (2015, pg. 7) concluded annual post-release survival for hatchery-origin sturgeon at age-2 and older ranges from 64-95 percent for previously released age-2 fish, and over 92 percent for age-3+ fish, and shows no evidence of decline. Additionally, genetic data indicates that in 2002-2009 brood years, approximately 70-80 percent of wild alleles were represented in surviving hatchery-origin juveniles (A. Schreier, pers. comm. 2016).

These results, in addition to the continued low level of natural in-river recruitment among Kootenai sturgeon, make it clear that continuing the conservation aquaculture program is vital to the recovery of the species.

7.6 Distribution

The Kootenai sturgeon is one of 18 landlocked populations of white sturgeon known to occur in western North America (USFWS 1999, pg. 3). Kootenai sturgeon occur in Idaho, Montana, and British Columbia and are restricted to approximately 167.7 RM of the Kootenai River extending from Kootenai Falls, Montana (31 RM below Libby Dam, Montana), downstream through Kootenay Lake to Corra Linn Dam, which was built on Bonnington Falls at the outflow from Kootenay Lake in British Columbia (RM 16.3). Approximately 45 percent of the species' range is located within British Columbia.

Bonnington Falls in British Columbia, a natural barrier downstream from Kootenay Lake, has isolated the Kootenai sturgeon since the last glacial advance roughly 10,000 years ago (Apperson 1992, pg. 2). Apperson and Anders (1990, pgs. 35-37; 1991, pgs. 48-49) found that at least 36 percent (7 of 19) of the Kootenai sturgeon tracked during 1989 overwintered in Kootenay Lake. Adult Kootenai sturgeon forage in and migrate freely throughout the Kootenai River downstream of Kootenai Falls at RM 193.9. Juvenile Kootenai sturgeon also forage in and migrate freely throughout the lower Kootenai River downstream of Kootenai Falls and within Kootenay Lake. Apperson and Anders (1990, pgs. 35-37; 1991, pgs. 48-49) observed that Kootenai sturgeon no longer commonly occur upstream of Bonners Ferry, Idaho. However, there are no structural barriers preventing Kootenai sturgeon from ascending the Kootenai River up to Kootenai Falls, and this portion of the range remains occupied as documented by Ireland (2005, pg. 1), Stephens et al. (2010, pgs. 14-16), and Stephens and Sylvester (2011, pgs. 21-34).

7.7 Consulted on Effects for Kootenai sturgeon

Consulted-on effects are those effects that have been analyzed through Section 7 consultation as reported in an Opinion. These effects are an important component of objectively characterizing the current condition of the species. To assess consulted-on effects to Kootenai sturgeon, we analyzed all of the Biological Opinions received by the Service from the time of listing until January 2018.

The Service issued jeopardy Opinions on the effects of Libby Dam operations on Kootenai sturgeon in 1995, 2000, and 2006 (the 1995 and 2000 Opinions included the effects of the FCRPS, and are referred to as the "FCRPS Opinions"). In 2008, in response to litigation over the 2006 jeopardy Opinion, a settlement agreement was signed between the Center for Biological Diversity, the Service, the Corps, the State of Montana, and the KTOI. In December 2008, in compliance with the terms of the settlement agreement, the Service clarified the RPA from the 2006 jeopardy Opinion (2008 Clarification).

The RPA from the 2006 jeopardy Opinion directed the Action Agencies (the Corps and Bonneville) to implement pilot habitat projects in the Braided and Meander reaches of the Kootenai River. The 2008 Clarification directed the Action Agencies to "cooperate in good faith with and support the KTOI's good-faith efforts to implement the Kootenai River Restoration Project Master Plan, including developing a funding strategy to implement the Plan."

In June 2011, the Service issued an Opinion on the implementation of Phase 1 of the Kootenai River Habitat Restoration Project (USFWS 2011a; FWS Reference: 14420-2011-F-0181). In that Opinion, the Service concurred with Bonneville's conclusion that the project "may affect", but is "not likely to adversely affect" bull trout and bull trout critical habitat. Also in that Opinion, the Service determined that implementation of the project was neither likely to jeopardize the continued existence of Kootenai sturgeon, nor likely to adversely modify

Kootenai sturgeon critical habitat. The Service also determined that implementation of the project is likely to provide long-term benefits to Kootenai sturgeon and their designated critical habitat. The project was implemented and completed in the summer and fall of 2011.

In July 2012, the Service issued an Opinion on the implementation of Phase 2 of the Kootenai River Habitat Restoration Project (USFWS 2012a; FWS Reference: 14420-2012-FC-0388). In that Opinion, the Service concurred with Bonneville's conclusion that the project "may affect", but is "not likely to adversely affect" bull trout and bull trout critical habitat. Also in that Opinion, the Service determined that implementation of the project was neither likely to jeopardize the continued existence of Kootenai sturgeon, nor likely to adversely modify Kootenai sturgeon critical habitat. The Service also determined that implementation of the project is likely to provide long-term benefits to Kootenai sturgeon and their designated critical habitat. The project was implemented and completed in the summer and fall of 2012.

In April 2013, the Service issued an Opinion on the construction of the Twin Rivers Aquaculture Facility as well as Bonneville's continued funding of the Kootenai sturgeon conservation aquaculture program (USFWS 2013c; FWS Reference: 01EIFW00-2013-F-0207). In that Opinion, the Service determined that construction of the new facility and operation of the conservation aquaculture program is not likely to jeopardize the continued existence of Kootenai sturgeon or bull trout, nor are they likely to adversely modify designated Kootenai sturgeon and bull trout critical habitat. The Service also concluded that operation of the Kootenai sturgeon conservation aquaculture program is expected to have an overall net positive effect for the Kootenai sturgeon (e.g., increased understanding of behaviors, life history, limiting factors; retention of genetic diversity of the existing population; prevention of extinction).

In July 2013, the Service issued a programmatic Opinion on the implementation of additional projects under the Kootenai River Habitat Restoration Program (USFWS 2013b; FWS Reference: 01EIFW00-2013-F-0278). In that Opinion, the Service concurred with Bonneville's conclusion that the project "may affect", but is "not likely to adversely affect" bull trout and bull trout critical habitat. Also in that Opinion, the Service determined that implementation of the program was neither likely to jeopardize the continued existence of Kootenai sturgeon, nor likely to adversely modify Kootenai sturgeon critical habitat. The Service also determined that implementation of the program is expected to provide long-term benefits to both Kootenai sturgeon and their designated critical habitat. Projects covered under the programmatic Opinion began to be implemented in 2013, and continue to be implemented annually.

7.8 Conservation Role of the Action Area (Kootenai Sturgeon)

Based on the best scientific information currently available, the habitat needs of Kootenai sturgeon, and impacts to those needs, are described below.

7.8.1 Primary Productivity

In a review of studies of the Kootenai River Basin, the Pacific Watershed Institute identified a broad swing in nutrient levels as one of the most significant changes affecting the sustainability of aquatic life in the Basin (NPCC 2005, pg. 9). The following four paragraphs discuss the loss of nutrients and effects to primary productivity stemming from two main causes: 1) trapping of nutrients behind Libby Dam, and 2) significant reductions in riparian function and floodplain interaction.

Tetra Tech (2004, pg. 7) noted that by acting as a nutrient trap, the presence of Libby Dam has decreased the productivity and overall carrying capacity of the downstream ecosystem. Specifically, Libby Dam has reduced downstream transport of phosphorus and nitrogen by as much as 63 percent and 25 percent respectively, with sediment trapping efficiencies exceeding 95 percent (NPCC 2005, pg. 404).

Prior to the diking of the mainstem Kootenai River and construction of Libby Dam, the Kootenai River floodplain downstream from Bonners Ferry was a vast complex mix of channels, wetlands and cottonwood stands, perhaps one of the largest and richest riparian forest and wetland complexes in the Pacific Northwest (Jamieson and Braatne 2001 as cited in NPCC 2005, pg. 61). In all, it is thought to have included approximately 70,000 ac of contiguous floodplain wetlands (Cole and Hanna 2001, pg. 12). However, construction of dikes, draining of wetlands, and flood risk management operations at Libby dam have allowed these wetlands to be converted to agricultural lands.

Specific to flood control operations at Libby Dam, the Kootenai Subbasin Plan (NPCC 2005, pg. 91) noted that large-scale floods have occurred in the Kootenai Basin once per 10 years on average. These recurring floods have allowed the native flora and fauna of the Kootenai Basin to evolve to an ecosystem that includes regular large-scale flooding and subsequent inundation of riparian and wetland areas. Therefore, flooding is a fundamental ecosystem process in the Kootenai Basin that creates a healthy environment for native fish and the food organisms they depend on. The reductions in ecosystem processes that are dependent on annual flooding have lowered the productivity of the Kootenai River downstream of Bonners Ferry (NPCC 2005, pg. 101).

An additional impact to primary productivity in the Kootenai River is the loss of kokanee runs. Because they die after spawning, kokanee are a key source of nutrients to freshwater systems (Gende et al. 2002, pg. 917). Historically, much of the former Kootenai River fish assemblage depended on kokanee as forage, with Kootenai sturgeon likely targeting spawning kokanee as they made their annual spawning migrations (NPCC 2005, pg. 299). Loss of these spawning kokanee and the associated loss of nutrients have negatively affected Kootenai sturgeon.

In many fish species, Kootenai sturgeon included, production of year classes is largely dependent on larval survival, with the primary causes of larval mortality being starvation and predation (Muir et al. 2000, pg. 25). As a result, the availability of suitable prey for larval sturgeon is crucial. However, due to the presence and operations of Libby Dam, construction of dikes along the mainstem Kootenai River, agriculture, human development, and other factors, the historic river conditions that allowed for the production of prey species important to larval sturgeon have been greatly diminished (KTOI 2009, pg. 2-4). As noted in USFWS 2011a (pg. 10), sturgeon managers have hypothesized that Kootenai sturgeon are experiencing a second bottleneck at the larval-to-age-2 stage, and that the cause of this bottleneck is nutrient/food related (i.e., there is an insufficient food supply for larval and age-1 sturgeon). Field data have indicated there is very little benthic zooplankton and macroinvertebrate production in the Kootenai River (USFWS 2011a, pg. 10). Macroinvertebrate densities in the Kootenai River are consistent with ecosystems with low nutrient levels (Snyder and Minshall 1996, as cited in NPCC 2005 pgs. 402-403). Hopkins and Lester (1995, as cited in NPCC 2005, pg. 402) found invertebrate densities in Lower Granite Reservoir of the Snake River, Idaho (which has a naturally spawning and recruiting white sturgeon population) that were nearly threefold greater than in the Kootenai River.

Since 2011, multiple large-scale habitat restoration projects have been implemented in the Kootenai Basin as part of the Kootenai River Habitat Restoration Program, including several projects specifically designed to address the loss of nutrient input into the Kootenai Basin (e.g., floodplain creation and reconnection, riparian enhancement). Additionally, Bonneville has funded nutrient addition projects in the Kootenai River (since 2005) and Kootenay Lake (2004). These ongoing nutrient addition programs continue to increase beneficial algal production, the abundance, biomass and diversity of invertebrate food items for fish, and overall biological productivity in the Kootenai system (Hoyle et al. 2014, pg. 1028; Minshall et al. 2014, pg. 1009).

7.8.2 Water Velocity

High "localized" water velocity is one of the common factors of known sites where white sturgeon spawn and successfully recruit in the Columbia River Basin. Mean water velocities exceeding 3.3 feet per second (ft/s) are important to successful spawning and recruitment in white sturgeon. Parsley and Beckman (1994, pg. 11070) suggested, based on information from four Lower Columbia River sites, that optimal spawning habitat for white sturgeon may occur when mean water column velocity is 5.9 ft/s or greater. These water velocities provide: cover from predation; normal free-embryo behavior and redistribution; and shelter (living space) for eggs and free-embryos through the duration of the incubation period.

Mean water column velocities observed by Paragamian et al. (2001, pg. 26) between RM 141.6 and 149.4 of the Kootenai River during spawning events (1991-1998) ranged from only 0.63 to 2.2 ft/s. Modeling of hydrologic conditions within the Meander Reach of the Kootenai River indicates that mean water velocities in excess of 3.3 ft/s are unlikely under existing management constraints (Barton et al. 2005 pg. 696).

Beginning at approximately RM 151.8 and extending upstream, there is an increase in the gradient of the bed of the Kootenai River. Water surface slope in the Meander Reach, which includes RM 141.6 to 149.4, averages roughly 0.02 ft per 1000 ft. However, in the braided reach between RM 151.8 and 159.7 the average water slope increases to 0.046 ft/1000ft (Barton 2004 p. 13). For comparison, water surface slope in the highly successful Bonneville Dam tailrace spawning reach (Columbia River) ranges between 0.1-foot and 1,000 ft at a discharge of 70,600 cfs and between 0.34-foot and 1,000 ft at 495,000 cfs (Parsley and Beckman, 1994). Because of the increased slope and shallow nature of the Kootenai River braided reach, water velocities in the range of 3.3 to 9.9 ft/s can be achieved with discharges in the range of 20,000 cfs to 40,000 cfs, even with a backwater effect associated with river stage up to 1,760 ft (measured at Porthill, at the U.S./Canada border) (Barton et al 2005 p. 9).

Since the start of Libby Dam operations in 1974, minimum flows during the spawning or incubation period (mid-May through mid-July) have been reduced in the Kootenai River from an average of 30 days annually to less than 5 days annually (Hoffman 2005). These flows are important in maintaining water velocities throughout the incubation period (up to about 43 days) in the braided and/or canyon reach.

Higher near-substrate water velocity associated with current base flows may allow free-embryos to enter the hiding phase sooner, thus reducing risk of predation (Brannon et al. 1985, Miller and Beckman 1996). Sturgeon eggs were recovered from stomachs of northern pikeminnow (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinu*), and suckers (*Catostomus* spp.) captured in or near sturgeon spawning areas currently being used in the Kootenai River (Anders et al. 2002). These researchers also note that egg predation may be an "important underestimated mortality factor for white sturgeon eggs in the Kootenai River" (Anders et al. 2002).

The threat of predation is also documented by Miller and Beckman (1996) at various white sturgeon spawning sites in the Lower Columbia River. These authors suggested that predation on eggs may be limited when sturgeon spawn in fast-flowing water (velocities greater than or equal to 3.3 ft/s). The threat of predation may be further exacerbated in the Kootenai River by declining population abundance of Kootenai sturgeon, coinciding with increases in relative abundance of egg predators, due in part to selective pressures from post-impoundment habitat conditions (Anders et al. 2002; Paragamian 2002). For example, Paragamian (2002) reported that in the vicinity of Kootenai River RM 162.7 (within the canyon reach), largescale suckers (*Catostomus macrocheilus*), a known egg predator, increased from 19 percent of the sample and 49 percent by weight in 1980, to 65 percent of the sample and 70 percent by weight in 1994.

7.8.3 Suspended Sediment/Turbidity

There has been an approximately 80 percent reduction in suspended sediment and turbidity in the Kootenai River since Libby Dam began operations (Barton 2005, p 3). Prior to impoundment by Libby Dam, turbidity remained high during the incubation period. White sturgeon are found in large rivers along the Pacific Coast between Monterey, California and Alaska (Page and Burr 1991, pg. 27). Such large river systems typically carry large suspended sediment loads and are highly turbid, particularly during the spring runoff period (Cole 1983, pgs. 154-155). In response, white sturgeon have evolved specific life strategies to persist in these conditions. Hildebrand et al. (1999, pg. 165) states about Columbia River white sturgeon in British Columbia:

> "White sturgeon are broadcast spawners and the eggs and post-hatch larvae are relatively large and black in colour. Post-hatch white sturgeon larvae undergo a passive downstream migration to rearing habitats. Turbid water conditions during the egg incubation and early pelagic larval stage would provide protection from visual predators for these life stages and also for the early benthic feeding stage of sturgeon fry. This suggests historical spawning habitats may have been situated in systems that had a high suspended sediment load such as the upper Columbia River or the lower Pend Oreille River."

Additional white sturgeon adaptations to higher turbidity and suspended sediment levels include:

1. influencing spawning site selection, with higher levels being associated with spawning in shallower habitats (likely due to increased cover) (Perrin et al. 2003, pg. 163; Hildebrand et al., 1999, pg. 167);

2. hatching and emergence into the water column occurring in low-light conditions (Brannon et al. 1985, pg. 24); and

3. larval white sturgeon being photophobic (Brannon et al. 1985, pg. 24).

The latter two adaptations appear to be related to predator avoidance. Gadomski and Parsley (2005 pg. 371) found that significantly more white sturgeon larvae were eaten by prickly sculpins (*Cottus asper*) at lower turbidity levels in a controlled laboratory experiment.

Given the adaptations described in the preceding paragraph, the significant loss of suspended sediment and turbidity in the Kootenai River may:

1. cause Kootenai sturgeon to restrict spawning sites to deeper habitats;

2. increase predation on incubating eggs;

3. disrupt larval behavior; and

4. increase predation on larvae.

Significantly more free-embryos may be preyed upon with lower turbidity (Gadomski and Parsley 2005) because at lower turbidity levels predators can see prey better and are therefore more efficient.

7.8.4 Water Depth

There has been a substantial reduction in river depth in the Meander Reach since the Kootenai River was impounded. Within this reach, both the backwater effect of Kootenay Lake and river flow may affect depth (Berenbrock and Bennett 2005). For example, at Bonners Ferry, the reduction in river depth between the historical mean peak runoff event (about 75,000 cfs), and the mean of peak flows since construction of Libby Dam (about 35,000 cfs), is about 12.25 ft. The total depth at Bonners Ferry during the historical mean annual runoff event was about 26.2 ft (Berenbrock 2005). The present average depth at Bonners Ferry of about 14 ft is nearly a 50 percent reduction from these historical mean peak runoff conditions (Berenbrock and Bennett 2005).

The operations of Corra Linn Dam at the outlet of Kootenay Lake in British Columbia continue to create a backwater effect throughout the present spawning area. Historically (1967 through 1974), the upstream extent of backwater influence generally extended to between RM 158.4 and 161.5. However, during the period 1994 through 2002, the upstream extent of backwater influence of Kootenay Lake typically reached only to approximately RM 155.3 to 156.5. Historically, the mean of annual peak water surface elevations at Queens Bay on Kootenay Lake was 1,765.1 ft above mean sea level, but since the start of river manipulation at Libby Dam in 1972 the average annual peak stage has dropped to 1757.8 ft above sea level (Paragamian et al. 2001), an average reduction in peak stage of 7.23 ft. Under unregulated and partially regulated conditions (1967 through 1974) backwater effects from Kootenay Lake increased water depth during the sturgeon spawning period throughout most of the braided reach in every year except 1973 (Hoffman 2005).

Prior to 1974, the mean peak discharge event measured at Bonners Ferry was about 75,000 cfs, but since then, this median annual peak event has been reduced to about 35,000 cfs. The average peak stage at Bonners Ferry under unregulated conditions (1914-1971) was 1,773 ft. Under regulated conditions, the mean peak stage was 1,758 ft measured at Bonners Ferry, a mean annual reduction in stage of 12.25 ft (Berenbrock 2005). The reduction in depth is due to the combined effects of reduced flow for flood control operations, and the reduced backwater from Kootenay Lake in approximately equal proportions (Corps 1982). The relative influence of each effect on depth is site-specific and variable.

As described above, the best information currently available indicates that water depth is a factor affecting both migratory behavior and spawning site selection among Kootenai sturgeon. Beginning with the Upper Meander project in 2012, multiple pools and pool-forming structures have been constructed in the braided reach as part of the Kootenai River Habitat Restoration Program. While the amount of change to overall river depth from these projects has not yet been quantified, annual monitoring indicates that the pools are persisting and the structures are performing as designed (KTOI 2016, pg. 15). Further, telemetry data from spawning Kootenai sturgeon indicates that the creation and enhancement of pools in the braided reach is a factor in the recent increase in the proportion of tagged spawning sturgeon migrating into the braided reach (IDFG 2018, pg. 19).

7.8.5 Rocky Substrate

Rocky substrate and associated inter-gravel spaces provide both structural shelter and cover for egg attachment, embryo incubation, and normal free-embryo incubation, as well as facilitate downstream redistribution of free-embryos.

Laboratory experiments suggest that embryos in sturgeon eggs may be suffocated by shifting fine-grained materials at relative low water velocities (0.046 inches per second) (Kock et al. in press) such as those that dominate the Kootenai River at the present spawning sites (Anders et al. 2002). During laboratory studies, Brannon (2002, pers. comm. cited in Anders et al. 2002) observed larval white sturgeon burrowing into fine sediments and apparently suffocating. Most of the known current Kootenai sturgeon spawning sites are within designated critical habitat (66 FR 46548). This habitat includes the upper most 11.2 miles of the Meander Reach of the Kootenai River. The Meander Reach has a low stream gradient, and substrates are composed primarily of sand and other fine materials overlying lacustrine (of, relating to, or formed in a lake) clay (Barton 2004; Fosness and Williams 2009). Most Kootenai sturgeon eggs found in this reach are covered with fine sand particles (Paragamian et al. 2001). However, coring data revealed that the substrate in the Meander Reach was historically (i.e., pre-dam) composed of sand, clay, and other fine materials (Barton et al. 2012). Exposed naturally deposited gravel is confined to a few small sites along the banks and streambed believed to be associated with old tributary inflows, and localized areas where steep river banks have been artificially armored with cobbles and boulders to control erosion (Bettin in lit. 2005). Collectively, this data indicates that suffocation of Kootenai sturgeon eggs and embryos in the Meander Reach is not the result of post-dam inundation of substrate with fine sediments, but is instead likely due to altered spawning site selection.

Additionally, as part of the Kootenai River Habitat Restoration Project, in 2014 small patches (approximately 0.5 ac to 1.0 ac each) of rocky substrates were placed in documented spawning areas in the Shorty's Island (RM 143.6) and Myrtle Creek (RM 145.5) areas. Rocky substrates were also placed in the straight reach (RM 152) in 2016. These substrate enhancement projects were implemented as pilot projects to test whether the substrates would persist (i.e., remain clear of sand and silt) and whether Kootenai sturgeon would continue to spawn at those specific sites. Current monitoring of both the substrates and spawning sturgeon indicate that the pilot projects have been successful in those specific regards (KTOI 2016, pg. 21).

7.8.6 Water Temperature

Suitable water quality is necessary for the viability of early life stages of Kootenai sturgeon, including both incubating eggs and free-embryos, and for normal breeding behavior. Average water temperatures in the Kootenai River are typically warmer in the winter and colder in the summer than they were prior to the construction of Libby Dam (Partridge 1983). Current average spring temperatures tend to be cooler than under pre-dam conditions, and the differences may be increased even more when outflow from Libby Dam dominates the total river flow (Corps 2004). These temperature alterations may also affect the rates of maturation, growth rates, and spawning behavior of sturgeon. Lower than normal water temperatures in the spawning reach may affect spawning behavior, location, and timing. Preferred spawning temperature for the Kootenai sturgeon is near 50 °F, and sudden drops of 3.5 °F to 5.5 °F cause males to become reproductively inactive, at least temporarily. Water temperatures also affect the duration of incubation of both embryos (eggs) and free-embryos.

7.9 Rangewide Status of Bull Trout

The bull trout was listed as a threatened species in the coterminous U.S. in 1999. Throughout its range, 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, 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). However, many of the Core Areas have observed declines, while a few have maintained or substantially increased their populations.

The 2015 Recovery Plan for bull trout identifies six Recovery Units within the listed range of the species (USFWS 2015a). Each of the Recovery Units are further organized into multiple bull trout Core Areas, which are mapped as non-overlapping watershed-based polygons, and each Core Area includes one or more local populations. Within the coterminous U.S., we currently recognize 109 occupied Core Areas, which comprise 600 or more local populations of bull trout (USFWS 2015a). Core Areas are functionally similar to bull trout metapopulations, in that bull trout within a Core Area are much more likely to interact, both spatially and temporally, than are bull trout from separate Core Areas.

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

For a detailed reference 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

8.1 Kootenai Sturgeon Critical Habitat

On September 6, 2001, the Service issued a final rule designating critical habitat for the Kootenai sturgeon (66 FR 46548). The critical habitat designation extends from ordinary high water line to ordinary high water line on the right and left banks, respectively, along approximately 11.2 miles of the mainstem Kootenai River from RM 141.4 to RM 152.6 in Boundary County, Idaho, (Unit 2, Figure 1). On February 10, 2006, the Service issued an interim rule designating the braided reach (RM 152.6 to RM 159.7) as critical habitat (71 FR 6383) (Unit 2, Figure 1). On June 9, 2008, the Service issued a final rule designating the braided reach as critical habitat (73 FR 39506). Both the meander and the braided reach are located entirely within Boundary County, Idaho, respectively downstream and upstream of Bonners Ferry. A total of 18.3 RM is designated as critical habitat for Kootenai sturgeon.

8.1.1 Primary Constituent Elements

Five PCEs are defined for Kootenai sturgeon critical habitat (73 FR 39506). These PCEs are specifically focused on adult migration, spawning site selection, and survival of embryos and free-embryos, the latter two of which are the life stages now identified as limiting the reproduction and numbers of the Kootenai sturgeon. The PCEs are defined as follows:

1. A flow regime, during the spawning season of May through June, that approximates natural variable conditions and is capable of producing depths of 23 ft (7 meters [m]) or greater when natural conditions (for example, weather patterns, water year) allow. The depths must occur at multiple sites throughout, but not uniformly within, the Kootenai River designated critical habitat.

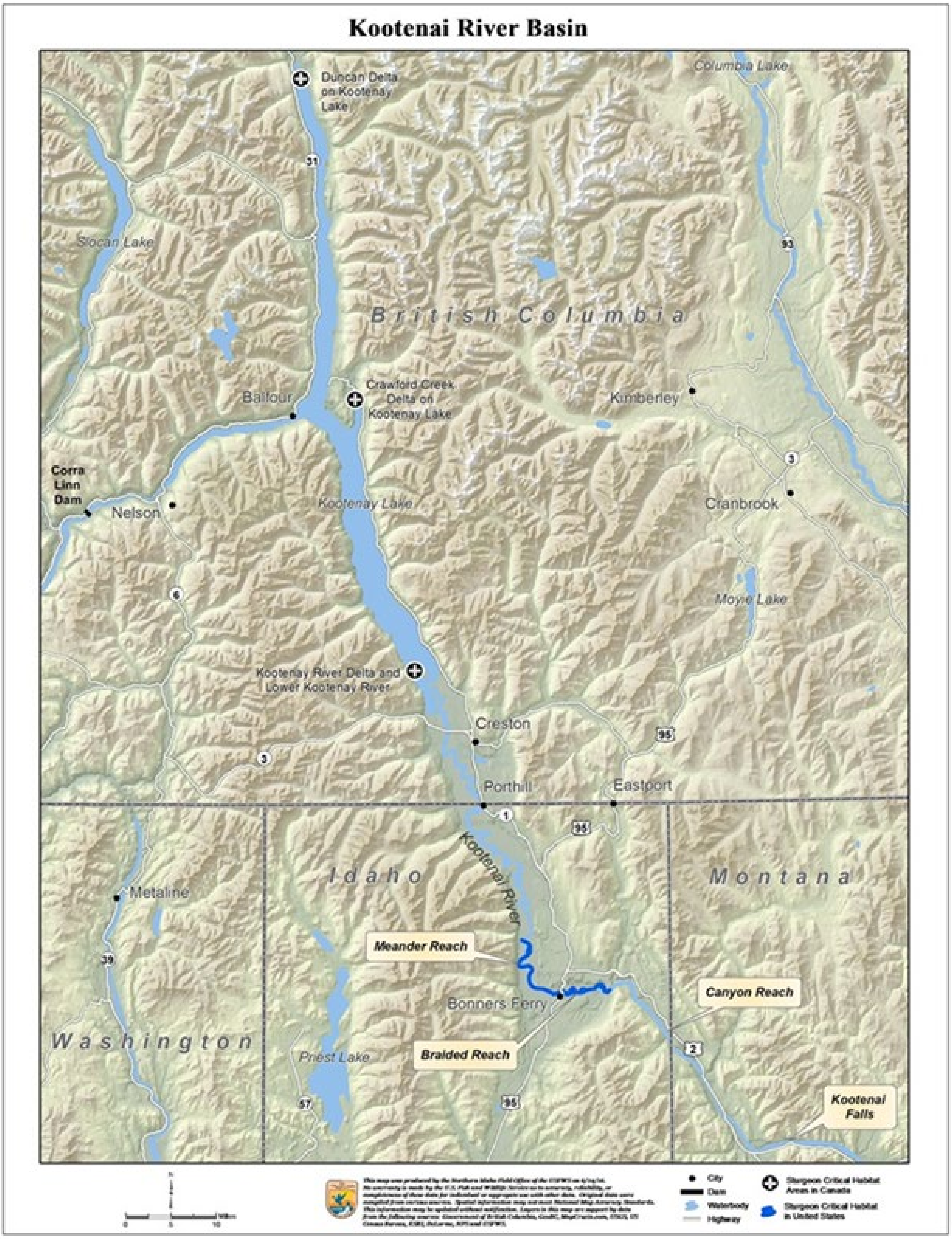

Figure 1. Geographic reaches within Kootenai sturgeon critical habitat

2. A flow regime, during the spawning season of May through June, that approximates natural variable conditions and is capable of producing mean water column velocities of 3.3 ft/s (1.0 meter per second [m/s]) or greater when natural conditions (for example, weather patterns, water year) allow. The velocities must occur at multiple sites throughout, but not uniformly within, the Kootenai River designated critical habitat.

3. During the spawning season of May through June, water temperatures between 47.3 °F and 53.6 °F (8.5 °C and 12 °C), with no more than a 3.6 °F (2.1 °C) fluctuation in temperature within a 24-hour period, as measured at Bonners Ferry.

4. Submerged rocky substrates in approximately 5 continuous RM (8 river kilometer [RKM]) to provide for natural free embryo redistribution behavior and downstream movement.

5. A flow regime that limits sediment deposition and maintains appropriate rocky substrate and inter-gravel spaces for sturgeon egg adhesion, incubation, escape cover, and free embryo development. Note: the flow regime described above under PCEs 1 and 2 should be sufficient to achieve these conditions.

8.1.2 Current Condition of Critical Habitat

8.1.2.1 Meander Reach

The Meander Reach is characterized by sandy substrate, a low water-surface gradient, a series of deep holes, and water velocities which rarely reach 3.3 ft/s. The morphology of the Meander Reach has changed relatively little over time (Barton 2004, pg. 1). Significant changes to this reach caused by the construction and operation of Libby Dam include: 1) a decrease in suspended sediment; 2) the initiation of cyclical aggradation and degradation of the sand riverbed in the center of the channel; 3) a reduction in water velocities (Barton 2004, pg. 1); and 4) reductions in floodplain interactions and riparian function, which negatively affect primary and secondary productivity in the river.

The upstream-most segment of the Meander Reach (approximately 0.6 RM in length) has rocky substrate and water velocities in excess of 3.3 ft/s under present river operations (Berenbrock 2005a, pg. 7). However, due to a reduction of average peak flows by over 50 percent caused by flood control operations of Libby Dam and the reduction of the average elevation of Kootenay Lake by approximately 7.2 ft (and the resultant backwater effect), the PCE for water depth is infrequently achieved in this reach of the Kootenai River (Berenbrock 2005a, pg. 7). A deep hole (49.9 ft) that is frequented by sturgeon in spawning condition exists near Ambush Rock at approximately RM 151.9 (Barton et al. 2005, pg. 36).

In 2014, as part of the Kootenai River Habitat Restoration Project, small patches (approximately 0.5 to 1.0 ac each) of rocky substrates were placed in documented spawning areas in the Shorty's Island (RM 143.6) and Myrtle Creek (RM 145.5) areas. Rocky substrates were also placed in the straight reach (RM 152) in 2016. These substrate enhancement projects were implemented as pilot projects to test whether the substrates would persist (i.e., remain clear of sand and silt) and whether Kootenai sturgeon would continue to spawn at those specific sites. Current monitoring of both the substrates and spawning sturgeon indicate that the pilot projects have been successful in those specific regards (KTOI 2016, pg. 21). Additional projects implemented in the Meander Reach involve reconnection and enhancement of floodplain areas, riparian enhancement, and tributary restoration.

8.1.2.2 Braided Reach

The braided reach of the Kootenai River was designated as critical habitat because it contains: 1) sites with seasonal availability of adequate water velocity in excess of 3.3 ft/s; and 2) rocky substrate necessary for normal spawning, embryo attachment and incubation, and normal free embryo dispersal, incubation and development. Within this reach, the valley broadens, and the river forms an intermediate-gradient braided reach as it courses through multiple shallow channels over gravel and cobbles (Barton 2004, pg. 7).

Similar to the 0.6 RM upstream-most segment of the Meander Reach, the lower end of the braided reach has also become shallower during the sturgeon reproductive period for the same reasons discussed above. Additionally, a loss of energy and bed load accumulation has resulted in a large portion of the middle of the braided reach becoming wider and shallower (Barton et al. 2005, pg. 18).

The net result of the changes described above may adversely affect Kootenai sturgeon in the following ways: 1) Kootenai sturgeon may generally avoid spawning in areas upstream of Bonners Ferry with suitable rocky substrates; 2) Kootenai sturgeon may instead spawn at sites that have unsuitable substrates and low water velocity (i.e., the Meander Reach); 3) the loss of floodplain interaction and riparian function may negatively affect primary and secondary productivity in the river, thereby reducing available food sources during sturgeon early life stages. While suitable water depth is still achieved under current operations at the downstream end of the braided reach, significant special management is needed to adequately address the PCEs for substrate and water velocity in this area.

Beginning in 2011, multiple habitat restoration projects have been implemented in the braided reach, as part of the Kootenai River Habitat Restoration Program. Projects implemented to date include side channel restoration, bank stabilization, island construction, pool construction, construction of pool-forming structures, riparian restoration and enhancement, and floodplain reconnection and enhancement. Further, telemetry data from spawning Kootenai sturgeon indicates that the creation and enhancement of pools in the braided reach is a factor in the recent increase in the proportion of tagged spawning sturgeon migrating into the braided reach (IDFG 2018, pg. 19).

8.2 Bull trout Critical Habitat

On October 18, 2010, the Service issued a final revised critical habitat designation for the bull trout (70 FR 63898). The critical habitat designation includes 32 CHUs in six proposed Recovery Units located throughout the coterminous range of the bull trout in Washington, Oregon, Idaho, Montana, and Nevada. The species' final recovery plan (USFWS 2015a) formally designated these Recovery Units. Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) FMO habitat. The conservation role of bull trout critical habitat is to support viable Core Area populations (75 FR 63943). 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.

The final rule excludes some critical habitat segments. 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 the 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 inclusion would impair their relationship with the Service; or, 3) waters where impacts to national security have been identified (75 FR 63898).

Bull trout have more specific habitat requirements than most other salmonids (USFWS 2010a, b). The predominant habitat components influencing their distribution and abundance include water temperature, cover, channel form and stability, spawning and rearing substrate conditions, and migratory corridors. The PCE or Primary Biological Factors (PBFs) of bull trout critical habitat, as revised in 2010, are (USFWS 2010a, b):

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

5. Water temperatures ranging from 2 °C to 15 °C (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; and,

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

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

9 ENVIRONMENTAL BASELINE

9.1 General Baseline Conditions

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

The effects or resulting impacts of past CRS operations and maintenance as well as the physical structures are included as part of the Environmental Baseline. Those effects have undergone consultation and contributed to the current condition of the species and critical habitat in the Action Area. Other past, present, and ongoing impacts of human and natural factors (including proposed Federal projects that have already undergone Section 7 consultation) contributing to the current condition of the species and critical habitat in the Action Area are included in the Environmental Baseline for Section 7 consultation purposes. A description of previous actions that have contributed to these current conditions are described in the following sections for both Kootenai River white sturgeon and bull trout. The operation of the CRS since construction of the dams is not one continuous Federal action in the context of ESA compliance. The CRS Proposed Action covered in the 2000 Opinion was different from the Proposed Action consulted on in the 2006 consultation for Libby Dam, which is different from the Proposed Action analyzed in this Opinion. Each had action-specific components and varying operating criteria, so they are separate Federal actions with completed separate ESA Section 7 consultations. These prior consultations do not reflect the operational changes that have occurred as a result of consultations completed by NMFS in 2008, 2010, 2014, and 2019 unless an individual consultation occurred (see Consulted on Effects [section9.4.7]).

The Columbia River Basin is the largest river system of the northwest U.S. The Columbia River and its tributaries travel more than 1,200 miles, drain approximately 200 million ac-ft, and cross portions of seven states and southern British Columbia, Canada (Corps et al 2020a; b). The headwaters of the mainstem Columbia River originate in the Rocky Mountains of British Columbia, where the river first flows northwest before heading south into the State of Washington. Eventually the Columbia River continues west along the boundary between Oregon and Washington until it drains into the Pacific Ocean. Where the river meets the coast, saltwater intrusion from the Pacific Ocean extends approximately 23 RM upstream from the mouth; tidal effects can be experienced up to Bonneville Dam, located 146 RM inland. Major tributary Basins feed the Columbia River, each having numerous tributaries of their own. These include:

- The Kootenai River, which originates in British Columbia, Canada and flows through Montana and Idaho, and joins the Columbia River in British Columbia;
- The Clark Fork River Basin, which consists of the tributaries and mainstem portions of the Clark Fork River, Flathead River, and Pend Oreille River, originates at the Rocky Mountain Continental Divide. The Clark Fork River flows west through Montana and includes major tributaries such as the Blackfoot, Bitterroot, St. Regis, and Flathead Rivers. The Flathead River, which originates in British Columbia, Canada, flows south through western Montana and enters the Clark Fork River prior to flowing into Lake Pend Oreille in Idaho. The Pend Oreille River originates at the outlet of the Lake Pend Oreille and flows through northern Idaho and northeastern Washington before joining the Columbia River in British Columbia;
- The Colville, Kettle, Spokane, SanPoil, Okanogan, Methow, Chelan, Wenatchee, Yakima, White Salmon, Lewis and Cowlitz Rivers and several smaller tributaries flow into the Columbia River in Washington
- The Snake River, which originates in Wyoming, flows westward through Idaho and eastern Washington. Major tributaries include the Tucannon, Clearwater, Grande Ronde, Salmon, Malheur, Payette, Owyhee, Boise, Bruneau, and Henry's Fork Rivers as well as several other smaller tributaries;
- The Willamette, Deschutes, John Day, Sandy, and Umatilla Rivers and several smaller tributaries flow into the Columbia River in Oregon.

The north-south Cascade Mountain Range, the Blue-Wallowa Mountains of northeast Oregon and southeast Washington, and the Rocky Mountains across the eastern and northern boundaries of the Basin strongly influence climate in the Columbia River Basin. The Basin is generally cooler and wetter on the western side of the Cascades and warmer and drier to the east toward the Rocky Mountains. The Basin has dramatic elevation changes ranging from sea level to more than 14,000 ft in the high mountains. The headwaters of the Columbia River and its major tributaries are in high-elevation and snow-dominant watersheds. High-elevation summers tend to be short and cool, while the lower-elevation interior regions are subject to greater temperature variability.

Over time, the Columbia River Basin has been altered from its historic wildness. Throughout the 19th and 20th centuries, the mainstem river and most of its tributaries were dammed, channeled and developed. While the exact number of dams and diversions throughout the entire Basin is unknown, rough estimates put the number well over 400. Other land management actions (i.e. mining, forestry, residential and commercial development) across the basin have altered sediment transport, habitat availability, shoreline and riparian structure, and water quality conditions. This historic development has shaped the current fish populations and ecological structure of the Columbia River Basin.

9.2 Climate Change

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

9.2.1 Climate Change and the Columbia River Basin

Climate change research for the larger Northern Rockies area predicts warmer springs, earlier snowmelt, and hotter, drier summers with longer fire seasons (Isaak et al 2015 p. 2540). In the Pacific Northwest, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation (ISAB 2007 p. iii). 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 p. 16).

Over the last century, average annual temperatures in the US have increased about 2 °F (0.2 °F per decade) over the last 50 years (USDA 2010 p. 3; Bonneville et al. 2017 p.92). Winter temperatures have increased more than other seasons, and the daily minimum temperatures, typically occurring at night, have increased more than daily maximums. Models indicate that temperature increases would occur during all seasons, with the greatest increases projected in summer. Precipitation predictions are considered less certain, but most models project decreased summer precipitation and increased winter precipitation.

The variation in precipitation and temperature patterns from one year to the next, combined with the geographic complexity of the Basin, result in highly variable Columbia River flows from year to year (Bonneville et al. 2017 p.19). The Columbia River has an annual average runoff of approximately 200 million acre feet per year (maf/year), with roughly 25 percent of that volume originating in the Canadian portion of the Basin (Reclamation 2016; Bonneville et al. 2017 p.92).

9.2.2 Climate Change and Sturgeon

Research for the larger Northern Rockies area predicts warmer springs, earlier snowmelt, and hotter, drier summers with longer fire seasons into the future (Isaak et al 2015 p. 2540; Bonneville et al. 2017 p.223). These future climate change scenarios, particularly earlier snowmelt and changes in precipitation patterns, would alter inflows and water temperatures in rivers in the Action Area, as well as altering the thermal characteristics related to modified seasonal volume and mixing within the reservoirs. There is still a great deal of uncertainty associated with predictions relative to the timing and magnitude of future climate change, with these uncertainties also varying by location. As described in the Status of the Species for Kootenai sturgeon, lower than normal water temperatures in the spawning reach may affect spawning behavior, location, and timing. Preferred spawning temperature for the Kootenai sturgeon is near 50 °F; there is a specific PCE that expects during the spawning season of May through June, water temperatures between 47.3 °F and 53.6 °F (8.5 °C and 12 °C), with no more than a 3.6 °F (2.1 °C) fluctuation in temperature within a 24-hour period, as measured at Bonners Ferry. Therefore, the influence of a changing climate on sturgeon reproduction is likely an important consideration.

9.2.3 Climate Change and Bull Trout

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 (Isaak et al 2015 p. 2540; Dunham et al 2014). For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of many trout species (Rieman et al 2007 p. 1557). 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 (Rieman et al. 2007 p. 1553). Increases in air temperature are likely to be reflected in increases in both surfacewater and groundwater temperatures.

Bull trout require very cold (<10 °C) water for spawning and incubation (Dunham et al 2014). 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 as well as juvenile survival. Low elevation river reaches are unlikely to provide suitably cold temperatures for bull trout spawning, incubation, and juvenile rearing under current temperatures. Therefore, the general impact of temperature and hydrologic changes may not be as extreme or range constrictions as pronounced as what may occur in higher elevation streams. As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations.

Projected changes in climate may be expected to result in several impacts to bull trout and habitat including contraction of the range of bull trout; variable or elevated stream temperatures that reduce survival and reproduction; altered ground water exchange that limits egg development; and changed geomorphology that reduces presence or quality of spawning habitat (USFWS 2015a). In addition, increased or variable flows from extreme precipitation events, rain on snow and longer dry periods may increase scouring of spawning areas, reduce juvenile rearing capacity of habitat, and inhibit movements during summer low flow conditions (USFWS 2015a). Increased frequency and extended periods of wildfires may result in loss and fragmentation of habitat (USFWS 2015a).

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). 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; Isaak et al 2015; Battin et al. 2007; Rieman et al. 2007). In streams and rivers with temperatures approaching or at the upper tolerance limits for bull trout, such as occurs in the Walla Walla, Yakima, Umatilla and Snake Rivers, there is little, if any likelihood, that bull trout will be able to adapt to or avoid the effects of climate change/warming without connectivity to cooler waters. As bull trout distribution contracts, patch size (contiguous catchment area of suitable spawning/rearing habitat) decreases and connectivity is truncated. Bull trout populations that may be currently connected will likely face increasing isolation (Dunham et al 2014; Rieman et al. 2007 p. 1553). Due to variations in landform 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 elevated 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.

9.3 Environmental Baseline: Kootenai River White Sturgeon and Designated Sturgeon Critical Habitat

9.3.1 Status of the Species within the Action Area

In order to address recovery and fill the demographic and genetic gaps left by limited natural reproduction, hatchery-origin Kootenai Sturgeon have been spawned from wild broodstock and released into the Kootenai River (throughout the range of Kootenai sturgeon) annually beginning in 1992. Since 1992, the KTOI's Kootenai Sturgeon aquaculture program has released over 300,000 hatchery-origin juvenile Kootenai sturgeon into the Kootenai River Basin (KTOI 2018, pg. 7). Dinsmore et al. (2015, pg. 7) concluded annual post-release survival for hatchery-origin sturgeon at age-2 and older ranges from 64-95 percent for previously released age-2 fish, and over 92 percent for age-3+ fish. The results also showed no indication of decline in survival rates over time. Additionally, genetic data indicates that in 2002-2009 brood years, approximately 70-80 percent of wild alleles were represented in surviving hatchery-origin juveniles (A. Schreier, pers. comm. 2016,).

9.3.2 Factors Affecting the Species in the Action Area

9.3.2.1 Libby Dam: Construction

Libby Dam was authorized for hydropower, flood control, and other benefits by Public Law 516, Flood Control Act of 1950. However, Libby Dam could not be constructed until the U.S. and Canada ratified the Columbia River Treaty in 1964. This allowed the reservoir behind Libby Dam (Koocanusa Reservoir) to extend into southeast British Columbia. The Corps began construction of Libby Dam in 1966 and completed construction in 1973. Commercial power generation began in 1975. Libby Dam is 422 ft tall and has three types of outlets: (1) three sluiceways; five penstock intakes, three of which are currently inoperable; and (3) a gated spillway. The crest of Libby Dam is 3,055 ft long, and the widths at the crest and base are 54 ft and 310 ft, respectively. A selective withdrawal system was installed on Libby Dam in 1972 to control water temperatures in the dam discharge by selecting various water strata in the reservoir forebay.

Koocanusa Reservoir (known also as Lake Koocanusa or Libby Reservoir) is a 90-mile-long storage reservoir (42 miles extend into Canada) with a surface area of 46,500 ac at full pool. The reservoir has a usable storage of approximately 4,930,000 ac-ft and gross storage of 5,890,000 ac-ft.

The authorized purpose of Libby Dam is to provide power, flood control, and other benefits. With the five units currently installed, the electrical generation capacity is 525,000 kilowatts. The maximum discharge with all 5 units in operations is about 26,000 cfs. The surface elevation of Koocanusa Reservoir ranges from 2,287 ft to 2,459 ft at full pool. The spillway crest elevation is 2,405 ft.

9.3.2.2 Operations

Presently, Libby Dam operations are dictated by a combination of power production, flood control, recreation, and special operations for the recovery of ESA-listed species, including the Kootenai sturgeon, bull trout, and salmon in the mid-and Lower Columbia River.

The Corps currently manages Libby Dam operations not to volitionally exceed 1,764 mean sea level at Bonners Ferry, the flood stage designated by the National Weather Service (Corps 1999, pgs. 19-20). In accordance with the NMFS' Opinion, the Corps manages Libby Dam to refill Lake Koocanusa to elevation 2,459 ft (full pool) by July 1, when possible (NMFS 2000a, pg. 3-2).

The Service's 1995 FCRPS Opinion recommended a flow regime that approached average annual pre-dam conditions, and would result in a pattern more closely resembling the pre-dam hydrograph (Figure 2) (USFWS 1995, pgs. 6-10; FWS Ref: 1-4-95-F-003). The Service's 2000

FCRPS Opinion and 2006 Opinion (USFWS 2006a; FWS Ref: 1-9-01-F-0279R) on Libby Dam operations continued this approach. However, the actual volume of these augmented freshets has been relatively insignificant when compared to the magnitude of the natural pre-dam freshet.

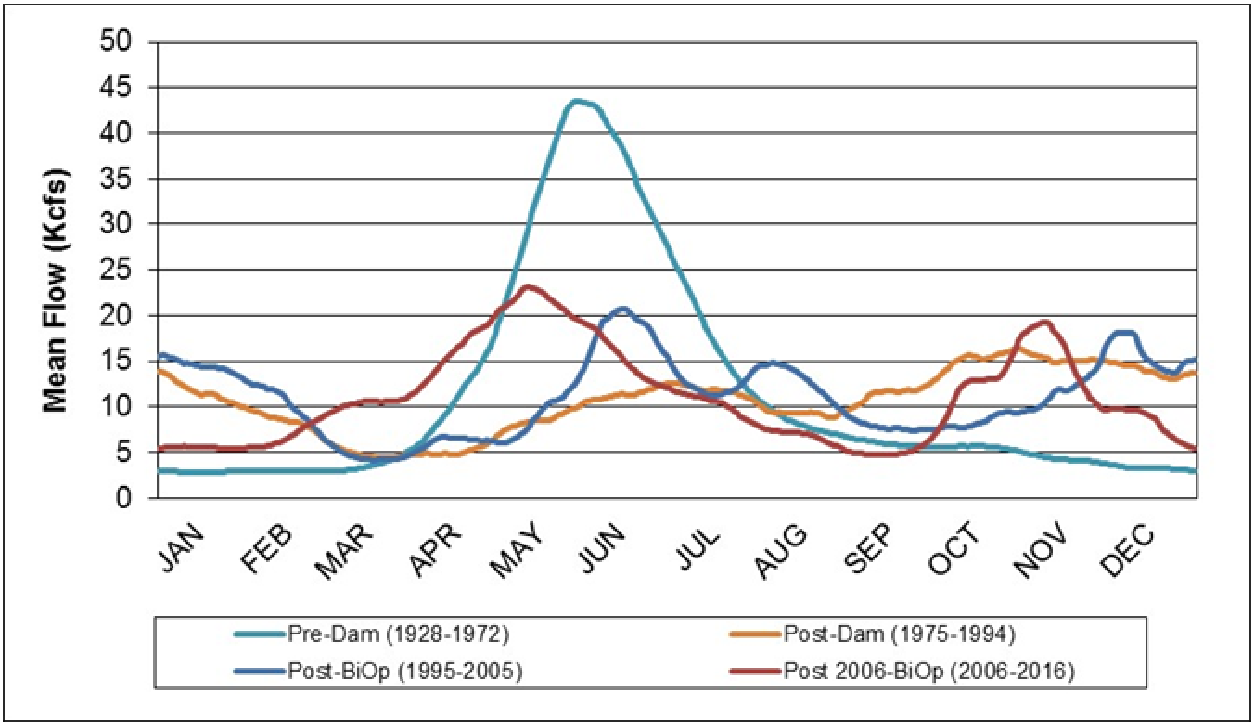

Figure 2. Mean annual hydrograph (calculated; Bonners Ferry) for pre-dam, post-dam, post-1995 Biological Opinion (1975-1994), and post-2006 Biological Opinion (1995-2004).

The Service's 2000 FCRPS Opinion and 2006 Opinion on Libby Dam included RPAs that required the implementation of Variable-Flow Flood Control (VARQ) operations at Libby Dam. In 2002, VARQ operations at Libby Dam began and continued on an "interim" basis until the completion of an EIS in April, 2006, and the signing of a Record of Decision to implement VARQ operations in June, 2008.

The Service's 2006 Opinion on Libby Dam also recommended Libby Dam operations provide for minimum tiered volumes of water, based on the seasonal water supply, for augmentation of Kootenai River flows during periods of sturgeon spawning and early life stage development. Figure 3 shows the sturgeon volume tiers for different seasonal water supply forecasts (WSF). Less volume is dedicated for sturgeon flow augmentation in years of lower water supply. Measurement of sturgeon volumes excludes the 4,000 cfs minimum flow releases from the dam.

An analysis of telemetry data by IDFG showed that in combination with habitat restoration projects, recent management of Libby Dam releases during the sturgeon spawning season has resulted in an increase in the proportion of Kootenai sturgeon spawners migrating into the braided reach (IDFG 2018, pg. 19).

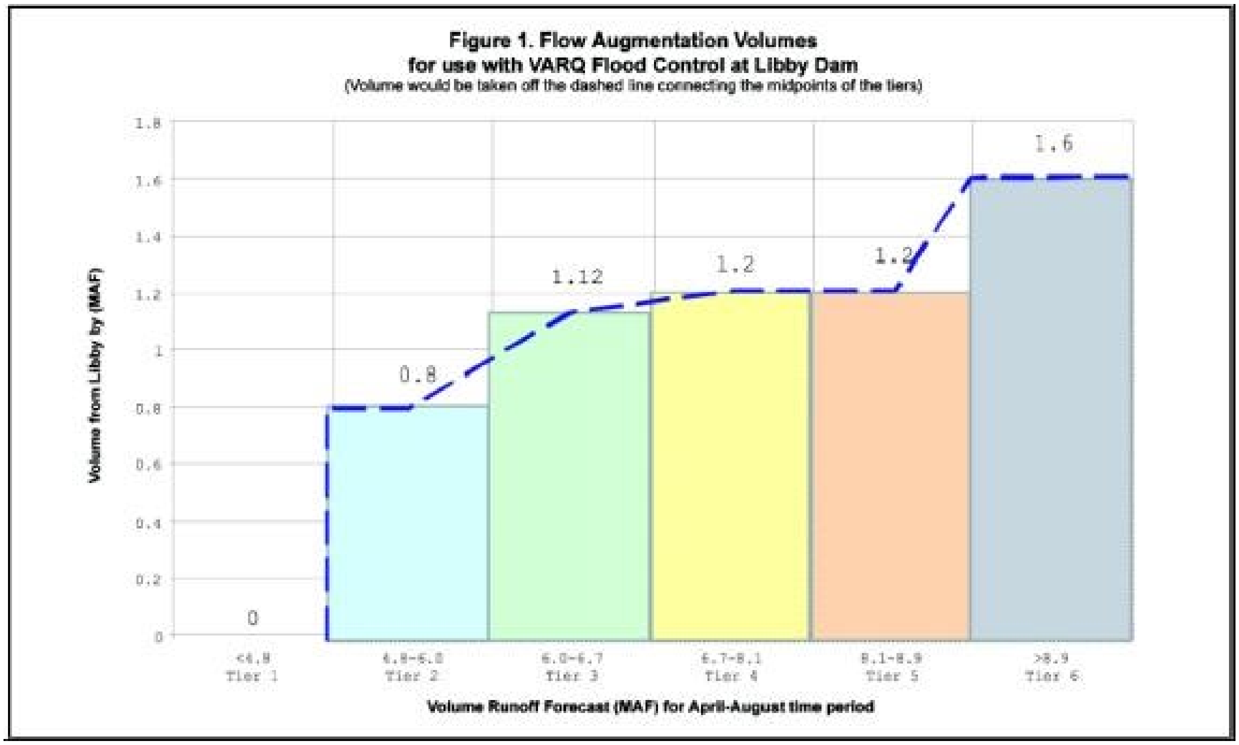

Figure 3. The "tiered" flow strategy for Kootenai sturgeon flow augmentation

9.3.2.3 Northwest Power and Conservation Council Fish and Wildlife Program

In its 2000 Columbia River Basin Fish and Wildlife Program, the first revision of the program since 1995, the Northwest Power and Conservation Council (NPCC) committed to revise the 1995 program's recommendations regarding mainstem Columbia and Snake River dam operations in a separate rulemaking. That rulemaking commenced in 2001. On April 8, 2003, the NPCC adopted the following mainstem amendments relative to Libby Dam operations:

- Continue to implement the VARQ flood control operations and implement Integrated Rule Curve operations as recommended by Montana Fish, Wildlife and Parks (MFWP).
- Refine operations using the 2000 FCRPS Opinion that specify a "tiered" strategy for flow augmentation from Libby Dam to simulate a natural spring freshet to benefit Kootenai sturgeon.
- Refill should be a high priority for spring operations so that the reservoirs have the maximum amount of water available during the summer.
- Implement an experiment to evaluate the following interim summer operation:
  - Summer drafting limits at Libby Dam should be 10 ft from full pool by the end of September in all years except during droughts when the draft could be increased to 20 ft.
- Draft Koocanusa Reservoir as stable or "flat" weekly average outflows from July through September, resulting in reduced drafting compared to the NMFS FCRPS Opinion.

In November 2007, the NPCC again requested written recommendations from the public regarding amendments to the Columbia River Basin Fish and Wildlife Program. In February 2009, the NPCC adopted the final revised Fish and Wildlife Program that included maintaining the above mainstem amendments.

The most recent version of the NPCC Fish and Wildlife Program was completed in 2014. The NPCC is currently updating their 2014 Program to include the most recent information on fish and wildlife resources in the Columbia Basin, the impacts from the CRS, and the measures needed to protect, mitigate and enhance fish and wildlife resources affected by project operations. This revision is expected to be completed in 2020. Under the Northwest Power Act, the Action Agencies are obligated to operate the CRS in a manner consistent with the Council's Fish and Wildlife Program. This includes operating consistent with the Mainstem Amendments to the Program, which include operational measures at Libby Dam.

9.3.2.4 Kootenay Lake and Backwater Effect

Corra Linn Dam located downstream on the Kootenay River in British Columbia, controls the level of Kootenay Lake for much of the year with the notable exception occurring during periods of high flows, such as during the peak spring runoff season. During the spring freshet, Grohman Narrows (RM 23), a natural constriction upstream from the dam near Nelson, British Columbia regulates flows out of the lake. Kootenay Lake levels are managed in accordance with the International Joint Commission (IJC) Order of 1938 that regulates allowable maximum lake elevations throughout the year. During certain high flow periods when Grohman Narrows determines the lake elevation, Corra Linn Dam passes inflow to maximize the flows through Grohman Narrows. Regulation of lake inflows by Libby Dam and Duncan Dam (on the Duncan River flowing into the north arm of the lake) maintains Kootenay Lake levels generally lower during the spring compared to pre-dam conditions.

Historically, during spring freshets, water from Kootenay Lake backed up as far as Bonners Ferry and at times further upstream (Barton 2004, pg. 4). However, since hydropower and flood control operations began at Corra Linn and Libby Dams, the extent of this "backwater effect" has been reduced an average of over 7 ft during the spring freshet (i.e. water from Kootenay Lake currently extends further downstream than historically) (Barton 2004, pg. 5).

9.3.2.5 Levee Degradation

Daily and weekly fluctuations of Kootenai River flows due to Libby Dam operations have been identified as the primary cause of the degraded condition of the levee system in Kootenay Flats (Corps 2006).

9.3.2.6 Effects of Libby Dam on Kootenai Sturgeon Habitat

Before the construction and operation of Libby Dam in the early 1970s, the natural hydrograph of the Kootenai River downstream of the dam consisted of a spring freshet with high peak flows, followed by a rapid drop in flows into August (Figure 2). Specifically, pre-dam river flows during sturgeon spawning varied from approximately 50,000 cfs to 100,000 cfs at Bonners Ferry, whereas post-dam releases from Libby Dam during Kootenai sturgeon spawning is typically between 8,800 cfs to 16,000 cfs (Figure 2). The average pre-dam hydrograph indicates that, in general, river flows began increasing in mid-to-late May, peaked in early to mid-June, and then gradually descended during July.

Tetra Tech (2004) found that the primary changes in hydrology from Libby Dam operations included a decrease in annual peak discharges on the order of 50 percent, a decrease in the duration of high and low flows, an increase in the duration of moderate flows, and a redistribution of seasonal flow characteristics. Together, these changes have affected the stage, velocity, and depth within the river, which in turn have altered sediment transport conditions as well as essential ecosystem functions (e.g., riparian function and floodplain interaction).

The presence and operations of Libby Dam have influenced biological processes in the Kootenai River by affecting nutrient and carbon transport and altering thermal regimes; Koocanusa Reservoir has acted as a nutrient sink, decreasing the productivity and overall carrying capacity of the system downstream (Tetra Tech 2004). The operation of Libby Dam has caused rapid changes in water levels, diminished hydrological connectivity, and altered natural hydrographs (NPCC 2005). Dam operations have altered natural down-river discharge patterns on a seasonal and sometimes daily basis (NPCC 2005).

The post-dam altered hydrograph has reduced the amount of depositional surfaces along the Kootenai River as well as the interaction of the Kootenai River with the floodplain, which has reduced the recruitment of riparian vegetation such as cottonwoods (*Populus* species) and willows (*Salix* species) (KTOI 2009). Additionally, fluctuations in Libby Dam discharges has increased bank erosion, which is a limiting factor for outer bank vegetation (KTOI 2009). As a result, aquatic and terrestrial vegetation that would have normally provided secure habitat along river margins and stabilized soils has not been able to fully reestablish each summer. The result of all these changes has been significant impacts to periphyton, aquatic insects, and fish populations (USFWS 2002a).

Average water temperatures in the Kootenai River are typically warmer in the winter and colder in the summer than they were prior to the construction of Libby Dam (Corps 2004). Current average spring temperatures tend to be cooler than under pre-dam conditions (Figure 4), and the differences may be increased even more when large flow from Libby Dam dominates the total river flow (Corps 2004). These temperature alterations may also affect the rates of maturation, growth rates, and spawning behavior of sturgeon.

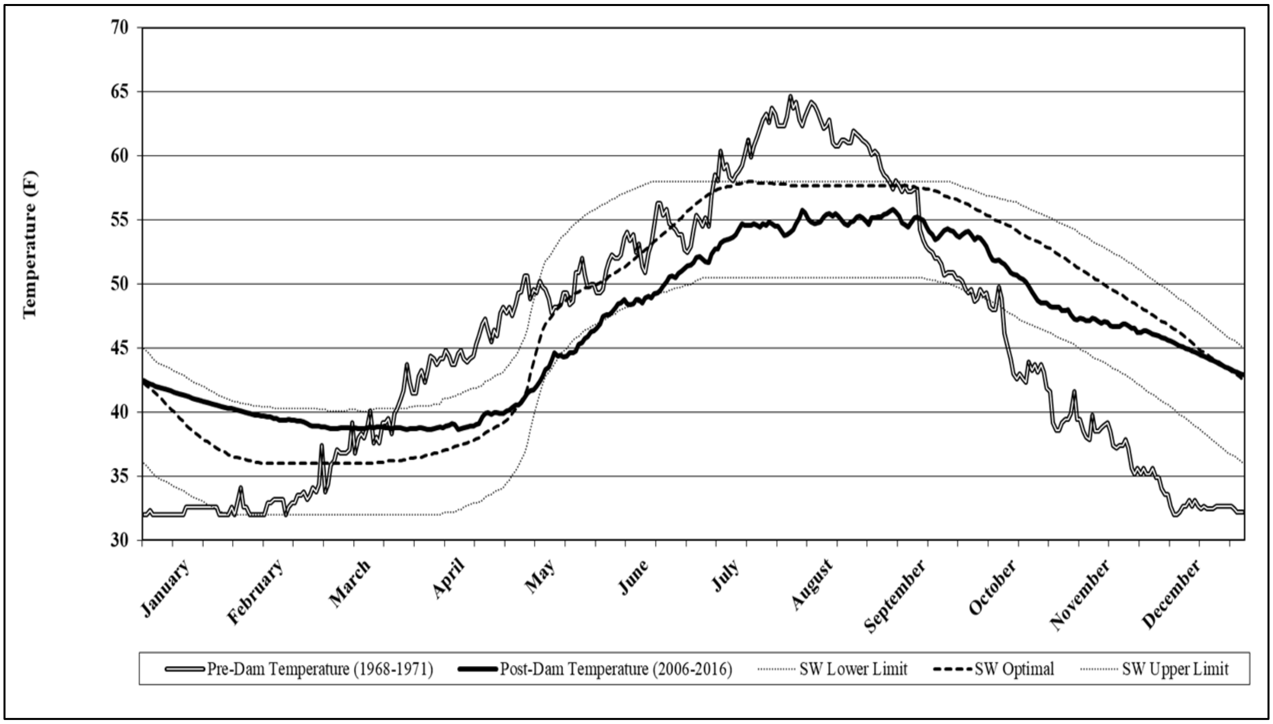

Figure 4. Libby Dam Discharge Temperature and Selective Withdrawal Rule Curve.
(Source: Hoffman Pers. Comm. 2020).

Suspended sediment levels in the Kootenai River have decreased substantially since the construction of Libby Dam (Corps 2004). Research has shown that increased turbidity can provide rearing white sturgeon larvae with additional cover, thus reducing predation (Gadomski and Parsley 2005, pg. 375), but can also be a significant mortality factor for incubating eggs (Kock et al. 2006, pg. 137). Suspended sediment records for the Libby Dam area show that, the only notable, multi-week suspended sediment transport event with streamflow that approached pre-Libby Dam conditions took place from April 24 to July 5, 1974, during the white sturgeon spawning season (Barton 2004, Corps 2004). Suspended sediment and turbidity may be a critical component of flow that allows for sturgeon egg and larvae survival; the last known year-class recruitment to the Kootenai sturgeon population occurred in 1974.

Hauer and Stanford (1997, as cited in NPCC 2005) state that with the exception of the density of net-spinning caddisflies and blackflies in the tailwater of Libby Dam, most zoobenthic species declined in abundance after Libby Dam began operations.

Libby Dam and human settlement has also allowed for the introduction of non-native species of fish, plants, and animals. Libby Dam converted what once was riverine habitat to reservoir habitat, allowing for the introduction of such non-native species as largemouth bass, bullhead, and others (NPCC 2005).

According to Jamieson and Braatne (2001, as cited in NPCC 2005), the lower Kootenai River floodplain downstream of the Moyie River in Idaho, probably supported one of the largest and richest riparian-forest and wetland complexes in the Pacific Northwest. Approximate 70,000 ac of ephemeral and perennial wetlands have been lost since 1890 (Jamieson and Braatne 2001 as cited in NPCC 2005, pg. 61). The substantial wetland losses are attributed to a combination of factors that include the operations of Libby Dam, reductions in hydrologic connectivity (diking and land leveling), draining associated with agricultural development, and tributary channelization (Richards 1997).

9.3.2.7 Other Factors Affecting Sturgeon Environment within the Action Area

Beginning in the early 1900s to 1961, in order to provide a measure of protection from spring floods, a series of dikes were constructed along the Kootenai River (below Libby Dam) and its tributaries. Other factors affecting the Kootenai sturgeon's environment within the Action Area include floodplain development, agriculture, and contaminant runoff from mining activities, over-harvest, municipal water use, livestock grazing, and timber harvest (NPCC 2005, pg. 110).

9.3.3 Kootenai Sturgeon Critical Habitat

On September 6, 2001, the Service issued a final rule designating critical habitat for the Kootenai sturgeon (66 FR 46548). The critical habitat designation extends from ordinary high water line to ordinary high water line on the right and left banks, respectively, along approximately 11.2 miles of the mainstem Kootenai River from RM 141.4 to RM 152.6 in Boundary County, Idaho (Unit 2, Figure 1). On February 10, 2006, the Service issued an interim rule designating the braided reach (RM 152.6 to RM 159.7) as critical habitat (71 FR 6383) (Unit 2, Figure 1). On June 9, 2008, the Service issued a final rule designating the braided reach as critical habitat (73 FR 39506). Both the meander and the braided reach are located entirely within Boundary County, Idaho, respectively downstream and upstream of Bonners Ferry. A total of 18.3 RM is designated as critical habitat for Kootenai sturgeon.

9.3.3.1 Primary Constituent Elements

Four PCEs are defined for Kootenai sturgeon critical habitat (73 FR 39506). These PCEs are specifically focused on adult migration, spawning site selection, and survival of embryos and free-embryos, the latter two of which are the life stages now identified as limiting the reproduction and numbers of the Kootenai sturgeon. The PCEs are defined as follows:

1. A flow regime, during the spawning season of May through June, that approximates natural variable conditions and is capable of producing depths of 23 ft (7 m) or greater when natural conditions (for example, weather patterns, water year) allow. The depths must occur at multiple sites throughout, but not uniformly within, the Kootenai River designated critical habitat.

2. A flow regime, during the spawning season of May through June, that approximates natural variable conditions and is capable of producing mean water column velocities of 3.3 ft/s (1.0 m/s) or greater when natural conditions (for example, weather patterns, water year) allow. The velocities must occur at multiple sites throughout, but not uniformly within, the Kootenai River designated critical habitat.

3. During the spawning season of May through June, water temperatures between 47.3 °F and 53.6 °F (8.5 °C and 12 °C), with no more than a 3.6 °F (2.1 °C) fluctuation in temperature within a 24-hour period, as measured at Bonners Ferry.

4. Submerged rocky substrates in approximately 5 continuous RM (8 RKM) to provide for natural free embryo redistribution behavior and downstream movement.

5. A flow regime that limits sediment deposition and maintains appropriate rocky substrate and inter-gravel spaces for sturgeon egg adhesion, incubation, escape cover, and free embryo development. Note: the flow regime described above under PCEs 1 and 2 should be sufficient to achieve these conditions.

9.3.3.2 Current Condition of Critical Habitat

9.3.3.2.1 Meander Reach

The Meander Reach is characterized by sandy substrate, a low water-surface gradient, a series of deep holes, and water velocities which rarely reach 3.3 ft/s. The morphology of the Meander Reach has changed relatively little over time (Barton 2004, pg. 1). Significant changes to this reach caused by the construction and operation of Libby Dam include: 1) a decrease in suspended sediment; 2) the initiation of cyclical aggradation and degradation of the sand riverbed in the center of the channel; 3) a reduction in water velocities (Barton 2004, pg. 1); and 4) reductions in floodplain interactions and riparian function, which negatively affect primary and secondary productivity in the river.

The upstream-most segment of the Meander Reach (approximately 0.6 RM in length) has rocky substrate and water velocities in excess of 3.3 ft/s under present river operations (Berenbrock and Bennett 2005, pg. 7). However, due to a reduction of average peak flows by over 50 percent caused by flood control operations of Libby Dam and the reduction of the average elevation of Kootenay Lake by approximately 7.2 ft (and the resultant backwater effect), the PCE for water depth is infrequently achieved in this reach of the Kootenai River (Berenbrock 2005, pg. 7). A deep hole (49.9 ft) that is frequented by sturgeon in spawning condition exists near Ambush Rock at approximately RM 151.9 (Barton et al. 2005, pg. 36).

In 2014, as part of the Kootenai River Habitat Restoration Project, small patches (approximately 0.5 to 1.0 ac each) of rocky substrates were placed in documented spawning areas in the Shorty's Island (RM 143.6) and Myrtle Creek (RM 145.5) areas. Rocky substrates were also placed in the straight reach (RM 152) in 2016. These substrate enhancement projects were implemented as pilot projects to test whether the substrates would persist (i.e., remain clear of sand and silt) and whether Kootenai sturgeon would continue to spawn at those specific sites. Current monitoring of both the substrates and spawning sturgeon indicate that the pilot projects have been successful in those specific regards (KTOI 2016, pg. 21). Additional projects implemented in the Meander Reach involve reconnection and enhancement of floodplain areas, riparian enhancement, and tributary restoration.

9.3.3.2.2 Braided Reach

The braided reach of the Kootenai River was designated as critical habitat because it contains: 1) sites with seasonal availability of adequate water velocity in excess of 3.3 ft/s; and 2) rocky substrate necessary for normal spawning, embryo attachment and incubation, and normal free embryo dispersal, incubation and development. Within this reach, the valley broadens, and the river forms an intermediate-gradient braided reach as it courses through multiple shallow channels over gravel and cobbles (Barton 2004, pg. 7).

Similar to the 0.6 RM upstream-most segment of the Meander Reach, the lower end of the braided reach has also become shallower during the sturgeon reproductive period for the same reasons discussed above. Additionally, a loss of energy and bed load accumulation has resulted in a large portion of the middle of the braided reach becoming wider and shallower (Barton et al. 2005, pg. 18).

The net result of the changes described above may adversely affect Kootenai sturgeon in the following ways: 1) Kootenai sturgeon may generally avoid spawning in areas upstream of Bonners Ferry that have suitable rocky substrates; 2) Kootenai sturgeon may instead spawn at sites that have unsuitable substrates and low water velocity (i.e., the Meander Reach); 3) the loss of floodplain interaction and riparian function may negatively affect primary and secondary productivity in the river, thereby reducing available food sources during sturgeon early life stages. While suitable water depth is still achieved under current operations at the downstream end of the braided reach, significant special management is needed to adequately address the PCEs for substrate and water velocity in this area.

Beginning in 2011, multiple habitat restoration projects have been implemented in the braided reach, as part of the Kootenai River Habitat Restoration Program. Projects implemented to date include side channel restoration, bank stabilization, island construction, pool construction, construction of pool-forming structures, riparian restoration and enhancement, and floodplain reconnection and enhancement.

The Action Area for this consultation encompasses the total extent of designated critical habitat for the Kootenai sturgeon. For that reason, the "Current Condition of Critical Habitat" section above addresses the environmental baseline for designated Kootenai sturgeon critical habitat.

9.4 Environmental Baseline: Bull Trout and Designated Bull Trout Critical Habitat

A general description of the environmental baseline was previously described and is incorporated here by reference (Section 9.1). The following discussion provides a more specific environmental baseline for the bull trout and its designated critical habitat. Section 9.4.7 Consulted on Effects for Bull Trout, summarizes ongoing projects that have undergone ESA Section 7 consultation and influence the baseline conditions for bull trout and bull trout critical habitat.

To understand the status of bull trout in the Action Area, it is necessary to discuss the bull trout in a broader area, including Recovery Units, Core Areas, and CHUs. The Proposed Action defines operation and maintenance of the CRS and encompasses a large portion of the Columbia River Basin (Figure 5). The Action Area and nearly all 14 project facilities fall within bounds of designated critical habitat for the bull trout. Bull trout are listed as a single DPS within the four-state area of the Action Area. The CRS operates within three of the six bull trout Recovery Units including the Columbia Headwaters, Mid-Columbia, and Coastal (Figure 5) (USFWS 2015a). Each Recovery Unit is subdivided into multiple bull trout Core Areas. Migratory life history forms of bull trout are key to the persistence and genetic diversity of each Core Area across the range, as well as throughout the Action Area. Within the three Recovery Units overlapping the Action Area, as many as 91 Core Areas, 4 Historic Areas, and one Research Needs Area (RNA) are adjacent to or within the bounds of the Action Area. Approximately 46 Core Areas, 4 historic areas, and one Research Needs Area (RNA) likely use or have the potential to use the Action Area in some capacity based on life histories and movement patterns. This represents more than 45 percent of the entire listed entity. Populations of bull trout in this Opinion are discussed in the context of Recovery Units and Core Areas. For each Core Area, the Service discusses the status and trend based on existing information on population estimates, redd counts or other demographic data combined with existing threats identified as impacting the long-term persistence of bull trout. The status of a Core Area is categorized as depressed (Population size is small or historic, experiencing substantial threats, and/or has a long-term declining trend in population/redd counts) or Stable (Core Area has long-term stable, consistent or increasing population numbers or redd counts and/or has few threats impacting population persistence). A Core Area trend is determined as Declining (population numbers or redd counts are reducing/declining in the last 7 years); Stable (No indication of population change in the last 7 to 10 years); or Increasing (Population numbers or redd counts have been improving/increasing in recent years). Critical habitat is discussed in the context of CHUs within each of the Recovery Units (USFWS 2010a). Critical habitat is characterized based on function (USFWS 1998).

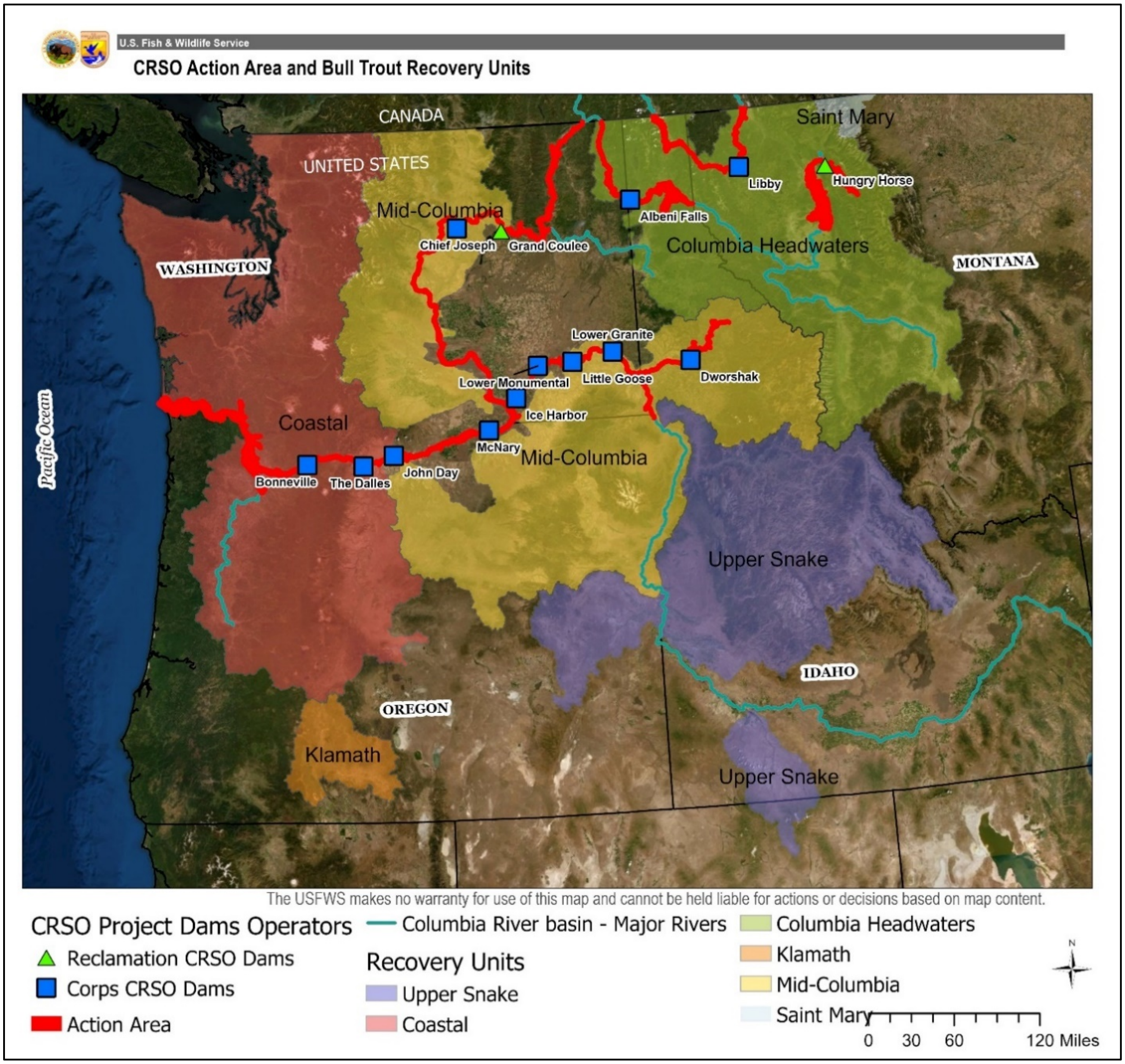

Figure 5. Bull trout Recovery Units in relationship to the Columbia River System Proposed Action and Action Area.

9.4.1 Columbia Headwaters Recovery Unit

The Action Area includes bull trout within a portion of the Columbia Headwaters Recovery Unit (CHRU) (USFWS 2015b; 2010). The portion of the Action Area that overlays the CHRU includes parts of western Montana, northern Idaho, and northeastern Washington. Major drainages include the Clark Fork River Basin, including the Clark Fork River, Lake Pend Oreille, the Pend Oreille River, the Flathead River, Flathead Lake, and the Kootenai River Basin. This

Recovery Unit is a stronghold for bull trout, as many of the headwater tributaries provide cold-water refugia and are located in high elevation wilderness or protected areas (USFWS 2015b). Areas affected by the operation of Hungry Horse Dam, Albeni Falls Dam, and Libby Dam are within the CHRU.

There are 35 bull trout Core Areas within the CHRU. Fifteen of the 35 are referred to as complex Core Areas, as they represent large interconnected habitats, each with multiple spawning streams and local populations. The 15 complex Core Areas contain the majority of individual bull trout and the bulk of the designated critical habitat within the CHRU (USFWS 2010a; b). Five of these complex Core Areas are within/overlap with the Action Area, including: Lake Koocanusa, Kootenai River, Hungry Horse Reservoir, Flathead Lake, and Lake Pend Oreille (USFWS 2015b). Bull trout from three additional Core Areas may migrate into the Action Area. The Bull Lake Core Area is located on Keely Creek, a tributary to the Kootenai River. The Swan River Core Area is a tributary to Flathead Lake. The Priest Lake Core Area is located upstream of Priest Lake Dam on the Priest River, a tributary to the Pend Oreille River. All three Core Areas (Swan River, Bull Lake and Priest Lake) are located above natural or manmade (Troy and Priest Lake dams) barriers outside of the Action Area. Each year, very small numbers of bull trout are entrained into the Action Area from these Core Areas. However, as there is no upstream connectivity to either Core Area, the Proposed Action will not affect the Core Area as a whole and no further discussion occurs in this document. Once bull trout leave the Swan River, Bull Lake and Priest Lake Core Areas, they become members of Core Areas within the Action Area and are counted as such. The following provides a summary of the environmental baseline for each of the five complex Core Areas within the CHRU portion of the Action Area.

9.4.1.1 Lake Koocanusa Core Area

Completion of Libby Dam created Lake Koocanusa on the Kootenai River (Figure 6). Lake Koocanusa is a large, deep, and cold water body with abundant forage where bull trout numbers have been increasing over time (USFWS 2006a). Lake Koocanusa is about 90 miles long and extends about 42 miles into Canada at full pool. Lake Koocanusa and its tributaries receive runoff from about 47 percent of the entire Kootenai River drainage Basin. The Kootenay, Elk, and Bull rivers, all in Canada, supply about 87 percent of the lake's inflow. The Tobacco River and numerous small tributaries flow into the reservoir south of the border. Stream flow in tributaries generally peak in late-May or early June after the onset of snowmelt, then declines to low flows from November through March. Flows also peak with rain-on-snow events.

The filling of Lake Koocanusa inundated approximately 90 miles of mainstem Kootenai River habitat, along with 40 miles of biologically important low-gradient tributary habitat. This conversion of a large segment of the Kootenai River from a lotic to lentic environment changed the aquatic community (Paragamian 1994). Also, as mitigation for inundation of the Kootenai River, the Corps built and funds the operation of Murray Springs Hatchery near Eureka, Montana. MFWP maintains broodstock of redband (*Oncorhynchus mykiss gardnerii)* and Gerrard rainbow trout (*O. mykiss*) for stocking Lake Koocanusa and nearby waters.

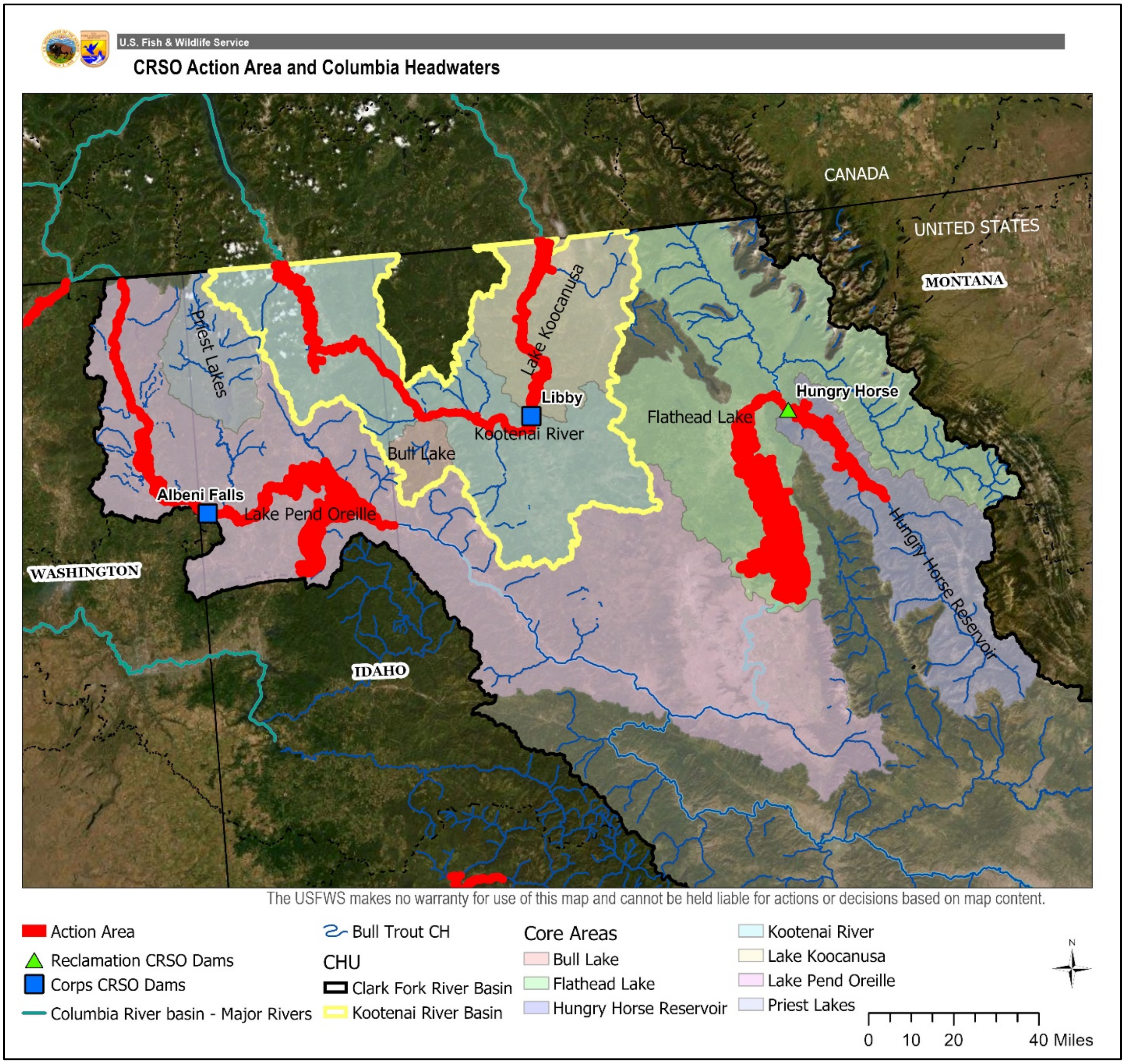

Figure 6. Bull trout Core Areas and the Action Area in relation to Libby, Hungry Horse, and Albeni Falls dams.

The Service's 2015 Bull trout Recovery Plan identified no current threats or recovery actions for bull trout in the Lake Koocanusa Core Area (USFWS 2015b). Historical land use practices such as timber harvest and mining that affected water quality, in-stream function (e.g., entrainment), and competition or hybridization with non-native brook trout likely have had some impact on local populations throughout the Core Area in the past. However, these impacts are considered managed by resource agencies in the Core Area (USFWS 2015b). Adult and sub-adult bull trout use Lake Koocanusa year-round. At present, Lake Koocanusa is one of the most robust Core Areas in the CHRU (Dunnigan et al. 2015). Many of the Kootenai Basin tributaries provide high-quality bull trout habitat. While recent mining activities have introduced some deforestation and selenium contamination, the headwaters are relatively undeveloped and retain many of their original wild attributes and native species complexes. There are low numbers of non-native fish that compete (brown trout) or hybridize (brook trout) with bull trout in the Lake Koocanusa Core Area (USFWS 2010b). The Canadian portion of the watershed upstream includes most of the highly productive portions of the Wigwam River, White River, Skookumchuck Creek, and other streams. The U.S. portions of Lake Koocanusa and the Wigwam River, as well as Grave Creek and the Tobacco River in Montana, also provide excellent habitat for bull trout (USFWS 2010b, 2015b).

The Lake Koocanusa Core Area contains two local populations: the Wigwam River in British Columbia, Canada and Grave Creek in Montana. Grave Creek is the predominant spawning tributary within Montana. Grave Creek redd counts peaked in 2003 (245) and have since exhibited a negative trend resulting in a count of 44 in 2019, mirroring the trend of redd counts observed in the Wigwam River in British Columbia (MFWP 2020a; Dux Pers Comm 2019). While recent negative trends in redd counts have been observed, both populations in the Wigwam River and Grave Creek are considered stable and likely higher than historic conditions (MFWP 2020a). Recent declines may be symptoms of bull trout harvest. Some impact may also occur from entrainment over Libby Dam and at the Glen Lake Irrigation Diversion. The irrigation diversion was screened in 2001. While the screen largely reduced the number of age 1+ bull trout from entrainment, an average of 141 bull trout were still entrained annually for years 2001-2008 (Dunnigan pers. Comm 2020). In 2014 a tree fell on the fish screen rendering it inoperable (Dunnigan et al. 2017). Since 2014, the irrigation diversion has entrained an unknown number of bull trout.

The Wigwam River, mostly in British Columbia, is the primary spawning stream for the Lake Koocanusa bull trout population. The peak redd count for the Wigwam River (including the headwaters in Montana) in 2006 was 2,298 redds (Dunnigan et al. 2017). Redd counts in the Wigwam River have declined since 2006. Redd counts in the Wigwam River have averaged approximately 1,475 since 1995, however, redd numbers declined to 888 in 2019 resulting in the change of harvest regulations by MFWP.

Since 1975, MFWP has conducted spring gillnetting in Lake Koocanusa to estimate fish abundance and composition within the reservoir. Since reservoir inundation in 1975, bull trout captures in gillnets significantly increased to a peak in 2000, followed by a period of stability for years 2005 through 2017 (Dunnigan et al. 2017). The increased catch of bull trout correlates with redd count numbers in the Wigwam River and Grave Creek (Dunnigan et al. 2017). Prey species in Lake Koocanusa remain abundant. Although the assemblage of prey species has changed since impoundment, kokanee, Columbia chub, and northern pikeminnow populations have increased, while cutthroat trout, rainbow trout, burbot, largescale and longnose sucker populations have decreased (Dunnigan et al. 2020). Since the unintended introduction of kokanee fry to Libby Reservoir from the Kootenay Trout Hatchery in British Columbia, kokanee comprise the second or third most abundant fish captured during fall gillnet sampling. Capture rates of kokanee during both the spring and fall gillnet sampling periods have been variable, but show no significant trend over time (Dunnigan et al. 2020). However, biomass of sampled kokanee has declined, suggesting kokanee are exhibiting density dependent growth (Dunnigan et al. 2020).

Libby Dam does not have fish passage facilities, but downstream movement occurs through the dam via turbine entrainment or during spill events. The water release rate, depth of withdrawal, and seasonal forebay fish density all influence the rate of entrainment through the dam (Skaar et al. 1996). Bull trout feed on kokanee (an introduced species) in Lake Koocanusa, and they may be entrained as they follow kokanee into the turbine intakes. On a seasonal basis, kokanee entrainment rates are highest in the spring (late April-early July) when dam outflow and forebay fish densities are high and withdrawal depth is the shallowest of the year (Skaar et al. 1996). Entrainment studies at Libby Dam using sonar and draft-tube netting documented low numbers of bull trout passing through the dam, primarily in the spring (Skaar et al. 1996). More recently, survival of entrained bull trout has been documented via genetic origin testing and, although no estimates are available for rates of entrainment or survival, greater than 50 percent of bull trout captured below Libby Dam for genetic assignment were assigned to the Wigwam River (DeHaan and Adams 2011).

9.4.1.2 Kootenai River Core Area

Below Libby Dam, the Kootenai River flows westward approximately 20 miles to Libby, Montana, and another 20 miles to Troy, Montana (Figure 6). At Troy, Montana, the Kootenai River flows northwest into Idaho. At Bonners Ferry, Idaho, approximately 35 miles downstream of Troy, the Kootenai River enters the broad floodplain area known as Kootenai Flats. The surrounding floodplain has been diked and much of it converted to agriculture in both the U.S. and Canada. Flowing northward through the Kootenai Flats, the river crosses the international boundary approximately 50 miles downstream of Bonners Ferry. About 25 miles north of the international boundary, the Kootenay River enters the south arm of Kootenay Lake, impounded by Corra Linn Dam in the 1930s (Figure 1 and 5). Operations of Corra Linn Dam and Kootenay Lake influence flow regimes in the Kootenai River upstream and flood risk in Bonners Ferry. Historically, during spring freshets, water from Kootenay Lake backed up as far as Bonners Ferry and at times even further upstream (Barton et al. 2004). However, since hydropower and FRM operations began at Corra Linn and Libby Dams, the extent of this backwater effect has been reduced (Barton 2004). Major tributaries to the Kootenai River below Libby Dam include the Fisher River, the Yaak River, and the Moyie River.

Bull trout within the Kootenai River Core Area are spread among eight local populations, six in Montana and two in Idaho. Until recently, bull trout populations in the Core Area were relatively stable, with widespread distribution and fluvial life history forms contributing to all local populations. However, densities in the Kootenai River Core Area appear to be declining. When redd trends are viewed cumulatively for all six of the local populations in Montana (West Fisher, Bear, Pipe, Quartz , O'Brien and Callahan creeks) a significant negative trend has been exhibited since 2000 (R^2=0.77). Historically, O'Brien, Quartz and Callahan creeks had robust local populations in the Core Area, contributing well over 100 redds annually and representing more than 75 percent of all redds counted in the Kootenai River Core Area between 1998 and 2015. However, beginning in 2009, redd counts in these three local populations began declining precipitously, and as of the 2015 redd count, these local populations contributed 45 redds total (MFWP 2020a).

For the two populations in Idaho (Boulder Creek and Long Canyon), collection of redd counts is sporadic. However, between 2002 and 2010, fewer than five redds have been documented (Paragamian et al. 2010). These populations are very small and likely functionally extirpated without supplementation by migratory adults from other populations.

Bull trout from populations in the Kootenai River Core Area migrate to spawning areas in tributaries of the Kootenai River between Late June and September. Aggregation of substrate at tributary mouths may delay timing or completely block passage of bull trout to spawning grounds, depending on discharge of the Kootenai River and spawning tributaries (Marotz et al. 1988; Sylvester et al. 2015; Dunnigan et al. 2017). Stream mouths have been aggrading at a rate of approximately 0.15 m/year below Libby Dam since the impoundment of Lake Koocanusa, and discharges from dam operation have been observed to be ineffective in moving the particle size necessary to remove aggregated materials (Zelch 2003). Spawning occurs in the tributaries between September and mid-October in water temperatures between 35 °F and 39 °F (1.7 °C and 3.9 °C). Bull trout typically return to the Kootenai River in late October. Sub-adults and non-spawning adults may be foraging in the Kootenai River year-round. Based on recent genetic studies, the Kootenai River populations directly downstream of Libby Dam are supplemented by entrained bull trout, as the majority of fish collected below the dam originated above it (DeHaan and Adams 2011).

Primary threats to bull trout in the Kootenai River Core Area include upland/riparian land management such as legacy timber harvest, mining and road construction; instream impacts from flow and flood management; and high level of brook trout hybridization in tributaries (USFWS 2015b). Impoundment of the Kootenai River by Libby Dam altered the habitat in the riverine reach downstream of Libby Dam through altered flow patterns, altered river temperatures, and modified sediment transport regimes. These alterations resulted in changes in periphyton, aquatic insects, and fish populations (Dunnigan et al. 2015).

Past Libby Dam operations altered water quality parameters and likely significantly impacted bull trout population stability and health throughout the corridor. Water temperatures at Bonners Ferry during sturgeon flow augmentation from 2006 to 2014 ranged from 43 °F to 56 °F (6.1 °C to 13.3 °C) (Corps and Bonneville 2009-2015). Reservoir de-stratification generally occurs in late fall or early winter and remains in this condition through early spring; temperature management is not possible during this time, though discharge temperatures remain within the optimal range for bull trout. Past spill events, which can elevate TDG levels to up to 135 percent, occurred several times during past dam operations. In studies of other fish species, including salmonids, supersaturated gases in fish tissues tend to pass from the dissolved state to the gaseous phase as internal bubbles or blisters; this condition, called gas bubble trauma (GBT), can be debilitating or even fatal. These events likely altered behaviors and timing of bull trout movements in the river.

Aggradation of sediments at tributary mouths has occurred over time as a result of changes to the historic hydrograph from past operations of Libby Dam. During periods of low stream flow, the enlarged deltas from deposition of bedload substrate in the low-gradient reaches of tributaries can impede or block fall-spawning migrations of bull trout. Prior to impoundment, the Kootenai River had sufficient hydraulic energy to remove these deltas every year, but since construction of the dam, peak flows have typically been limited to maximum turbine capacity (roughly 27,000 cfs). Hydraulic energy is now insufficient to remove these deposits (Dunnigan et al. 2015). In 2000, MFWP completed stream stabilization and re-channelization at the mouth of O'Brien Creek to mitigate for delta formation and to ensure that bull trout passage continues.

In addition, Koocanusa Reservoir acts as a nutrient sink, retaining approximately 63 percent of total phosphorus and 25 percent of total nitrogen entering the system (Woods and Falter 1982). Due to low current velocities in the lake, these nutrients bind to sediments and precipitate out of the water column, or in the case of nitrogen, are taken up biologically, making them unavailable to organisms in the river below the dam (Snyder and Minshall 1996). Consequently, the Idaho portion of the Kootenai River has been considered nutrient-poor (ultra-oligotrophic) and phosphorus-limited. However, this may not fully explain the low levels of nutrients in the river, as tributaries in Idaho also appear to be low in nutrients (IDEQ 2006, p. 60). The geologic setting may be a poor nutrient producer, in addition to the trapping of nutrients in Lake Koocanusa (IDEQ 2006). In addition, loss of floodplain connectivity to the entire Kootenai River valley has reduced riparian function and natural nutrient inputs. In the Idaho portion of the Kootenai River, the diminished nutrients have reduced primary productivity over the past two decades (Ross et al. 2015).

Another result of the low-nutrient (primarily phosphorus) conditions below the dam has been the increasing success of the nuisance algae, Didymo (*Didymosphenia geminata*), which became readily apparent in the Kootenai River below Libby Dam in Montana in the early 2000s. Didymo frequently forms dense mats on the river bottom and negatively affects bull trout abundance because of reduced numbers of large and desirable invertebrate prey (e.g., Ephemeroptera, Plecoptera, and Trichoptera) (Sylvester and Stephens 2011).

Phosphate and nitrate fertilizer has been added to the river at the Idaho-Montana border annually during summer months since 2005, and to the south arm of Kootenay Lake since 2004. Nitrogen was added to the river once in 2009. The addition of these nutrients is intended to stimulate lower trophic production, which may ultimately increase the abundance and growth of bull trout prey sources such as Kokanee salmon (Hardy et al. 2013, p. 74).

Recent mining activities in the Kootenay River headwaters have introduced some deforestation and selenium contamination that enter the lake via tributaries. Elevated selenium concentrations have been detected in some bull trout in Koocanusa Reservoir. USFWS (2015b) recommended continued monitoring of the selenium levels in the Kootenai River system and research on the impact of selenium on bull trout, particularly with respect to potential reproductive impairment (including adult reproductive failure and early life stage growth abnormalities and mortality) (Lemly 2002), because this threat is not yet well understood. Additionally, the Kootenai National Forest formally consulted with the Service for proposed permitting of the Montanore Mine in 2014 (USFWS 2014). In 2017, U.S. District Judge Donald Malloy overturned the approval for the proposed copper and silver mine, finding that "the project is expected to reduce stream flows for threatened bull trout and increase the potential for human interactions with threatened grizzly bears" (Montanore Ruling 2017).

At this time the Kootenai National Forest has not undergone further consultation, but is in the process of reviewing and resubmitting a BA for the permitting of the Montanore Evaluation Project. This consultation will assess the effects of permitting the initial "evaluation" of the ore body within the Montanore project area. If permitted as proposed, the evaluation would have negative effects to the Kootenai River Core Area. Specifically, the Montanore Evaluation Project will likely affect local bull trout populations by contributing sediment to spawning and rearing streams (Libby and Bear creeks) as a byproduct of updating and improving roadways and heavy traffic use further exacerbating aggrading conditions at tributary mouths.

The negative bull trout population responses from the previously proposed mine development would be attributed to reduced quantity and quality of spawning areas (baseflow depletions), disruption of hyporheic flows in spawning and egg incubation gravels (baseflow depletions), increased water temperature during spawning and egg incubation periods (Libby Creek due to water releases from treatment facilities), and to short-term increased sediment accumulations in streams (from mining related activities and road usage, construction and re-construction) in spawning, egg incubation, and rearing substrates. Since some of the affected bull trout populations are present in very low numbers or at risk for a variety of reasons, the expected response may be loss of persistence from portions of some drainages (Libby Creek). The expected bull trout population response to the previously proposed mining activities would be a reduction in reproduction and survival of bull trout within Libby Creek, Rock Creek and East Fork Bull River, stemming from water depletion, and increases in water temperature and sedimentation.

Introduced non-native species are widespread throughout the Kootenai River Core Area including brook trout and predator species such as northern pike. Brook trout hybridization with bull trout is of particular concern in the Core Area and has been documented in West Fisher, Pipe, and O'Brien Creeks (USFWS 2015b).

9.4.1.3 Hungry Horse Reservoir Core Area

Hungry Horse Dam is 15 miles south of the west entrance to Glacier National Park and 20 miles northeast of Kalispell, Montana. The headwaters of the South Fork Flathead River are located in the Bob Marshall Wilderness. Construction of Hungry Horse Dam in 1952 impounded the lower South Fork of the Flathead River drainage, occupying approximately 38 percent of the total stream length (Figure 6) (Zubik and Fraley 1987). The South Fork of the Flathead River has a contributing watershed area of 1,663 square miles (mi^2), and lies predominantly (98 percent) within the Flathead National Forest (CSKT and MFWP 2004). The Hungry Horse Reservoir Core Area includes all of Hungry Horse Reservoir and the South Fork Flathead River and all tributaries upstream of Hungry Horse Dam. Hungry Horse Dam isolates the South Fork Flathead River drainage from its former connectivity with the remaining Flathead Lake system, isolating about 38 percent of the spawning and rearing habitat that would otherwise occur in the Flathead Lake Core Area (Zubik and Fraley 1987). The Hungry Horse Reservoir Core Area bull trout population originated from adfluvial (life history where fish spawn in rivers, forage and rear in lakes) Flathead Lake stocks that were trapped upstream of Hungry Horse Dam.

The 2015 Recovery Plan did not identify primary threats to bull trout populations in the Core Area, although construction and operation of Hungry Horse Dam, historic land use practices, and natural events may have affected populations over time through increased sedimentation in tributaries and reduced habitat complexity. Hungry Horse Dam (564 ft high) is a complete barrier to all upstream movement of bull trout. The upstream barrier at Hungry Horse Dam also provides some benefit to populations in the Core Area by eliminating the upstream migration of non-native species (e.g. lake trout) into the Core Area. Downstream movement and entrainment of bull trout through the turbines and spillway probably occurs at low levels (Marotz et al. 1996). However, due to the depth and configuration of penstock withdrawal and the status of populations, the effect of entrainment at the bull trout population level within the Core Area is low. The reservoir formed in the South Fork Flathead River upstream of Hungry Horse Dam provides fish refugia, and the barrier the dam presents to upstream movement of non-native species (e.g., lake trout) is currently considered an asset to bull trout recovery.

Operations of the dam in the past have led to extreme variability in pool elevations within Hungry Horse Reservoir, with drawdowns at times of over 188 ft below full pool (Marotz et al. 1996). Despite the variability in pool elevations, bull trout populations in the Core Area have not shown any measurable negative response. Although drawdowns of that magnitude have not occurred in recent years, the State of Montana continues to express concern over the effect of water level fluctuation on native fish and recreation.

In 2003, a series of major fires burned large portions of the bull trout habitat in the South Fork of the Flathead River drainage, which are the headwaters of this Core Area (USFWS 2015b). In recent years, logging activities have been infrequent with the exception of some post-fire salvage. Rain-on-snow events heavily impacted west-side reservoir tributaries in 2003 and again in 2006, with large debris flows and several culvert and bridge blowouts. Despite this, bull trout spawning numbers in several of these streams (e.g., Wounded Buck and Wheeler Creeks) increased through the period from 2006 to 2008 (USFWS 2017c). There are eight bull trout spawning index reaches in the Hungry Horse Core Area. Collectively, these eight reaches represent up to 85 percent of the total Basin-wide spawning of bull trout. The data show that the four index streams in the Bob Marshall Wilderness support approximately 70 percent of the bull trout spawning in the Hungry Horse Core Area (USFWS 2017c).

The distribution of bull trout populations throughout the Hungry Horse Reservoir Core Area is probably similar to historic patterns, as is life history form expression (adfluvial). This is a large Core Area with some natural barriers in headwaters and occasional temporary barriers resulting from beaver dams or other natural activities. There are no known human-caused barriers on bull trout spawning and rearing streams. Historic bull trout redd counts are not available. The number, size, and age composition of bull trout that were trapped upstream of the dam at closure in 1953 are unknown. It is likely that numbers were lowest immediately following the construction of Hungry Horse Dam and filling of the reservoir and then quickly rebounded with the new habitat and food resources afforded by the reservoir. The population likely expanded for a period of several years through the 1960s (USFS 2013). However, heavy angling, logging on non-wilderness lands surrounding the reservoir, and extreme reservoir drawdowns likely caused the bull trout population to decline during the 1970s and 1980s. In 1993, fisheries resource managers restricted intentional angling for bull trout to minimize impacts to populations.

Adult and sub-adult bull trout are present in Hungry Horse Reservoir. Because the reservoir inundated a portion of the migratory corridor for fish from Flathead Lake, records of natural carrying capacity for this portion of the system in isolation are unavailable. Rather, this Core Area incorporated about 38 percent of the spawning and rearing habitat for the Flathead Lake Core Area (Zubik and Fraley 1987). The loss statement for the Hungry Horse Dam mitigation program concluded that dam construction eliminated between 1,840 and 2,089 adult bull trout from the Flathead Lake population (Zubik and Fraley 1987). The reservoir and the watershed upstream contain one of the strongest local populations of bull trout in Montana, due in large part to the substantial amount of undisturbed habitat present in the Bob Marshall Wilderness (Marotz et al. 1996; MBTSG 1998). Current bull trout densities in the Hungry Horse Core Area appear stable or increasing at about 2,500 to 3,000 adults (total population size likely 2-3 times this), based on MFWP redd count data from 1993 to present (MFWP 2020b). Redd monitoring has been conducted in the South Fork Flathead River watershed since 1993, and as of 2014, redd numbers continue to appear stable (MFWP 2020b).

The recreational bull trout fishery on Hungry Horse Reservoir has continued since 2004 and is closely monitored by MFWP and others (Hensler and Benson 2007; Rosenthal 2009, 2010; Rosenthal and Hensler 2008). Over a six year period, nearly 7,300 bull trout were caught, of which 390 (roughly 5 percent) were harvested. Given the stability of yearly redd counts and known harvest rates; populations in the Hungry Horse Reservoir Core Area represents a stronghold in the Recovery Unit.

9.4.1.4 Flathead Lake Core Area

The South Fork Flathead River flows downstream from Hungry Horse Dam into the mainstem Flathead about 6 miles upstream from Columbia Falls, Montana, and then drains into Flathead Lake impounded by Sèliš Ksanka Qĺispè (SKQ) Dam (formerly Kerr Dam) (Figure 6). The Flathead Lake Core Area is one of the largest, most complex, and best-documented bull trout Core Area in the upper Columbia River watershed. The Flathead Lake Core Area includes all of Flathead Lake, the North Fork Flathead River, Middle Fork Flathead River, South Fork Flathead River (up to Hungry Horse Dam) and their tributaries. The Whitefish and Stillwater Core Areas, though separate Core Areas, are insignificant contributors of bull trout to the Flathead Lake Core Area, largely due to low population densities and limited distribution.

Currently, non-native fish species and fisheries management represent the primary threats to bull trout in the Flathead Lake Core Area (USFWS 2015b). The early 1900s saw a series of introductions of non-native fishes in Flathead Lake that had negative impacts to bull trout through competition, hybridization (brook trout), and added angling pressure (USFS 2013). Yellow perch, brook trout, lake trout, Yellowstone cutthroat trout, rainbow trout, and kokanee were stocked in the Flathead Lake system between 1910 and 1916. Lake trout introduction likely had the greatest negative effects on bull trout in the Flathead Lake Core Area through direct predation and competition for similar food resources in Flathead Lake. However, it was not until the introduction of Mysis shrimp into Flathead Valley lakes in 1967 that the negative interaction between non-native lake trout and bull trout was fully realized (USFWS 2015b). The establishment of Mysis shrimp in Flathead Lake provided juvenile lake trout with consistent prey in their deep-water habitats and allowed the lake trout population in Flathead Lake to expand.

Spencer et al. (1991) concluded that the benefit Mysis shrimp introduction had on lake trout was responsible for the collapse of a formerly large population of kokanee salmon through direct predation by lake trout. Further, it has been determined that predation, competition, or other forms of negative interaction with lake trout is the factor most responsible for the currently depressed condition of bull trout in this Core Area (Fredenberg et al. 2005). Based on these impacts, in 2014, the Confederated Salish and Kootenai Tribes (CSKT) instituted gillnetting to reduce lake trout populations in Flathead Lake (CSKT 2014). In the mid-1990s, greater angling restrictions were implemented on bull trout harvest in the Flathead Lake Core Area. Currently, there is no harvest of bull trout allowed in the Flathead Lake Core Area, but some incidental mortality associated with the heavy angling pressure for lake trout in Flathead Lake and heavy angler use on the Flathead River system occurs. Some incidental mortality of bull trout, as a result of lake trout gillnetting, also occurs (CSKT 2016).

While the integrity and connectivity of habitat in the North and Middle Fork Flathead River drainages is high, construction of Hungry Horse Dam on the South Fork Flathead River isolated a substantial portion (approximately 38 percent) of the spawning and rearing habitat in the Core Area. Bull trout populations in the Flathead Lake Core Area are greatly reduced relative to historic levels. This reduction is likely results from the combination of non-native species presence (lake trout) and habitat and connectivity alterations. Estimates range from 10 percent to 50 percent of the historical population. Approximately 1,600 spawning adult bull trout inhabit Flathead Lake (USFS 2013). This value was derived from redd counts, and only represents bull trout that are mature enough to spawn. The absolute number of bull trout in the Flathead Lake Core Area is likely twice that number. The distribution of populations throughout the Core Area is likely similar to historic patterns as local populations are still relatively widespread in about 22 tributaries and occur in all historically occupied systems.

An extensive redd count monitoring program was developed and implemented by MFWP beginning in 1980 (MFWP 2020b). There are 13 local populations within the Flathead Lake Core Area on the Flathead National Forest. Streams occupied by eight of these local populations are used as “index reaches” in MFWP’s redd monitoring program. The index reaches are Trail Creek, Whale Creek, Coal Creek, Big Creek, Morrison Creek, Lodgepole Creek (tributary to Morrison Creek), Granite Creek, and Ole Creek. Although adfluvial bull trout do spawn in other tributaries, these eight streams support the majority of the adfluvial spawning population, and redd numbers within them appear to represent about 45 percent of the total adfluvial spawning that occurs in the Flathead Lake Core Area. Bull trout index stream redd counts ranged from about 300-600 in the 1980s (averaging 392), then dropped drastically in the early 1990s to a range of 83-243 in the seven years prior to listing (averaging 137 between 1991 and 1997). From 1998 through 2017, index redd counts ranged from 130 to 251 redds, averaging 195 (MFWP 2020b). Based on these counts, the recent trend appears relatively stable at a level roughly half of that observed in the 1980s. Entrainment over Hungry Horse Dam from the Hungry Horse Reservoir Core Area likely adds only minor recruitment to the Flathead Lake Core Area.

9.4.1.5 *Lake Pend Oreille Core Area,*

Within the Action Area, Albeni Falls Dam impounds 25 miles of the Pend Oreille River (Albeni Falls pool) and deepens Lake Pend Oreille (Figure 6). Downstream to the U.S.-Canada border, flows and hydrology are altered by operation of Albeni Falls Dam, as well as two Federal Energy Regulatory Commission (FERC) licensed dams: Box Canyon and Boundary dams. Flows in the Clark Fork River Basin are altered by upstream operations of Hungry Horse, SKQ (Kerr), Thompson Falls, Noxon Rapids, and Cabinet Gorge dams prior to entering Lake Pend Oreille.

The Lake Pend Oreille (LPO) Core Area is one of the largest and most complex bull trout Core Areas across the range of bull trout. Therefore, in the 2015 recovery plan, the Service subdivided the Lake Pend Oreille Core Area into three recovery management segments (USFWS 2015b). LPO-A incorporates the Clark Fork River Drainage upstream of Cabinet Gorge Dam, which is a FERC licensed dam, upstream to the confluence with the Flathead River. LPO-B represents the portion of the Core Area between Cabinet Gorge Dam on the Clark Fork River, downstream to Albeni Falls Dam and includes the nearly 95,000 ac Lake Pend Oreille proper. Lastly, 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 U.S.-Canada border).

Bull trout in the Lake Pend Oreille Core Area appear to be almost entirely adfluvial, though some resident life histories occur in tributaries. Adult bull trout make spawning migrations into the larger tributaries beginning in April, with juvenile outmigration occurring as early as March and lasting until June for tributaries feeding directly into Lake Pend Oreille. Fall migrations (from September through October) follow a similar pattern of movement with adults moving further upstream to spawn (then returning to Lake Pend Oreille to overwinter) and juveniles moving downstream into Lake Pend Oreille. Migratory bull trout spawning in the Middle Fork East River and Uleda Creek, tributaries to the East River downstream of Priest Lake, or in the Action Area, exhibit a unique life history strategy described as allacustrine (fish migrate from downstream riverine habitat and tributary spawning areas upstream into a lake to forage and overwinter) (Dupont et al. 2007, p. 1272; R2 Resource Consultants 2010). These fish migrate downstream out of Lake Pend Oreille into the Pend Oreille River, before ascending the Priest River and ultimately the East River for spawning, and ultimately migrating back to Lake Pend Oreille, demonstrating an allacustrine migratory pattern (Dupont et al. 2007, p. 1269). Bull trout in the Priest River drainage were part of the Priest Lake Core Area in prior versions of the Recovery Plan (USFWS 2002b). However, the privately-managed Priest Lake dam is a total passage barrier between Priest River and Priest Lake. Given their migratory movements to and from Lake Pend Oreille and not Priest Lake, bull trout in the Priest River are included in the Lake Pend Oreille Core Area. All populations downstream of Albeni Falls Dam to the Canadian border likely exhibit this allacustrine life history as well. Juveniles requiring this upstream migration to the lake, often migrate in the late winter and early spring at larger sizes than observed in other adfluvial populations.

In LPO-A, the 2015 Bull trout Recovery Plan indicated that 15 local populations are negatively impacted by upland/riparian land management, poor water quality in the mainstem river, instream impacts, connectivity impairments, and non-native species (USFWS 2015b). Three FERC licensed dams (Cabinet Gorge, Thompson Falls and Noxon Rapids) influence bull trout connectivity and distribution in LPO-A. While this portion of the Core Area is not included within the Action Area, nor influenced by the operation of Albeni Falls Dam, bull trout entrained over Cabinet Gorge Dam use habitat within Lake Pend Oreille. Since 2001, an average of 35 adult bull trout each year captured below Cabinet Gorge Dam genetically assign to tributaries within Montana. The capture efficiency of the trap and transport program has been estimated at 39 percent (GEI 2009), suggesting a minimum of 90 individuals from LPO-A populations may be present in Lake Pend Oreille and the Action Area at any time. Based on an estimated 85 percent survival rate of fish passing through the three non-federal dams in the Clark Fork River (Cabinet Gorge, Thompson Falls, and Noxon) and survival rates of juvenile bull trout to adulthood between 441 and 1,766 juveniles may also be in the Action Area at any point in time.

Currently, upstream passage is not present at Cabinet Gorge Dam. Avista Corporation, the owner of Cabinet Gorge dam, is proposing to construct a fish passage facility as required by their FERC license. Noxon Rapids Dam also does not have upstream fish passage. At this time, only Thompson Falls has volitional upstream fish passage.

Lake Pend Oreille or LPO-B supports a strong adfluvial and resident population of bull trout. The 2015 Recovery Plan identified legacy impacts from upland/riparian land management as the only primary threat for this portion of the Core Area. In addition, non-native species management occurs within the Basin to keep lake trout and brook trout populations stable or trending downward, limiting negative impacts to bull trout and other native fish species.

In 1925, the U.S. Fish Commission stocked 100,000 lake trout (*S. namaycush*) into Lake Pend Oreille and its tributaries (Fredenberg 2002). Lake trout have migrated downstream out of Flathead Lake, where they were introduced 20 years earlier. Lake trout compete with native bull trout for food resources and studies suggest that bull trout will not persist in the presence of lake trout (Fredenberg 2002; Martinez et al. 2009). For example, Priest Lake experienced dramatic declines in bull trout numbers as corresponding lake trout numbers increased (Martinez et al. 2009). In recent years, IDFG and others have put in considerable effort to suppress the lake trout population in Lake Pend Oreille through angler incentive programs, and trap netting and gill netting projects. While these efforts have been successful in managing lake trout numbers, some bycatch of bull trout occurs annually with management activities, often leading to bull trout mortality. For example, in the spring of 2011, gillnetting operations successfully removed 5,841 lake trout from Lake Pend Oreille, with 113 direct mortalities of bull trout (Wahl et al. 2013, p. 53). Despite the bull trout mortalities, long-term benefits of non-native species removal are positive. Since the program began, lake trout population estimates have declined by more than 50 percent (Hansen et al. 2019).

Within LPO-B, as many as 19 local populations of bull trout are present and considered healthy and stable (USFWS 2015b, p. D-31). To monitor bull trout population trends, IDFG implements an extensive redd count monitoring program in the Lake Pend Oreille Core Area within the state of Idaho. IDFG is working to update population estimates. However, Meyer et al. (2014) provided estimate of an adult bull trout population of 12,513 for 2008 for Lake Pend Oreille. Thus, the population has appeared relatively steady since 1994. Based on recent redd counts and lake trout bycatch, total abundance appears to be stable throughout LPO-B. For example, in six annually surveyed index streams, redd counts range from a low of 208 in 2016, to a high of 794 in 2006 (IDFG 2018). During lake trout gillnetting in 2017, IDFG caught 1,418 bull trout (446 mortalities) (Rust et al. 2020). The numbers of bycatch in 2017 are consistent with previous years.

Bull trout populations in the LPO-C portion of the Lake Pend Oreille Core Area are very small and depressed (USFWS 2015b). The 2002 Bull Trout Draft Recovery Plan identified one extant local population in LeClerc Creek that drains into Box Canyon Reservoir. By 2008, the Service determined the LeClerc Creek local population was likely functionally extirpated (USFWS 2008a). Since 2001, resource agencies in the Pend Oreille watershed have not documented bull trout juveniles or redds, though targeted surveys have been sporadic. In 2014, the Service observed a single adult bull trout in LeClerc Creek during redd surveys, but no redds were observed. Bull trout were abundant in the Pend Oreille River through 1957, and then abruptly their numbers decreased to the point that individual fish are now noteworthy. This abrupt decline correlates with the commencement of operation of Albeni Falls Dam in 1952 (Corps, 2018 pg.4). For the LeClerc Creek local population, the option to move up to Lake Pend Oreille was blocked by Albeni Falls Dam. Other than LeClerc Creek, bull trout spawning surveys have not occurred in any other tributary of the Lower Pend Oreille River in the last 15 years. Every year a handful of bull trout are observed or captured downstream of Albeni Falls Dam during fisheries management and research activities (Paluch et al. 2020 *Draft Report*). Genetic samples are collected and all to date have been assigned to populations of bull trout upstream of Albeni Falls Dam (USFWS *unpublished data*).

Several primary threats to the recovery of bull trout populations are identified in LPO-C (USFWS 2015b). These include historic and current upland/riparian land management practices, instream impacts, water quality issues, connectivity impairments, small population size, and non-native fishes (USFWS 2015b). These primary threats continue to limit habitat and therefore, demographic improvements to populations in the Core Area. Several efforts by agencies and groups in the Lower Pend Oreille are making strides to improve habitat within the tributaries through reduction of non-natives (i.e. brook trout) and instream habitat projects such as LW placement, riparian plantings, and different land management. While these actions have improved tributary habitat, impacts from historic operation of Albeni Falls Dam and the lack of passage at both Box Canyon and Albeni Falls dams have limited the survival and life history patterns of the populations downstream. Passage at Box Canyon Dam is currently under construction.

In 2017, the Corps consulted on construction of upstream fish passage at Albeni Falls Dam (USFWS 2018a). The 2018 Opinion assumed construction of Albeni Falls fish passage would occur by 2022, based two years of construction beginning in 2021 (Corps 2017b). Recently, the Corps received funding for full design of the fish passage facility (Corps et al 2020b; Corps 2020a; Corps 2020b). Based on more recent information estimates, the Corps expects it will take approximately 3 years for design (completed in 2024), and then once funding is received for construction, another four years (1 for acquisition, and 3 for construction). Due to some uncertainty regarding exactly when full construction funding may be available, the Service conservatively estimates that the passage facility will not be operationally complete until 2030. In addition, as part of recovery efforts, the Service is currently assessing the feasibility and risks associated with reintroducing bull trout to LPO-C.

The lack of connectivity in LPO-A, LPO-B, and LPO-C influences bull trout distribution throughout the Core Area. In addition to three dams in the Lower Clark Fork River, Albeni Falls Dam, and Box Canyon Dam, log cribs, beaver dams, large alluvial deposits and culverts are also recognized as fish passage barriers across the Core Area. To improve fish passage, many of these barriers (e.g., culverts, log cribs) have been removed or replaced. While the aforementioned barriers influence fish passage on a local scale, large hydroelectric dams have had the greatest impact on bull trout connectivity and distribution throughout the Core Area (USFWS 2015b). Dams have permanently blocked established bull trout migration routes and eliminated connectivity of the three subdivided segments (LPO-A, LPO-B, and LPO-C), isolating LPO-A and LPO-C from the productive waters of Lake Pend Oreille. Three dams on the lower Clark Fork River have significantly reduced the amount of spawning and rearing habitat available to Lake Pend Oreille bull trout populations. Other effects of these dams to bull trout habitat include changes in water quality (temperature, sediment, TDG and nutrients) and quantity, reservoir drawdowns, a reduction in shoreline food sources, and direct losses of fish into water conveyance systems (turbines, spillways, or water delivery systems).

In addition to above, the Pend Oreille River and Lake Pend Oreille shorelines have been significantly altered by residential development along the shoreline. Bank armoring associated with wave action and erosion and recreational docks have limited complexity and large wood (LW) recruitment, modified natural hydraulic processes, and removed vegetation that provide shade and forage. These impacts have furthered limited the potential for bull trout to use of the river and the overall persistence of the species in the action area.

9.4.2 Critical Habitat in the Columbia Headwaters Recovery Unit

Critical habitat in the CHRU includes two CHUs that fall within the Action Area. The upper Basin areas related to Libby Dam fall within the Kootenai River CHU 30 (Figure 6), while the areas around Hungry Horse Dam and Albeni Falls Dam fall within the Clark Fork River Basin CHU 31 (Figures 6).

9.4.2.1 Kootenai River CHU 30

The Kootenai River Basin CHU 30 represents essential areas for the Kootenai River and Lake Koocanusa Core Areas of bull trout and encompasses two Critical Habitat Subunits (CHSUs) of the same names (USFWS 2010a; b). In 2010, the Service identified the CHU as essential to the species due to its support of the strongest adfluvial population across the range in Lake Koocanusa and the largest spawning run of bull trout across the range in the Wigwam River of British Columbia (USFWS 2010a; b).

The Service identified the Lake Koocanusa CHSU as providing some of the most secure and stable bull trout refugia and coldwater across the range, and may provide a very important stronghold against potential extinction (USFWS 2010a; b). Bull trout likely exhibited a fluvial life history prior to construction of Libby Dam within the CHSU. The formerly fluvial population adapted to the newly expanded habitat and now exhibit an adfluvial life history (USFWS 2010b, p. 821). Therefore, the critical habitat within this CHSU has taken the form of lake refugia for populations. The most important spawning stream within this CHSU is the Wigwam River in British Columbia and it supports between 1,500 and 2,500 bull trout redds annually (USFWS 2010a; b).

While the Lake Koocanusa sub-unit is strong and resilient, supporting large populations of adfluvial bull trout, hydropower dam construction and operation significantly altered the Kootenai River CHSU. The construction of Libby Dam effectively severed populations in the Kootenai River from productive spawning habitat in Grave Creek, Wigwam River, and other river systems in Canada (USFWS 2010b, p. 821). Gas bubble trauma, reduced nutrients, productivity, and LW; fragmented connectivity; tributary delta aggregation; changes in peak and base flows; and altered thermal regimes associated with dam operation have reduced function and quality of critical habitat in the sub-unit. The Service identified the Kootenai River CHSU as essential to bull trout conservation because it conserves a relatively rare "big river fluvial" life history form in the CHRU, and produces some of the largest fluvial individuals within the range of the species (USFWS 2010b). However, data has shown that entrainment from upstream populations plays a key role in this population by increasing abundance, and when genetic analysis was last conducted, greater than half of the individuals captured were assigned to spawning tributaries above Libby Dam (DeHaan and Adams 2011). Although non-native species (primarily brook trout and northern pike), past and present timber harvest, and road construction activities have had detrimental impacts to this CHSU, the construction of Libby Dam has been/led to the most significant negative impact(s) to bull trout in this CHSU during the current era (USFS 2013).

9.4.2.2 Clark Fork CHU 31

The Clark Fork CHU (CHU 31) is the largest and one of the most diverse CHUs in the species' range. Including 12 CHSUs, the unit represents the evolutionary heart of migratory adfluvial bull trout (USFWS 2010b p. 827). Flathead Lake and Lake Pend Oreille are two of the largest lakes throughout the range of bull trout and have, historically, supported large, migratory bull trout that traveled as many as 200 miles to spawning areas. Over time, construction and operation of dams, including Hungry Horse and Albeni Falls increasingly fragmented the Basin. Many of the migratory populations have declined and isolated resident populations have formed (USFWS 2010b. p 827). Within the Action Area, three of the CHSUs are represented. These include South Fork Flathead River and Hungry Horse Reservoir; Flathead Lake, Flathead River, and Headwater Lakes; and Lake Pend Oreille Sub-units.

The Service identified the South Fork Flathead (above Hungry Horse Dam) CHSU as essential for bull trout conservation, as it is one of the most stable refugia for bull trout throughout the coterminous range (USFWS 2010b p. 909). Most of the spawning and rearing habitat in this CHSU is protected and unaltered habitat within the Bob Marshall Wilderness. The presence of high-quality spawning and rearing habitat, along with groundwater-influenced streams, makes it one of the strongholds for bull trout with respect to changing climate (USFWS 2010b p.909). Within this sub-unit, human activities that have degraded bull trout habitat include the operation and maintenance of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and introduction of non-native species (USFWS 2015b). Hungry Horse Reservoir supports a stable and expanding population of bull trout, and MFWP allows anglers to harvest bull trout in the Hungry Horse Reservoir and South Fork Flathead (USFWS 2017c).

The Flathead Lake, River and Headwater Lakes CHSU is influenced by operation of Hungry Horse Dam, and occurs downstream to SKQ Dam (formerly Kerr Dam). The sub-unit excludes the Swan River, which is its own sub-unit. The Service determined that the size and scope of this sub-unit made it essential for the persistence of bull trout (USFWS 2010b p.887). The sub-unit includes as many as 20 spawning and rearing streams and as many as 20 isolated headwater lakes (USFWS 2010b p. 887). Many of these areas fall within protected boundaries of Glacier National Park. The extensive network of high quality, glacially-fed streams and lakes provides long-term refugia for adult and sub-adult bull trout under climate change scenarios (USFWS 2010b p. 887).

The Lake Pend Oreille CHSU includes the Lower Clark Fork River below Cabinet Gorge Dam, Lake Pend Oreille, Lower Pend Oreille River below Albeni Falls Dam and their tributaries. The value of secure and stable refugia, as well as the predominantly adfluvial life history justified the sub-unit as essential for recovery of bull trout. Re-establishing broadly distributed local populations throughout the sub-unit was necessary for recovery within this sub-unit (USFWS 2010b p. 835). The unique life history of allacustrine (spawning downstream of lake habitat) adfluvial bull trout further supports the necessity of the sub-unit for recovery. The construction and operation of Albeni Falls, Box Canyon, and Boundary Dams on the Pend Oreille River has fragmented habitat and has negatively affected migratory bull trout (USFWS 2002b). Other dams and diversions without fish-passage facilities in tributaries to Lake Pend Oreille and the Pend Oreille River, including the Cabinet Gorge and Noxon Rapids Dams, further fragmented habitat and reduced connectivity (USFWS 2002b). In addition to eliminating connectivity, dams within the system have significantly negatively altered habitat characteristics in the Pend Oreille River. Operation of each facility continues to have a significant negative impact on bull trout habitat. Typical spawning, rearing, and overwintering habitat in a free flowing river with pools, glides, riffles and side habitat has been eliminated. Water temperatures have risen during the summer months and macrophytes and warm-water fish species (including predators of bull trout) have proliferated in this changed environment (USFWS 2002ba; NPCC 2004a, p. 3-6).

Baseline conditions for bull trout critical habitat in CHU 30 and CHU 31 are described by PBF in the sections below.

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

Kootenai River CHU 30

Above Libby Dam in the Lake Koocanusa, floodplains and coldwater influences are relatively in tact. In general, the Kootenai River downstream of Libby Dam is largely disconnected from its historic floodplain due to diking and historic Libby Dam operations. Floodplain development associated with the river’s floodplain disconnection has likely limited some hyporheic connections, though the magnitude and influence of hyporheic flow alterations on mainstem water quality is unknown. Some streambank armoring is present but does not significantly impair this PBF. As a result, this PBF is not properly functioning through most of the CHU other than in tributaries.

Clark Fork River CHU 31

PBF 1 is present, and contributes to FMO habitat in Hungry Horse Reservoir. In reservoir environments, subsurface connectivity and thermal refugia are a function of several factors including thermal stratification within the reservoir, tributary inflow, wetland influence, and groundwater recharge. In deep reservoirs such as Hungry Horse Reservoir, thermal stratification is typically the primary mechanism providing thermal refugia. Tributary inflow may also play a role in providing subsurface connectivity between cold water refugia in the reservoir and tributary habitat. The large, cold, deep expanse of Hungry Horse Reservoir provides cold water refugia for native species (USFWS 2015b). PBF 1 is present and contributes substantially to FMO habitat in the Flathead River. Cooling hyporheic flows are connected to the mainstem as the river meanders through a broad, and well-connected floodplain in most areas. Some streambank armoring is present but does not significantly impair this PBF throughout the reach. The Flathead River is connected to a shallow alluvial aquifer, and groundwater easily moves between the aquifer and the Flathead River (Boyd et al 2010; Mills et al 2012). In most places near the river, the water table is less than 5 ft below the surface (Flathead Lakers 2005). Areas with high groundwater influence tend to remain unfrozen in the Flathead River during harsh winter conditions, while adjacent stream sections ice over or contain extensive accumulations of anchor ice. Bull trout have access to overwintering habitat in areas where groundwater upwelling provides areas free of anchor ice.

In 1995, Reclamation installed a selective withdrawal system to control release temperatures from Hungry Horse Reservoir into the South Fork of the Flathead River in Montana. Reclamation designed the selective withdrawal system to be able to withdraw water from the surface of the reservoir, more closely approximating pre-dam temperatures. In general, temperatures in the river remain somewhat warmer during the winter months than pre-dam conditions and slightly cooler during summer months (Reclamation 2006).

In deep lake environments, subsurface connectivity and thermal refugia are a function of several factors, including thermal stratification within the lake, tributary inflow, wetland influence, and groundwater recharge. In Lake Pend Oreille, thermal stratification is typically the primary mechanism providing thermal refugia. Tributary inflow may also play a role in providing subsurface connectivity between cold-water refugia in the reservoir and tributary habitat. Downstream of Albeni Falls and Box Canyon Dams, cold-water habitat is limited, but some patches persist in tributaries (e.g., Indian Creek and LeClerc Creek (Box Canyon pool), Sullivan Creek (Boundary Pool), and others). These areas are vulnerable to changes in precipitation, temperature increases, and hydropower operations.

Overall, across the entire CHU, cold-water refugia is properly functioning in the reservoirs and tributary subunits. However, within the Action Area, mainstem river corridors are highly influenced by lost floodplain connectivity, shoreline development, and altered flow regimes that limit wetland and riparian development, and the input of surface reservoir waters. The decreased floodplain connectivity has led to increased vulnerability of bull trout to temperature changes and fluctuating precipitation patterns and reduced thermal refugia for bull trout in the Action Area.

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

Kootenai River CHU 30

Bull trout in Lake Koocanusa benefit from high quality FMO habitat and proximity to productive spawning and rearing habitat in the upper Kootenay River watershed in British Columbia and Grave Creek and portions of the Wigwam River in the U.S.

The current state of the Kootenai River downstream of Libby Dam is significantly altered from its historical state due to the construction and operation of Libby Dam, along with floodplain development and modified land use practices. In-stream habitat conditions have been permanently altered, due largely to flow regulation and reduction or elimination of nutrient delivery and wood to the river downstream of the dam. Such modifications may have reduced the carrying capacity of the mainstem for bull trout, though the post-dam thermograph is likely more suitable for bull trout than the pre-dam thermograph. The physical barrier presented by Libby Dam separates the lower Kootenai River from some of the most productive and coldest headwater spawning and rearing habitat in the range of the species (e.g., the upper Kootenay River watershed in British Columbia).

The modified hydrograph of the Kootenai River downstream of Libby Dam has resulted in the formation of large deltas of deposited bedload materials (sand, gravel, and boulders) at the confluence of some tributaries to the Kootenai River, including Quartz, Libby, O'Brien, Callahan, Boulder and Long Canyon Creeks. During periods of low stream flow, the enlarged deltas impede or block fall-spawning migrations of bull trout, thereby negatively affecting their overall productivity (Marotz et al. 1988; MBTSG 1998).

While migration habitat is functional in the Lake Koocanusa subunit, the overall status of migration habitat in the Action Area is not properly functioning. Migration barriers from Libby Dam, bedload deposition at tributary mouths as well as seasonal temperature barriers have resulted in altered connectivity between local populations and delayed spawning.

Clark Fork River CHU 31

Historically, the Clark Fork River Basin was well connected. Construction of the dams across the Basin divided the Basin into 12 subunits and all but eliminated connectivity between Core Areas and local populations. Hungry Horse Dam does not provide upstream fish passage and passage downstream occurs through turbines and spillways. Therefore, bull trout that formerly migrated between spawning areas in the headwaters of the South Fork Flathead River and Flathead Lake are now isolated and reach maturity in Hungry Horse Reservoir (Zubik and Fraley 1987). Bull trout spawn in several Hungry Horse Reservoir tributaries (e.g., Sullivan Creek, Wheeler Creek) and migrate to the reservoir (generally to littoral (i.e., near the shore) flats, shallow bays, and/or inundated tributary outlets). The USFWS (2015b) reports that, while

Hungry Horse Reservoir provides a thermal refugia for a healthy bull trout population, Hungry Horse Dam has fragmented a large system formerly occupied by fluvial or adfluvial bull trout into a number of smaller systems, which may threaten downstream bull trout populations (e.g., Hungry Horse Reservoir fragmented the Flathead Lake population). Changes in reservoir operations implemented in 2009 have reduced water level fluctuations during the summer and fall, which overlaps with the primary period when bull trout are migrating to spawning habitats in tributaries.

Within the Lake Pend Oreille subunit, migration barriers from dams in the Clark Fork River and Pend Oreille River have reduced or eliminated connectivity with important lake foraging and overwintering habitat in Lake Pend Oreille. Within the Action Area, PBF 2 in the Lake Pend Oreille subunit is influenced by operation of Cabinet Gorge upstream and Albeni Falls, Box Canyon and Boundary dams downstream. Only one of the four dams in the Lake Pend Oreille subunit has fish passage facilities constructed or planned in the near future. FERC relicensing processes have included commitments to develop fish passage at Boundary Dam on the Pend Oreille River as well as Cabinet Gorge Dam on the Clark Fork River, upstream of Lake Pend Oreille. An upstream fish passage facility at Box Canyon Dam is under construction.

No fish passage is provided at Albeni Falls Dam. A temporary Denil trap was installed at Albeni Falls Dam and electrofishing occurs below the dam to provide selective upstream fish passage. The effectiveness of these temporary fish collection and trapping methods is poor. To date, the temporary trap has not collected fish. The Service expects that a permanent upstream passage facility at Albeni Falls Dam will be operational by 2030. Bull trout that move downstream of Albeni Falls Dam likely survive entrainment through the spillways or turbines (Normandeau 2014). Once downstream of the dam, fish cannot regain access to the upper river or lake, other than through temporary collection methods described above.

Overall, migratory habitat in the Clark Fork CHU is currently not properly functioning within the Action Area.

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

<u>*Kootenai River CHU 30*</u>

Bull trout in Lake Koocanusa benefit from an expanded forage base that has developed since the formation of the reservoir (USFWS 2015). Specifically, the unintentional introduction of kokanee in the British Columbia portion of Lake Koocanusa has altered the food web in favor of bull trout. Seventeen species of fish are present or have been found in Lake Koocanusa providing excellent forage, including: kokanee salmon (*Oncorhynchus nerka*), rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), Westslope cutthroat trout (*Oncorhynchus clarki lewisi*), mountain whitefish (*Prosopium williamsoni*), burbot (*Lota lota*), largemouth bass (*Micropterus salmoides*), white sturgeon (*Acipenser transmontanus*), northern pike (*Essox lucius*), yellow perch (*Perca flavescens*), pumpkinseed (*Lepomis gibbons*), redside shiner (*Richardsonius balteatus*), peamouth chub (*Mylocheilus caurinus*), northern pikeminnow

(*Ptychocheilus oregonensis*), largescale sucker (*Catostomus macrocheilius*), and longnose sucker (*Catastomus catastomus*). Bull trout in excess of 20 pounds are common in Lake Koocanusa as a result of the enhanced food supply (USFWS 2006a).

The mainstem of the Kootenai River downstream of Libby Dam provides year-round FMO habitat for bull trout (USFWS 2010b). In the Kootenai River below Libby Dam, the reduced allochthonous inputs (organic and inorganic materials from other sources), reduced nutrient levels, modified hydrograph, and altered thermal conditions resulting from dam construction and historic operation have resulted in negative/positive impacts to the aquatic food web for bull trout (Sylvester et al. 2015). Entrained kokanee salmon and other species provide supplemental forage for bull trout downstream of the dam. As discussed above, nutrient and wood reduction has led to decreased primary productivity, which may have a cascading effect up the food chain on bull trout prey. The modified hydrograph primarily during the winter period (January-March), has led to increases in the primary productivity of *Didymosphenia geminata*, often forming dense mats that alter the aquatic invertebrate community to one dominated by dipterans (Sylvester et al. 2015). This shift in the aquatic invertebrate community likely decreases fish condition within the Kootenai River (Sylvester et al. 2015).

Within the Action Area, abundant food resources are functioning at risk due to high levels of forage in Lake Koocanusa, but nutrient and resource limited in the Kootenai River.

<u>*Clark Fork River CHU 31*</u>

The large, cold, deep reservoirs provide an abundant prey for bull trout, including Westslope cutthroat trout, in Hungry Horse Reservoir, Flathead Lake, and Lake Pend Oreille. Aquatic productivity is largely controlled by the volume and surface area of the reservoirs during the productive summer months because reservoir drawdowns eliminate aquatic organisms in the dewatered zones, and they must recolonize newly inundated habitat each year when the pools refill. Recent operations have reduced water level fluctuations during primary vegetation growth periods, with the intent of increasing habitat cover and complexity.

The Flathead River supports an abundant and diverse community of benthic macroinvertebrates. Bull trout also feed on abundant westslope cutthroat trout and mountain whitefish. However, Muhlfeld et al. (2008) suggest that the presence of piscivorous, non-native northern pike may reduce the relative abundance of native prey fish in the Flathead River.

Lake Pend Oreille provides abundant prey (e.g., kokanee) for bull trout. (USFWS 2002b; 2000). Kokanee salmon populations declined starting in the 1960s, following the construction of Albeni Falls Dam and Cabinet Gorge Dam, as well as the introduction of mysid shrimp (*Mysis relicta*) to the lake. The mysid, which was thought to be a food source for kokanee, can compete with juvenile kokanee for zooplankton resources. The shrimp also provides a food source for juvenile lake trout, which compete with kokanee. In 2012, the mysid shrimp population in the lake nearly collapsed (Wahl et al. 2015, p. 11). Although it is unknown why the shrimp population declined, this change may have benefited kokanee. IDFG biologists are working to understand what might have contributed to the shrimp decline, and what effects on kokanee might occur if the shrimp return (Wahl et al. 2015).

Downstream of Albeni Falls Dam, native fish assemblages have changed since construction of the dam. Historic migratory populations of Westslope cutthroat trout and mountain whitefish have altered to more resident life histories. In addition, populations of non-native warm water species have increased, including pumpkinseed, yellow perch, smallmouth bass, largemouth bass, tench and others.

Across the Clark Fork River CHU within the Action Area, abundant forage is not considered limiting and this PBF is considered to be properly functioning. Large populations of native and non-native forage are present throughout the unit.

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

Kootenai River CHU 30

The inundation of the river upstream of Libby Dam that created Lake Koocanusa converted these habitats from lotic (fast-moving) to lentic (slow-moving). River-habitat-forming processes, including water velocities, depths, and sediment, wood, and nutrient retention, were changed to lake habitat processes. Bull trout in the Lake Koocanusa Core Area converted from a fluvial to an adfluvial strategy following the construction of Libby Dam. Bull trout benefit from high-quality FMO habitat and associated expanded forage base. These conditions currently support bull trout numbers that likely exceed pre-dam population sizes (USFWS 2015b).

The Kootenai River downstream of Libby Dam provides adequate cover and shelter for adult and sub-adult bull trout, which use the river for foraging, migration, and overwintering purposes (USFWS 2010b). However, the regulated nature of the mainstem Kootenai River may negatively alter FMO habitat by eliminating recruitment of new LW and allowing aggregation of gravel deltas that make access to some tributary streams difficult at lower flows (USFWS 2015b). Ongoing river habitat restoration efforts have recently been completed or are under construction that benefit bull trout by introducing LW and cover habitat in the Kootenai River (KTOI 2015).

Given the above conditions, habitat complexity is considered functioning at risk due to areas of available cover and complexity, and reduced floodplain function and wood recruitment in the mainstem river.

Clark Fork River CHU 31

Hungry Horse Reservoir depth, thermal stratification, and shallow shoreline habitat (supporting prey species for bull trout) provide the most significant habitat complexity and contribution to favorable FMO conditions for bull trout. Construction and historic operation of Hungry Horse Dam inundated riverine pools and riffles and replaced them with deep-water habitat. Reservoir drawdown and subsequent filling has created a varial zone (area demarcated by the range of flows during "typical" peaking operations) along the shoreline of the reservoir where vegetation is limited due to varying water levels. This lack of vegetation and woody debris limits the establishment of cover for rearing juvenile bull trout, though suitable rearing habitat is available in spawning tributaries that discharge to Hungry Horse Reservoir. The implementation of measures to balance FRM with operations to assist downstream salmonid migration (by operating to 75 percent probability of meeting the April 10 Upper Rule Curve and to refill about June 30), were first introduced as part of the 1995 NMFS FCRPS Opinion. These efforts, along with implementation of VARQ flood control have reduced deep power drafts and maintain more stable reservoir elevations during the peak spring and summer primary productivity seasons (NPCC 2004a).

Although complex habitat is present, it has been altered in the Flathead River primarily due to the development of transportation and utility corridors in the early or mid-20th century (USFWS 2015a). This development has negatively affected bull trout habitat through the permanent loss of pools in some areas. The Flathead River channel from the confluence with the South Fork to Kalispell is extensively braided among side channels, islands, and gravel bars. Downstream from Kalispell, the Flathead River changes into a single, wide, meandering channel that extends into Flathead Lake. The Flathead River contains deepwater habitat suitable for bull trout overwintering (Muhlfeld et al. 2003) and ample amounts of LW from the North and Middle Forks (Malanson and Butler 1990). Bull trout use available deep runs with cobble and boulder substrate, pools with LW, and deep lake-influence areas of the lower river (Muhlfeld and Martoz 2005). Other important habitat like oxbows and sloughs are available and contribute to this PBF, as well as deep runs that are believed to be used for overwintering habitat during the formation of anchor ice in the Flathead River (Muhlfeld and Martoz 2005).

Substantial lake depth, thermal stratification, and shallow shoreline habitat in Lake Pend Oreille provide the most significant habitat complexity and contribution to bull trout FMO habitat. The seasonal operation of Albeni Falls Dam has altered historic lake levels and adversely affected shoreline vegetation.

During the summer months, the lake is full; drawdowns begin after Labor Day. By maintaining high lake levels throughout the summer, shoreline vegetation has decreased substantially, resulting in relatively barren shorelines during lower winter lake elevations, and increasing shoreline erosion relative to the pre-dam condition (Corps and Bonneville 2011b). Erosion from wave action and undercutting of the sparsely vegetated (or barren) banks also inhibits the establishment of vegetation (Corps and Bonneville 2011b) and has resulted in increased armoring of shorelines around the lake.

PBF 4 is present but impaired in the Pend Oreille River downstream of Albeni Falls Dam. Sediment from forest roads, logging, and livestock grazing cause riparian and in-stream degradation, loss of LW, and pool reduction in FMO habitat and most spawning and rearing tributaries downstream of Albeni Falls Dam (e.g., LeClerc Creek, Calispell Creek, and Tacoma Creek) (USFWS 2015a). The river between Albeni Falls and Box Canyon dams consists mainly of shallow, lentic water, numerous sloughs and backwater areas, and supports an abundance of macrophytes. During high-flow events, backwater habitats typically become flooded in the Pend Oreille River, providing additional habitat for aquatic species. A qualitative analysis of river cross-sections surveyed downstream of Albeni Falls Dam to Box Canyon Dam indicates that this backwater habitat becomes flooded as flows increase above 30,000 cfs. At lower flows, the river is relatively confined in its channel (Corps and Bonneville 2011b).

Across the Action Area in the Clark Fork River CHU, habitat complexity is limited by dam operation, woody debris recruitment, and shoreline development and armoring. Therefore, this PBF is considered functioning at risk.

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

Kootenai River CHU 30

Lake Koocanusa typically stratifies each summer. Cold-water refugia for bull trout is retained within the range specified by the PBF, beginning at approximately 5 ft below the surface (Woods and Falter 1982). The adfluvial life history form of bull trout thrives and has access to adequate thermal refugia in Lake Koocanusa (USFWS 2015b). Bull trout in the Lake Koocanusa Core Area mostly use the upper Kootenay River watershed in British Columbia (outside the Action Area) for spawning and rearing. The Grave Creek local population and a small portion of the Wigwam River local population spawn in the U.S. These areas support one of the most secure and stable bull trout refugia across the range of the species and may provide an important stronghold against potential extinction (USFWS 2010b) and climate change (USFWS 2015b).

The Kootenai River downstream of Libby Dam provides appropriate temperatures for adult and sub-adult bull trout (spawning does not occur within the mainstem) due to management of Libby Dam release temperatures for sturgeon life history needs and maintenance of water temperatures, according to an agreement with the State of Montana.

Within the Action Area, temperatures appear to be properly functioning within normal ranges in the Kootenai River CHU.

Clark Fork River CHU 31

Adfluvial bull trout overwinter in Hungry Horse Reservoir, migrating to tributaries in late spring and returning to the reservoir in November to overwinter. Bull trout that do not migrate would primarily occupy cooler, deep-water of the reservoir but forage opportunistically in shallower waters. The USFWS (2015b. p. D-36)) stated that the Hungry Horse Reservoir Core Area is one of three collective Core Areas (Flathead Lake and Blackfoot River are other two) that are projected to contain more than 50 percent of the suitable cold-water spawning and rearing habitat for bull trout by 2080 in the CHRU.

PBF 5 in the Flathead River is impacted by operation of Hungry Horse Dam, and currently meets bull trout temperature needs. The North and Middle Forks of the Flathead River are unregulated and retain natural flow and temperature regimes throughout the year. Water temperature in the South Fork Flathead River is regulated by the selective withdrawal structure on Hungry Horse Dam (Corps et al. 2020a). The structure is designed to mimic the natural temperature regime of the Flathead River downstream (NPCC 2004a). The unregulated flows from the North and Middle Fork, combined with operations at Hungry Horse Dam, allow for water temperatures in the Flathead River Reach between the South Fork confluence and Flathead Lake to follow a natural temperature regime.

Temperatures in the main body of Lake Pend Oreille range from 36 °F to 72.5 °F, and in the nearshore areas range from 36 °F to 79.7 °F (Tetra Tech and Tri-State Water Quality Council 2002, p. 6). Bull trout thermoregulate in the lake by occupying colder temperatures at depths below the thermocline (Goetz 1989). Typically, the warmest temperatures occur in early to mid-August in the lake, and the coolest are in the impounded riverine section in late January and in the deeper section of the lake in March (Tetra Tech and Tri-State Water Quality Council 2002, p. 6). Thermal stratification develops in the deep sections of the lake by early June to mid-July at depths between 26 ft and 66 ft. The thermocline persists until mid-October. Thermal stratification does not develop in the impounded river due to its riverine character (Hoelscher et al. 1993).

Water releases from Albeni Falls Dam exceed 68 °F from early July through late September. Consequently, the Pend Oreille River is on the Washington State 303(d) list for temperature downstream of the dam (Baldwin and Whiley 2011; USFWS 2002b). Water temperatures in mainstem FMO habitat (including the lower Pend Oreille River and run-of-the river reservoirs), and the lower reaches of most tributaries are marginally high for bull trout survival in the summer, and these conditions are worsening for bull trout and other aquatic species that depend on cold water for all or a portion of their lives (USFWS 2015b; Pickett 2004). Throughout the Pend Oreille River downstream of Albeni Falls Dam, PBF 5 is significantly impaired and degraded.

Preferred temperatures are variable for bull trout across the Clark Fork River CHU and within the Action Area. Lake habitats such as Flathead Lake, Hungry Horse Reservoir, and Lake Pend Oreille are properly functioning with regard to temperatures. However, mainstem river habitat in the Clark Fork River and Pend Oreille River are significantly impacted by elevated summer temperatures. Therefore, as a whole, this PBF is functioning at risk within the Action Area.

PBF 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo over-winter survival, fry emergence, and young-of-the-year and juvenile survival.

Kootenai River CHU 30

Bull trout spawn, incubate, and rear in tributaries of the Kootenai River and Lake Koocanusa, but not within the Action Area (USFWS 2010b). Therefore, this PBF is not applicable.

Clark Fork River CHU 31

Bull trout spawn, incubate, and rear in tributaries of the Flathead Lake, Hungry Horse Reservoir, Clark Fork River, Lake Pend Oreille and the Pend Oreille River, but not within the Action Area (USFWS 2010b). Therefore, this PBF is not applicable.

PBF 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.

Kootenai River CHU 30

Libby Dam operations for FRM, hydropower, and recreation have fundamentally altered the annual hydrograph above and below the dam, with lower spring flows, somewhat higher summer and fall flows, and higher winter flows compared to the pre-dam hydrograph. Bull trout habitat in the mainstem Kootenai River downstream of Libby Dam has been negatively affected by altered in-stream flow patterns (USFWS 2015b). As a result of Libby Dam operations, substrate at the mouths of Kootenai River tributaries are aggrading, and seasonally may block fish passage (Paragamian et al. 2010). This PBF is considered not properly functioning in the CHU.

Clark Fork River CHU 31

The natural hydrograph of the Clark Fork Basin, which includes all areas from Hungry Horse Reservoir downstream to the Flathead River, the Clark Fork River, and the Pend Oreille River, is significantly altered by hydropower operations by both Federal and non-Federal facilities. The status of the natural hydrograph varies depending on hydropower operations at all of the dams across the CHU.

Although flows downstream of Hungry Horse Dam have been highly altered compared to pre-dam conditions and are largely controlled by dam operations, current flow management is designed to mimic natural conditions as much as practicable. Approximately 6 miles downstream of Hungry Horse Dam, the South Fork joins the mainstem Flathead River. The North and Middle Forks of the Flathead River are unregulated and retain natural flow and temperature regimes throughout the year. Minimum flow targets have been established for the mainstem Flathead River at Columbia Falls (Corps 2006). These targets range from 3,200 cfs to 3,500 cfs based on the WSF. Hungry Horse Dam releases water to maintain this minimum flow when the combined flow of the North and Middle Forks of the Flathead River is less than 3,500 cfs. The minimum flow in the South Fork Flathead River downstream of Hungry Horse Dam is also based on the WSF and ranges from 400 cfs to 900 cfs (Marotz and Muhlfeld 2000).

Muhlfeld et al. (2012) found that the availability of bull trout habitat is closely tied to water released from Hungry Horse Dam. The Action Agencies modified operations with ramping rates and minimum flows beginning in 2001, and since 2002, a variable flow (i.e. VARQ) strategy has been implemented at Hungry Horse Dam. This strategy aims to replicate a more natural river flow pattern during spring runoff while maintaining flood control constraints. Habitat conditions for bull trout have improved following implementation of these more natural flow regimes (Muhlfeld et al. 2012). The hydrograph, although varying from natural, currently provides for adequate foraging, connectivity, and overwintering habitat.

Under historic regulated conditions, drawdown of Lake Pend Oreille occurs from September to about November 15. Flows downstream of the dam are altered from a natural hydrograph due to summer storage and flexible winter operations. Generally, there is an altered hydrograph, with flows that are higher in the winter, lower during the spring peak, and higher during the late summer and fall timeframe than would occur naturally. Summer flows are determined by maintaining the water elevation in Lake Pend Oreille. Stages in the river are higher in summer following peak runoff and going into the fall prior to full drawdown, than they were historically.

The majority of the flow in the Pend Oreille River is the discharge from Albeni Falls Dam. Flows from tributaries to the Pend Oreille River within Washington provide only a minor contribution to the river due to the narrow drainage Basin and moderate snowpack in the surrounding mountains between Albeni Falls and Box Canyon Dam (Andonaegui 2003). At typical winter flows, average river velocities are on the order of 1 ft/s or lower depending on the location (Corps and Bonneville 2011b). Peak flows occur during the season of snowmelt runoff. Spring freshet flood flows typically begin in mid-April, peak in early June, and are dropping by early July (Pickett and Jones 2007).

Across the entire Clark Fork River CHU, dams have altered the natural hydrograph. Therefore, within the Action Area, this PBF is considered not properly functioning.

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

Kootenai River CHU 30

Water quality and quantity in Lake Koocanusa upstream of Libby Dam provides high quality FMO habitat and connection to spawning and rearing habitat for bull trout. Past Libby Dam operations followed VARQ FRM procedures, as well as provided tiered sturgeon augmentation flows, minimum bull trout flows, and flows for juvenile salmon outmigration. However, bull trout critical habitat in the mainstem Kootenai River downstream of Libby Dam is negatively affected by reduced flushing flows, elevated TDG, altered temperature regimes, low nutrient, and recent Didymo blooms (USFWS 2015b). Additional in-stream impacts from upland and riparian land management (e.g., legacy timber harvest and roads, agricultural development) also negatively affect water quality in the Kootenai River (USFWS 2014c).

In Idaho, there are no segments of the Kootenai River listed as impaired under Subsection 303(d) of the CWA (IDEQ 2014). However, in Montana, the mainstem Kootenai River is listed as impaired for flow regime alterations and water temperature (MDEQ 2014). No total maximum daily loads (TMDLs) are developed for the Kootenai River in Montana or Idaho (MDEQ 2014, IDEQ 2014), though TMDLs for temperature and sediment have been implemented for tributaries that contribute water to (and influence water quality in) the Action Area (IDEQ 2006, IDEQ 2014, MDEQ 2014).

Within the Action Area, PBF 8 in the Kootenai River CHU is considered functioning at risk.

Clark Fork River CHU 31

PBF 8 is present in Hungry Horse Reservoir, and water quality conditions in the reservoir are suitable for bull trout and their prey (PBF 3). Most of the watershed contributing to Hungry Horse Reservoir is managed as a wilderness area by the Flathead National Forest. Therefore, pollution, nutrient levels, and dissolved oxygen (DO) are not limiting factors for bull trout in the reservoir. Historic mining throughout the Basin has likely modified or altered water quality over time. Although Hungry Horse Reservoir was listed on the 1996 303(d) list as water-quality impaired for siltation and suspended solids, the Montana Department of Environmental Quality removed the reservoir from the 303(d) list in 2000 when modified dam operations addressed dramatic water elevation fluctuations accelerating shoreline erosion (USEPA 2004). However, tributaries discharging to Hungry Horse Reservoir continue to experience elevated turbidity during storm events as a result of runoff from forest roads. PBF 8 is present and contributes to FMO habitat in the Flathead River, but surrounding agricultural development contributes to localized reductions in water quality.

Although the Flathead River is not listed as water-quality impaired, urban and agricultural land uses along the Flathead River contribute nutrient loading to Flathead Lake and downstream habitats (MDEQ 2014). High levels of turbidity occur in the Flathead River during spring freshets and winter storms. Water quality measurements at Holt (at Sportsmans Bridge) show that peak total suspended solid values are under 400 mg/l most years between 1977 and 2008 (Flathead Lakers 2014). Suspended solids in the Flathead River is not a limiting factor for bull trout (USFWS 2015b). Hungry Horse Dam is operated to minimize spill and associated TDG. To the extent possible, TDG is managed to below the state standard of 110 percent from the dam. Flows from the North and Middle Fork Flathead rivers dilute TDG to within the natural range for the Flathead River.

Hungry Horse is operated to support the year-round minimum flow of 3,200 to 3,500 cfs at Columbia Falls, based on the water supply forecast. Transmission limits in the Flathead Valley reduce generation capacity at Hungry Horse from plant capacity of approximately 12,000 cfs to 9,000 cfs. Hungry Horse Dam is operated to the extent possible to manage spill to 15 percent of total outflow or less to prevent TDG from exceeding Montana state water quality standards of 110 percent. During the flow augmentation period, Hungry Horse releases are calculated to either operate at a constant release from July through September or for gradually declining outflows in an attempt to provide a beneficial flow regime for resident fish below the project.

PBF 8 is present in Lake Pend Oreille, though reproduction does not occur there, and water quality conditions are not optimal. Lake Pend Oreille is generally considered oligotrophic, or nutrient-poor (USFWS 2002b; Corps and Bonneville 2011b). However, nutrient concentrations in shoreline areas and in the northern Basin of the lake are considerably higher because of urbanization and suspended sediments in Clark Fork River inflow (USFWS 2002b). In response to public concern over the presence of nuisance algae due to high phosphorus concentrations, Lake Pend Oreille was 303(d) listed for nutrients, and a TMDL was established for the nearshore portions of the lake in 2002 (Tetra Tech and Tri-State Water Quality Council 2002). Toxic substances (primarily heavy metals) emanating from abandoned mine sites could block migratory corridors or impact life stages of bull trout, but, to date, heavy metals have not been identified as a significant water quality problem in the direct tributaries to Lake Pend Oreille (USFWS 2002b).

The states of Idaho and Washington and the Kalispel Tribe have established a water quality maximum standard of 110 percent saturation for TDG. Operation of Cabinet Gorge Dam influences TDG saturation levels in Lake Pend Oreille and at Albeni Falls Dam. TDG below Albeni Falls Dam can exceed 110 percent saturation during high-flow events (Corps and

Bonneville 2011b). A band of land surrounding the lake drains directly to the lake rather than through tributary flows. This band represents the nearshore drainage area that affects nearshore water quality. The dominant land use in this nearshore drainage area is forest; however, there are areas of concentrated developed land in the nearshore drainage of the lake (Tetra Tech and Tri-State Water Quality Council 2002, pp. 7-8). Seasonal fluctuations in lake levels controlled from Albeni Falls Dam expose shoreline areas during drawdown in winter, making these areas more susceptible to erosion (Corps and Bonneville 2011b).

PBF 8 is present in the Pend Oreille River, but bull trout reproduction does not occur there. Portions of the river downstream of Lake Pend Oreille are 303(d) listed for temperature and dissolved gas supersaturation (Pickett 2004). Ongoing efforts at Cabinet Gorge Dam to mitigate and reduce seasonally elevated levels of TDG are progressing through modifications to the dam and spill gates (Weitkamp et al. 2003a; b; Peterson et al. 2015).

The Idaho section of the Pend Oreille River was included in the 2002 and 2008 Section 303(d) list as impaired for temperature and total phosphorus (Corps and Bonneville 2011b). Immediately downstream of Albeni Falls Dam, total phosphorus and total nitrogen concentrations have recently been rated as “good” with a median water quality index score of 95.5 for total phosphorus and 100 for total nitrogen (Corps and Bonneville 2011b). In general, present concentrations of nutrients are low in the Pend Oreille River year-round.

Shoreline erosion has been documented downstream of Albeni Falls Dam (Andonaegui 2003). The majority of erosion downstream of Albeni Falls Dam results from high flows during the spring runoff events that scour streambanks and substrates (Corps and Bonneville 2011b). Albeni Falls operations may result in elevated TDG during periods of high flows, which typically occur during the spring freshet. When TDG baseline levels are sufficiently high in the forebay, discharge through the Albeni Falls Dam spillways can lead to exceedances of the TDG water quality standard (Corps et al. 2020a; Pickett and Jones 2007; IDEQ; Corps and Bonneville 2011b). Although spill can increase under Flexible Winter Power Operations or FWPO, increases in TDG would be expected to be relatively low (Corps and Bonneville 2011b).

Water quality is impacted across the entire Clark Fork River CHU as a result of historic mining and land use, dam operations, and elevated temperatures. Given the factors described above, this PBF is considered not properly functioning within the Action Area.

PBF 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.

Kootenai River CHU 30

There are low numbers of non-native fish that compete (brown trout) or hybridize (brook trout) with bull trout in the Lake Koocanusa Core Area compared to some other bull trout Core Areas, although their presence still remains a potential threat (USFWS 2010a).

Bull trout within the Kootenai River Core Area are affected by the presence of non-native fish (e.g., lake trout, kokanee). Brook trout hybridization occurs in West Fisher, Pipe, and O'Brien Creeks (USFWS 2015b). Bull trout compete with brown trout in this Core Area as well (USFWS 2014c). Northern pike are also present and are of concern as both predators and competitors.

The Service considers this PBF to be functioning at risk based on presence of non-native competitive and predatory species as well as hybridizing species throughout the Kootenai River CHU and little indication of negative impacts to bull trout populations, especially in the Lake Koocanusa subunit.

Clark Fork River CHU 31

PBF 9 is present and contributing to FMO habitat in Hungry Horse Reservoir. Hungry Horse Dam functions as a barrier to the spread of non-native lake trout that can compete with bull trout (USFWS 2015b). Brook trout are not present in the reservoir, which has a low abundance of non-native species overall (USFWS 2015a).

PBF 9 is impaired in the Flathead River, and the proliferation of non-native species, particularly northern pike and lake trout, is considered a primary threat to bull trout (USFWS 2015a). Northern pike inhabit sloughs and seasonally flooded off-channel habitat along the Flathead River that are occupied by juvenile bull trout. Muhlfeld et al. (2008) estimate that northern pike consume 0.8 metric tons of bull trout (or nearly 3,500 fish) annually. The USFWS (2014c) reports that successful lake trout control is ongoing in Flathead Lake. Removal efforts in the lake could reduce the presence of lake trout in accessible portions of the Flathead River. Pike are an invasive predatory fish whose introduction has potentially significant consequences for the conservation and recovery of bull trout and other native fish species. Pike are believed to have been illegally introduced to the Flathead River system in Montana during the 1970s or 1980s. The species was dispersed throughout the lower Clark Fork system during a record flood event in 1997 and have subsequently become established in Lake Pend Oreille and in impounded habitats on the mainstem Pend Oreille River downstream of Albeni Falls Dam (CBFWNB 2011). Northern pike were detected in Box Canyon Reservoir on the Pend Oreille River in 2004, probably having migrated downstream from Lake Pend Oreille. The Kalispel Tribe, whose reservation borders the Pend Oreille River in Washington, has documented exponential growth of the population from 400 adult fish in 2006 to 5,500 in 2010, along with an expansion of their range within the river, and is engaged in eradication efforts.

This PBF is impaired in Lake Pend Oreille. Lake trout are common and represent the primary threat to bull trout in the FMO habitat in Lake Pend Oreille (USFWS 2015b). The lake trout population increased substantially in the 1990s. In 2006, IDFG instituted unlimited harvest regulations and started providing a monetary reward to sport anglers for each lake trout or rainbow trout harvested; rewards were discontinued and regulations were reestablished for rainbow trout in 2012. IDFG also hired a commercial fishing crew from the Great Lakes to remove lake trout with gillnets and deepwater trap nets; trap netting was discontinued in 2017. The peak of lake trout removal occurred in 2010 with over 26,000 lake trout taken by anglers and netters, and totals steadily declined through 2014 to about 13,000 fish. Anglers' share topped out in 2007 at about 18,000 fish, then dropped to just 2,600 by 2018 (Rust et al. 2020, p. 34).

Monitoring showed adult and juvenile lake trout were reduced by 64 percent and 56 percent, respectively, since the program began in 2006 (Dux et al. 2019). This program is expected to continue.

In addition to lake trout, Lake Pend Oreille supports a variety of introduced trout, including brook trout, brown trout, and rainbow trout, all of which compete with bull trout for food resources. Additional non-native fishes that threaten bull trout in Lake Pend Oreille include northern pike, walleye, Kamloops rainbow trout, and smallmouth bass (USFWS 2015b).

PBF 9 is impaired in the Pend Oreille River. Both brook trout and brown trout are present in this reach and compete with bull trout for food and habitat at the adult, juvenile, and spawning life stages. Non-native northern pike, smallmouth bass, walleye, and to a lesser extent brown trout and lake trout occupy artificially created FMO habitat downstream of Albeni Falls Dam.

Northern pike, brook trout and lake trout represent significant threats to bull trout productivity and stability across the Clark Fork River CHU, and they are present in many subunits. Based on the presence of non-native competitive and predatory species as well as hybridizing species throughout entire Clark Fork River CHU within the Action Area, the Service considers this PBF not properly functioning.

9.4.3 Conservation Role of the Action Area to Columbia Headwaters Recovery Unit

The CHRU is a stronghold for bull trout, as many of the headwater tributaries provide coldwater refugia, and are located in high elevation wilderness or protected areas. The Action Area within the CHRU encompasses 5 of the 15 Complex Core Areas for bull trout and represent a majority of individuals and geographic area within the total CHRU. These include Lake Pend Oreille, Flathead Lake, Kootenai River, Hungry Horse Reservoir, and Lake Koocanusa. To meet recovery criteria for the CHRU, at least 75 percent of the 15 complex Core Areas must have threats managed. Therefore, the five Core Areas within the Action Area are significant to meeting recovery criteria.

The baseline condition of CHRU populations in the Action Area are degraded as a result of the existence of barriers limiting connectivity, past hydropower operations, historic land management, and the presence of non-native species. Bull trout in these Core Areas are directly and indirectly affected by operations of three Federal projects – Libby Dam, Hungry Horse Dam, and Albeni Falls Dam. Bull trout are also affected by six non-Federal hydropower projects - Boundary, Box Canyon, Noxon Rapids, Thompson Falls, Cabinet Gorge, and SKQ Dam (formerly Kerr Dam).

Bull trout use the Action Area primarily for foraging, overwintering and migration. Lake Koocanusa, Hungry Horse Reservoir, and Lake Pend Oreille each provide large amounts of forage resources and quality habitat that support large fecund adult bull trout each year. Populations adjacent to these large lakes are generally stable and healthy. However, the conditions of populations downstream of the federal dams in the Pend Oreille River, Flathead River, and Kootenai River tend to face greater challenges related to lost connectivity, poor habitat quality, and reduced forage availability.

The lack of fish passage at hydropower projects within the Action Area limit the connectivity of bull trout populations in this Recovery Unit. Libby, Hungry Horse, and Albeni Falls currently offer no fish passage to allow bull trout movement in their Core Areas. In addition, the natural hydrograph has been significantly altered, reducing riparian development, productivity, and habitat quality and increasing erosion and bank stabilization. Legacy effects from mining, logging, road building, and agriculture have adversely effected the water quality and sediment distribution throughout the Recovery Unit. However, many of the headwater tributaries upstream of the Federal projects have some of the highest water quality anywhere in the Recovery Unit.

Bull trout critical habitat occurs throughout the CHRU and the Action Area. In general, critical habitat upstream of the Federal projects appears to be reasonably intact and highly functional. The Federal project reservoirs provide deepwater habitat for adult and sub-adult bull trout. The tributaries provide suitable, perhaps historic, habitat for spawning and rearing. The bull trout in these areas have adapted to an adfluvial life history pattern. Although the lack of passage at the dams has prevented the upstream movement of bull trout, it has also prevented the introduction of non-native fish that would compete or prey on bull trout (e.g. Hungry Horse Dam). Conversely, the critical habitat downstream of the Federal projects is either not functional or is "at risk." These areas are adversely affected by numerous factors including project operations, degraded habitat, non-native fish species, and legacy effects from previous and ongoing human activities.

9.4.4 Mid-Columbia Recovery Unit

The Mid-Columbia Recovery Unit (MCRU) includes portions of central Idaho, eastern Washington, and eastern Oregon (USFWS 2015a; 2015c). Major drainages include the 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. The MCRU encompasses 21 Core Areas, two historically occupied areas, and one RNA (Northwest Washington RNA). The majority of these interact with the Action Area. Bull trout throughout this Recovery Unit co-exist with salmon, steelhead, and, in some areas, Pacific lamprey (USFWS 2015c).

The status of bull trout in the MCRU is variable across the unit. Some Core Areas, such as the Umatilla and Yakima Rivers contain small, threatened populations. However, other Core Areas found in the Imnaha, Clearwater, and Wenatchee River Basins are strong. The stronghold populations tend to occur within intact habitat areas, such as wilderness areas and protected forestlands. Throughout the MCRU, consistent primary threats from upland/riparian land management, habitat loss, fish passage barriers, and water quality and quantity exist (USFWS 2015c). Connectivity between Core Areas of the MCRU is key to the persistence and genetic stability of bull trout.

Due to the wide spatial extent of the MCRU in the Action Area, the discussion of the Recovery Unit was broken into smaller geographic Basins (USFWS 2015c). These include the mainstem Mid-Columbia River (John Day Dam upstream to Canadian border), the Lower Snake River, and the Clearwater River. Generally, bull trout Core Areas in the MCRU fall outside the bounds of the Action Area. However, bull trout from these Core Areas use the Action Area for much of the year to forage, overwinter, and possibly colonize other areas. Therefore, bull trout status, threats, and brief descriptions about habitat use are provided for each of the adjacent Core Areas. The discussion summarizes the use of the Action Area by individual bull trout from adjacent Core Areas and the conservation value of the Action Area to the adjacent Core Areas.

9.4.4.1 Mainstem Mid-Columbia River Basin

In this Opinion, the mainstem Mid-Columbia River Basin encompasses areas of the mainstem Columbia River from John Day Dam to the Canadian border (Figure 7). The Action Area includes Grand Coulee Dam (including impounded waters forming Lake Roosevelt), Chief Joseph Dam (including impounded waters forming Rufus Woods Lake) upstream to Grand Coulee Dam, McNary Dam (including impounded waters forming Lake Wallula), and John Day Dam (including impounded waters forming Lake Umatilla) (Figure 7).

Construction of Grand Coulee Dam and Chief Joseph Dam without fish passage facilities completely blocked passage of salmon, steelhead, bull trout, and other native fish species from areas upstream. Since fish-passage facilities were not constructed, current fish assemblages, above both dams, contain resident native and non-native species. Entrainment (downstream movement) of both non-native and native fish occurs at both dams, but the extent is unclear. Above the two dams, including Rufus Woods Lake, Lake Roosevelt and their tributaries, little information exists on the history and status of bull trout populations. The Service identified the area upstream of Chief Joseph Dam as the Northeast Washington RNA in the 2015 Recovery Plan (USFWS 2015c).

Downstream of Chief Joseph Dam, bull trout populations face threats from connectivity impairment and reduced access to historic FMO habitat in the mainstem Columbia River (USFWS 2015c). Five non-federal dams (Wells, Rocky Reach, Rock Island, Priest Rapids, and Wanapum) are located downstream of Chief Joseph Dam on the mainstem Columbia River. Each non-federal hydroelectric project has undergone FERC licensing, consultation with the Service on operational impacts to bull trout and bull trout critical habitat including flow and backwater fluctuations at tributary mouths, and each coordinates operations with other dams throughout the CRSO. The impacts of their ongoing operation for the length of their FERC licenses are considered in the baseline. McNary Dam is located downstream of the Snake River confluence with the Columbia River, and upstream of the confluence of the Umatilla River and the Columbia River. John Day Dam is located approximately 76 miles downstream of McNary Dam. The John Day River enters the Columbia River just upstream of John Day Dam near Rufus, Oregon.

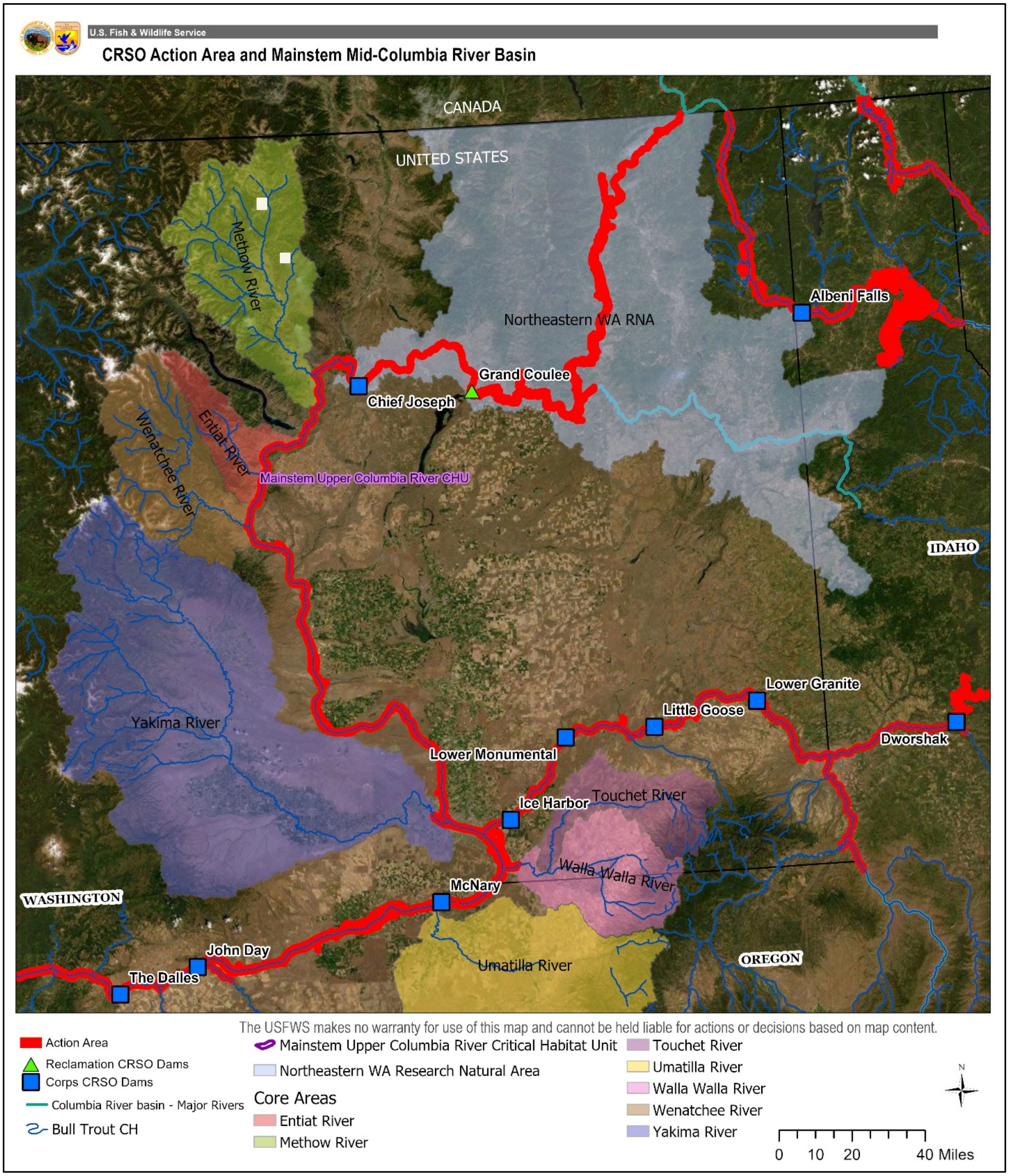

Figure 7. Action Area, bull trout Core Areas, and dams associated with the Mid-Columbia Recovery Unit.

9.4.5 Northeast Washington Research Needs Area

The total drainage area above Grand Coulee Dam is 74,100 mi^2 and includes all of the Columbia River in Canada, and the Kootenai, Pend Oreille/Clark Fork and Spokane Rivers in the U.S., with an average annual runoff of 77 maf (Corps et al. 2020a). The reservoir impounded by Grand Coulee Dam is Franklin D. Roosevelt Lake (Lake Roosevelt), which has a total storage of approximately 9.4 maf, with an active capacity of 5.2 maf, and extends 151 miles upstream to the U.S.-Canada border (Corps et al. 2020a). Grand Coulee Dam and Lake Roosevelt provide the diversion dam for the CBP. Water from Lake Roosevelt is pumped through the John W. Keys III pump generating plant to Banks Lake (a reregulation reservoir) for r distribution to the CBP. Banks Lake is a 715,000 ac-ft reservoir formed by the North Dam, which is located about 2 miles southwest of Grand Coulee Dam, and the Dry Falls Dam, which is located about 29 miles south of Grand Coulee Dam. Banks Lake feeds water to the CBP through the Main Canal at Dry Falls Dam, and provides water to operate the pump/generators in generation mode at John W. Keys III. Current deliveries have a range that average around 2.9 maf, for nearly 700,000 acres of land, but the consultation is for a maximum diversion of up to approximately 3.4maf when fully implemented providing water to around 770,000 acres This total of 3.4 maf includes other irrigation diversions for the CBP that are already part of the environmental baseline; these include 164,000 acre-feet covered by the Odessa Subarea Special Study 2012 Final Environmental Impact Statement and corresponding Section 7 consultation (Reclamation 2012a). The Service completed consultation on the Odessa Special Study on October 10, 2012 (USFWS 2012b) and determined that impacts to bull trout were insignificant (USFWS 2012b). More detail on the CBP is in Section "9.4.7 Consulted on Effects for Bull Trout."

The Northeastern Washington RNA encompasses the mainstem Columbia River and its tributaries above Chief Joseph Dam upstream to the Canadian Border, Spokane River and tributaries upstream to Post Falls Dam, and the Pend Oreille River mainstem and its tributaries, in the U.S., downstream of Boundary Dam.

Geographically, the area is located in the Okanogan Highlands and bounded by the Kettle, Calispell, and Huckleberry Mountain Ranges. Treaty and ceded lands of the Colville, Spokane, and Kalispel tribes overlap much of the area. Major tributaries include the Nespelem, Sanpoil, Spokane (up to Post Falls Dam), Kettle, Colville, and Pend Oreille (up to Boundary Dam) rivers. Approximately 90 percent of this RNA is in public or tribal ownership managed by the U.S. Forest Service (USFS), Colville Confederated Tribes, and the Spokane Tribe of Indians. The National Park Service manages Lake Roosevelt. Lake Roosevelt and numerous other tributaries with sufficient water and temperatures to support bull trout are also present in the area, including Big Sheep, Wilmont, Barnaby, Deep, Sherman, Onion, Ninemile, Stranger, and Hall creeks.

Operation of the CRS which includes Chief Joseph and Grand Coulee dams, have negatively altered bull trout habitat and populations. These dams impound the mainstem Columbia River as managed reservoirs. Some of the major negative impacts include changed flow regimes, increased barriers to movement, and increased interactions with non-native species (Wissmar and

Craig 1997, 2004; Rieman and McIntyre 1993). A significant loss of range in Northeast Washington and Canada as well as connectivity between Core Areas throughout the Columbia River Basin occurred with construction of Chief Joseph and Grand Coulee dams.

Based on interviews with Tribal elders, bull trout appears to have been ubiquitous throughout streams on the Colville Reservation (Hunner and Jones 1996). Accounts by Colville Tribal elders confirm historic presence of bull trout in several of the larger creeks that are direct tributaries to Lake Roosevelt including: Ninemile Creek, Wilmont Creek, Twin Lakes/Stranger Creek, Hall Creek and Barnaby Creek (Hunner and Jones 1996). Bull trout are thought to have been extirpated in several rivers of the Northeast Washington RNA, including the Nespelem, Sanpoil, and Kettle Rivers (USFWS 1998; Mongillo 1993; USFWS 2015c). Bull trout are occasionally observed near the mouths of tributaries in Lake Roosevelt and in the upper mainstem Columbia River. Observation data is sporadic and often anecdotal (USFWS *unpublished data*). Since 2011, reports of bull trout observations in Lake Roosevelt have increased, often in association with high water years. In 2012, observations of 19 bull trout were reported throughout Lake Roosevelt by tribal and educational survey crews, local citizens, and fishing charters (USFWS 2015c). Most of these were assumed to be entrained fish from spawning areas in Canada and the Pend Oreille River. However, genetic assignment to populations has not occurred on any of the bull trout observed. Six bull trout were observed in Sheep Creek that year (Honeycutt in litt. 2014). Another four bull trout were documented in Lake Roosevelt in 2017 (Baker in litt. 2017; Paluch in litt 2019).

In Rufus Woods Lake, bull trout accounted for less than 0.1 percent of the catch during a fish inventory of the lake in 1999 (LeCaire 2000; Beeman et al. 2003). As with Lake Roosevelt bull trout observations, the bull trout likely stem from populations upstream in Canada or the Pend Oreille River Basin. The Colville Confederated Tribes and the NPCC concluded that bull trout use of Rufus Woods Lake was minimal (CCT 2000). Although Chief Joseph Dam operates as a run-of-the-river project, it also reduces the peak discharges from Grand Coulee dam. If bull trout exist in the Nespelem River, a tributary to Rufus Woods Lake, it is likely a resident population upstream of a natural migration barrier located at RM 1.5 (CCT 2000). Although suitable spawning habitat is located in several tributaries to Lake Roosevelt and Rufus Woods Lake, no known spawning occurs in the tributaries.

To date, there are no known observations of bull trout in Banks Lake or Potholes Reservoir. Poor habitat quality, elevated contaminants (303d listed areas, Washington Department of Fish and Wildlife [WDFW] fish consumption restrictions), and high water temperatures within Banks Lake and Potholes Reservoir likely make them inhospitable for bull trout. High levels of non-native species such as bass and walleye further make the reservoirs unsuitable for bull trout.

9.4.5.1.1 Methow, Entiat, Wenatchee, and Yakima River Core Areas

Between Chief Joseph Dam and the Yakima River, the Service considers the mainstem Columbia River as FMO habitat for bull trout. This reach encompasses five non-Federal dams and their associated reservoir pools on the mainstem Columbia River, including Wells Dam (Douglas County Public Utility District (PUD), Rocky Reach and Rock Island dams (Chelan County PUD), and Wanapum and Priest Rapids dams (Grant County PUD). There are six Core Areas adjacent and connected to the mainstem Columbia River through this reach, including the Entiat River, Methow River, Wenatchee River, and Yakima River Core Areas. In addition, the Service identified Chelan and Okanogan rivers as important FMO habitat for bull trout (USFWS 2015c).

Bull trout in the reach below Chief Joseph Dam represent fluvial and adfluvial populations that migrate into the Columbia River mainstem from natal tributaries in nearby Core Areas mentioned above. As many as 34 local populations in the four Core Areas (Methow 10, Entiat 2, Wenatchee 7, and Yakima 15) are connected to the mainstem Columbia River between Chief Joseph Dam and the Yakima River (USFWS 2015c). Evidence of migration to the Columbia River exists for roughly half of these local populations (USFWS 2015c; Barrows et al. 2016; Nelson and Johnson 2012). Abundance in the Action Area reflects habitat conditions and carrying capacity in the tributaries as well as connectivity to the Columbia River. The Service assumes sub-adult and adult presence in the mainstem Columbia River during most months. Crews at Chief Joseph Dam collected two adult bull trout from Turbine 2 in January 2016 during turbine dewatering (S. Stonecipher, Chief Joseph Dam, pers. comm. as cited in Bonneville et al. 2017a). Additional documentation of bull trout in the Chief Joseph Dam tailrace has occurred sporadically in the past during surveys and recreational fisheries. These fish likely originated from a local Core Area and migrated upstream into the draft tube, given the low likelihood bull trout originated from populations upstream of Grand Coulee Dam that were entrained.

Approximately 73 adult (~16 per year bull trout have been counted at Wells Dam. Crews count an average of 176 adult bull trout at Rocky Reach Dam and an average of 93 adult bull trout at Rock Island Dam each year (Stevenson et al. 2009). Radio telemetry and PIT tag information have showed that bull trout from the Methow Core Area have been observed at each of these dams and adults can migrate downstream through turbines, spill, or smolt bypass systems and return through upstream adult salmon ladders. BioAnalysts, Inc. (2004; 2007; 2008) and LGL and Douglas PUD (2008) described successful spawning migrations with minimal delay between dams. A total of 414 PIT tagged bull trout have interacted with Wells Dam, recently (Douglas PUD 2016 p. 11). At Rocky Reach and Rock Island dams, total detections of bull trout have been 1,413 (Stevenson et al. 2009). An average of five adult bull trout are observed in the upstream passage facilities at Priest Rapids and Wanapum dams annually. While observations of adult and sub-adult bull trout have occurred at all five non-federal dams between Chief Joseph and McNary dams, there is limited information on which populations they derive from. Therefore, these observations could stem from any population in the Methow, Entiat, Wenatchee, Yakima, and Walla Walla Core Areas.

Since 2000, the Service has completed several consultations on the five non-federal dams operated in this reach of the Columbia River (USFWS 2006b; 2007; 2008b; 2011b; 2012c). In the following sections, the Service provides a brief summary of baseline conditions for Core Areas between Chief Joseph Dam and the Yakima River, including use of the Action Area by bull trout from those adjacent Core Areas. Detailed descriptions on the status of bull trout and bull trout critical habitat is incorporate by reference (USFWS 2006b; 2007; 2008b; 2011b; 2012c).

Methow River Core Area

The Methow River Core Area is located in Okanogan County and drains an area of approximately 4,895 square kilometers (km^2) (1,890 mi^2) (NPCC 2004b). The watershed drains in a northwest to southeast direction and over 60 percent of the annual precipitation within the Methow River Basin occurs between October and March (NPCC 2004b; Parametrix, Inc. et al 2000). The confluence of the mouth of the Methow River with the Columbia River is at RKM 843 (RM 524) near Pateros in north central Washington. Both legacy and ongoing threats continue to impact bull trout populations in the Methow Core Area. Management actions such as fire suppression and timber harvesting have changed much of the area to an unnatural high-intensity fire regime with increased fire burned areas, where high-intensity summer rainstorms and rain on snow events can accelerate rates of erosion. Forest management on both National Forest and private timber lands, agriculture operations, fish management at the Winthrop National Fish Hatchery, and numerous irrigation diversions have both legacy and current ongoing impacts affecting the Core Area. Connectivity between Core Areas from dam operations impact persistence of bull trout in the Core Area (USFWS 2015c).

In the Methow River Core Area, bull trout persist at low numbers, in ten small, fragmented, local populations (DeHaan and Neibauer 2012). Since 2000, total redd counts have remained relatively stable between 117 and 174, with an annual average of 152 (DeHaan and Neibauer 2012). The Methow River Core Area exhibits multiple life history strategies similar to other Core Areas in the Columbia River. As many as 15 to 20 percent of bull trout in this Core Area migrate between other Core Areas and to the mainstem Columbia River annually (USFWS 2015c; USFWS 2006b; Nelson and Nelle 2008; Kelly Ringel et al. 2014; BioAnalysts 2004; Stevenson et al. 2009).

Radio telemetry, screw traps, and other monitoring occurring throughout the Basin indicates that sub-adult bull trout move into the Columbia River in spring and fall months, while the majority of adult movements occur between September and December after spawning (Barrows et al. 2016). Early fall movement of sub-adult bull trout may be impacted in the Twisp River, Lost River, and mainstem Methow River because of seasonal dry or subsurface flow reaches (Nelson and Johnson 2012; LGL and Douglas PUD 2008).

Entiat River Core Area

The Entiat River is located in Chelan County and drains an area of approximately 1,085 km^2 (419 mi^2) (NPCC 2004b; Andonaegui 1999). The headwaters of the Entiat River are in glaciated Basins near the Cascade Crest. Flowing southeasterly the Entiat River enters the Columbia River near the town of Entiat, approximately 32 kilometers (km) (20 miles) upstream from Wenatchee at RM 484 of the Columbia River (USFS 2017). Due to the small size of the watershed, bull trout habitat and carrying capacity is limited in the Entiat River Core Area. Entiat Falls, located at approximately RM 34, limits the upstream range of bull trout in the Basin (USFS 2017). Legacy and ongoing land management actions have negatively affected bull trout habitat, and have included timber harvest and fire suppression that have increased the risk for catastrophic and high intensity fires in the Basin. In addition, irrigation diversions, grazing, and overfishing threatened bull trout populations. The Entiat River is also subject to anchor ice scour in winter and flooding in spring and fall rainstorms, which combined with fire, irrigation, and grazing impacts has led to increased loss of habitat complexity. Loss of connectivity between Core

Areas in this region of the Columbia River have further impacted bull trout population resiliency. Unique to the Entiat River Core Area, as much as 90 percent of the population uses the mainstem Columbia River for FMO (USFWS 2015c).

Currently, the Entiat Core Area supports two local populations of bull trout: one in the upper mainstem Entiat River and one in the Mad River. Since 2000, the number of redds in the Entiat River has fluctuated widely between 1 and 50 (Nelson 2014 p. 27). Within the Mad River, redd counts have varied from 7 to 52, continuing this trend through 2012 (USFS 2003 p. 1; Nelson 2014 p. 27). The low numbers of spawning migratory bull trout in the Entiat Core Area increases the risk of extirpation from stochastic events. High variations in annual redd counts, high risk of extirpation from stochastic events, and reduced connectivity with other Core Areas classifies the Entiat River Core Area as depressed in this Opinion. Bull trout from the Entiat Core Area move into the Columbia River at similar timing as the Methow populations (Barrows et al. 2016). Returning spawners begin staging at the mouth of the Entiat River in May and June (Nelson 2014 p. i). Sub-adults move out of the Entiat in both the spring and fall and have been documented moving upstream of Wells Dam, downstream into the Wenatchee (Nelson et al. 2011; Nelson 2014 p. i), Yakima Rivers, and moving up into the Yakima River in June, staying for up to 9 months and moving back to the spawning grounds in the Entiat River.

Wenatchee River Core Area

The Wenatchee Basin is located in Chelan County and encompasses approximately 3,551 km^2 (1,371 mi^2) in central Washington (NPCC 2004b; Andonaegui 2001). The Wenatchee River drains into the Columbia River at RM 470 near the town of Wenatchee (NPCC 2004b). There are seven local populations in tributaries of the Wenatchee River including the White and Little Wenatchee Rivers, the Chiwawa River, Nason Creek, Chiwaukim Creek, Icicle Creek, and Peshastin Creek, (USFWS 2015c). In the Wenatchee Core Area, threats to bull trout include habitat loss, historical land use practices including timber harvest, water withdrawals, fish management, and lost connectivity (USFWS 2015c).

The Wenatchee River Core Area exhibits multiple life history patterns and is one of the most diverse populations in the MCRU (USFWS 2015c). Most populations spawn from mid-September to mid-October. Local populations consist of a migratory form that migrates from spawning areas near the crest of the Cascade Mountains to Lake Wenatchee, the mainstem Wenatchee, the Columbia River and back to other Core Areas to forage and overwinter. A small percentage (15 to 20 percent) is estimated to migrate long distances, including into other Core Area, for foraging or overwintering and may migrate back to spawning areas annually, semi-annually, or every few years (USFWS 2006b; Kelly Ringel et al. 2014; BioAnalysts 2004; Nelson and Nelle 2008; Stevenson et al. 2009). Resident bull trout exist upstream of barrier falls (i.e., Little Wenatchee River). Two populations are declining in abundances (i.e. Nason and the Little Wenatchee) with fewer than 10 redds from approximately 20 migratory individuals; three populations have moderate abundance (i.e. Peshastin, Chiwaukum, and Icicle Creeks); and two populations are strong (i.e. White and Chiwawa). The Chiwawa is the only population in the Wenatchee River Core Area that exhibits all life history stages and remains stable with 500 to 1,000 migratory redds annually. The Chiwawa River also exhibits both lacustrine-fluvial and lacustrine adfluvial forms, which migrate both upstream and downstream of rivers and lakes to spawn. Overall, the trend for the Wenatchee Core Area seems to be stable and suggests a slightly increasing trend, although most of the stable trend is due to a single local population in the Chiwawa River.

Yakima River Core Area

The Yakima River Basin is located in south central Washington, draining approximately 15,900 km^2 (6,155 mi^2) into the Columbia River (NPCC 2004c; WDFW 1997). The Yakima River flows southeasterly from its headwaters in the Cascade Mountains to its confluence with the Columbia River at RM 333 (NPCC 2004c). Historic and ongoing land use including irrigation and agriculture altered the Yakima River Core Area (USFWS 2015c). The Yakima River Basin's water supply is over-allocated, and reservoir storage and flow releases are highly regulated, emphasizing irrigation and flood control obligations above all other functions. The effects of the highly altered flow regime on the bull trout and its designated critical habitat include mortality, reduction of prey, disruption of aquatic functions, and poor habitat connectivity that impairs or prevents bull trout from accessing spawning tributaries and limits FMO opportunities, and impacts to water quality and quantity.

Five major storage reservoirs are located in the upper Yakima, Naches, and Tieton Basins. These storage reservoirs and associated dams have restricted connectivity and movement between populations in the Core Area, as well as limited downstream movement to the mainstem Columbia River (USFWS 2015c). In addition, altered flow regimes have increased water temperatures in the lower Basin. Other threats facing populations of bull trout in the Yakima Core Area include legacy impacts of transportation infrastructure, grazing, non-native species introductions, and small population size (USFWS 2015c). The Service is currently consulting with Reclamation on the operations and maintenance of the Yakima Irrigation Project (FWS Reference: 01EWFW00-2015-F-0651) for effects to bull trout and bull trout critical habitat. The Yakima Irrigation Project is a large water delivery system operated by Reclamation and includes: 5 major storage reservoirs, 3 smaller dams, and 6 major diversions that deliver water to irrigate 175,503 ac. The network includes 420 miles of canals, 1,697 miles of laterals, and 81 pumping plants. There are also two hydropower plants, each with a power canal about 10 miles long. Reclamation is also responsible for the fish facilities (screens, ladders, traps) associated with the structures. The Action Area is nearly the entire Yakima River Basin.

Bull trout populations are distributed across the Yakima River Core Area in 15 local populations but are adversely effected by the lack of fish passage at dams and diversions. Currently, populations appear to be declining. Three populations are considered functionally extirpated (i.e., Teanaway, Cle Elum, and Waptus) based on little to no observations of spawning (USFWS 2015c). Seven of the local populations (i.e., Ahtanum, Crow, N. Fork Tieton, Box Canyon, Kachess, Gold, and Upper Yakima River) have extremely low abundance (i.e., less than 20 redds/population). Rattlesnake Creek and American River exhibit moderate abundance with average annual redd counts between 20 and 50 (USFWS 2015c). Two populations (Indian Creek and Deep Creek) used to be stable but are now in a rapid decline, likely due to variables within the Rimrock and Bumping Reservoirs. In addition, several landslides and droughts have affected spawning areas and connectivity. Populations in South Fork Tieton appear stable with average annual redd counts ranging from 137 to 207 on average (USFWS 2015c). It is likely that historically, the mainstem Columbia River provided valuable overwintering and foraging areas for bull trout from the Basin (Barrows et al. 2016). To date, there is no documentation of bull trout from the Yakima Core Area moving from the headwaters into the mainstem Columbia River but the movement of bull trout in this Core Area to the Columbia River has not been well-studied (Barrows et al. 2016). Bull trout from the Entiat Core Area move into the Yakima (see Entiat discussion) and back to the Entiat to spawn. In addition, bull trout from the Walla Walla River move up the Columbia River above the Yakima and through Priest Rapids Dam. Currently, the lack of passage and very low abundance of Yakima bull trout likely reduce migration to the Columbia River and interactions with other Core Areas connected to the Columbia River (i.e. Entiat, Methow, Wenatchee, and Walla Walla).

9.4.5.1.2 Walla Walla River and Touchet Core Areas

McNary Dam is located just downstream of the Walla Walla River confluence with the Columbia River. The Walla Walla River headwaters drain from the western slopes of the Blue Mountains in northeastern Oregon/southeastern Washington to its confluence with the Columbia River at approximately RM 316 (Schaller et al. 2014). Major tributaries include the Touchet River (a separate Core Area), Mill Creek, and the South Fork of the Walla Walla River (South Fork). The North Fork Walla Walla River (North Fork) and Yellowhawk Creek are smaller tributaries within this Core Area. The Walla Walla River Core Area contains three local populations in upper Mill Creek, Low Creek, and the South Fork Walla Walla River. Primary threats within the Walla Walla River Core Area include dewatering/low flows that result in seasonal barriers; water quality impairments from multiple sources (e.g., agricultural practices, urban development), elevated water temperatures, and structural passage barriers to migration (USFWS 2015c; 2008a). Improving connectivity among local populations and between Core Areas throughout the Walla Walla River watershed and the mainstem Columbia River is critical to maintaining redundancy and supporting resiliency of bull trout in the Walla Walla River Core Area (USFWS 2015c; Schaller et al. 2014).

While the South Fork Walla Walla and Mill Creek currently support sizable populations of bull trout, including multiple life history expressions (Schaller et al. 2014), redd counts over the last 15 years have indicated notable declines in abundance (USFWS 2015c; Anglin et al 2008a, 2008b). Between 2001 and 2012, redd counts in the South Fork Walla Walla declined from over 400 to 100. Populations in Mill Creek also declined as much as 63 percent between 2006 and 2010 (USFWS 2015c; Howell and Sankovich 2012, Howell et al. 2018). Several reports attribute declines in population to loss or reduced numbers of large migratory bull trout throughout the Basin (USFWS 2015c; Schaller et al. 2014; Barrows et al. 2016).

Bull trout migrations in the Walla Walla River Core Area are relatively well-documented (Barrows et al. 2016; Al-Chokhachy and Budy 2007, 2008; Al-Chokhachy et al. 2005, 2007, 2008, 2009; Budy et al. 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012; Bowerman and Budy 2012; Bowerman 2013; Hemmingsen et al. 2001a, 2001b, 2001c, 2001d, 2002). Bull trout entering the Columbia River range between sub-adults (> 200 millimeters [mm]) and small adults (< 350 mm) (Anglin et al. 2008b, 2009a, 2009b, 2010; Barrows et al. 2012a, 2012b). Downstream movements to the mainstem Walla Walla River or Columbia River typically begin in March and continue as surface flows decrease and water temperatures increase in June through August (Schaller et al. 2014; Koch 2014). Downstream migration resumes during fall and winter into lower subbasin reaches (i.e., lower one-third of the subbasin) and into the mainstem Columbia River through February (Barrows et al. 2016). Mobile tracking data from acoustic-tagged bull trout indicated that bull trout were actively moving while occupying the mainstem Columbia River corridor (Barrows et al. 2016).

Bull trout return to the Walla Walla River and into upper tributaries between March through June, generally peaking in April and May. However, only 54 percent of the acoustic-tagged bull trout that entered the Columbia River subsequently returned to the mouth of the Walla Walla River. To reach overwintering areas after spawning, bull trout make rapid, incremental downstream movements as far as the mainstem Columbia River from September through February (Barrows et al. 2016).

Between 2005 and 2009, the Corps funded the installation and operation of a PIT detection array near the mouth of the Walla Walla River. The purpose was to determine bull trout use of the Columbia River, and to estimate the number of Walla Walla subbasin bull trout that were using the Columbia River (Anglin et al. 2008b, 2009a, 2009b, 2010; Barrows et al. 2012a, 2012b). Eighty-nine PIT-tagged bull trout were detected moving downstream past the PIT array from October through February, peaking in November and December during most migration years. Sixteen (18 percent) were subsequently detected returning to ascend the Walla Walla River, of which only two (13 percent) reached headwater spawning areas. Only one (1 percent) of the 89 individual bull trout detected at the ORB PIT array has migrated to the Columbia River multiple times. PIT tags from six (7 percent) of the individual bull trout detected at the ORB PIT array were subsequently recovered on avian nesting colonies on islands in the mainstem Columbia River (Barrows et al. 2016). One bull trout was recaptured within the Umatilla River Subbasin. The ultimate fates of 66 (74 percent) of the 89 PIT-tagged bull trout that were detected at the Oasis Road Bridge PIT array are unknown but they did not return to ascend the Walla Walla River (Barrows et al. 2016). Data from PIT-tagged bull trout indicate that bull trout use the mainstem Columbia River year-round and likely interact frequently with McNary Dam and other dams throughout the Action Area.

As a tributary to the Walla Walla River, the Touchet River Core Area drains the northern and northwestern portions of the Walla Walla Basin before entering the lower mainstem Walla Walla River about 21.6 miles upstream of the Columbia River near the community of Touchet, Washington. The North Fork, South Fork and Wolf Fork feed into the Touchet River at the base of the Blue Mountains near the City of Dayton. Lewis Creek and Spangler Creek are main tributaries to the North Fork Touchet River, while the Burnt Fork is the main tributary to the South Fork Touchet River. Elevated water temperatures from factors such as damaged riparian vegetation, increased sedimentation, and decreased water flows have reduced habitat quality for bull trout in the Touchet drainage (USFWS 2015c; Mendel et al. 2003). Flood control levees have confined the river and reduced channel complexity and wood recruitment. Recent climate change modeling indicates that the Touchet drainage is at high risk for reduced instream summer flows, elevated water temperatures, and reduced habitat suitability into the future and existing habitat threats will likely be exacerbated (USFWS 2015c; Schaller et al. 2014).

Historically, bull trout were widely distributed in the Touchet River watershed (Mendel et al. 2003). Local populations in the Touchet River Core Area occur in the North Fork, Wolf Fork, and in the Burnt Fork of the South Fork Touchet River (Kassler and Mendel 2007; Mendel et al. 2014). Kassler and Mendel (2007) determined that more than 50 percent of migratory bull trout in the Touchet River Core Area originate from the Wolf Fork population. Redd counts in the North Fork and Wolf Fork between 1999 and 2013 suggest that these two local populations are stable (Mendel et al. 2014). However, redd count data for the Burnt Fork of the South Fork Touchet is more limited. Bull trout redds were first observed in 2000, but were not detected in 2003 or 2004 (Mendel et al. 2004; Mendel et al. 2007; Mahoney et al. 2006, 2008, 2012; Fitzgerald, pers. comm. 2015). Few surveys have been conducted since.

Several studies looked extensively at bull trout spawning and early life history in the Touchet River Core Area (Mendel et al. 1999, 2000, 2001; Mahoney et al. 2012). Both fluvial migratory and resident forms are present throughout. However, recent telemetry and PIT tag data indicate migratory bull trout in the Touchet River Core Area remain within the overall Walla Walla Basin, foraging and overwintering in the lower Touchet drainage or mainstem Walla Walla River, and do not migrate further downstream into the Columbia River (Schaller et al. 2014). While there are no barriers to movement of Touchet River bull trout into the Columbia River, the large amount of data indicate unlikely use by this Core Area (Barrows et al. 2016).

9.4.5.1.3 Umatilla River Core Area

Umatilla River Basin headwaters drain from the coniferous forested, western slopes of the Blue Mountains in northeastern Oregon through steep volcanic canyons, rolling foothills, and broad alluvial lowlands before eventually reaching the Columbia River at about RM 292 below McNary Dam (USFWS 2002c). Major tributaries of the Umatilla River include the North and South forks, Meacham Creek, Birch Creek, Butter Creek, and Wildhorse Creek. Of these, the North and South forks and Meacham Creek contain the most current and potential bull trout spawning and rearing habitat for bull trout (USFWS 2002c). The recovery plan (USFWS 2015c) identified one local population, the upper Umatilla Complex that includes the North Fork and South Fork Umatilla Rivers, although spawning has only been documented in the North Fork Umatilla River.

Along the Umatilla River downstream from Pendleton, irrigated agriculture dominates, and there are six major irrigation dams and diversions (Anglin et al. 2008a). Historically, sections of the lower river were often dewatered during the irrigation season (March to October). Congress enacted the Umatilla River Project Act in 1988 to ensure adequate flows were provided for migrating salmon and steelhead. Despite the enactment, sections of the mainstem Umatilla River have inadequate streamflows to provide fish passage (typically from mid-July to late August) (Anglin et al. 2008a). Water temperature data from the South Fork Umatilla River and its tributaries indicate that suitable habitat for bull trout is very limited in this drainage (USFS 2001a, Contor 2007). The 16-km (10-mile) section of the mainstem Umatilla River downstream from the mouth of McKay Creek (RKM 82 [RM 51]) is the only section of the lower river thought to have summer temperatures suitable for salmonids (Contor 2007). This section of the stream is kept artificially cool by hypolimnetic (deep, colder) water releases from McKay Reservoir. The greatest threats within the Umatilla Core Area include water quality impairment from multiple sources (e.g., agricultural practices, urban development, etc.), dewatering/low flows, agricultural practices (irrigation diversions, water quality effects), passage barriers to migration, and development (e.g., urbanization and transportation networks) (USFWS 2008a).

The Umatilla River contains both resident and fluvial bull trout. At the time of listing, the one local population in the Basin was considered depressed (USFWS 1998b). In 2008, the population was estimated between 50 to 250 individuals, but the trend in abundance was unknown (USFWS 2008a). Redd counts have been done each year since 1998 on the North Fork Umatilla River, and periodically in the South Fork Umatilla River and North Fork Meacham Creek. In 2003 and 2004, the North Fork Umatilla River appeared to support the Core Area's entire bull trout spawning population, with no redds detected in the South Fork Umatilla or in North Fork Meacham Creek. Redd totals on the North Fork Umatilla River have fluctuated considerably, and have averaged about 50 redds since 1998. However, redd counts between 2009 and 2013 resulted in an annual average of 19 redds (USFWS 2015c). This indicates the population is very depressed. Solitary bull trout are occasionally captured at Three Mile Dam in the lower Umatilla River, so migration to and from the Columbia River is likely (Barrows et al 2016 p. 57). Between 2006 and 2015, four bull trout were observed in McNary Dam ladders, based on visual counts and PIT detections (Bonneville et al. 2017).

9.4.5.1.4 John Day River Core Areas

The John Day River is the fourth largest drainage Basin in Oregon, consisting of the Upper Mainstem, North Fork, Middle Fork, and South Fork rivers. The 20,979 km^2 (8,100 mi^2) river Basin contains more than 804 km (500 miles) of stream in the mainstem and its three forks. The John Day River is one of the longest free-flowing streams in the continental U.S. (BLM 2001, p 1). The Upper Mainstem, Middle and North Fork Rivers, constituting the three Core Areas in this Basin, originate in the Blue Mountains, and the South Fork originates in the Ochoco Mountains. The mainstem originates southeast of the community of Prairie City and flows west through the communities of John Day and Dayville where it is joined by the South Fork. Downstream from Dayville, the river turns north through Picture Gorge and continues on to the community of Kimberly, where it joins with the North Fork. The Middle Fork joins the North Fork 32 miles upstream from the confluence of the North Fork and the mainstem, 13 miles from the town of Monument. The division between the upper mainstem John Day River and lower John Day River occurs at the confluence of the North Fork and mainstem. The lower John Day River is considered FMO habitat that is used seasonally by bull trout.

Agriculture is the main land-use practice affecting bull trout in the John Day River Basin. A high number of push-up dams, unscreened irrigation diversions and livestock grazing occur within bull trout habitat. These land-use practices result in intermittent passage, and resultant impacts such as sedimentation, reduced flows, channel alteration and associated water quality impacts (CBMRCDA 2005 p. 41). Although numerous passage improvement projects have been implemented over the last decade, many issues persist, especially in the mainstem John Day River.

Bull trout abundance measures or descriptors of species status were not presented in the listing document. Recent (2015-2017) redd surveys and occupancy work in the all three Core Areas do not provide sufficient information to generate abundance estimates at the Core Area or population scales. However, bull trout were detected in most populations in all Core Areas at low numbers, indicating depressed populations. Sub-adult and adult bull trout are regularly captured in low numbers while sampling spring Chinook during March and April in the mainstem John Day River near Spray indicating movement into and use of FMO habitat (ODFW, unpublished data).

Information on use of the mainstem Columbia River by bull trout individuals in John Day River Core Areas is limited. To date, a total of three bull trout have been counted in the fish ladders at John Day Dam from 2006-2015. PIT detection systems were not installed in the fish ladders at John Day Dam until the winter of 2016 to 2017, so the origin of those fish is unknown (Bonneville et al. 2017). Given the information above and the vast quantity of habitat available for bull trout in the John Day River Basin, it is expected that, while bull trout could enter the mainstem Columbia River, total numbers are likely to be low due to low populations and the extent of available habitat in the John Day River Basin.

9.4.5.2 Lower Snake River Basin

The Lower Snake River Basin of the MCRU includes the Snake River from the confluence of the Salmon River downstream to its confluence with the Columbia River (Figures 5 and 8). Four project dams are located on the Snake River: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams (Figure 8). Since the 2000 Opinion (USFWS 2000), operation and structural components of the four Snake River dams have changed through coordinated efforts to reduce impacts to salmon and steelhead (Corps et al. 2020a). The Snake River between Lower Granite Dam and the confluence with the Columbia River includes three impoundments created by Little Goose, Lower Monumental, and Ice Harbor Dams. Asotin Creek and the Clearwater River enter the Snake River upstream of Lower Granite Dam within the Action Area. The Tucannon River and the Palouse River enter the Snake River in the lower portion of Lower Monumental Reservoir. Meadow and Deadman creeks are smaller tributaries to Little Goose Reservoir, but do not contain bull trout and are not designated as critical habitat.

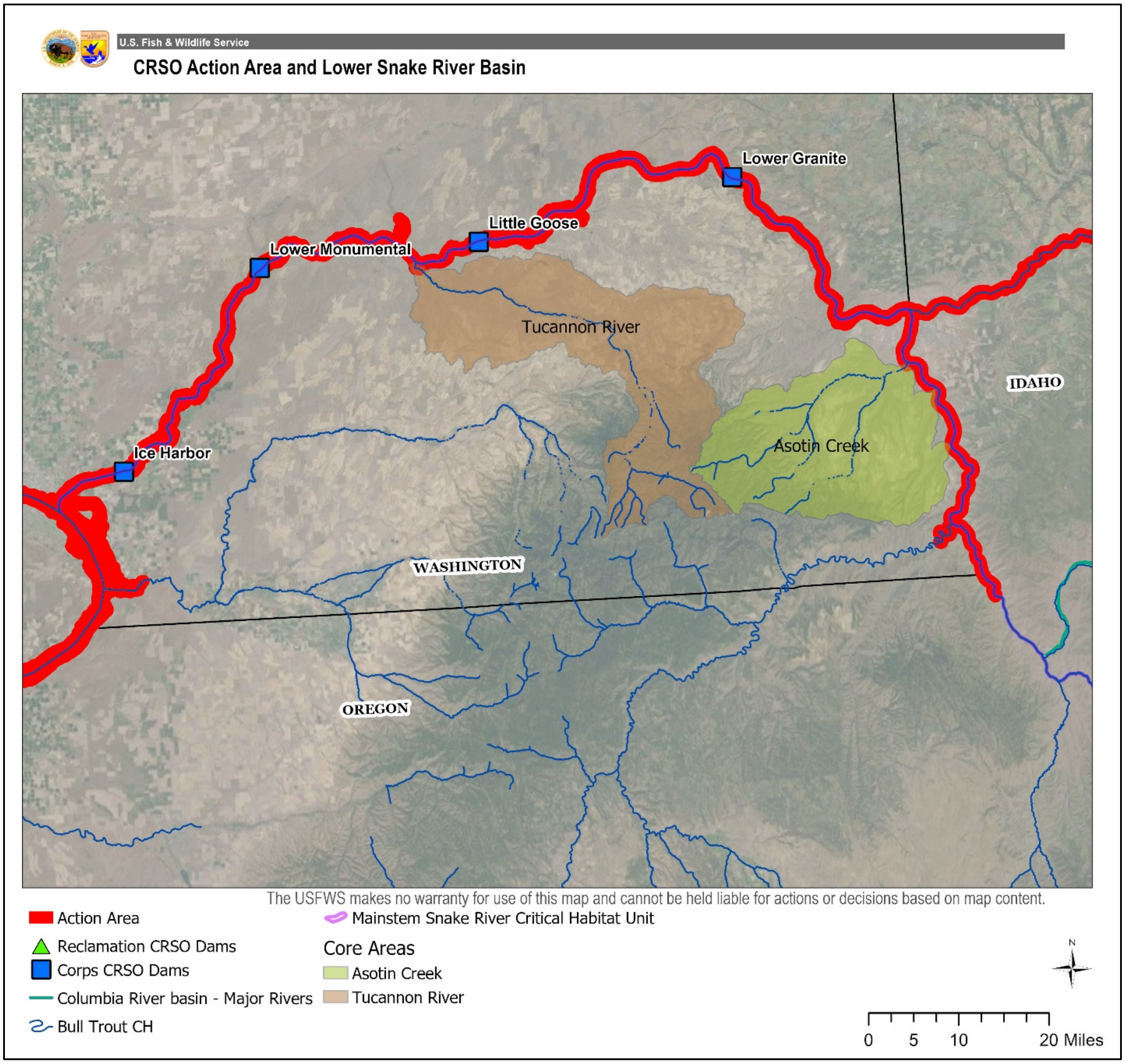

Figure 8. Lower Snake River Region within the Action Area, bull trout Core Areas, and associated dams.

The Lower Snake River Region supports six Core Areas for bull trout (i.e. Clearwater River Basin [four Core Areas], Tucannon River, and Asotin Creek). In addition, individuals from Core Areas outside of the Action Area, such as from the Grande Ronde, Imnaha and Salmon River Basins may enter the Snake River and Action Area throughout the year. FMO habitats for bull trout occur in the mainstem Snake River and in the middle to lower reaches of major tributaries, while spawning and rearing habitats occur in the extreme upper reaches of the major tributaries. In general, sub-adult bull trout migrate from their respective subbasins to the Snake River during the fall/winter (from October to February), and to some extent during the spring/early summer (April to June) (Barrows et al. 2016). Movement from some subbasins to the mainstem has been documented during other months, but this was less common (Barrows et al. 2016). Upstream movements within the mainstem river corridor were most common during the spring and summer (from March to September), and less frequent from October to November. Downstream movements were documented in the mainstem during all months (Barrows et al. 2016). Downstream passage timing for bull trout includes the time period when the juvenile fish bypass systems at the dams are shut down, leaving the turbines and adult fish ladders as the remaining downstream passage routes (Barrows et al. 2016).

Radio-tagged bull trout from mid-Columbia subbasins exhibit a wide range of behaviors, moving upstream, downstream, displaying high fidelity to an area, or showing no discernible pattern to their movements (Barrows et al. 2016). In addition, subadults from mid-Columbia River subbasins can spend multiple years using FMO habitat in the mainstem before ascending tributaries to spawn (Barrows et al. 2016).

Bull trout use of the Lower Snake River has been documented from observations in the fish ladders, PIT tag detections in the fish ladders and juvenile bypass systems, through various research projects, through PIT tag detections from bull trout entering the mainstem from tributary subbasins, and through anecdotal accounts (Barrows et al. 2016). In many cases, it is unknown from which populations or Core Areas these bull trout originate (Table 4). Therefore, total observations at the Snake River Dams are summarized below (Table 5). While bull trout have been documented at the Lower Snake River dams and facilities, the exact number of bull trout at the facilities remains unknown. It is likely the numbers below are low in relation to total numbers of bull trout present in the Snake River.

Table 4. Total bull trout PIT tag detections at CRS dams from 2006 - August 2018.

Dam	Total # detected (range per year)	Size Range at tagging (mm)	Watershed tagged, if known
Bonneville	2 (0 - 1)	180 - 193	50% Hood River 50% White Salmon River
John Day	0	N/A	N/A
McNary	6 (0 - 3)	144 - 314	25% Tucannon River 75% Walla Walla River
Ice Harbor	2 (0 - 2)	233 - 234	100% Tucannon River
Lower Monumental	9 (0 - 4)	234 - 370	22% Unknown origin 78% Walla Walla River
Little Goose	18 (0 - 5)	179 - 580	38% Tucannon River 72% Unknown origin
Lower Granite	14 (0 - 9)	265 - 410	8% Tucannon River 92% Unknown origin

(Source: PTAGIS)

Table 5. Bull trout observations at passage facilities at the Lower Columbia and Snake River Dams

Bull Trout Observations between 1991 and 2014 at Lower Snake River Dams		**Bull Trout Observations between 2005 and 2014 at Lower Columbia River Dams**	
Dam Facility	**Total number (range/yr for adult ladders only)**	**Dam Facility**	**Total number (range/yr)**
Ice Harbor	4 (0-3)	McNary	2 (0-2)
Lower Monumental	179 (2-47)	John Day	4 (0-1)
Little Goose	570 (3-161)	The Dalles	0 0
Lower Granite	36 (0-8)	Bonneville	4 (0-3)

(Adapted from Barrows et al. 2016 Appx A)

9.4.5.2.1 Asotin Creek Core Area

Originating out of the Blue Mountains in southeastern Washington, Asotin Creek drains a total area of approximately 83 km^2 (32 mi^2) and includes 524 km (326 miles) of perennial and intermittent streams (Kuttel 2002 p. 79). Asotin Creek enters the Snake River near Clarkston, Washington at RKM 234 (RM 145), and approximately 56 km (35 miles) upstream of Lower Granite Dam (Kuttel 2002 p. 14; Barrows et al. 2016). Main tributaries to Asotin Creek include George, Charley, North Fork Asotin, Pintler, and South Fork Asotin Creeks (Kuttel 2002 p. 79; Barrows et al. 2016). Land use through the Basin consists of residential, agricultural, and public land uses. The majority of the Asotin Creek headwaters occur on public lands in the Umatilla National Forest and in the Asotin Creek Wildlife Area managed by Washington Department of Fish and Wildlife (2006). The Asotin Creek Wildlife Area includes three non-contiguous management units (Asotin Creek, George Creek, and Weatherly) within the forks and tributaries of Asotin Creek and George Creek (WDFW 2006).

Within the Asotin Creek Core Area, there is one known local bull trout population in North Fork Asotin Creek, which includes Cougar Creek (Kassler and Mendel 2008; J. Trump, pers. comm. 2015). Abundance information and redd count data indicate that the population is very small and likely at critical levels (Martin et al. 1992; Underwood et al. 1995; Mendel et al. 2006; J. Trump, pers. comm. 2015; Barrows et al. 2016). Redd counts in North Fork Asotin and Cougar Creeks ranged from 10 to 13 in survey years 2005, 2006, and 2012 (J. Trump, pers. comm. 2015). Current data suggest that the population consists of both resident and migratory forms of bull trout in the Asotin Creek Core Area (Kassler and Mendel 2008; Mayer and Schuck 2004; Mayer et al. 2006; Crawford et al. 2011; Barrows et al. 2016). However, data also suggests that instream conditions may seasonally limit movement of migratory bull trout in the Basin (Barrows et al. 2016). While studies have shown movement of bull trout throughout the Asotin

Creek Core Area (Barrows et al. 2016) low instream flows, intermittent flows with areas of subsurface flows, and a partial to full passage barrier at Headgate Dam (RM 9 [RKM 6]) negatively impact the persistence of migratory bull trout and reduce connectivity between tributaries within the Core Area.

Legacy effects of livestock grazing, forest practices, transportation, and recreation negatively affect water quality, sedimentation, and channel complexity throughout the Core Area (Kuttel 2002). Extensive flood damage to the channel and riparian zone in the mid-1990s are still apparent in George Creek (Ullman and Barber 2009). Many of these effects in the tributaries are being addressed through watershed planning and implementation processes and other mechanisms (WDFW 2006; Ullman and Barber 2009; Middle Snake Watershed Planning Unit 2011; Ecology 2011). The quality of FMO in the Snake River as well as habitat in the headwaters are likely to be important to the persistence of bull trout in Asotin Creek.

Few bull trout from the Asotin Core Area have been documented in the Snake River in recent years due to few tagging or genetic studies within the Basin. In 2016, a single bull trout from North Fork Asotin was documented at the fish passage facilities at Lower Granite Dam (Tables 4 and 5) (Marsh Pers. Comm. 2017). Due to the small population size of bull trout in the Asotin Core Area, total numbers of bull trout using the Snake River are likely to be low and represent the few remaining migratory bull trout in the Basin.

9.4.5.2.2 Tucannon River Core Area

The Tucannon River originates in the Wenaha-Tucannon Wilderness Area of the Blue Mountains in southeastern Washington and drains approximately 1,303 km^2 (503 mi^2) (CCD 2004; Faler et al. 2008). The Tucannon River enters into the Snake River at RM 62, upstream of Lower Monumental Dam and downstream of Little Goose Dam (USFWS 2000). Several tributaries feed the Tucannon River, including Pataha, Kellogg, Willow, Tumalum, Cummins, and Panjab Creeks (CCD 2004; Bilhimer et al. 2010; Anchor 2011).

Current and historical land uses throughout the Basin include dry and irrigated cropland, livestock rangeland, logging, recreation, and low yield mining (CCD 2004). Much of the headwaters on the mainstem Tucannon River remain in public ownership under management of the USFS and the WDFW (Wooten Wildlife Area). Bull trout still occupy most of their historic range in the Tucannon River watershed, and prior to 2000 the population of the Core Area was considered relatively large (USFWS 2010b). Genetic analyses indicate there are currently five local populations of bull trout, and possibly a sixth, within the Core Area of the Tucannon River watershed (USFWS 2008a; Kassler et al. 2013). These local populations are fairly isolated from local populations in other regional tributaries of the Walla Walla River, Clearwater River, and Asotin Creek (USFWS 2010). Both resident and migratory forms of bull trout still occur in the Tucannon River watershed (Martin et al. 1992; WDFW 1997) and recent data indicate that migratory bull trout from the Tucannon River regularly use the mainstem Snake River (Underwood et al. 1995; WDFW 1997; Faler et al. 2008; Bretz 2011; D. Wills, pers. comm. 2014).

Between 2000 and 2007, redd counts and capture records suggest that populations in the Tucannon River underwent a noticeable decline. The average number of redds documented annually in the upper watershed dropped from over 100 during the early 2000s to less than 20 by 2007 (Mendel et al. 2008; Bretz 2011), while the number of migrating bull trout documented annually at the Tucannon Hatchery trap declined from over 250 to approximately 50 during the same time period (Mendel et al. 2008; Bretz 2011). Many of the bull trout captured in 2007 were also considered in poor health with new or recent injuries (cuts and scrapes) around their heads and gills. The cause(s) of these declines and the poor condition of some of the captured fish are unknown, although two large fires occurred in the Tucannon River watershed during the mid-2000s that resulted in higher sediment delivery to streams in the Core Area (USFWS 2008a).

Over this time, the declines of bull trout may have coincided with a reduction in migratory fish due to fish age (older fish died after spawning) or as a result of seasonal migration barriers preventing returns (Bretz 2011 p. 19). Loss of nutrients and a declining prey base from dwindling anadromous salmonid populations, and physical (e.g., dams, fences, nets, weirs) or temperature barriers in the mainstem Tucannon River and its tributaries are also likely contributing factors (CCD 2004 p. 136). More recent information indicates the Tucannon River population may have rebounded somewhat since 2007, with over 230 bull trout observed during trapping and survey activities in 2013 (WDFW 2014 p. 7) and recent redd count data. However, it is still unclear if the populations have stabilized.

The local populations of bull trout within the Tucannon River watershed can still generally move freely among their natal streams (Deeds 2008 p. 14). However, several partial, seasonal or potential barriers exist throughout the Basin and dams on the Snake River hinder bull trout movement between Core Areas. The Tucannon Hatchery trap, located at RKM 58 (RM 36), is a partial barrier to bull trout movements during the trapping season from January to September. In addition, rock, and debris dams on several Tucannon River tributaries have been known to block migration of bull trout in the watershed (Faler et al. 2008). Other ongoing threats include flood control, irrigation withdrawals, livestock grazing, logging, hydropower production, management of non-native fish species, recreation, urbanization, and transportation networks (USFW 2008; Anchor 2011). Bull trout from the Tucannon River Core Area routinely use the mainstem Snake River and Action Area (Tables 4 and 5).

9.4.5.2.3 Other Snake River Core Areas

Several Core Areas are located outside of the Action Area. However, bull trout from these Core Areas are not limited or blocked from entering the Snake River and Action Area as a result of migratory or foraging activities. In many cases, low to no documentation of use of the mainstem Snake River occurs in the Action Area by bull trout from these other Core Areas. But in some (i.e. Imnaha), bull trout from these Core Areas are observed or documented in the mainstem Snake River or at the dams (Barrows et al. 2016). In all cases, the Service assumes that individuals from these Core Areas may be in the Action Area in low numbers at any time of year.

1. The Clearwater River subbasin has four bull trout Core Areas, and 44 bull trout local populations (described in detail below) (Barrows et al. 2016 p.86). Each Core Area supports migratory bull trout that use the mainstem Clearwater River, but use of the Snake River by migratory bull trout has not been demonstrated (Barrows et al. 2016). Since there are no barriers to downstream movement in to the Snake River, it is expected that bull trout from the Clearwater River Basin may be present in the Snake River at low numbers.

2. The Grande Ronde River supports four Core Areas, with 17 local populations. Three of the Core Areas and at least seven of the local populations support migratory bull trout (Barrows et al. 2016 p. 96). Use of the mainstem Snake River by migratory bull trout from the Grande Ronde River Core Areas has not been directly observed, however sampling near the mouth suggests it is likely. There is no documentation of interactions with mainstem Snake River dams (Barrow et al. 2016). However, given several populations express migratory life histories, the Service expects that small numbers of bull trout from Grande Ronde Core Areas may use the mainstem Snake River and Action Area seasonally for foraging, migration, and overwintering purposes.

3. The Salmon River subbasin, part of the Upper Snake River Recovery Unit, supports 10 Core Areas with 123 local populations (USFWS 2015d p. E-4). The majority of these populations are considered stable. Migratory bull trout are present in all but possibly one of the Core Areas. Migratory adult bull trout disperse seasonally throughout the major tributaries in the subbasin. Use of the Snake River by migratory bull trout has not been demonstrated (Barrows et al. 2016). As with populations in the Grande Ronde, the Service anticipates that, while there has not been documented use of the Snake River by populations in the Salmon River, the expression of migratory life histories and lack of barriers to downstream movement suggest that small numbers of bull trout from Salmon River Core Areas may be present seasonally.

4. The Imnaha River subbasin supports one Core Area with eight local populations (USFWS 2015c p.C-33). The Core Area supports both resident and migratory bull trout. Sub-adult bull trout move into the Lower Snake River mostly in the fall (Barrows et al. 2016 p.103). Adult bull trout move into the Lower Snake River shortly after spawning and continue into January (Barrows et al. 2016 p.103). Approximately 800 to 1200 adult bull trout return from the Lower Snake River to the Imnaha River each year. Radio-telemetry indicates use of the Lower Snake River by bull trout from just below the confluence of the two rivers upstream to Hells Canyon Dam (Barrows et al. 2016). Interactions with mainstem Lower Snake River dams are largely unknown, and none have been detected at the PIT detection arrays on any of the four Lower Snake River dams (Barrows et al. 2016). However, from 2006 to 2011, 12 bull trout were collected at the Little Goose Dam juvenile fish facility, and samples were taken for genetic analysis. One of those samples was determined to be from the Imnaha River.

9.4.5.3 Clearwater River Basin

The Clearwater River Basin is located east of Lewiston, Idaho, and extends from the Snake River confluence at Lewiston on the west to headwaters in the Bitterroot Mountains along the Idaho-Montana border. The Clearwater River Basin includes four Core Areas: South Fork Clearwater River, North Fork Clearwater River, Lochsa River, and the Selway River. The North Fork Clearwater Core Area occurs upstream of Dworshak Dam and is within the Action Area (Figure 9). The mainstem Clearwater River and Middle Fork Clearwater River (Clearwater River shared FMO) provide essential FMO habitat and connectivity between all four Core Areas. Both adult and subadult bull trout use the Clearwater and Middle Fork Clearwater Rivers and various tributaries primarily as foraging, migratory, rearing, and overwintering habitat (USFWS 2015c, pp. C-3, C-321).

Bull trout distribution occurs throughout most of the large rivers and associated tributary systems within the Clearwater River Core Areas (USFWS 2002d) and exhibit adfluvial, fluvial, and resident life history patterns. Fluvial and resident bull trout are the predominant life history forms known to occur within each Core Area. Two naturally occurring adfluvial bull trout populations occur within the Clearwater River Basin; one is associated with Fish Lake in the North Fork Clearwater River drainage, and the other is associated with Fish Lake in the Lochsa River drainage (USFWS 2002d).

The mainstem Clearwater River, Middle Fork Clearwater River, and their tributaries comprise the Clearwater River shared FMO habitat, which encompasses about 664,000 hectares [ha] (1,640,500 ac). Adult and subadult bull trout use the Lower (mainstem) Clearwater River, Middle Fork Clearwater River, and their tributaries primarily as foraging, migratory, subadult rearing, and overwintering habitat (USFWS 2015c), although the extent of use is unclear. Bull trout abundance is very low throughout the Clearwater River shared FMO area (USFWS 2002d); however, the area provides access to Core Areas in the Clearwater River Subbasin, providing essential FMO habitat and connectivity. As described in the next section, several hatchery facilities under the Proposed Action are located in this shared FMO habitat, both on the mainstem Clearwater River and its tributaries (USFWS 2015c).

Bull trout use of the mainstem Clearwater River is seasonal, as summer water temperatures exceed those preferred by bull trout, especially outside Dworshak Dam influenced reaches. The factors limiting bull trout in the Clearwater River Subbasin include habitat degradation, loss of prey species, passage barriers, hybridization and competition with exotics, and illegal harvest (CBBTTAT 1998a, pp. 15-20). During late spring and summer water is released from lower levels of the Dworshak reservoir to help cool water temperatures in the Lower Snake River downstream of the Clearwater and Snake River confluence. These cooler waters improve thermal conditions for bull trout, salmon, and steelhead in the Lower Snake River (Cook and Richmond 2004, p. 1) and in the Clearwater River. Deep pools in the Middle Fork may support overwintering and provide thermal refugia (USFWS 2002d). Clear Creek was previously reported to potentially support spawning and rearing habitat for bull trout (USFWS 2002d, p. 39). However, spawning and rearing has not been documented in Clear Creek or any other tributary streams in the Lower and Middle Fork Clearwater River watersheds (USFWS 2015c, p. C-3; USFWS 2014b, p. 4).

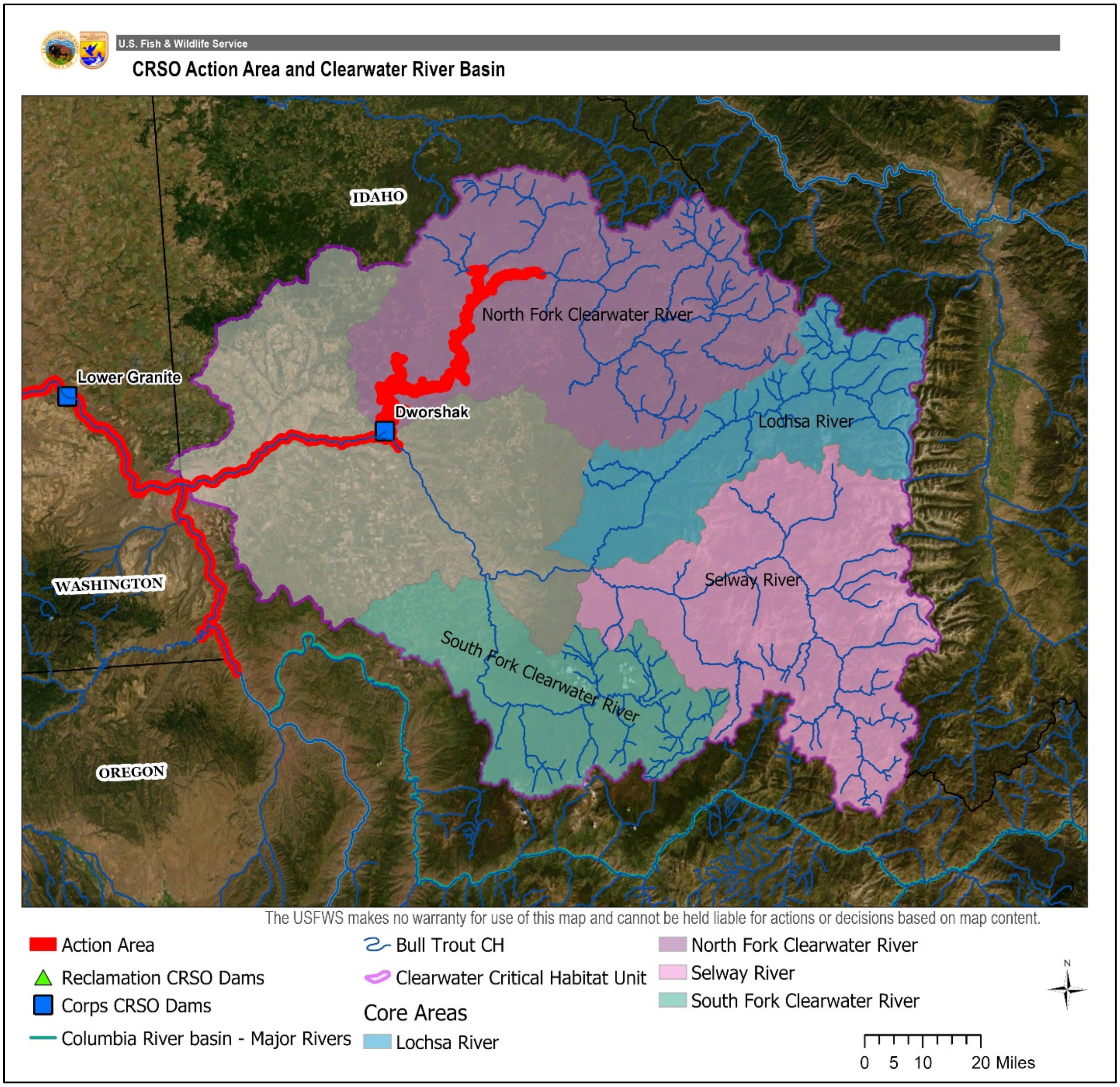

Figure 9. Clearwater River Basin with the Action Area, bull trout Core Areas, and Dworshak Dam

9.4.5.3.1 North Fork Clearwater River Core Area

The North Fork Clearwater River Core Area includes the North Fork Clearwater River and all tributaries upstream of Dworshak Dam. Major tributaries within the Core Area include North Fork Clearwater River, Elk, Little, Beaver, Quartz, Skull, Orogrande, Weitas, and Kelly Creeks (USFS 2001b; USFWS 2015c, pp. C-323-324). While no primary threats were identified in the 2015 Recovery Plan for the North Fork Clearwater River Core Area, historic and legacy activities from forest practices, road construction, mining, lost connectivity and entrainment at Dworshak Dam, declining prey base, and introduction of non-native brook trout likely negatively impacted bull trout populations over time (USFWS 2015c, p. C-324). Elevated water temperatures contribute to habitat constraints and fragmentation in areas used by bull trout (USFWS 2015c, p. C-324).

Although the reservoir provides overwintering and foraging habitat, Dworshak Dam isolates bull trout populations in the North Fork Clearwater River Core Area from the Middle and Lower Clearwater, South Fork Clearwater, Lochsa, and Selway Rivers (USFWS 2002d, p. 17; USFWS 2005b). Prior to the construction of Dworshak Dam, bull trout likely migrated into the mainstem Clearwater River to overwinter, and mixed with individuals from the Lochsa, Selway, and South Fork Clearwater River Core Areas (USFS 2001b). The mainstem portion of the North Fork Clearwater River from Dworshak Reservoir slack water upstream to the confluence with Kelly Creek supports subadult and adult rearing and migration, although current bull trout densities in this area are low (less than 0.5 fish/100 m^2) (CBBTTAT 1998b, p. 46).

The Service identified 12 local populations of bull trout in the North Fork Clearwater Core Area including the Kelly Creek Complex, Cayuse Creek Complex, Moose Creek Complex, Upper North Fork Clearwater River Complex, Weitas Creek Complex, Quartz Creek, Skull Creek, Isabella Creek, Little North Fork Clearwater River Complex, Floodwood Creek, Fourth of July Creek, and Fish Lake (USFWS 2015c, pp. C-323-324). With the exception of Fish Lake, all of these local populations are stream complexes that have multiple stream reaches with suitable habitat for bull trout spawning and rearing. Dworshak Reservoir provides foraging, rearing, and overwintering habitat for subadult and adult fish that occupy the reservoir (USFWS 2002d; CSS 2001). IDFG has radio-tagged bull trout captured in Dworshak Reservoir and documented their spawning migration into headwater tributaries of the North Fork Clearwater River and their return to the reservoir for overwintering. In those studies, IDFG observed adult bull trout migrate out of the reservoir starting late May to mid-June and return mid-October (Cochnauer et al. 2001, Shreiver and Schiff 2003, p. 21; and Schiff and Shreiver 2004, p. 9).

Based on redd counts as an indicator of the Core Area population trend for all streams in the North Fork Clearwater River Core Area, the population went through an increasing trend from about 2000-2010's (USFWS 2013d; Meyer et al. 2014; Erhardt and Scarnecchia 2014; cited in USFWS 2015c), but then stabilized beginning in 2001 (Hand et al. 2018, p. 80). The most recent redd counts have been declining but further monitoring is needed to determine stability. Bull trout are widely distributed within the North Fork Clearwater River Core Area, with bull trout redds documented in at least 33 streams associated with the 12 stream complexes identified.

The Service did not identify entrainment as a primary risk to recovery of bull trout, but did suggest it as a risk factor (USFWS 2015c). Incidental entrainment of bull trout through Dworshak Dam has been documented using direct and indirect methods. The Clearwater River Basin Bull Trout Technical Advisory Team (CBBTTAT) (1998a) concluded that some degree of bull trout entrainment occurs based on entrainment rates documented at other locations, observations of adult migrant bull trout below the dam during spawning migration season, and documented entrainment of kokanee, a preferred prey resource. Subsequent research has demonstrated that entrainment rates for adult bull trout are low and insignificant at the population level. Hanson et al. (2006) documented only two adult bull trout entrained over

Dworshak Dam during telemetry studies between 2000 and 2006. The entrainment risk of sub-adult bull trout is unknown, however bull trout can rear year round throughout the reservoir (Hanson et al. 2006).

Bull trout exposure to entrainment is primarily a function of proximity to the selector gate intakes and spillways during operation (Flatter 1999, p. 33). Available information suggests some level of ongoing risk affecting only a small portion of the bull trout population in Dworshak Reservoir. Schiff and Schriever (2004) and Schiff et al. (2005) studied migratory behavior in the Dworshak Reservoir. They determined that the majority of the migratory bull trout population overwintered in the middle reach of the reservoir several kilometers distant from the dam, but a small percentage of the population stayed in close proximity to the dam (within 1 km) throughout the winter and spring. Hanson et al. (2006) found the highest percentage of adult bull trout near the dam during March. These individuals are presumably foraging on kokanee that are also found in deep water near the dam. These individuals are potentially subject to entrainment through the turbines or spillway during drawdown events (Hanson et al. 2006).

9.4.5.3.2 South Fork Clearwater River Core Area

The mainstem South Fork Clearwater River provides subadult and adult rearing habitat as well as FMO habitat, and the Core Area provides connectivity for local populations within and among other Core Areas. The lower reaches of large tributaries in the Core Area provide thermal refuge in summer months (USFWS 2015c, p. C-323). The 2015 Bull Trout Recovery Plan identified threats from legacy upland and riparian land management, instream impacts, and non-native fish as influencing populations in the South Fork Clearwater (USFWS 2015c, p. C-323). Forest practices, mining, roads, and grazing activities have altered stream segments by reducing LW recruitment, pool formation, and off-channel areas, and by increasing sedimentation (USFWS 2015c, p. C-30, C-323).

IDFG (Schriever et al. 2008, pp. 131-138) has conducted juvenile bull trout distribution studies in most tributaries and headwater streams of the Core Area. These studies have confirmed that bull trout are widely distributed throughout the South Fork Clearwater River (USFS 2014, p. 33). Local populations currently use spawning and rearing habitat in five stream complexes within the South Fork Clearwater River including the Red River Complex, Crooked River Complex, Newsome Creek Complex, Tenmile Creek Complex, and Johns Creek Complex (USFS 2014, p. 33; USFWS 2015c, pp. C-322). Populations in the South Fork are considered strong. No threats were identified in the Recovery Plan for the Core Area (USFWS 2015c, p. C-30). Bull trout from the South Fork Clearwater Core Area use the mainstem Clearwater River for FMO and may be present in the Action Area in small numbers seasonally as temperatures allow.

9.4.5.3.3 Selway River Core Area

The Selway River originates in the Bitterroot Mountains on the Idaho-Montana border and joins the Lochsa River at Lowell, Idaho, to form the Middle Fork Clearwater River. The Selway River Core Area is located in Idaho and Clearwater counties and includes the Selway River and all its tributaries. The Core Area encompasses approximately 520,242 ha (1,285,516 ac), about 85 percent of which occurs in the Selway-Bitterroot and Frank Church-River of No Return

Wilderness Areas (USFS 2001b, p. 1-9). Although no facilities under the Proposed Action are located in the Selway River Core Area, hatchery-origin anadromous juveniles are released from several sites in the Core Area, including the Upper and Lower Selway River mainstem and Meadow Creek.

The Selway River provides FMO habitat for 10 local populations of bull trout in the Core Area, and provides connectivity for populations in other Core Areas of the Lower Snake River geographic region (USFWS 2008a, 2015c). Local populations are well-connected within this Core Area (USFS 2001b, p. 4-114) and include the Meadow Creek Complex, Moose Creek Complex, Little Clearwater River Complex, Running Creek Complex, White Cap Creek Complex, Bear Creek Complex, Deep Creek Complex, Indian Creek Complex, Magruder Creek, and Upper Selway River Complex. The Selway River Core Area supports a metapopulation of fluvial bull trout that are widely distributed in variable densities; resident local populations are present in some upper tributary reaches. No threats to bull trout in the Selway Core Area were identified in the 2015 Bull Trout Recovery Plan (USFWS 2015c).

Subadult and adult bull trout have been observed in the Selway River (CBBTTAT 1998a) and use it for FMO. Bull trout occupancy has been verified by USFS stream surveys (USFS 2009) and individuals are likely to use all accessible areas of the Selway River Core Area. High water temperatures may preclude use in some reaches during low flow, hot summer months (USFWS 2008a). Bull trout from the Selway Core Area use the mainstem Clearwater River for FMO and may be present in the Action Area seasonally as temperatures allow in small numbers.

9.4.5.3.4 Lochsa River Core Area

The Lochsa River Core Area is located in Idaho County and encompasses an area of about 303,024 ha (748,773 ac). The Lochsa River Core Area is located completely outside of the Action Area. The Core Area extends from the confluence of the Lochsa and Selway Rivers to the headwaters of Colt Killed and Crooked Fork creeks, which converge to form the Lochsa River. The Lochsa River provides important FMO habitat for the local populations within the Core Area and connectivity to populations in other Core Areas of the Clearwater River Basin (USFWS 2015c). The 2015 Recovery Plan identified no threats to populations in this Core Area.

Seventeen local populations of bull trout are currently known to use spawning and rearing habitat throughout the Lochsa River Core Area including Fish, Legendary Bear, Boulder, Fox, Shotgun, Crooked Fork/Hopeful, Rock, Haskell, Colt Killed (White Sands), Beaver, Storm, Brushy Fork, Spruce, Twin, Walton, and Lower Warm Springs creeks and Fish Lake (USFWS 2015c, CBBTTAT 1998c, Watson and Hillman 1997). Adults and subadults are suspected to use nearly all accessible areas of the Core Area for FMO and rearing (CBBTTAT 1998c, p. 23), and the lower reaches of multiple tributaries provide thermal refuge from high summer in-stream temperatures in the mainstem Lochsa River. As there are no barriers to downstream movement, bull trout may be present in the Action Area from the Lochsa Core Area in small numbers seasonally as temperatures allow.

9.4.5.4 Critical Habitat in the Mid-Columbia Recovery Unit

Within the MCRU, three CHUs fall within the bounds of the Action Area (USFWS 2010b). The mainstem Upper-Columbia River CHU 22 includes the Columbia River from John Day Dam upstream to Chief Joseph Dam. The mainstem Snake River CHU 23 includes the Snake River from Hells Canyon Dam downstream to the confluence with the Columbia River. Lastly, the Clearwater River CHU 21 includes all portions of the Clearwater River Basin to its confluence with the Snake River.

Within adjacent tributaries, several other CHUs are designated. These include the Upper Columbia River Basins CHU 10, the Yakima River CHU 11, John Day River CHU 12, Umatilla River CHU 13, Walla Walla River Basin CHU 14, and the Lower Snake River Basins CHU 15. While connected to the three CHUs present in the Action Area, these adjacent CHUs do not fall within the Action Area and are not addressed further in this Opinion.

Following brief descriptions of each of the CHUs present in the Action Area, status of all nine PBFs for each CHU is provided.

9.4.5.4.1 Clearwater River CHU 21

The Clearwater River CHU (Unit 21) consists of 2,702.1 km (1,679.0 miles) of streams, as well as portions of some lakes and reservoirs. The CHU is located in north-central Idaho and extends to the Montana border. It represents the easternmost extent of the MCRU and includes the Clearwater River and numerous tributaries including the South Fork, Middle Fork, and North Fork Clearwater rivers. In 2010, the Clearwater River CHU was determined essential for bull trout to maintain distribution in a unique area of the Mid-Columbia Recovery Unit (USFWS 2010b).

Dworshak Dam within the Action Area bisects the Clearwater River CHU. The Clearwater River CHU includes five CHSUs: Middle-Lower Fork Clearwater River, South Fork Clearwater River, Selway River, Lochsa River (and Fish Lake), and the North Fork Clearwater River (and Fish Lake).

9.4.5.4.2 Mainstem Upper Columbia River CHU 22

The Mainstem Upper Columbia River CHU 22 includes the mainstem Columbia River from Chief Joseph Dam downstream to John Day Dam and all inundated/backwater portions of tributaries (USFWS 2010b). This CHU was identified essential for bull trout to conserve migratory corridors for fluvial bull trout in adjacent Core Areas (USFWS 2010b). The entirety of the Mainstem Upper Columbia River CHU 22 falls within the Action Area.

The Mainstem Upper Columbia River CHU 22 supports FMO habitat for bull trout and provides connectivity between the mainstem Lower Columbia River (CHU 8), Snake River (CHU 23), and several tributary CHUs adjacent to the Action Area (USFWS 2010b; USFWS 2008a; BioAnalysts 2004, 2007, 2008). Numerous tributaries as well as associated designated CHUs drain into the Mainstem Upper Columbia River CHU 22. These include the Upper Columbia River Basins CHU 10, Yakima River CHU 11, Mainstem Snake River CHU 23, Walla Walla River CHU 14, Umatilla River CHU 13, and the John Day River CHU 12.

The Columbia River upstream of Chief Joseph Dam, including Rufus Woods Lake and Lake Roosevelt above Grand Coulee Dam, are not designated critical habitat. However, changes to water quality from elevated TDG, temperature, and other factors as well as flow conditions upstream influence PBFs within designated critical habitat downstream. TDG levels below Lake Roosevelt, including Rufus Woods Lake, at times of high flows in order to manage flood risk or lack of market or turbine capacity, exceed State water quality criteria when spill occurs at Grand Coulee Dam. These elevated TDG levels can persist, and at times be further elevated, when spilling also occurs at Chief Joseph Dam. Adjustments to past system operations to minimize spill have helped improve conditions in designated critical habitat. Grand Coulee Dam outflow water temperature has a temporal lag behind the warming/cooling inflow to Lake Roosevelt, observed at the U.S.-Canada border. In general, water temperatures released from Grand Coulee tend to be cooler than reservoir inflows throughout much of the spring and early summer, and warmer in late summer/fall. Because Lake Rufus Woods does not stratify and has a residence time of about 4 days, it passes on the lagged water temperatures created by Lake Roosevelt.

Land ownership in the reach is a mixture of local, state, tribal, Federal, and private interests, though the majority of land use consists of agriculture, rangeland, and residences (USFWS 2015c p. C-344). Major habitats include waterbodies such as the Columbia River reservoirs and associated tributaries, wetlands associated with tributary floodplains and low-lying depressions, riparian areas, and the adjacent upland communities that include managed agriculture/pasture lands, shrub-steppe, and forest habitats (Douglas County PUD 2011). While bull trout spawning and rearing does not occur within CHU 22, bull trout occur year round using the unit for FMO. The mainstem Upper Columbia River (CHU 22) provides connectivity between many core habitats and is likely impaired due to the presence of nine dams and temperature and habitat constraints.

9.4.5.4.3 Mainstem Lower Snake River CHU 23

The Mainstem Lower Snake River CHU 23 falls entirely within the Action Area. This CHU is essential to migratory life history expression, facilitate genetic exchange, and ensure connectivity between Core Areas along the Snake River. Connectivity between populations in the Tucannon, Asotin, Walla Walla, Clearwater, Grande Ronde and Imnaha Core Areas has likely been limited by operation of Lower Granite and Little Goose dams (USFWS 2010a, 2010b). In addition to dam construction and operation, the Mainstem Lower Snake River has been altered by reduced habitat complexity, little to no natural floodplain connectivity due to levees and bank armoring, and from agricultural practices alongside the river. Bull trout are known to occupy and use the Mainstem Snake River throughout the year for foraging and overwintering.

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

Clearwater CHU 21

PBF 1 is present in Dworshak Reservoir, although development around the reservoir, along with pool management, has disconnected the reservoir from adjacent riverine wetlands and sources of cooling groundwater. In reservoir environments, subsurface connectivity and thermal refugia are a function of several factors, including thermal stratification within the reservoir, tributary inflow, wetland influence, and groundwater recharge. In deep reservoirs, thermal stratification is typically the primary mechanism providing thermal refugia. Tributary inflow may provide a source of cooling groundwater, though some streams that discharge into the North Fork and Dworshak Reservoir exhibit high summer temperatures (see discussion for PBF 5).

PBF 1 is present but provides limited contribution to FMO habitat in the Clearwater River downstream of Dworshak Dam. A well-developed highway and county road system is present in the Lower Clearwater as U.S. Highway 12 and the Camas Prairie railroad parallel the Clearwater River. Encroachment has constrained river meanders, eddies, and hydraulic energy (CBBTTAT 1998a as cited in USFWS 2002d). Such encroachment reduces the connectivity of the mainstem to off-channel habitat and backwater areas. Channel straightening has also occurred along the mainstem, precluding lateral movement and connection to off-channel habitats that may support wetlands and other sources of cooling groundwater (USFWS 2002d).

Within the Action Area, this PBF is Functioning at Risk at a result of impacts from transportation corridors, channel straightening, and reservoir operations.

Mainstem Upper Columbia River CHU 22

Reservoirs in the mainstem Columbia River have inundated wetlands and off-channel habitats, which influence subsurface water connectivity and thermal refugia. Shoreline development for transportation corridors has further reduced the interaction between the mainstem river and shoreline springs. High in-stream temperatures are common. The cities of Pasco, Kennewick, and Richland, Washington are protected from flooding by 16.8 miles of levees, further isolating natural subsurface connectivity.

Presence of thermal refugia is also a function of thermal stratification within the reservoirs. Tributary inflow may also play a role in providing subsurface connectivity between cold-water refugia in the reservoir and tributary habitat. Some groundwater influence may occur in riverine areas of the mainstem not dominated by bedrock or immediately below dams, although little is known regarding the ecological significance of this exchange (Corps 2013). Areas throughout that provide some coldwater or natural hyporheic connectivity likely provide bull trout in the mainstem with summer refugia, particularly for sub-adults.

This PBF is considered Not Properly Functioning within the Action Area due to lost wetlands and floodplain connectivity from dam operations and shoreline development.

Mainstem Snake River CHU 23

As with the Mainstem Columbia River CHU, PBF 1 in the Mainstem Snake River CHU has limited interaction with its historic floodplain. The riparian corridor and shoreline is heavily impacted by railroad and highway levees, bank armoring, and dam operations. Tributary inflow may also play a role in providing subsurface connectivity between cold-water refugia in the reservoir and tributary habitat. Some groundwater influence may occur in riverine areas of the mainstem not dominated by bedrock or immediately below dams, although little is known regarding the ecological significance of this exchange (Corps 2013). Areas throughout that provide some coldwater or natural hyporheic connectivity likely provide bull trout in the mainstem with summer refugia, particularly for sub-adults.

This PBF is considered Not Properly Functioning within the Action Area due to lost wetlands and floodplain connectivity from dam operations and shoreline development.

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

Clearwater CHU 21

Dworshak Dam is the most significant influence on connectivity within the Clearwater CHU. Because Dworshak Dam lacks fish passage facilities, bull trout inhabiting the North Fork Clearwater River drainage have been isolated from other Core Areas in the Clearwater and Snake River Basins as well as mainstem habitat since the dam was constructed in 1971. Drawdowns of Dworshak Reservoir can entrain bull trout and carry them into the mainstem Clearwater River; these fish likely have low survival after entrainment and are unable to return to spawning and FMO habitat upstream (USFWS 2015c). Upstream of the dam, habitat is relatively unfragmented, with the exception of a few developed areas with passage barriers, including several culverts. Two culverts in Beaver Creek below Sheep Mountain sub-watershed occur within the area affected by the Dworshak Reservoir pool elevation (USFWS 2002d).

Low reservoir levels and summer drawdowns may also affect spawning migrations by reducing bull trout access to tributaries entering the reservoir due to thermal and physical barriers (CBBTTAT 1998a as cited in USFWS 2002d). Hanson et al. (2006) found that more than 90 percent of tagged bull trout left the reservoir by the end of May from 2000 to 2006. Based on these observations, only a small percentage of bull trout remain in the reservoir after June, indicating that warmer temperatures affect a small portion of the population.

Downstream of Dworshak Dam, there are no known barriers in the Mainstem Clearwater River and migration between Core Areas is possible. As a whole, the Clearwater River CHU is Functioning at Risk within the Action Area for migration as a result of Dworshak Dam operation.

Mainstem Upper Columbia River CHU 22

PBF 2 has been significantly altered by construction and operation of dams throughout the CHU. The lack of fish passage facilities at Chief Joseph and Grand Coulee dams block access to historic FMO habitat and limit connectivity with historic populations upstream and in Canada.

Passage facilities (i.e., fish ladders) at the non-Federal dams on the Mainstem Columbia River downstream of Chief Joseph Dam were primarily designed and operated for anadromous salmon and steelhead (NMFS 2011a), but may also be used by bull trout. Bull trout are documented at McNary Dam annually in the fish passage facilities (Tables 4 and 5) (Anglin et al. 2010). McNary Dam includes two fish ladders for passage, one on each shore, a juvenile bypass facility, and extended-length submersible bar screens and vertical barrier screens. Spill for juvenile fish passage occurs annually at McNary Dam, and the spillway includes two spillway surface weirs designed to improve juvenile salmonid downstream passage. NMFS considers the fish passage facilities at McNary to be state-of-the-art, and bull trout have been observed using the fish ladders (Corps 2008); however, their use is limited in comparison to salmon and steelhead. Dams with fish passage can still delay upstream and downstream passage of bull trout, which in turn delays access to spawning tributaries and, thus, can limit reproductive success.

Bull trout are observed passing the upstream fishways and downstream through turbines and spillways at the non-federal Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams at similar or lower rates compared to salmon and steelhead (BioAnalysts, Inc. 2004; USFWS 2008b). These fishways also comply with NMFS fishway design guidelines and are therefore similar in design, dimension, and operations to upstream fishways at the Federal mainstem dams. Fishway operations at Wells Dam did not appear to influence the movements of adult bull trout as upstream passage events appeared to be associated with water temperature, photoperiod, and time of year (Douglas County PUD 2011). A small number of sub-adults and adult bull trout have been collected at the Rock Island Dam Smolt Monitoring Facility and at the Rocky Reach Dam surface collector sampling facility (FPC 2018). USFWS (2008b) reports that although juvenile fish passage facilities were not developed for the downstream passage of larger fish such as adult bull trout, verifiable injury or mortality of adult bull trout passing downstream through turbines and spillways has not been reported at the mainstem Columbia River dams, including those in the project reach.

While passage at mainstem Columbia River Dams exists, the operation is focused on salmon and steelhead. At the juvenile bypass systems, one to three percent mortality rate and up to a 10 percent injury rate has been measured in some years to adult salmonids passing through the juvenile fish bypass system at McNary Dam (Axel et al 2005). On the lower Snake River, up to 60 percent of kelts using the Lower Granite Dam juvenile bypass system were observed with non-lethal head injuries in 2014, with higher rates among larger sized adults (Hatch et al. 2015). In 2018-2019, extensive modifications to the Lower Granite Dam juvenile bypass system were made with design consideration given to reduction of injuries.

Adult passage through turbines has also been studied on the lower Columbia and Snake River dams (Rayamajhi et al. 2013; Colotelo et al. 2014). Survival of Snake River steelhead kelts through the turbines ranged from 50-100 percent at each dam between Lower Granite and Bonneville dams; the poorest survival was seen at The Dalles Dam. Turbine route proportions were relatively low (less than 9 percent) in both years. It is increasingly recognized that ‘overshoot’ of overwintering steelhead to reservoirs upstream of the natal tributary is a common behavior for many populations and that downstream passage occurs when adult steelhead are returning to natal tributaries (Richins and Skalski 2017; 2018). At McNary Dam, the average survival rate for overwintering steelhead was estimated at 91 percent of fish that passed through turbines, and 98 percent survival rate through the spillway, surface top-spill weir (Normandeau 2014b). Similar direct injury and survival studies has shown comparable results. At Albeni Falls, turbine passage survival rates for subadult and adult steelhead, 99-100 percent and 88-93 percent, respectively (Normandeau 2014a). A study at Bonneville Dam also recorded average direct survival rates of 98 percent through the ice and trash sluiceway (Powerhouse 1) and 98 percent at the corner collector (Powerhouse 2), with most mortality caused by active pinniped predation in the tailrace during the study period (Normandeau 2011). The fallback rate for salmon and steelhead at the mid-Columbia hydroelectric projects has been documented to range between 0 percent and 7 percent (NMFS 2002b). "Fallback" rates relate to the potential for fish to "fallback" through the dams, resulting in contact with structural features of the dam (spillways, turbines, or fish ladders). Adult mortality is likely to be higher than for juveniles (USFWS 2000, 2012c). Further, incidents of fallback or downstream passage of adult bull trout through the mid-Columbia hydroelectric projects appeared to be low (4 percent) and show no apparent mortality (BioAnalysts, Inc. 2004 and LGL and Douglas PUD 2008). This operation may not represent sufficient passage for bull trout and the function of this PBF is limited.

Given the above information, passage and migration corridors throughout the Mainstem Upper Columbia River CHU 22 are likely insufficient for bull trout. This PBF is considered Functioning at Risk.

Mainstem Snake River CHU 23

Similar to the Mainstem Upper Columbia River CHU 22, migration corridors are present, but limited. Fish passage facilities are present at the four Lower Snake River dams, but still pose difficulties, likely passage delays, and mortality risks for passage. The incidental collection of bull trout at juvenile bypass facilities, the observation of bull trout within adult fish ladders, and radio telemetry and PIT tag research have shown that bull trout utilize the mainstem Snake River as a migratory corridor as well as deep-water habitat for overwintering and feeding (USFWS 2015c). The loss of migratory corridors through habitat fragmentation associated with dams has been identified as a threat to the diversity, stability, and persistence of bull trout populations (Kuttel 2002; USFWS 2015c).

Bull trout have been observed at all Lower Snake River dams, smolt monitoring traps, juvenile fish facilities, and fish ladders, although observations were anecdotal to salmon monitoring prior to 2000. Bull trout counts have been included in the annual adult fish passage reports since 2006. Numbers of bull trout recorded in 2011 were lowest at Ice Harbor and Lower Granite Dams, with only a single adult observed at each, and counts were highest at Little Goose Dam, where 85 were observed (Corps 2011b). In the mainstem Snake River, only five bull trout have been observed passing Lower Granite Dam since 1998 (FPC 2018). The extent of bull trout use and efficacy of passage is not fully understood in CHU 23. Thermal barriers between tributary habitat and the mainstem Snake River exist seasonally and further impact the function of this PBF in the Action Area. Seasonally high river temperatures potentially delay or impede migration to and from spawning areas and FMO. Based on the above information, the Service considers PBF 2 functioning at risk in the Mainstem Snake River CHU 23.

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

Clearwater CHU 21

PBF 3 is present in Dworshak Reservoir. Because Dworshak Dam lacks fish passage facilities, anadromous fish no longer have access to the watershed above the dam, thus leading to a decrease in prey abundance for bull trout. In Dworshak Reservoir, introduced kokanee may partially compensate for losses to the bull trout's historic anadromous salmonid prey base and for losses of anadromous fish-related nutrient flow into the Basin (USFWS 2002d). However, substantial numbers of kokanee can be entrained below the dam during spills (USFWS 2015c). PBF 3 is present and contributes to FMO habitat in the Clearwater River. However, armoring along the mainstem Clearwater River downstream of Dworshak Dam has reduced the presence of riparian vegetation and the associated input of allochthonous (i.e., not indigenous) prey items. Based on reduced native salmon forage and riparian function below Dworshak Dam, the Service considers this PBF functioning at risk in the Action Area.

Mainstem Upper Columbia River CHU 22

PBF 3 is present in and contributes to FMO habitat in this reach of the Columbia River. The variation in inundation due to the dams has reduced riparian areas and limited terrestrial organism and nutrient inputs (extended inundation followed by drawdown). The conversion of riverine habitat into reservoirs may have improved the productivity and the quantity of available prey, though species assemblages are likely different from before the dams (USFWS 2011b). The mainstem Columbia River in this reach, including the reservoirs, provides an abundant food source for migratory bull trout during the fall, winter, and spring (USFWS 2007). Forage fish such as juvenile salmon and steelhead provide a large forage base for bull trout, as well as whitefish, sculpins, suckers, and minnows that inhabit the reservoir (USFWS 2010b). The declines of native salmon and steelhead populations have likely reduced or altered bull trout diets in the Action Area.

Upper Columbia River mainstem habitats and reservoirs provide rearing habitat for ocean-type Chinook, which provide a source of prey for bull trout. Large numbers of hatchery-raised salmonids are released into the CRS annually and provide an abundant source of prey for bull trout (USFWS 2007), though smolts may also compete with bull trout for smaller prey species. Tributary mouths support populations of non-endemic rainbow trout, bass, crappie, carp, bluegill, catfish and other species that may provide forage for bull trout.

Based on reduced native salmon forage and riparian function through the Action Area, the Service considers this PBF functioning at risk.

Mainstem Snake River CHU 23

PBF 3 is present and contributes to FMO habitat in this reach of the Lower Snake River. The conversion of mainstem habitat from riverine flow to a lacustrine-like condition has altered the prey composition in the mainstem Snake River. Conversion of aquatic habitats due to backwatering effects of dams and degradation of the riparian corridor have negatively affected the productivity of native species; however, these habitat changes have increased non-native fish production to provide a prey base for bull trout (USFWS 2010a, b). Native species of fish, including salmonid and steelhead, still occupy the reservoirs and also provide a food source for bull trout. Thirty-four species of resident fishes were collected from the Lower Snake River reservoirs during fisheries studies conducted from 1979 through 1993 (USFWS 2010b). Forage fish such as juvenile salmon and steelhead, whitefish, sculpins, suckers, and minnows are present throughout the Lower Snake River (USFWS 2010a, b). The number of non-salmonid fish predators has increased since the Lower Snake River reservoirs were created (USFWS 2002e). Based on reduced native salmon forage and riparian function through the Action Area, the Service considers this PBF functioning at risk.

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

Clearwater CHU 21

PBF 4 is present in and contributes to FMO habitat in Dworshak Reservoir. Substantial reservoir depth, thermal stratification, and shallow shoreline habitat (supporting prey species) provides the most significant habitat complexity and contribution to FMO habitat. Habitat conditions in tributaries that discharge into the North Fork and Dworshak Reservoir have been negatively affected by forestry activities, which have reduced LW that could later be recruited, pool quantity, and overall habitat complexity. Livestock grazing has degraded aquatic habitat complexity in some portions of the North Fork Core Area through bank destabilization, stream channel widening and incision, and a reduction in pool frequency (USFWS 1998b). The majority of livestock grazing in the North Fork Clearwater watershed occurs on tributaries of Dworshak Reservoir. Impacts vary from low to high.

In tributary confluences influenced by dam operations, pool frequency is decreased due to activities that occurred prior to dam construction. Prior to the establishment of the Idaho Forest Practices Act (about 1975), streams and riparian areas received no protection from harvesting, road construction, skidding, and processing impacts. Management activities in the 1970s also included removal of LW from stream channels to prevent flooding and debris torrents. The legacy of these activities still affects fish habitat in portions of the North Fork Core Area, resulting in decreased inputs of LW (from log skidding directly in streams and removal of woody debris), lack of recruitable LW, increased water temperatures from harvest of riparian forests, and lack of pools and habitat complexity (CBBTTAT 1998a as cited in USFWS 2002d).

PBF 4 is present and contributes to FMO habitat in the Clearwater River downstream of Dworshak Dam, though the PBF is impaired compared to pre-dam conditions. The presence of Federal, state, and county roads in the lower reaches of the Clearwater River, including U.S. Highway 12, have reduced shoreline and in-stream habitat complexity through a reduction of recruitable LW and an associated reduction in pools and habitat complexity. High levels of sediment in the mainstem result in substrate embeddedness in lower velocity areas, which may reduce substrate complexity and the depth of holding pools. The PBF has been affected by intensive logging that has reduced streamside vegetation and LW (riparian and in-stream) throughout the reach.

Based on lowered habitat complexity downstream of Dworshak Dam as a result of dam operations, the Service considers this PBF to be functioning at risk in the Action Area.

Mainstem Upper Columbia River CHU 22

PBF 4 has been functionally reduced by impoundments created by the hydroelectric projects throughout the Upper Columbia River CHU. Mainstem Columbia reservoirs have inundated off-channel habitats and wetlands. The dams have converted previously free-flowing riverine habitats to more lacustrine habitats in reservoir reaches and homogenized habitat conditions in much of the reach. Pools have been inundated and essentially replaced by deep-water habitat in the mainstem (USFWS 2011b). Riparian areas along the mainstem Columbia River are generally narrow in this project reach, and their structure and condition are influenced by daily fluctuations in river level due to dam operation (USFWS 2011b). Dam operations, flow management, and the related inundation of off-channel and floodplain areas have reduced the size, quality, and function of floodplains along the upper Columbia River (NMFS 2000a as cited in USFWS 2002f). Off-channel diking, levees and bank armoring along the mainstem and within tributaries has resulted in the loss of floodplain and off-channel habitats that could provide important rearing areas for bull trout (USFWS 2002f). Roads and other features have disconnected hydrologic linkages between off-channel areas and the main channel, interrupted overbank-flow processes, and degraded both wetland function and riparian vegetation.

Residential, agricultural, and recreational development along the mainstem has resulted in the loss of riparian vegetation. Streambanks throughout the mainstem Upper Columbia River are typically characterized as sparsely vegetated steep canyons, with steep shorelines, often armored with riprap, especially along the banks immediately downstream of dams, to prevent erosion during larger spill events. In Wells Reservoir (Lake Pateros) downstream of Chief Joseph Dam, shorelines are relatively steep, with banks rising sharply to 20 ft to 40 ft above reservoir elevations. Shoreline areas near point bars and at the mouths of tributaries are more gradual, with a diversity of habitats, including dense riparian vegetation, unstable and eroding areas, areas of minimal vegetation and exposed bedrock, and areas that are relatively unvegetated and have been stabilized by riprap (Douglas County PUD 2011). One area of diverse habitat that remains is at the mouth of the Okanogan River, near Brewster.

Residential, agricultural, and recreational development along the mainstem has also resulted in the loss of riparian vegetation. Dam operations and reservoir management have reduced the size, quality, and function of floodplains along the upper Columbia River (NMFS 2000a).

Transportation corridors along the Columbia River further limit the formation of off-channel habitat. Reduced floodplain connectivity has also decreased the recruitment of LW needed for the formation of complex habitat. Levees along the Columbia River and the lower portions of tributaries have also limited the development of complex habitats. The Tri-Cities are protected by 16.8 miles of levees.

Habitat complexity in the Mainstem Upper Columbia CHU is not properly functioning based on the information above.

Mainstem Snake River CHU 23

PBF 4 is impaired in the mainstem Lower Snake River. The mainstem habitat is composed of deep reservoirs with little to no habitat complexity. Only a few tributaries enter the reservoirs. A few backwater areas have been inundated by the impoundment. Recruitable large wood is limited in the Lower Snake River reservoirs, and off-channel habitats are scarce. Riparian vegetation along the Lower Snake River is dominated by Russian olive (*Elaeagnus angustifolia*), with some black cottonwood (*Populus trichocarpa*), black locust (*Robinia pseudo-acacia*), and various alder and willow shrubs. The steep shorelines and arid landscape associated with project reservoirs limit development of riparian communities (Corps 2002). Streambanks along the Snake River are sparsely vegetated and often armored with riprap, especially along the banks immediately downstream of dams, to prevent erosion during larger spill events. Reservoir habitat in this reach is generally uniform and does not form complex pool habitat common in smaller streams. Little Goose and Lower Monumental Reservoirs have a greater number of backwater areas than Ice Harbor. The confluences of two major tributaries (the Palouse and Tucannon Rivers) with the Snake River provide additional backwater habitat in Lower Monumental Reservoir. These reservoirs tend to support species that depend on shallow-water habitats during some part of their life histories (Corps 2002). Emergent wetland habitat increased significantly after construction of the dams and impoundments due to sedimentation and flooding of backwater areas (Corps 2002).

Habitat complexity in the Mainstem Snake River CHU is not properly functioning based on the information above.

PBF 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.

Clearwater CHU 21

Several streams that provide FMO in the North Fork Clearwater Core Area are listed as water quality-impaired for temperature on the CWA 303(d) list, including portions of Dworshak Reservoir and contributing tributaries downstream to the reservoir. Data from streams in the lower North Fork Clearwater River indicate that elevated water temperatures are common in summer (IDEQ 2002, p. xxiv).

Improved stream temperature models have been used at the Dworshak Dam in response to the 2008 FCRPS Opinion (NMFS 2008). In 2010, the CE-QUAL-W2 model was used at the dam from late June through early September 2010 to support decisions regarding operation of Dworshak Dam for flow augmentation and temperature management on the Lower Snake River (Corps 2011). Fluctuations in water level in Dworshak Reservoir, coupled with the characteristic unstable steep-sided banks, essentially preclude establishment of rooted littoral vegetation, which may lead to elevated in-stream temperatures around the perimeter of the reservoir. Rooted vegetation does occur on some gentler slopes; however, these areas are above the waterline during the reservoir evacuation period.

PBF 5 is present in the mainstem Clearwater River downstream of Dworshak Dam, though summer impairments are common. At the U.S. Geological Survey's (USGS) Gage 13341050, approximately 5 RM downstream of Dworshak Dam, mean monthly temperatures of 52.5 °F

(11.4 °C), 54.0 °F (12.2 °C), 51.3 °F (10.7 °C) and 53.1 °F (11.7 °C) have been documented (through 2014) for the months of June, July, August, and September, respectively. While these temperatures are suitable for year-round bull trout use, forestry practices have reduced streamside vegetation in some areas, which has contributed to elevated in-stream summer temperatures (USFWS 2015c), particularly along the shallow river margins. Streambank armoring associated with numerous roads, including U.S. Highway 12 along the Clearwater River, has similarly resulted in a minor loss of shade-producing vegetation from the mainstem riparian corridor, though the adjacent mountains provide the bulk of shading in this area. The presence of major roads immediately adjacent to the mainstem has reduced the connectivity to floodplain habitats, resulting in the interception of groundwater that could contribute to in-stream cooling. The presence of numerous stormwater outfalls along U.S. Highway 12 likely contributes to elevated in-stream temperatures in localized shoreline habitats.

Given the above information, water temperatures in the Clearwater River CHU are functioning at risk within the Action Area.

Mainstem Upper Columbia River CHU 22

In the designation of critical habitat, PBF 5 was identified as not present in the Mainstem Columbia and Snake Rivers due to construction of the dams and elevated temperatures. While not identified as a PBF in the CHU, temperatures in the Columbia River influences distribution, migration, and foraging opportunities for bull trout throughout the Action Area and between Core Areas. Seasonally, elevated temperatures in passage facilities and in the river impede movement of bull trout, specifically non-spawning adults and sub-adults.

Mainstem Snake River CHU 23

In the designation of critical habitat, PBF 5 was identified as not present year-round in the Mainstem Columbia and Snake Rivers due to construction of the dams and elevated temperatures. While not identified as a PBF in the CHU, temperatures in the Snake River influence distribution, migration, and foraging opportunities for bull trout throughout the Action Area and between Core Areas. Seasonally, elevated temperatures in passage facilities and in the river impede movement of bull trout, specifically non-spawning adults and sub-adults.

PBF 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo over-winter survival, fry emergence, and young-of-the-year and juvenile survival.

Clearwater CHU 21

Spawning and rearing habitat occurs within this CHU; however, is not present within the Action Area.

Mainstem Upper Columbia River CHU 22

Spawning and rearing does not occur within this CHU, therefore this PBF is not present.

Mainstem Snake River CHU 23

Spawning and rearing does not occur within this CHU, therefore this PBF is not present

PBF 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.

Clearwater CHU 21

Operation of Dworshak Dam has altered the natural hydrograph of the Clearwater River throughout the Action Area. The North Fork Clearwater River flows about 74 miles from its headwaters near the Idaho-Montana border to the slack water in Dworshak Reservoir. The streams in the Basin have a pattern of low flows during the late summer and early fall and high flows in the spring and early summer. The peak discharge is typically in late May or early June. Prior to construction of Dworshak Dam, this pattern was likely more evident. However, the North Fork now enters the slack water of the reservoir about 54 miles upstream of the dam. Dam operation includes seasonal spills and drawdowns of the reservoir elevation to 155 ft below full pool for FRM and to supply downstream flows for anadromous fish migration (CBBTTAT 1998a as cited in USFWS 2002d). Due to the low-gradient slopes and the amount of water evacuated downstream during drawdowns, the surface area of the reservoir can be reduced by as much 52 percent (Ecovista et al. 2003 p. 111).

The mainstem Clearwater River below the confluence with the North Fork is influenced by Dworshak Dam operations (Ecovista et al. 2003, p. 10). Before the construction and operation of Dworshak Dam in late 1971, the natural hydrograph of the lower Clearwater River downstream of the dam consisted of a spring freshet with high peak flows, followed by a rapid drop in flows into August. Since the construction and operation of the dam, the hydrograph is similar, though peak flows, on average, have decreased during the spring freshet. Flows at USGS Gage 13341050, located on the mainstem Clearwater River about 5 miles downstream of the dam, indicate maximum discharge (107,000 cfs) from 1965 to 1971 occurred in May (1971) prior to regulation in the Dworshak Reservoir. The maximum discharge since regulation began in 1972 is 127,000 cfs, recorded in June 1974. In response to RPA 4 of the 2008 NMFS FCRPS Opinion, flows are released at Dworshak Dam during spring to aid downstream smolt migration.

In addition to dam operations, agricultural practices, such as irrigation withdrawals, have indirectly affected hydrologic conditions in the Clearwater River Basin. Combined with stream channel alterations and increased runoff, these changes have altered the hydrologic function of most tributaries in the lower Clearwater Basin (CBBTTAT 1998b as cited in USFWS 2002e). The timing, peak, and magnitude of flows have changed in these tributaries, resulting in increased flood frequencies and intensities, decreased water remaining in the watersheds for late season baseflows, increased water temperatures, increased incidence of intermittent stream flows due to low water and high bedload conditions, and decreased stream complexity (CBBTTAT 1998b as cited in USFWS 2002d).

As described above, Dworshak Dam operations alter flows and the hydrograph throughout the Action Area. Therefore, the Service considers this PBF to be functioning at risk.

Mainstem Upper Columbia River CHU 22

The current hydrograph is significantly altered as a result of construction and operation of the dams. Dams have increased the river cross-section and moderated peak and base flows in the mainstem, with the river level only changing a few feet annually. Surface water withdrawals throughout the mainstem and tributaries have also reduced in-stream flow, particularly in smaller Basins. The hydrograph, although varying from the natural hydrograph, currently provides for FMO habitat.

Chief Joseph, McNary and John Day Dams are run-of-river facilities, meaning that daily inflow through the dam generally equals daily outflow. Run-of-river projects cannot store or draft a significant volume of water. As such, flows at the dam and downstream are primarily shaped by the operations at the Canadian and Federal storage projects upstream, particularly Grand Coulee Dam. Overall, storage dams in the Columbia River Basin have dampened the natural hydrograph with decreased high flows during the summer and increased low flows during the winter (National Research Council 2004). Flows can also vary on shorter timescales (i.e., daily) to optimize power generation during peak energy demands. Power peaking at Columbia River dams creates river stage fluctuations that result in a pronounced change in the natural hydrograph compared to pre-dam conditions.

The inflow to the Wells Reservoir (Lake Pateros) is controlled by operations of Chief Joseph Dam and Grand Coulee Dam. In Lake Pateros, reservoir fluctuations are minor (1 ft to 2 ft daily). From 2001 through 2005, the reservoir operated within the upper 4 ft (781 ft to 777 ft mean sea level in elevation) 95.1 percent of the time (Devine, Tarbell & Associates 2006). The uppermost 5-mile section of Lake Pateros immediately downstream from the Chief Joseph Dam tailrace is characteristic of a riverine environment, with relatively fast flow through the narrow canyon (Douglas County PUD 2011). The middle 10-mile section between the town of Brewster and just upstream of Chief Joseph State Park resembles a more lacustrine environment, with slower water velocities. The lowermost 15-mile section is relatively narrow and fast-flowing but eventually slows and deepens on approach to Wells Dam (Douglas County PUD 2011).

In addition to the dams, but to a much lesser extent, irrigation or other surface water diversions have reduced river flows. Agriculture, grazing, and development have altered the mainstem Columbia River corridor and stream hydrology with increased runoff and decreased floodplain storage connectivity. These flow reductions and subsequent alterations to in-stream habitat are more evident in the contributing tributaries.

Within the Mainstem Upper Columbia River, numerous dams alter the flow regime and hydrograph of critical habitat. Therefore, this PBF is not properly functioning in the Action Area.

Mainstem Snake River CHU 23

The natural hydrograph is significantly impaired by the presence and operation of dams throughout the Snake River. The mainstem Snake River upstream of Lower Granite Dam is influenced by operations at the Hells Canyon Complex and Dworshak Dam on the Clearwater River. While the four dams on the Lower Snake River are run-of-river facilities, their presence and operations maintain and enhance reservoir habitat resulting in changes to flow regimes, backwatering in tributaries, and changes to sediment and substrate composition. Overall, storage dams throughout the Columbia River Basin have dampened the pre-dam hydrograph, with decreased high flows during the summer and increased low flows during the winter (National Research Council 2004). Flows can also vary on shorter timescales (i.e., daily) to optimize power generation during peak energy demands.

Operations of four dams on the Lower Snake River as well as upstream dams in the Snake and Clearwater Basins alter the flow regime and hydrograph throughout the Mainstem Snake River CHU. Therefore, this PBF is not properly functioning within the Action Area.

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

Clearwater CHU 21

PBF 8 is present in Dworshak Reservoir, though water quality conditions are directly affected by dam operations and legacy mining operations in the North Fork Clearwater River. Many Dworshak Reservoir tributaries, and portions of the reservoir remain un-assessed (Category 3 waters) in Idaho's 2012 Integrated Report (IDEQ 2014). As discussed for PBF 5, portions of the reservoir and some discharging tributaries are 303(d) listed for elevated in-stream temperature. In addition, a segment of the North Fork Clearwater River immediately downstream of Dworshak Dam is 303(d)-listed for dissolved gas super-saturation.

In-stream dredging associated with placer mining has resulted in increased sediment loading in the river and atop substrates, and such activities re-suspend fine sediment. Approximately 50 recreational dredges have been reported to operate in the North Fork downstream to the Dworshak Reservoir, a portion of which may operate during any given summer (CBBTTAT 1998a as cited in USFWS 2002d).

Stockner and Brandt (2006) report that Dworshak Reservoir is in a state of nutrient imbalance, with low N:P ratios. There has been nutrient enhancement work in Dworshak Reservoir in an effort to reduce blue-green algae concentrations and to improve carbon flow up the food web (Corps 2017a). Data collected from Dworshak Reservoir in 2010 showed that the Idaho Department of Environmental Quality guidelines were not exceeded (Scofield et al. 2011). USFWS (2002d) characterized Dworshak Reservoir as a deep, cold-water reservoir, with the lower 20 miles being monomictic (meaning the lake waters mix once a year) and the upper reservoir being dimictic (meaning the lake waters mix twice a year). After 3 years, the reservoir dropped from moderately productive to oligotrophic. Wave action on exposed side and bottom sediments was identified as a continuous source of turbidity. Nitrogen was noted as the nutrient generally limiting algal growth.

USFWS (2005) reports that, with the exception of water temperature and fine sediment, water quality in the North Fork Clearwater River Basin is considered to be excellent, with no incidences of chemical or biological pollution. TMDLs have been developed for several direct tributaries to the Dworshak Reservoir (i.e., those whose lower reaches are part of the Action Area). These include Breakfast (sediment), Elk (temperature), Cranberry (sediment, temperature and bacteria), and Swamp (sediment and temperature) Creeks (IDEQ 2002).

PBF 8 is present and contributes to FMO habitat in the Clearwater River downstream of Dworshak Dam. The mainstem North Fork Clearwater River (below Dworshak Dam) and the mainstem Clearwater River from the confluence with the North Fork to approximately 26 RM downstream are 303(d)-listed for dissolved gas supersaturation (IDEQ 2014). U.S. Highway 12 and the Camas Prairie railroad are located within the riparian corridor and floodplain of the mainstem Clearwater River. The presence of this infrastructure has contributed to decreased water quality in the form of increased suspended sediment levels. Relatively high surface erosion potential and landslide hazards combine to create substantial sediment production concerns throughout this reach.

Based on the above information, this PBF is functioning at risk in the Action Area.

Mainstem Upper Columbia River CHU 22

The mainstem Columbia River is CWA 303(d) listed for several impairments, including temperature, DO, pH, TDG, metals, polychlorinated biphenyls (PCBs) dichlorodiphenyltrichloroethane (DDT), and its derivatives, dioxin, and pesticides (USFWS 2011b). Primary water quality concerns in this area include the potential for dissolved gas supersaturation (in excess of state standards of 110 percent), which can harm fish. Because little degassing occurs during transport through Rufus Woods Lake, TDG measured at the Chief Joseph forebay is largely a function of TDG released from Grand Coulee.

The Action Agencies have made operational and structural modifications to reduce TDG levels downstream of Chief Joseph Dam. At Grand Coulee, if the reservoir water surface elevation is above 1265.5 ft, spill can be directed over the drum gates, which produces significantly lower levels of TDG compared to spill though the outlet tubes. When the reservoir water surface elevation is below 1265.5 ft, Reclamation operates the upper and mid-level outlet tubes at the same time, in an over/under method. This method has been effective in reducing TDG when using the outlet tubes. At Chief Joseph Dam, spillway flow deflectors have been successful at reducing TDG levels in the spillway releases. A pre-deflector study determined that TDG exchange in spillway flows ranged from about 111 percent to 134 percent and were a direct function of the specific spillway discharge (Schneider and Carroll 1999 as cited in Easthouse 2011). The post-deflector study showed that spillway deflectors substantially reduced TDG exchange in spillway flows with measured TDG saturations ranging from about 110 percent to 120 percent (Schneider 2012). This is still above the state maximum standard of 110 percent saturation, but considered less harmful for bull trout than the higher saturations generated by Grand Coulee Dam, and is within design parameters for the deflectors.

If the Chief Joseph Dam powerhouse is operating when Grand Coulee Dam is spilling, then high TDG concentrations can be passed through the powerhouse and entrained into spilled water, propagating high TDG levels downstream. But the Action Agencies' system spill priority list has been able to prioritize power generation to be favored at Grand Coulee with spill at Chief Joseph during times when spill is necessary. This supports improved water quality not only downstream of Chief Joseph Dam, but also in Rufus Woods Lake.

The five non-Federal dams in this reach of the CHU have been subject to separate regulatory compliance requirements and relicensing agreements addressing TDG generation. A combination of operational and/or structural modifications have been implemented at each of these dams to increase juvenile salmon survival during outmigration while avoiding or minimizing adverse water quality impacts.

The Corps installed additional spillway deflectors at McNary Dam in 2004 (an initial set of deflectors was installed during the 1970s). The spillway deflectors are designed to reduce TDG saturation during spill. The Corps has continuously measured TDG saturation below McNary since 1990. Spill is managed to keep TDG concentrations within prescribed limits (by Ecology and ODEQ) in the tailrace of the lower Snake and Columbia River dams during the juvenile salmon passage seasons, which is generally from April through August. Outside the juvenile salmon passage season, spill is minimized to the extent possible. Whenever spill occurs outside the fish passage season, it is involuntary, which means it is unavoidable.

In addition to water quality concerns in the CHU, water quantity is highly influenced by Federal and non-Federal actions in the mainstem Upper Columbia River. As much as 6 percent to 10 percent of river flows are withdrawn from the Columbia River for federal irrigation projects (Section 9.4.7). This does not include non-Federal irrigation withdrawals which are difficult to quantify. Reduced flows, especially during warmer summer months, can impact overall water temperatures and reduce the functionality of the habitat for bull trout. In the mainstem Columbia River the federal CRS storage projects release stored water to augment summer flows. Additionally, Grand Coulee Dam outflow water temperature has a temporal lag behind the warming/cooling inflow to Lake Roosevelt, observed at the U.S.-Canada border. In general, water temperatures released from Grand Coulee tend to be cooler than reservoir inflows throughout much of the spring and early summer, and warmer in late summer/fall. Because Lake Rufus Woods does not stratify and has a residence time of about 4 days, it passes on the lagged water temperatures created by Lake Roosevelt.

Thus, PBF in the Mainstem Upper Columbia River is not properly functioning.

Mainstem Snake River CHU 23

PBF 8 is impaired in this reach and provides a limited contribution to FMO habitat in the lower mainstem Snake River. Impoundment of the river has altered flow characteristics and temperature regimes, and one of the primary water quality constituents affecting bull trout use of the mainstem Snake and Columbia Rivers is temperature (see PBF 5). Water quality in the mainstem Snake River is also limited by several pollutants, including sediment, bacteria, DO, nutrients, pH, mercury, pesticides, and TDG. Dissolved gas supersaturation (in excess of state standards of 110 percent) can harm fish. Spill from the Lower Snake River dams can cause gas supersaturation conditions. Sampling for DO levels in 2010 identified levels above 100 percent throughout the three reservoirs, and the highest values were recorded at stations in Ice Harbor Reservoir (Seybold and Bennett 2010). High flows and water turbulence from Lower Monumental Dam, combined with the respiration of abundant submerged macrophytes, could have contributed to high dissolved gas concentrations at the stations in Ice Harbor Reservoir.

The Corps has installed spillway deflectors at all Snake River dams in this reach. The spillway deflectors are designed to reduce TDG saturation during spill. The Corps has continuously measured TDG saturation below Lower Granite, Little Goose, Lower Monumental, and Ice

Harbor dams since 1990. Spill is managed to keep TDG concentrations below prescribed limits in the tailrace of lower Snake and Columbia River dams during the juvenile salmon passage seasons, which is generally from April through August. Any spill occurring outside the juvenile salmon passage season is unavoidable.

Based on the above information on temperatures and TDG, PBF in the Mainstem Snake River is not properly functioning.

PBF 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.

Clearwater CHU 21

This PBF is impaired due to the presence of non-native brook trout, which is identified as a threat to bull trout habitat and population sustainability in the North Fork Clearwater River (USFWS 2014d). Brook trout in some spawning and rearing tributaries and mainstem FMO habitats contribute to competition, predation, range reduction, and possible hybridization with bull trout (USFWS 2015c p. C-324). Brook trout were widely stocked in the early 1900s, and there are currently several populations in the North Fork Clearwater Basin (USFWS 2015c b p. C-324). Areas where brook trout were introduced include high mountain lakes in the Meadow Creek drainage, and in the Orogrande and Beaver Creek drainages. Brook trout are present primarily in the upper watershed, and hybridization appears to be a localized problem in this Core Area (CBBTTAT 1998a as cited in USFWS 2002d). There are currently several brook trout populations in the lower Clearwater Basin, including the Potlatch River system (CBBTTAT 1998b as cited in USFWS 2002e). Northern pikeminnow, a predatory species, are native to the lower North Fork Clearwater subbasin (IDEQ 2002). Predatory smallmouth bass were stocked into the Reservoir in 1979 (Miller 1987).

Based on the presence of brook trout populations throughout the Action Area, the Service considers this PBF to be functioning at risk.

Mainstem Upper Columbia River CHU 22

Introduced species are present throughout the Columbia River (Wydoski and Whitney 2003). Conditions in reservoir reaches typically favor non-native species, and these are prevalent in the mainstem Snake and Columbia Rivers. USFWS (2010b) cited a study that identified 36 non-native fish species in the Lower Columbia River. Some of these species, such as brown trout, may compete with bull trout for food resources, thereby affecting bull trout survival. Many were historically stocked to provide additional recreational and sport fishing opportunities. Hybridization between brook trout and bull trout has been documented in in some tributaries. Non-native predatory fish including walleye, smallmouth bass, and northern pike have entered or been introduced into the Mainstem Upper Columbia River.

Based on the numerous species of non-native species found in the Columbia River, the Service considers this PBF as not properly functioning.

Mainstem Snake River CHU 23

PBF 9 is impaired in the Lower Snake River. Conversion to a more lacustrine habitat has increased predator abundance and productivity of non-native predatory and competing fish species. Conditions in reservoir reaches typically favor non-native species and these are prevalent in the mainstem Snake and Columbia Rivers.

Seventeen non-native fish species currently share resources with 18 native species in the Lower Snake River reservoirs (USFWS 2002e). Although numbers differ, species composition of resident fish differs little among the reservoirs. Species found in high abundance in all reservoirs include suckers, northern pikeminnow, bass, chiselmouth, and redside shiners (Bennett et al. 1983; Bennett and Shrier 1986; Bennett et al. 1988). Crappie, sunfish, and largemouth bass are highly abundant in backwaters of all reservoirs. Most recently, walleye numbers have increased in the region. The highest densities of smallmouth bass in the Columbia and Snake Rivers occur in the Lower Granite forebay, tailrace, and reservoir (NMFS 2000a,b).

Based on the numerous species of non-native species found in the Snake River, the Service considers this PBF as not properly functioning.

9.4.5.5 Conservation Role of the Action Area to Mid-Columbia Recovery Unit

The MCRU includes varying statuses of bull trout populations. Some areas within the MCRU are characterized by small, increasingly threatened bull trout populations. Other areas with intact riverine habitat, including wilderness areas and protected forestlands, support more robust bull trout populations. The MCRU, which includes 24 Core Areas, two historically occupied areas, and one RNA (the Northeastern Washington RNA), intersects the Action Area. While bull trout occupying this unit fall primarily outside of the Action Area, they still use the Action Area during the year for foraging, migration, and overwintering purposes. Throughout these areas, bull trout populations are impacted by Federal and non-Federal operations on the mainstem Mid-Columbia River, Lower Snake River, and the Clearwater River.

The mainstem Mid-Columbia River, a geographic Basin within the MCRU, is characterized by rearing and FMO habitat for sub-adult and adult bull trout. Bull trout populations vary in number, size, and stability in this Basin, ranging from few, depressed populations in the John Day River Core Areas to 34 local populations in the four Core Areas (Methow, Entiat, Wenatchee, and Yakima) connected to the river between Chief Joseph Dam and the Yakima River. The mainstem Lower Snake River Basin, which falls entirely within the Action Area, is essential in enabling bull trout migration and facilitating genetic exchange between Core Areas. Both the mainstem Lower Snake River and the Clearwater River Basins provide essential rearing and FMO habitat and connectivity for sub-adult and adult bull trout, which occupy these large rivers and associated tributary systems on a seasonal basis, throughout most of the year.

Without safe, timely and effective (adequate) fish passage facilities, dams and associated infrastructure associated with the CRS in the Action Area have limited connectivity among aquatic environments and threatened bull trout and native migratory fish (e.g., salmon and steelhead) from accessing critical upstream habitat. The presence of the dams have also negatively altered flow, water quality, and temperature regimes, limiting bull trout survivability throughout their complex life history stages. Legacy and ongoing human and land management activities (e.g. irrigation diversions and grazing) have led to overall reductions in bull trout habitat complexity, thereby negatively impacting the resiliency of bull trout populations in facing future ecological threats and challenges, like the potential establishment of non-native species (e.g., bass and walleye). Additionally, entrainment of bull trout, especially through Dworshak Dam, has been cited as a risk factor negatively affecting population sustainability in the MCRU.

Within the MCRU, three bull trout CHUs fall within the bounds of the Action Area and, within adjacent tributaries, additional CHUs are designated. In general, these CHUs are essential for maintaining bull trout distribution patterns, providing access to FMO habitat, and ensuring connectivity (i.e., conserving critical migratory corridors). Upstream of the CRS dams, habitat is relatively intact apart from some developed areas with passage barriers (i.e., culverts). Due to a variety of environmental and anthropogenic factors (e.g., elevated TDG levels and water temperature, encroachment, lack of adequate and appropriately-sized fish passage facilities, and habitat fragmentation) resulting from dam presence within the Action Area, bull trout critical habitat in the MCRU is generally considered either "at risk" or not functional.

9.4.6 Coastal Recovery Unit

The Coastal Recovery Unit (CRU) in the Action Area includes the mainstem Columbia River downstream of John Day Dam to the Pacific Ocean, including the estuary (Figure 10). Operations of Bonneville and The Dalles dams influence habitat and bull trout through this reach. Of the 22 Core Areas and 4 historic areas in the CRU, seven Core Areas (Lewis River, Klickitat River, Hood River, Upper Willamette River, Odell Lake, Clackamas River, and Lower Deschutes River) and two historic areas (White Salmon and Upper Deschutes) are located in the Lower Columbia River Basin adjacent to the Action Area (USFWS 2015e). Due to manmade and natural barriers, there is no evidence that bull trout from the Lewis River, Upper Willamette River, Odell Lake, or Clackamas River Core Areas enter the Columbia River. In the rare event that bull trout leave these Core Areas, they are unable to return to spawning and rearing areas within the Core Areas. If bull trout from these Core Areas enter into the Action Area at all, it is likely that only few individuals enter the Action Area. The Proposed Action will not affect these Core Areas as a whole and no further discussion occurs in the document.

Aquatic habitat in this reach includes the mainstem river, embayments (isolated off-channel ponds), backwaters, and mouths or lower reaches of tributaries and associated seasonally flooded and riparian lands as well as the Columbia River Estuary (NPCC 2004d). The landscape surrounding Bonneville Reservoir is characterized by steep-forested hillsides and transitions to a broad valley landscape east of The Dalles Dam (Thorson et al. 2003). Vegetation surrounding the western portion of Bonneville Reservoir is dominated by conifer and hardwood forests with smaller areas of riparian wetlands. Near Hood River, the vegetation transitions into ponderosa pine forest. The vegetation changes entirely to grasslands and shrub steppe habitat, with few trees, for the eastern portion of the segment to John Day Reservoir.

Current land uses surrounding Bonneville Reservoir include residential, commercial, and industrial development in urban centers, including Stevenson, Home Valley, and Bingen, Washington and Cascade Locks, Hood River, and The Dalles, Oregon. These urban centers contain industrial sites of varying sizes consisting of maintained harbors, reclaimed building sites, and shoreline moorings. Agriculture is the primary land use surrounding The Dalles Reservoir, and a significant portion of the former sagebrush steppe, grassland, and riparian communities has been converted to agriculture for dryland grains and irrigated crops (NPCC 2004d). Washington State Route 14 parallels the north shore throughout the Lower Columbia River Reach and Interstate 84 runs along the south shore. The Burlington Northern Railroad runs parallel to the north shore, and the Union Pacific Railroad runs along the south shore. These transportation corridors are reinforced by riprap revetments along significant lengths of shoreline. Hydraulic connection beneath portions of the transportation corridor between embayments (and mouths of streams) and the river's mainstem is accomplished through culverts, bridges, and trestles. Agriculture is prominent along the middle and eastern portions of the reach, particularly on the southern side of the river. Recreational and tribal fishing is present in this segment. The river segment between Bonneville Dam and McNary Dam comprise the vast majority of the Tribal fishing areas on the mainstem Columbia River.

This portion of the Columbia River provides connectivity between other Core Areas, including the Hood River, White Salmon River, and Klickitat River. These river basins support populations of bull trout, but other than the lower few miles of river at their confluence with the Columbia, are not affected by CRS operations and are therefore outside the Action Area designated for this consultation. The Mainstem Columbia in these reaches can provide some potential connectivity between these tributary populations, and the connection between these Recovery Units through the mainstem Columbia River allows expression of fluvial bull trout life history and exchange of genetic diversity between Recovery Units. The Lower Columbia River also provides FMO habitat for bull trout.

9.4.6.1 Klickitat River Core Area

The Klickitat River Subbasin is located in south-central Washington, within the Columbia River gorge. The Klickitat River headwaters drain from the eastern side of the Cascade Range to its confluence with the Columbia River at RKM 290, approximately 19 RKM below The Dalles Dam. The presence of brook trout in the watershed was identified in the 2015 Bull trout Recovery Plan as the only threat to this population (USFWS 2015e).

The Klickitat River supports a single bull trout local population within one Core Area. This local population occurs in the West Fork Klickitat River (West Fork) and is comprised of bull trout from five tributaries: Trappers Creek, Clearwater Creek, Little Muddy Creek (Byrne et al. 2001), Two Lakes Stream, and an unnamed tributary to Fish Lake Creek (Thiesfeld et al. 2002). Information on bull trout spawning and life history has been collected in the Klickitat River through several efforts (Byrne et al. 2001; Thiesfeld et al. 2002; USFWS 2002g). It is believed this population is comprised of only a resident life history strategy. Genetic analysis of these populations (Small et al. 2007) confirmed some genetic variation among West Fork tributaries but it was not statistically significant, and the bull trout in those tributaries are therefore considered to be a single, local population. All evidence in the Klickitat Basin indicates the population is depressed based on small size and isolated nature. There are no documented occurrences of this population using the mainstem Columbia River. While use of the mainstem Columbia River is unknown, there are no known barriers to downstream movement.

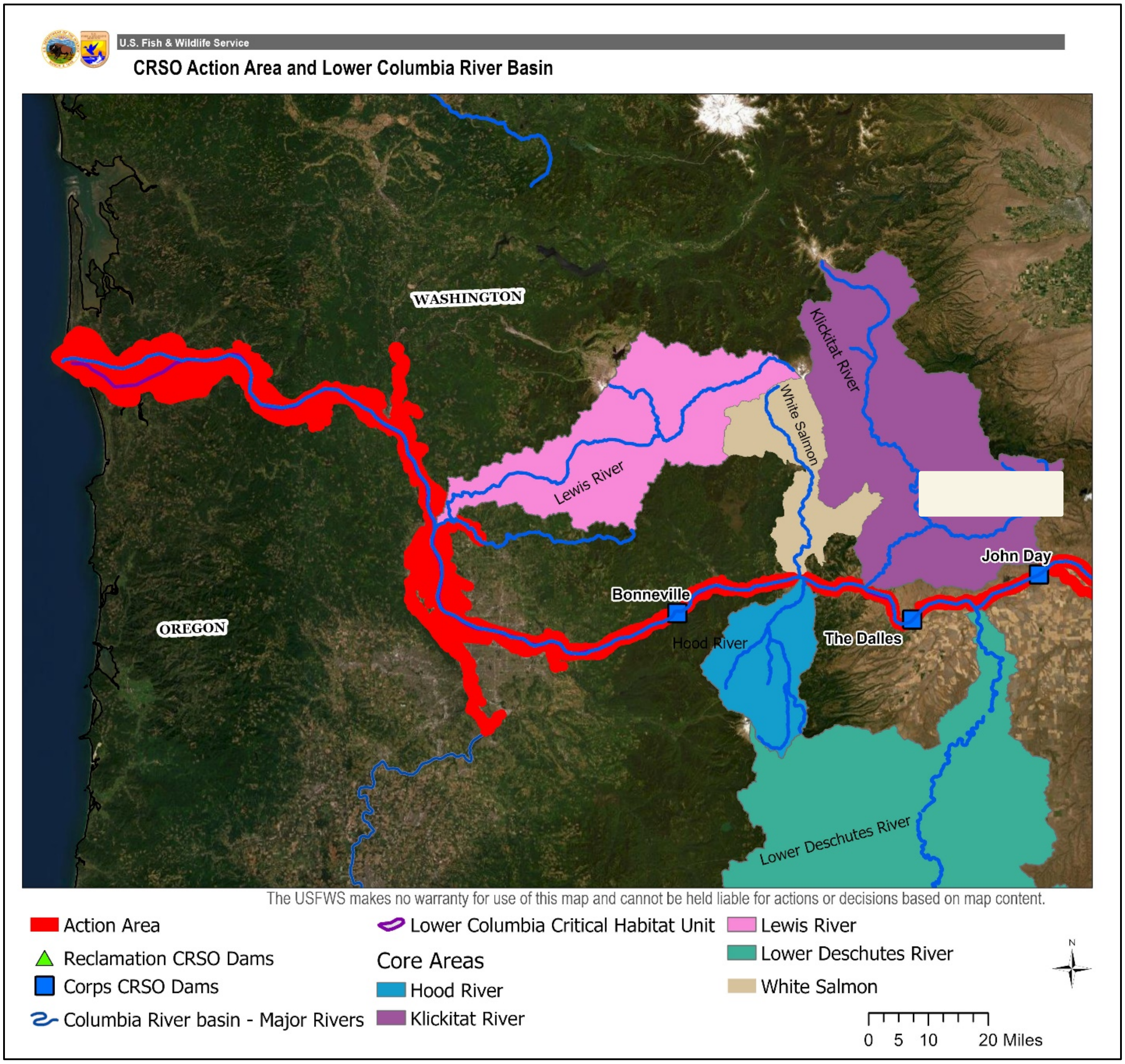

Figure 10. Lower Columbia River, bull trout Core Areas, and dams.

9.4.6.2 Hood River Core Area

The Hood River is located in north central Oregon. There are three major tributaries – the East, Middle, and West Forks – which originate from the northeast flanks of Mount Hood and generally flow north and converge to form the mainstem Hood River from its confluence with the Columbia River. Primary threats to populations of bull trout in the Hood River Core Area include upland and riparian land management, instream impacts, water quality, and connectivity impairment (USFWS 2015e).

Historically, bull trout distribution in the Hood River included primarily the mainstem, Middle Fork and tributaries, and a short reach of the West Fork. Bull trout also likely used the Columbia River for juvenile rearing and adult foraging (Buchanan et al. 1997). Although Hood River bull trout share a genetic past with Puget Sound and Olympic Peninsula regions, it is unclear to what extent the Lower Columbia River Core Areas supported an anadromous life history in the past or could in the future (Ardren et al. 2011; USFWS 2015e). Bull trout in the Hood River likely functioned as a single population prior to the construction of the Clear Branch Dam, which fragmented the population and spawning habitat (ODFW 2005).

While the bull trout recovery plan (USFWS 2015e) identified two local populations in the Hood River (Laurance Lake and Hood River), the local bull trout working group has determined there is only one local population (Laurance Lake) and that bull trout observed below Clear Branch Dam are likely fish that have been entrained and are now rearing in other areas of the Hood River and mainstem Columbia River. No spawning or early juvenile rearing is currently known to exist below Clear Branch Dam in other tributaries of the Middle Fork Hood River or in the West Fork Hood River or East Fork Hood River and associated tributaries.

Prior to the removal of Powerdale Dam on the Hood River (Oregon), bull trout were observed annually passing in small numbers at the upstream ladder and trap, indicating that a migratory population of bull trout persists. (Coccoli et al 2004). It is now thought that these observations of migratory bull trout at Powerdale Dam were of individual bull trout that were entrained through Clear Branch Dam (Middle Fork Hood River) and were using the mainstem Columbia River for FMO habitat. A study is currently underway by the Middle Fork Irrigation District, owner and operator of Clear Branch Dam, to assess the feasibility of constructing fish passage via trap and haul at the base of Clear Branch Dam and promoting safe downstream passage via modification to the dam's spillway (MFID 2010 p. 19).

There have been no studies to estimate the total abundance of fluvial bull trout emigrating from the Hood River Subbasin to the Columbia River. Nearly complete documentation of returning fluvial adults occurred via the trapping effort by the Oregon Department of Fish and Wildlife at Powerdale Dam from 1992 through 2010. Powerdale Dam was removed in 2010, and trapping at the dam was terminated on June 30, 2010 (Reagan 2011).

Current abundance of spawning bull trout in the Laurance Lake local population is determined by census redd counts conducted annually in Pinnacle Creek and Upper Clear Branch Creek, both tributaries of Laurance Lake. Recent surveys conducted by Oregon Department of Fish and Wildlife and the USFS, Mt. Hood National Forest suggest a short-term negative trend in redd counts from a high of 66 in 2014 to counts of 26, 35, and 12 in 2015, 2016, and 2017 respectfully (Saiget 2017, p. 10). This data indicates the population is likely depressed.

9.4.6.3 Lower Deschutes Core Area

The Deschutes River originates on the east slope of the Cascade Mountain range in central Oregon. The river begins flowing out of Little Lava Lake and into several reservoirs before reaching the Columbia River at RKM 328. The Deschutes River flows approximately 405 RKM from its origin and discharges into Lake Celilo, the reservoir created by The Dalles Dam (RKM

307). Parts of the Metolius River subbasin and all of Shitike Creek and the Warm Springs River subbasins lie within the boundaries of the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). The bull trout recovery plan did not identify any primary threats for the Lower Deschutes Core Area although there is a long-term decline of bull trout in the Warm Springs River local population. From 1998 – 2006, bull trout redd counts in Warm Springs River index reaches averaged 83.7 (range 53 – 113) but averaged 18.3 (4 – 29) from 2007 – 2016 (CTWSR 2017, p. 18).

The Deschutes River Subbasin contains one Core Area with five local bull trout populations (USFWS 2015e). The five local populations reside in the Lower Deschutes Core Area and include the Shitike Creek local population, Warm Springs River local population, and three local populations in the Metolius River complex. Bull trout still exhibit resident, fluvial, and adfluvial life histories in the Lower Deschutes Core Area. All three life histories are present in the Metolius River complex as bull trout are known to reside in the upper Metolius tributaries (resident), migrate into the mainstem Metolius River (fluvial), and migrate into Lake Billy Chinook (adfluvial), the reservoir created by Round Butte Dam (RKM 328.177) (Buchanan et al. 1997). Due in part to multiple Metolius River tributaries that contain an abundance of complex habitat and cold consistent ground water, bull trout local populations in the Metolius River are among the most robust and stable in the CRU (USFWS 2015e). Redd counts over the last decade in the Metolius River local populations have averaged 500 annually. A bull trout redd ratio of 2.3 fish per redd originating from several studies over the last two decades suggests a spawning population of over 1,000 individuals (Ratliff et al. 1996).

Observations of Deschutes River origin bull trout entering the Columbia River are rare, and no studies have been conducted specifically to describe Deschutes River bull trout movements or habitat use within the Columbia River. A 2007 radio-telemetry study conducted by CTWSRO recovered two radio tags from bull trout taken in mainstem Columbia River tribal fisheries. One bull trout was harvested below John Day Dam (RKM 348) (Graham et al. 2011). The other bull trout was harvested immediately below The Dalles Dam, approximately 22 km downstream from the mouth of Deschutes River. This indicates that Deschutes River origin bull trout, in small numbers, may use the Columbia River as FMO habitat.

9.4.6.4 Lower Columbia River CHU 8

Within this reach, CHU 8 includes the free-flowing reaches of the Columbia River up to ordinary high-water mark elevations. The Lower Columbia River CHU was determined as providing essential FMO habitat for extant tributary populations of bull trout in the Lewis, Hood, Klickitat, and Deschutes rivers and connectivity between these Core Areas, as well as facilitating the potential reestablishment of a population within the White Salmon River (USFWS 2010b).

The Lower Columbia River from the Pacific Ocean upstream to the John Day Dam provides essential FMO habitat for extant tributary populations of bull trout in the Lewis, Hood, Klickitat, and Deschutes rivers and connectivity between these Core Areas, as well as facilitating the potential reestablishment of a population within the White Salmon River. Numerous anthropogenic stressors have led to significant habitat modification in the Lower Columbia

River. In lower portions of this reach, navigation channel development and maintenance, as well as diking, draining, and filling of estuarine wetlands and off-channel habitats are the primary stressors.

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

Lower Columbia River CHU 8

In the mainstem, PBF 1 is present but provides a limited contribution to FMO habitat. The construction and operation of dams, and levees, dikes, and shipping channels has significantly altered the timing and magnitude of hydrologic events and significantly reduced overbank flows and connections between the river and its floodplain (NMFS 2011b). The inundation of wetlands from the construction of Bonneville and The Dalles dams has resulted in the drying and loss of many wetland and riparian habitats (NPCC 2004d). Shoreline development for transportation corridors has further reduced the interaction between the mainstem river and shoreline springs.

Based on lost floodplain connectivity, reduced overbank connection, and inundation of wetlands and riparian areas, this PBF is considered not properly functioning in the Action Area.

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

Lower Columbia River CHU 8

Historically, the Lower Columbia River region is believed to have largely supported the fluvial life history form of bull trout; however, dams built within a number of the bull trout Core Areas have isolated or fragmented watersheds causing bull trout to now adopt the adfluvial life history form (USFWS 2015e).

Bonneville and The Dalles dams may hinder bull trout movement at the dams (USFWS 2010b). Fish ladders at Bonneville and The Dalles dams are designed and operated to meet NMFS anadromous fish passage guidelines (NMFS 2011a). From 2006 to 2014, a total of three bull trout were observed in the fish ladder at Bonneville, and none were observed at The Dalles and John Day dams (Barrows et al. 2016). The USFWS (2015e) anticipates that the mainstem Columbia River could provide important foraging and overwintering habitat for fluvial bull trout. Downstream passage survival at Bonneville and The Dalles dams are above 94 percent for all life stages of salmon and steelhead (Corps et al. 2020a). Similar survival rates would be expected for bull trout.

Since passage facilities at the Lower Columbia projects (McNary, John Day, The Dalles and Bonneville) were designed to pass adult salmon and steelhead upstream, it is likely they are insufficient for all life stages of bull trout, specifically smaller sub-adults. Therefore, the Service considers this PBF to functioning at risk in the Action Area.

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

<u>*Lower Columbia River CHU 8*</u>

The mainstem Columbia River provides productive foraging habitats for migratory bull trout, and an abundant food source exists throughout the year in this reach (USFWS 2015e). Historical changes to the estuary from operations of the dams have likely altered the function of forage habitat and diversity of species. It is unclear what effect this may have had on bull trout in the Lower Columbia River. While bull trout in the Lower Columbia River are genetically linked to anadromous populations along the Pacific Coast and in Puget Sound, it is also unclear to what extent bull trout in the Lower Columbia River were anadromous (Ardren et al. 2011). Forage fish within this reach include juvenile salmon and steelhead, whitefish, sculpins, suckers, and minnows (USFWS 2010b). The large numbers of hatchery-raised salmon and steelhead released into the Columbia River annually provide an abundant source of prey for bull trout. Some species, such as juvenile salmon and steelhead, may also compete with juvenile and sub-adult bull trout for prey.

Based on the above information, the Service considers this PBF to be properly functioning.

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

<u>*Lower Columbia River CHU 8*</u>

The presence and operation of dams, and levees and channel modifications have restricted habitat-forming processes such as sediment transport and deposition, erosion, and natural flooding. Almost no functioning riparian habitat exists along the mainstem itself; most of the floodplains that provided favorable hydrologic conditions have been inundated (Ward et al 2001). The remaining functional riparian habitat is located primarily on NWR lands bordering the Lower Columbia River and the estuary. Transportation corridors along the river have reduced the amount of riparian vegetation and limited the formation of off-channel habitat. Reduced floodplain connectivity has also decreased the recruitment of LW needed for the formation of complex habitat. Levees and dam operations have reduced the recruitment of LW by curtailing overbank flows. Shoreline development for transportation corridors has also reduced the amount of riparian vegetation available for potential LW. The dominant shoreline type within the impoundments is usually riprap, followed by smaller rock or sand (Ward et al 2001; NPCC 2004e). Shoreline gradient in riprapped areas is often very steep. Generally, PBF 4 is not present in Snake and Columbia River reservoirs (USFWS 2010b).

Near the mouth of the Columbia River, tide flats and shallow subtidal habitats have been converted to deeper-water habitats through dredging, or uplands through diking or fill. The remaining tidal marsh and wetland habitats in the estuary are restricted to a narrow band along the Columbia River and its lower tributaries (NMFS 2004). Some high-quality backwater and side-channel habitats have persisted along the Lower Columbia River banks and near undeveloped islands.

Land use practices have significantly reduced the delivery of LW in the Lower Columbia River (NMFS 2011b). Loss of riparian habitat due to floodplain development limits the input of LW in this system. The Lower Columbia Estuary Partnership (2012 p. 137) reports that several LW enhancement projects were completed in the Lower Columbia River Estuary Reach (e.g., Mirror Lake). Parametrix (2010) reports that the Columbia River in the vicinity of North Portland Harbor contains fewer than 80 pieces of LW per mile of stream, and the potential for LW recruitment is low due to the urbanized nature of the Action Area and the limited number of mature riparian trees along the riparian corridor.

Shallow-water habitat within this reach has decreased as river stage has declined due to operation of the navigation channel (Bottom et al. 2005). The absence of wood in the Lower Columbia River Estuary Reach precludes the establishment of pools. Parametrix (2010) reports that the Columbia River in the vicinity of North Portland Harbor contains few to no backwaters, ponds, oxbows, and other low-energy off-channel habitat. Few refugia (such as pools, boulders, LW, overhanging riparian vegetation) are present (Parametrix 2010), and riparian buffers are fragmented and often disconnected from the mainstem. Subsequently, pool quality is also degraded due to lack of cover (e.g., LW, overhanging banks, and alcoves). Loss of habitat-forming elements, including LW and sediment, have reduced the availability of low-velocity side channel habitat in this reach. Maintenance of the Federal navigation channel (via dredging) has resulted in the filling of shallow-off channel habitats (NMFS 2011b).

The historic operation of the dams and dredging of the navigation channel throughout the Columbia River have altered recruitment of LW, habitat complexity, off channel areas, and other environments of this PBF. Therefore, the Service considers this PBF to be not properly functioning.

PBF 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.

Lower Columbia River CHU 8

In the designation of critical habitat, PBF 5 was identified as not present in the Mainstem Columbia and Snake rivers due to construction of the dams and elevated temperatures. While not identified as a PBF in the CHU, water temperatures in the area influence bull trout use and are seasonally limiting.

PBF 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo over-winter survival, fry emergence, and young-of-the-year and juvenile survival.

Lower Columbia River CHU 8

Spawning and rearing does not occur within this CHU, therefore this PBF is not present.

PBF 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.

<u>*Lower Columbia River CHU 8*</u>

Operation of the CRS has reduced the annual spring freshet flows through the Lower Columbia River by about one-half of the pre-development levels (NMFS 2008). Overall, dams on the Columbia River have dampened the natural hydrograph with decreased high flows during the spring and summer and increased low flows during the winter (National Research Council 2004). Flows can also vary on shorter timescales (i.e., daily) to optimize power generation during peak energy demands.

The Columbia River historically exhibited significant seasonal variation in flows, and annual spring freshet flows averaged 75 to 100 percent higher than current conditions. Historic winter flows (October through March) were about 35 to 50 percent lower than current flows (ISAB 2000). The mean pre-development maximum spring freshest flow date was June 12, compared to the present mean date of May 29 (Bottom et al. 2005).

Prior to the construction of major dams throughout the mainstem, annual discharges ranged from 79,000 cfs to more than 1 million cfs, with average discharges of 273,000 cfs. Currently, discharge ranges from 100,000 to 500,000 cfs, with an average annual discharge at RM 53.8 of 217,000 cfs (CH2M Hill 2009). Kukulka and Jay (2003a) report that climate change, flow regulation, and irrigation diversions have changed the magnitude and shape of the annual flow hydrograph, reducing peak flow by more than 40 percent.

Within the Mainstem Upper Columbia River, numerous dams alter the flow regime and hydrograph of critical habitat. Therefore, this PBF is not properly functioning in the Action Area.

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

<u>*Lower Columbia River CHU 8*</u>

PBF 8 is present but impaired in the Lower Columbia River between Bonneville and John Day dams. Dam operations have decreased spring flows and sediment discharges that have resulted in reduced turbidity levels compared to historic levels throughout the Lower Columbia River (Williams et al. 2006).

Total suspended solids concentrations are typically highest during spring runoff and then decline as flows diminish through late summer and into fall. The highest levels observed during spring runoff ranged from 20 parts per million (ppm) to 60 ppm during May and June, but these levels generally decreased to less than 10 ppm for the remainder of the year. Suspended sediment concentration average 2,649 mg/l or 2,829 tons per day.

Environmental contaminants can enter the Columbia River through a variety of point and non-point sources. Point sources may include outfalls at numerous agricultural, transportation, and industrial facilities along the river. Major non-point sources may include agricultural applications of pesticides, insecticides, and herbicides (Ward et al 2001).

Dissolved gas supersaturation (in excess of state standards of 110 percent) has shown in lab tests can harm fish, and spill from the Lower Columbia River dams can cause gas supersaturation conditions well above these conditions. Spill at these projects occurs as part of juvenile fish passage operations, and can also occur in circumstances when river flows exceed powerhouse hydraulic capacity, passing debris, or FRM in spring. The Corps has installed spillway improvements, such as flip-lips, at each mainstem dam and manages spill operations to reduce gas entrainment (NMFS 2008).

Water quality is generally degraded in this reach due to a legacy of urban, industrial, and agriculture practices. Oregon Department of Environmental Quality (2012) reports that the Lower Columbia River is 303(d) listed for the following pollutants (in addition to temperature): fecal coliform, PCBs, Polycyclic aromatic hydrocarbons or PAHs, DDT metabolites such as dichlorodiphenyldichloroethylene or DDE, and arsenic. The Lower Columbia River is on the Washington State 303(d) list for temperature and PCBs (Ecology 2020). The Environmental Protection Agency (EPA) has approved TMDLs for dioxin and TDG in the Lower Columbia River (ODEQ 1991). Dissolved copper is also elevated in this reach of the Columbia River (NMFS 2011b). The Lower Columbia River is on the Washington state 303(d) list for DO (Ecology 2020).

Based on the water quality impairments from elevated TDG, temperature, and agricultural and industrial runoff, the Service considers this PBF to be not properly functioning within the Action Area.

PBF 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.

Lower Columbia River CHU 8

PBF 9 is impaired in the Columbia River between John Day and Bonneville dams. Introduced species are present throughout this reach. Dam construction and subsequent conversion of habitat from riverine to more reservoir-like conditions has increased habitat suitability for non-natives that prefer such conditions over riverine conditions. Introduced fish species that are present in the Lower Columbia River include predators such as largemouth bass, smallmouth bass, black crappie, white crappie, walleye, yellow perch, channel catfish, and bluegill (CH2M Hill 2009). Northern pikeminnow, a native predatory species, are prevalent in the Columbia River in this reach.

PBF 9 is impaired in the Columbia River downstream of Bonneville Dam. Introduced fish species that are present in freshwater portions of the Lower Columbia River include predators such as largemouth bass, smallmouth bass, black crappie, white crappie, walleye, yellow perch, channel catfish, and bluegill (CH2M Hill 2009). Other aquatic species are introduced into the Lower Columbia River Estuary Reach due to ballast water exchange and hull fouling (Sytsma et al. 2004).

The large numbers of non-native species within the Action Area identify this PBF as not properly functioning.

9.4.6.5 Conservation Role of the Action Area to Coastal Recovery Unit

The CRU includes the estuary, and the mainstem Columbia River downstream of John Day Dam to the Pacific Ocean. General aquatic habitat within the CRU is diverse, providing connectivity and accessibility for bull trout during migration and plentiful opportunities for foraging and rearing. Of the total number of Core Areas (22) and historic areas (4) in the CRU, seven Core Areas (Lewis River, Klickitat River, Hood River, Upper Willamette River, Odell Lake, Clackamas River, and the Lower Deschutes River) and two historic areas (White Salmon and Upper Deschutes) are situated adjacent to the Action Area. Manmade and natural barriers prevent bull trout from traveling to and from some Core Areas (e.g., Lewis River and the Upper Willamette River), thereby limiting their accessibility to spawning areas and the Action Area. Within the Klickitat, Hood River, and Lower Deschutes Core Areas associated with the CRU, bull trout populations vary in number from 1, to 1, to 5 populations, respectively. Estimations of the total abundance of fluvial bull trout are unclear due to lack of studies.

Land use (i.e., residential, commercial, and industrial development and agriculture) and management activities associated with Bonneville Reservoir, and operations of Bonneville Dam and The Dalles dams primarily influence bull trout habitat and population viability in the CRU. In general, they have led to reductions in overall FMO habitat and habitat complexity, limited connectivity, and depressed bull trout populations. Additionally, dam infrastructure may hinder, rather than encourage, bull trout movement through the CRU and other Recovery Units. For example, fish ladders at Bonneville and The Dalles dams may be insufficient for bull trout, potentially leading to greater threats to bull trout survival rather than salmon and steelhead survival. Within specific Core Areas, such as the Hood River Core Area, upland and riparian land management and associated, instream impacts that have degraded water quality also threaten remaining bull trout.

An abundance of human activities (e.g., diking, draining, and filling) have significantly altered some areas in the CRU, like the Lower Columbia River. However, this reach also includes bull trout critical habitat (CHU 8). From the Pacific Ocean upstream to the John Day Dam, this free-flowing reach provides essential FMO habitat to support extant tributary bull trout populations in the Lewis, Hood, Klickitat, and Deschutes rivers. Given the availability of habitat in this area and connectivity among diverse aquatic systems, there is the possibility of bull trout population reestablishment, for example, in the White Salmon River.

Based on the diversity of general aquatic habitat associated with the mainstem Columbia River, productive foraging opportunities for migratory bull trout exist in this area throughout the year. Thus, the critical habitat in the mainstem Columbia River is considered to be properly functioning. Conversely, due to the presence and operations of the CRS, land use and management activities, instream infrastructure (e.g., levees and associated channel modification), and the potential establishment of non-native species (e.g., largemouth bass, channel catfish, and bluegill) bull trout critical Habitat elsewhere throughout the CRU, largely, is considered to be not properly functioning, “at risk,” or not functioning at all.

9.4.7 Consulted on Effects for Bull Trout and Designated Critical Habitat

Consulted-on effects represent the effects of proposed Federal actions on listed species and designated critical habitat that have been the subject of past Opinions. Consideration of consulted-on effects is an important component of objectively characterizing the environmental baseline for the species or critical habitat at the range-wide and Action Area scales.

The Service queried their on-line database of consultations as of June 19, 2018. There were 928 formal consultations that were concluded, or are ongoing, addressing Federal actions that may affect bull trout. Forty of those were batched consultations covering multiple projects, and 127 were programmatic consultations. Seventy-four of the total were active on that date, and the rest had been concluded. The consulted-on effects ranged from beneficial or improved conditions, to insignificant or discountable effects, and to adverse effects resulting in injury, mortality or loss of habitat function at the individual, population, and Core Area scales. Only one of the consultations was a jeopardy determination for bull trout: the consultation on Idaho Water Quality Standards for Toxic Pollutants (Reference number: 01EIFW00-2014-F-0233); this was also an adverse modification determination for bull trout critical habitat (USFWS 2015). Numerous consultations completed across the region included bank stabilizing that in many cases resulted in loss or degraded riparian conditions within the Action Area. Not summarized here are numerous consultations related to FERC licensed mainstem dams that are operated in a coordinated effort with the CRS. These are generally discussed in the Environmental Baseline where applicable.

Most formal consultations for bull trout included an analysis of critical habitat, and types of activities considered would be similar. Critical habitat was designated on the mainstem Columbia and Snake Rivers in 2010, and critical habitat would have been considered for federal actions in those locations after that date.

The duration of effects can be a single event (one day or week), a year or multiple years, and in perpetuity. Life histories affected include adult holding pre-spawning, fertilization to emergence, emergence to juvenile out migration, juvenile out migration, adult migration to spawning areas, and sub adult FMO, and adult FMO. The effects associated with all but a few of these projects sampled will be fully part of the baseline by 2020. Several projects that were previously consulted on and are related to the ongoing operations of CRS and include, but are not limited to actions in Table 6.

Table 6. Related Actions with long-term, ongoing actions with existing Consultations

Project	Date Reference #	Brief description
Habitat Improvement Program Consultations; Bonneville	In Consultation; 01EOFW00-2013-F-0199	Programmatic consultation for restoration activities that are funded by Bonneville
Corps Aquatic Habitat Restoration Programmatic, Seattle District, Corps	13410-2008-F-0209	Programmatic consultation for restoration activities that are authorized/permitted by the Seattle District Corps Office
Aquatic Restoration Biological Opinion USFS	01EOFW00-2013-F-0090	Programmatic consultation for restoration activities on Forest Service lands.
Tributary Irrigation Projects Reclamation	Multiple	More than 70 consultations related to irrigation and stream diversions. Seven result in depletions to the Columbia River, considered in this Opinion.
Hatcheries and Harvest Management USFWS, NMFS, Bonneville	Multiple	As many as 29 consultations have been completed on hatchery activities across the Action Area, many of which are mitigation hatcheries associated with the federal dams
	United States v. Oregon February 23, 2018: 01FLSR00-2018-F-001	Management agreement for fish harvest policies for treaty and non-treaty fisheries.
Dredging and Sediment Management Corps	October 18, 2004; 13410-2004-F-0027 November 13, 2014; 01EWFW00-2014-F-0660 November 13, 2014, 01EWFW00-2013-F-0104	Lower Snake River Winter Maintenance dredging Programmatic Sediment Management Plan for Snake River Dams, Site-specific Consultation: Lower Snake River Channel Maintenance Project

9.4.7.1 Irrigation Projects and Mainstem Depletions of Flow

Forty-eight consultations in our consultation database address irrigation, and 23 formal consultations address stream diversions, many of which are also associated with irrigation. The BA also included information on irrigation projects implemented by the Action Agencies, and the depletions of water associated with those projects. The irrigation project infrastructure, operations, and maintenance are considered part of the baseline; however, the mainstem Columbia River water depletions are considered part of the Proposed Action. The action includes the mainstem Columbia River hydrologic depletions for the CBP. Reclamation included cumulative depletions on the mainstem Columbia River for six (6) of Reclamation's irrigation projects that are not operated in coordination with the CRS within the Proposed Action. Four of these irrigation projects are located on tributaries to the Columbia River, and consultations on these have been, or are in the process of being conducted separately (see Table 7). However, the analysis in these separate consultations ends at the confluence of the Columbia River, and does not include mainstem effects. Two of the six irrigation projects are pump facilities located on the mainstem Columbia River. Depletions from all these irrigation projects are included in the CRS mainstem flow models and accounted for in the CRS modeling.

The total acreage in the U.S. portion of the Basin that is irrigated by Federal projects (including Hungry Horse, Columbia Basin, Chief Joseph Dam, Yakima, Umatilla, The Dalles, and Deschutes) is about 1.4 million ac. Irrigation diversions are more susceptible to annual variation than the amount of irrigated land. Because the methods of determining diversions differ, irrigation diversions are only intended to be a general guide (Reclamation data are a mix of actual diversions and estimated based on irrigated acres and expected conveyance). The area of land irrigated in any single year varies from 10 percent to 20 percent with water supply and the general economy; therefore, these data are only intended to be a general guide.

The operation of Reclamation projects for irrigation and the resulting average depletion impacts on the Columbia River are summarized in Table 7 (Corps et al. 2020a Appx C p.7-8). The CBP is shown in Table C-3. These data include the effects of storage delivery of water for multiple purposes. There are three points that reflect the flow in the river after depletions were removed. Those points include Priest Rapids, McNary, and Bonneville Dams. The impacts of the tributary operations are included in the system modeling efforts through the 2010 Modified Flows. Many of the irrigation projects have undergone previous consultations, however typically the effects of depletions on the mainstem Columbia River were not addressed; only the effects to the tributaries. Therefore, the depletions from the projects are summarized below.

Table 7. Summary of previous or ongoing Section 7 consultations for Reclamation tributary irrigation projects

Project	Status of ESA Compliance	Source
Chief Joseph Dam [Irrigation Project]	Completed consultation with Service for screen modification in 2001. There is no tributary associated with this project. Mainstem effects were previously analyzed in USFWS 2000 Biological Opinion; NMFS 2019 Biological Opinion	USFWS 2000 Biological Opinion (USFWS 2000); NMFS 2019 Biological Opinion (NMFS 2019).
Crooked River and Deschutes Projects	Completed informal consultation with Service in 2004 and formal consultation with NMFS in 2005. Reinitiating consultation because of adult and juvenile fish passage at Pelton Round Butte Dam and flow effect of operational change because of Habitat Conservation Plans associated with steelhead reintroduction (with other considerations, for example, for Oregon Spotted Frog). Draft HCP submitted to NMFS and Service in October 2019. Reclamation submitted Final Deschutes Basin Project Biological Assessment for reinitiating consultation with FSWS and NMFS on October 4, 2019.	NMFS Biological Opinion for Deschutes River Basin Projects, February 2005 (NMFS 2005); Service Letter of Concurrence for Deschutes Basin Projects, February 2004 (USFWS 2004a). Final Deschutes Basin Project Biological Assessment sent to USFWS and NMFS on October 4, 2019 (Reclamation 2020).
The Dalles [Irrigation Project]	There is no tributary associated with this project. Mainstem effects were previously analyzed in USFWS 2000 Biological Opinion and NMFS 2019 Biological Opinion	USFWS 2000 Biological Opinion (USFWS 2000); NMFS 2008, 2014 Biological Opinions (NMFS 2008, 2014a).
Umatilla Project	Completed ESA consultation with Service in 2008. Completed ESA consultation with NMFS in April 2004. Reinitiated formal consultation with NMFS in July 2019.	USFWS Biological Opinion for Umatilla Project, July 2008 (USFWS 2008c).
Yakima Project	In progress. Biological Assessment sent to NMFS and USFWS in April 2015. Updated Yakima Project Operations and Maintenance Biological Assessment supplements sent to USFWS in October 2018 and to NMFS in January 2019.	Biological Assessment for operations and maintenance of the Yakima Project, April 2015 (Reclamation 2015). Yakima Project Operations and Maintenance Biological Assessment Supplements sent to USFWS, October 2018 (Reclamation 2018),

(Source: Corps et al. 2020a Appx C)

9.4.7.1.1 Columbia Basin Project

Grand Coulee Dam is the primary storage and diversion structure for the CBP. Irrigation diversions are pumped from Lake Roosevelt to Banks Lake via the John W. Keys III Pump/Generating Plant (JWKIII). Operation for the CBP irrigation diversions are coordinated with other authorized project purposes in a complex operational regime. For more information on operations of Grand Coulee Dam for multiple purposes, including FRM, see Appendix A.

The irrigation season extends from about mid-March to November 1. For the purposes of this consultation, the action diverts up to 3.4 maf[7] annually—this includes an additional 45,000 ac-ft that is a new action as part of this Proposed Action (depletions by month are provided in Table C-2). This total of 3.4 maf includes a small section (3,460 ac) of the CBP is served by the Burbank Pumps at Blocks 2 and 3, which pump from the Snake River (McNary Pool) near the confluence with the Columbia River to lands located south of the Snake River. The maximum pumping rate at the Burbank pumps is about 60 cfs, with a total diversion of about 23,000 ac-ft of water, of which about 10,000 ac-ft return to the river through seepage and surface return flows. This total of 3.4 maf also includes other irrigation diversions for the CBP that are already part of the environmental baseline; these include 164,000 ac-ft covered by the Odessa Subarea Special Study 2012 final EIS and corresponding Section 7 ESA consultation (letter of concurrence for that project (October 12, 2012; Reference number 01EWFW00-2013-I-0004). These diversions occur at the JWKIII. Reclamation is currently informally consulting with the Service on the operation and maintenance of the CBP.

9.4.7.1.2 Chief Joseph Dam (Pumping Project)

The Chief Joseph Dam Project occupies lands along the Columbia and Okanogan Rivers in north-central Washington and is not part of Chief Joseph Dam, which the Corps operates (Corps et al. 2020a Appx C p.9). There are four divisions and a total of seven units, five of which result in depletions to the Columbia River. All of the units are separate land areas with independent irrigation systems. The project serves about 16,760 irrigable ac.

Facility operation is generally limited to the irrigation season, which begins sometime from about mid-April to mid-May and ends sometime from mid-September to October 1. The average annual depletions for the Chief Joseph Dam Project add up to about 37,150 ac-ft. The depletion compared to the total flow at Priest Rapids Dam varies from 0.01 percent (October; 5 cfs) to 0.12 percent (July; 180 cfs) of the flow at Priest Rapids (Corps et al. 2020a Appx C Table C-2 and C-4).

9.4.7.1.3 Yakima Project (Tributary Irrigation Project)

The Yakima Project provides irrigation water for approximately 465,000 ac. Consultation with the Service on Operations and Maintenance of the Yakima Project is in progress, however the action does not address the impacts of depletions on the mainstem Columbia River. The depletions from the Yakima are additive to the depletions from the upstream Chief Joseph Dam, and the downstream Umatilla project and are compared to river flows at McNary Dam (Corps et al. 2020a Appx C Table C-2). The depletions from this project occur all months of the year, with the lowest depletions in January (900 cfs), and the highest in May (8,170 cfs) (Corps et al. 2020a, Appx C Table C-2 and C-5).

[7] This includes 30,000 ac-ft diverted through JWKIII for the Lake Roosevelt Incremental Storage Releases Project covered under a June 2009 Environmental Assessment.

The sum of depletions from Chief Joseph Dam Project, the Yakima Project, and the Umatilla Phase II pump exchange (described below) compared to flows at McNary Dam vary from less than 1 percent (820 cfs in January) to 3 percent (8,300 cfs in May) (Corps et al. 2020a Table C-2). If we added the depletions from the CBP compared to McNary flows, the highest would be 6 percent of flows in July (Corps et al. 2020a Table C-2 and C-3).

9.4.7.1.4 Umatilla Project (Tributary Irrigation Project)

The original Umatilla Project furnishes a full supply of irrigation water to more than 17,000 ac and a supplemental supply to approximately 22,500 ac. These lands, located in north-central Oregon, are divided into three divisions (Corps et al. 2020a Appx C p.10-11). In addition, there are approximately 3,800 ac not included in an irrigation district that are provided either a full or supplemental water supply from McKay Reservoir under individual storage contracts.

Reclamation prepared a BA with an additional supplement (Reclamation 2003a) that fully describes project operations. Reclamation prepared an Operations Plan for the Umatilla Basin Project (Reclamation 2011, 2012b) that describes the project facilities and operations. Reclamation reinitiated consultation with NMFS on the operation of the Umatilla Project, because the April 23, 2004, Opinion was only issued for a 10-year duration.

Reclamation prepared a new BA for the Umatilla Project and requested re-initiation of consultation on September 15, 2016. Reclamation received a non-jeopardy Opinion from NMFS on July 2, 2019. The consultation includes mainstem effects, but only for a short reach of the Columbia River from McNary Dam, where the Phase II pumping facility water intake is located, to where the Umatilla River confluence with the Columbia River. These Opinions do not include mainstem effects downstream of the Umatilla confluence with the Columbia River. Mainstem effects are included as part of this CRS action.

Phase I water pumped from the Columbia River is exchanged for Umatilla River flows that are not diverted by the irrigation district, but are left in the lower 3 miles of the Umatilla River to aid anadromous fish migration. Phase II water is pumped from the Columbia River to replace water previously diverted from the Umatilla River (Corps et al. 2020a Appx C p.11). The Umatilla Phase I Pump Exchange project depletes flow from March to October, with the depletions varying from 5 cfs in March, to 80 cfs in June. The Umatilla Phase II project depletes flows during the same months, and varies from 10 cfs to 120 cfs. The total mainstem effects, included positive flows during some months varies from a positive 40 cfs in November, to depletions of 345 cfs in April.

9.4.7.1.5 Deschutes Project (Tributary Irrigation Project)

Tributary consultation for the Deschutes River Irrigation Project included two Reclamation projects, including the Crooked River and Deschutes projects. The Deschutes Project is located near Madras, Oregon. The project provides a full water supply to about 50,000 irrigable ac and a supplemental water supply for about 48,000 irrigable ac. Reservoirs include Wickiup Reservoir, Haystack Reservoir, and Crane Prairie Reservoir, with a total active storage of about 260,900 ac-ft on the Upper Deschutes, and Prineville and Ochoco with an additional 111,100 ac-ft on the

Crooked River. Reclamation prepared an operations report (Reclamation 2003a) and BA (Reclamation 2003b) that describe in detail the authorizations, facilities, operations, and maintenance activities associated with the Deschutes Project. These documents are incorporated by reference.

An HCP on the operations in the Deschutes River is currently being developed, and a Draft HCP document was submitted to the Service and NMFS in October 2019. In addition, Reclamation has reinitiated consultation with the Service and NMFS because of the operational changes in the Deschutes Project resulting from HCP development. Reclamation submitted a Final Deschutes Project BA to NMFS and the Service on October 4, 2019. The tributary consultation ends at the Deschutes River's confluence with the Columbia River and does not include mainstem effects. Mainstem effects are included as part of this CRS action. The flow effects occur year round, and the depletions of the mainstem from the two projects varies from 170 cfs in March, to 1570 cfs in May (Corps et al. 2020a Appx C Table C-7).

9.4.7.1.6 The Dalles Project (Pumping Project)

The Dalles Project, Western Division, is on the south side of the Columbia River adjacent to The Dalles, Oregon, about 80 miles east of Portland, Oregon. The Dalles Project is not part of The Dalles Dam, which the Corps operates. The Dalles Project pumps directly from Bonneville Dam forebay. Although the project includes about 6,000 irrigable acres, water from the Columbia River is supplied to an annual average of 5,600 ac that produce fruit, primarily sweet cherries (Corps et al. 2020a Appx C p.12). The irrigation season is from about Mar 1 to October 31, and the depletions vary from 10 cfs in April to 50 cfs in July and August (Corps et al. 2020a Tables C-2 and C-8).

The sum of the depletions from the Chief Joseph, Yakima, Umatilla projects, Deschutes Project, Crooked River Project, and The Dalles Project as compared to river flows at Bonneville Dam vary from 1 percent during winter and early spring, to 4 percent during May (Corps et al. 2020a Appx C Table C-2). If we added the depletions from the CBP compared to Bonneville flows, the highest would be 6 percent of flows in April, May, and July (Corps et al. 2020a Appx C Table C-2 and C-3).

9.4.7.1.7 Tualatin Project

The effects on the mainstem Columbia River due to operation of the Tualatin Project were included in past FCRPS Opinions. Since then, Reclamation completed a consultation on operations of the Tualatin Project with NMFS in 2014. Operations of the Tualatin Project were considered to have unmeasurable flow impacts in the Willamette River as well as to the Columbia River in the NMFS 2014 Tualatin Project Opinion (NMFS 2014b). For that reason, Reclamation's Columbia River flow effects from future operation of the Tualatin Project have been removed from this consultation.

9.4.7.1.8 Wapinitia Project

The effects on the mainstem Columbia River due to the operations of the Wapinitia Project in the Deschutes River Basin were included in past FCRPS Opinions. An HCP on the operations in the Deschutes River is currently being developed, and a draft HCP document was submitted to the Service and NMFS in October 2019. In addition, Reclamation has reinitiated consultation with the Service and NMFS because of the operational changes resulting from HCP development. That consultation has fully analyzed the effects of operating the Wapinitia Project and has determined that operational effects of this project are small enough that effects of operations are unmeasurable in the Deschutes River, and therefore are unmeasurable in the Columbia River. For that reason, Reclamation's Columbia River flow effects from future operation of the Wapinitia Project have been removed from this consultation.

9.4.7.1.9 Okanogan Project

Reclamation is currently conducting a separate consultation of the Okanogan Project. That consultation will include all impacts from the operation of the Okanogan Project, including Okanogan River flow depletions and their effects on Columbia River flows. Because the flow depletions of the Okanogan and Columbia Rivers from the Okanogan Project are small, these impacts are anticipated to be extremely small or unmeasurable in the Columbia River. For that reason, Reclamation's Columbia River flow effects from future operation of the Okanogan Project have been removed from this consultation.

9.4.7.2 Mitigation Hatcheries

Across the Action Area, numerous hatchery and production programs have undergone consultation for effects to bull trout. A summary of the majority of the consultations is included in the consultation completed for the U.S. v. Oregon 2018 Management Agreement and incorporated by reference (USFWS 2018b Appx A). The following sections summarize some (but not all) of the hatchery programs that are found in the immediate Action Area. The majority of the hatchery production facilities and operations result in some level of take of bull trout from handling and capture during broodstock collection or research, monitoring and evaluation activities. In other cases, take is authorized for impacts of the operations and maintenance of the physical structures of the hatchery facilities. In all cases, the Service has determined that the levels of take associated will not result in the jeopardy of bull trout. Since many of the hatcheries are related to mitigation for loss salmon resources across the Basin, the majority of the facilities are located within the MCRU for bull trout.

9.4.7.2.1 Snake River Fall Chinook Hatchery Programs (TAILS# – 01EIFWO-212-F-0448). 05/16/2017

The operation and maintenance of facilities associated with the Snake River fall Chinook hatchery program are located in the Snake River Basin in Idaho, Oregon, and Washington, and the Clearwater River Basin in Idaho. The Service reviewed minor modifications to the Proposed Action in 2018 and concluded that re-initiation of consultation was not warranted (reference number - 01EIFW00-2018-TA-1558). Federal Action Agencies include, NMFS (issuance of section 10(a)(1)(A) permits, the Service (operating facilities associated with the LSRCP, Bureau of Indian Affairs, and Bonneville (funding).

The majority of actions that bull trout may be exposed to are not likely to adversely affect these individuals or their designated critical habitat. The exception is related to carrying out RM&E activities involving weirs, seins, smolt traps, angling, and electrofishing during which bull trout are incidentally captured and handled, potentially resulting in harm or mortality. The Incidental Take Statement (ITS) identified no more than a total of 200 individuals will experience sublethal impacts, with a possible 23 individuals suffering mortalities. These individuals are expected to be from local populations in the Clearwater, South Fork Salmon, Tucannon, and Grand Ronde Basins.

9.4.7.2.2 Construction and Operation of the Crystal Springs Hatchery Program for Spring/Summer Chinook salmon (TAILS# – 01EIFW00-2018-F-0203). 12/20/2017

The Crystal Springs spring/summer Chinook hatchery program includes construction and operation of a hatchery facility adjacent to the Salmon River and associated facilities and activities on Yankee Fork and Panther Creek in Bingham, Custer, and Lemhi counties, Idaho. Effects to individual bull trout will occur as a result of the development and construction of the hatchery and associated facilities and from ongoing operations, particularly effects from broodstock collection and other RM&E actions, resulting in migratory delay, capture, and handling of bull trout. These activities occur FMO habitat (well downstream of spawning and rearing habitat) in both the Yankee Fork and Panther creek. Because adverse effects are limited to individual feeding, migrating, or overwintering bull trout, the Service does not expect adverse effects at the larger population, Core Area, Recovery Unit, or range-wide levels. The Service identified an expected level of take at specific facilities and are summarized below.

Facility construction will result in sublethal impacts (from salvage) to up to 20 bull trout in Yankee Fork and 10 bull trout in Panther Creek; no more than one bull trout from each area is expected result in a mortality. Broodstock collection (and associated adult RM&E) is expected to result in sublethal impacts (from delay, capture and handling) to up to 300 individual bull trout in Yankee Fork (15 of which may be mortalities) and 40 individuals in Panther Creek (1 of which may result in a mortality). Finally, RM&E activities are anticipated to result in sublethal impacts to up to 100 individuals (screw trap) and 700 individuals (electrofishing) in Yankee Fork and to up to 100 individuals (screw trap) and 700 individuals (electrofishing) Panther Creek; additionally, up to 15 mortalities in Yankee Form and 15 mortalities in Panther Creek are expected.

9.4.7.2.3 Snake River Sockeye Salmon Hatchery Program (TAILS# – 01EIFW00-2017-F-0819). 12/18/2017

The Snake River sockeye salmon hatchery program includes a range of activities at multiple facilities and locations Idaho, Oregon, and Washington. There is a range of activities necessary to implement the program; however, adverse effects to bull trout and designated critical habitat are limited to the Upper Salmon River Basin and occur as harassment, injury, and mortality from capture, handling, surveying, and potential migration delays. The potential for bull trout or designated critical habitat to be adversely affected outside the Upper Salmon River Basin as a result of program activities is insignificant or discountable. Activities adversely affecting bull trout are broodstock collection and RM&E activities involving weirs, smolt traps, seines, gill-netting, angling, and trawling during which bull trout are incidentally captured and handled, potentially resulting in harm or mortality. These activities are implemented by IDFG and the Shoshone-Bannock Tribe throughout the Action Area in the Salmon River Basin in bull trout FMO habitat. Snake River sockeye broodstock collection and RM&E do not occur in bull trout spawning and rearing habitat. Because adverse effects are limited to individual feeding, migrating, or overwintering bull trout, the Service does not expect adverse effects at the larger population, Core Area, Recovery Unit, or range-wide levels.

All activities that result in adverse effects to bull trout occur on an annual basis. Adult collection, whether for broodstock or other RM&E purposes, will occur at Sawtooth Hatchery and Redfish Lake Creek, and is expected to result in sublethal effects to 380 individual bull trout, with up to 12 mortalities. Juvenile outmigration monitoring will result in sublethal impacts at a number location in the upper Salmon River watershed to 99 individual bull trout, with up to 7 mortalities. Population abundance monitoring will result in sublethal impacts to four bull trout with up to two mortalities.

9.4.7.2.4 Nez Perce Tribal Hatchery Kelt Reconditioning Facility Construction and Program (TAILS# – 01EIFW00-2019-I-0164). 11/14/2018

The collection and selection of steelhead for kelt reconditioning is currently conducted at Lower Granite Dam, Little Goose Dam, and the South Fork Clearwater River (i.e., via the angler program) where trapping and/or handling of steelhead and other anadromous species is an ongoing activity associated with other hatchery programs or dam operations. Bull trout have been captured or handled incidentally at these facilities in the past and will continue to be captured and/or handled in the future with or without the kelt reconditioning program's collections and selections. The Service has addressed this incidental capture and handling of bull trout in Opinions for the Snake River Fall Chinook Salmon Hatchery Program (01EIFW00-2012-F-448) and the Clearwater Hatchery Programs (01EIFW00-2017-F-1143) as well as in the ongoing consultation between the Service and the Corps on the operation and maintenance of the CRS.

9.4.7.2.5 Hood River summer steelhead and Chinook salmon production programs and associated operation and maintenance (TAILS# – 01EOFW00-2018-F-01410). 12/19/2017

The Hood River summer steelhead and Chinook salmon production programs are carried out at facilities and locations throughout the Hood River Basin, in north central Oregon. The proposed project's effects would be caused during adult fish trap operations, rearing and acclimation, release, and certain RM&E associated with the winter steelhead and spring Chinook production programs. The primary effects from project operations include harassing, capture, handling, and marking a small number of adult bull trout annually. The Service anticipates that a total of three bull trout may be harmed from trapping activities and an additional 35 individuals being harassed through this same action. All individuals are likely form the Hood River Basin populations. No mortalities are expected.

9.4.7.2.6 Hells Canyon and Salmon River Steelhead and Spring/Summer Chinook Salmon Programs – Idaho and Oregon (TAILS# – 01EIFW00-2017-F-1079). 12/08/2017

The Hells Canyon and Salmon River steelhead and spring/summer Chinook salmon programs are carried out in Idaho (Adams, Custer, Clearwater, Gooding, Idaho, Lemhi, Valley, and Valley Counties) and Oregon (Baker County). Adverse effects to bull trout occur through capture and handling, competition and predation, reductions in available stream habitat, and increases in suspended sediment and turbidity. However, the effects of this consultation extend beyond the range of the Action Area for the CRS consultation. It is expected that up to five individual bull trout from populations in the Clearwater River will experience sublethal impacts, including up to one mortality, from trapping activities associated with Dworshak National Fish Hatchery trap. Individual bull trout that are adversely affected by other activates are part of populations not generally thought to be exposed to CRS effects.

9.4.7.2.7 Melvin R. Sampson coho salmon (O*ncorhynchus kisutch*) facility located in Kittitas County, Washington (TAILS# – 01EWFW00-2017-F-0445). 07/20/2017

Melvin R. Sampson coho salmon facility located in Kittitas County, Washington. Adverse effects to bull trout are expected to occur from implementation of broodstock collection, interspecific competition, and RM&E activities. Broodstock collection will occur at Roza, Prosser, Cowiche, and Wapatox dams and result in sublethal effects during capture and handling of no more than five individual bull trout per year (up to 100 individuals over the 20-year life of the project), with no mortalities expected. An additional unknown number juvenile, sub-adult, and adult bull trout will be adversely affected as a result of ecological interactions (i.e., completion for space and other resources with hatchery-origin coho salmon). Finally, harm and harassment is expected from monitoring, with no more than five individual bull trout per year (up to 100 individuals over the 20-year life of the project) impacted by electrofishing and an additional unknown number of individual harassed during spawner and snorkel surveys. All bull trout are from local populations in the Yakima Core Area.

9.4.7.2.8 Northeast Oregon and Southeast Washington Spring/Summer Chinook, Steelhead, and Rainbow trout programs funded under the LSRCP and Northwest Power Act (TAILS# – 01EOFW00-2015-F-0154). 08/22/2016

The three Action Agencies are: NMFS (issuance of section 10(a)(1)(A) permits), the Service (operation and maintenance of hatchery programs and facilities associated with the LSRCP), and Bonneville (continued funding of these hatchery programs). Adverse effects are anticipated from operation of adult collection facilities, water diversions, acclimation and release, monitoring and evaluation, and non-routine maintenance activities associated with the proposed programs to individual bull trout from local populations in the following river Basins: Imnaha River, Grande Ronde River, Asotin Creek, and Tucannon River. The Service identified an expected level of take at specific facilities and are summarized below.

Grande Ronde River Management Unit

Big Canyon: (sublethal) 15 total; (lethal) < 2/year, 1 total over the term of the Opinion

Lostine: (sublethal) 135/year; (lethal) 6 total over the term of the Opinion

Lookingglass: (sublethal) 251/year; (lethal) no more than 5/year and 25 total over the term of the Opinion.

Upper Grande Ronde: (sublethal) 21/year; (lethal) 3 total over the term of the Opinion.

Catherine Creek: (sublethal) 182/year; (lethal) 6 total over the term of the Opinion.

Imnaha River Management Unit

Little Sheep: (sublethal) 12/year; (lethal) 2 total over the term of the Opinion

Imnaha: (sublethal) 989/year; (lethal) 35 total over the term of the Opinion

Snake River Washington Management Unit

Tucannon: (sublethal) 535/year; (lethal) 13/year.

9.4.7.2.9 Continued Operation of the Clearwater Steelhead, Spring/Summer Chinook Salmon and Coho Salmon Hatchery Programs – Idaho (Clearwater River Basin (TAILS# – 01EIFW00-2017-F-1143). 12/15/2017

The Action Area includes the mainstem Clearwater River and associated tributaries down to and including the Snake and Columbia rivers. Activities adversely affecting bull trout include broodstock collection, smolt releases, RM&E activities, water withdrawal, and in-water facility maintenance as a result of capture and handling, competition and predation, reductions in available stream habitat, and increases in suspended sediment and turbidity. Some activities may be in downstream proximity to bull trout spawning and rearing habitat but do not occur in that habitat. Because adverse effects are limited to individual feeding, migrating, or overwintering bull trout, the Service does not expect adverse effects at the larger population, Core Area, Recovery Unit, or range-wide levels. Most individuals exposed to the action will experience sublethal effects, with low levels of mortalities anticipated. In total, the Service expects up to 320 individuals to be subjected to sublethal effects, with up to 19 of these resulting in mortalities.

9.4.7.2.10 Umatilla Hatchery Program (TAILS# – 01EIFW00-2008-F-0109). 09/12/2008

The Umatilla Hatchery Program is primarily carried out at facilities located within the Umatilla River watershed, with additional associate facilities and activities occurring in the Walla Walla Basin and even a small extent of the Columbia River. The effects of the Project elements are expected to be limited to individual bull trout in the Umatilla River and Walla Walla River Core Areas. The release of hatchery-raised Chinook, steelhead, and coho smolts into the Umatilla River, each year, will likely result in direct or indirect interactions between the hatchery-raised fish and bull trout. Hatchery fish will eat prey, occupy space in the river, provide food for predators, influence nutrient flow through carcasses, and potentially introduce pathogens.

A small number of bull trout may be temporarily disrupted from their normal behavior during Project activities such as adult broodstock collection, smolt releases, and adult releases. Additionally, based on past experience with Project activities, the Service expects death or significant injury to be extremely rare from Project activities but are likely to occur during Project's activities during capture, genetic sampling and release at Three Mile Falls Dam facilities. Project activities are not likely to adversely affect bull trout local populations in the Umatilla and Walla Walla River Core Areas and effects to the Umatilla-Walla Walla Recovery Unit are likely to be minimal.

The Service anticipates that at least one bull trout may be annually killed, harmed or harassed through activities undertaken as part of the Proposed Action. The Service estimates a total of three (3) bull trout may be *lethally* taken every 10 years by Project activities and of these three, no more than one (1) bull trout may be *lethally* taken in any given year.

9.4.7.2.11 Walla Walla Basin Spring Chinook Hatchery Program (TALIS# – 01EOFW00-2018-F-0527). 07/19/2018

The Walla Walla spring Chinook hatchery program includes construction and operation of a spring Chinook salmon hatchery on the South Fork Walla Walla River in Umatilla County, Oregon. Effects to individual bull trout from local Walla Walla River populations will occur as a result of in-water construction to build the facility, with ongoing operations, particularly effects from broodstock collection and other actions, resulting in migratory delay, capture, and handling of bull trout.

In-stream and near-water construction activities are expected to result in the injury and possibly death of a small number of bull trout that happen to be in the immediate vicinity of the project area when the work takes place. An exact number of fish taken cannot be quantified, but it is expected to be less than 20 sub-adult fish and three adult fish.

Over the initial ten-year period covered by the consultation, operation of the hatchery and the broodstock collection trap at Nursery Bridge is expected to result in the harm and harassment of bull trout on an annual basis. Most of this take will be occurring during times of the year when adult bull trout are migrating upstream. The vast majority of take is expected to be non-lethal with few long-term consequences to the affected fish. However, it is anticipated that up to five adult fish per year are expected to be either significantly injured or killed by impingement on the weir or trap box, time spent in the trap box, or problems associated with handling (e.g., processing, PIT-tagging, transporting). A small number of bull trout are expected to avoid entering the trap and thus will be prevented from migrating upstream to their spawning grounds, however this needs to be monitored to confirm the number of fish affected is small.

9.4.7.3 Tributary Habitat Improvement and Restoration Programs

Bonneville funds tributary habitat improvements related to mitigation and restoration efforts for impacts of CRS on listed salmon and steelhead populations. Bonneville has completed consultation with the Service on the impacts and benefits of tributary habitat improvement and restoration actions occurring within bull trout habitat. The Habitat Improvement Programmatic Consultation has been renewed several times and is currently in consultation. The Service authorized take of bull trout from handling, capture, and other behavioral effects as a result of restoration projects. The intent of the action is to improve habitat conditions for aquatic species.

Both the USFS and Corps have developed programmatic consultations with the Service for habitat restoration activities occurring within their jurisdiction. As with the Habitat Improvement Programmatic consultation, the Service has authorized take of bull trout during activities to improve aquatic habitat.

9.5 Summary of Baseline Conditions

9.5.1 Kootenai Sturgeon and Critical Habitat

Kootenai sturgeon occur in the Kootenai River Basin in Idaho, Montana, and British Columbia, Canada. Kootenai sturgeon were listed as endangered under the ESA on September 6, 1994. In 2019, an interim progress report from IDFG estimated that the wild adult Kootenai sturgeon population abundance had declined from approximately 2,072 individuals in 2011 to 1,744 individuals (confidence interval 1,232 to 2,182) in 2017 (Hardy and McDonnell 2019). Annual survival rates (estimated by mark-recapture analysis) are estimated to be approximately 96 percent. The primary threats to Kootenai sturgeon stem from the presence and operations of Libby Dam, and fall into three main categories: (1) reductions in peak spring flows, (2) alterations to the annual thermal regime in the Kootenai River, and (3) reductions to/losses of nutrients and fundamental ecosystem processes (e.g., food web, floodplain interaction, riparian function).

Changes in hydrology from Libby Dam operations include a decrease in annual peak discharges, a decrease in the duration of high and low flows, an increase in the duration of moderate flows, and a redistribution of seasonal flow characteristics. Together, these changes have affected the stage, velocity, depth, temperature, and shear stress within the river, which in turn have altered sediment and nutrient transport conditions and have greatly reduced the physical forces needed to produce and maintain physical habitat diversity and complexity. The reductions in peak spring flows and associated altered river conditions during the Kootenai sturgeon spawning period are the likely reason Kootenai sturgeon spawn over sand and silt substrates downstream of Bonners Ferry, rather than over the rocky substrates from Bonners Ferry upstream to Kootenai Falls.

The presence and operations of Libby Dam have also substantially influenced biological processes in the Kootenai River by affecting nutrient and carbon transport and altering thermal regimes; Koocanusa Reservoir has acted as a nutrient sink, decreasing the productivity and overall carrying capacity of the system downstream. The result of all these changes has been significant impacts to the food web, including periphyton, aquatic insects, and fish populations. These changes negatively affect Kootenai sturgeon via reductions in prey items that are important for early life stages, and reduction in overall ecosystem productivity, which negatively affects all life stages.

9.5.1.1 Kootenai Sturgeon Critical Habitat

Critical habitat for the population was designated in 2001 (66 FR 46548). An interim rule designating additional critical habitat was published in 2006 (71 FR 6383) and a final rule published in 2008 (73 FR 39505). Both the meander and the braided reach are located entirely within Boundary County, Idaho, respectively downstream and upstream of Bonners Ferry. A total of 18.3 RM is designated as critical habitat for Kootenai sturgeon.

Four PCEs are defined for Kootenai sturgeon critical habitat (73 FR 39506). These PCEs are specifically focused on adult migration, spawning site selection, and survival of embryos and free-embryos, the latter two of which are the life stages now identified as limiting the reproduction and numbers of the Kootenai sturgeon.

The Meander Reach consists of sand/silt substrate and low water velocities (less than 3.3 ft/s). Significant changes to this reach caused by the construction and operation of Libby Dam include: 1) a decrease in suspended sediment; 2) the initiation of cyclical aggradation and degradation of the sand riverbed in the center of the channel; 3) a reduction in water velocities; and 4) reductions in floodplain interactions and riparian function, which negatively affect primary and secondary productivity.

The braided reach consists of rocky substrate and higher water velocities (greater than 3.3 ft/s). The presence and operation of Libby Dam has negatively affected this reach by: 1) reducing river depth, and reducing floodplain interactions and riparian function, which negatively affect primary and secondary productivity.

Beginning in 2011, multiple habitat restoration projects have been implemented in the meander and braided reaches, as part of the Kootenai River Habitat Restoration Program. Projects implemented to date include addition of rocky substrate at sturgeon spawning sites, side channel restoration, bank stabilization, island construction, pool construction, construction of pool-forming structures, riparian restoration and enhancement, and floodplain reconnection and enhancement. Implementation of these projects have increased and/or enhanced in-river complexity, access to suitable habitats for spawning sturgeon, overall floodplain area and function, overall riparian area and function, and fundamental ecosystem processes.

9.5.2 Bull Trout and Critical Habitat

In 1999, the Service listed all populations of bull trout in the coterminous U.S. as threatened under the ESA under one single DPS. Though wide ranging in parts of Oregon, Washington, Idaho, and Montana, bull trout in the Columbia River Basin presently occur in only about 45 percent of the historical range (USFWS 2015a). As the Service developed the Recovery Plan, bull trout populations were further refined into six Recovery Units across the listed entity and

109 Core Areas, six Historic Areas, and one RNA (USFWS 2015a). The Action Area for the FCRPS/CRS, which covers a vast majority of the Columbia River Basin in Montana, Washington, Oregon and Idaho, overlays with three of the six Recovery Units and interacts to some extent with bull trout from 46 Core Areas, 4 historic areas and one RNA (45 percent of the listed entity).

Across the Action Area, declining trends due to the combined effects of habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, angler harvest and poaching, entrainment into diversion channels and dams, and introduced non-native species (e.g., brook trout) have resulted in declines in range-wide bull trout distribution and abundance (USFWS 2015a, b, c, d, e). In nearly all Core Areas and Recovery Units within the Action Area, the main threat facing the stability and long-term viability of bull trout is diminishing connectivity between Core Areas and local populations. In some areas, populations are stable (.e.g., Clearwater River Core Areas). However, many populations and Core Areas are depressed and declining (e.g. Kootenai River, Yakima River, and Umatilla River Core Areas). Sixteen of the 46 Core Areas (41 percent) representing at least 86 local populations that may interact with the Action Area are considered depressed. Of the 30 Core Areas considered stable, more than half have minimal interactions with the Action Area, primarily through entrainment into the Action Area (Table 8). The large geographic area of the Columbia River Basin within the Action Area, which represents half of the Recovery Units and geographic range of the bull trout, makes it critically important to the continued persistence and recovery of bull trout.

9.5.2.1 Bull Trout Critical Habitat

As with the listed entity of bull trout, designated critical habitat in the Action Area overlays six of 32 CHUs. The majority of the Action Area occurs within important FMO habitat for bull trout. In all six CHUs, PBFs are degraded or not properly functioning due to impacts to migratory corridors, natural hydrographs, water quality and temperature, and introduced species (Table 9).

Table 8. Summary of Baseline Conditions for bull trout by Core Area within the Action Area.

Recovery Unit	Core Areas	# of Local Populations	Status (Stable/ Depressed)	Presence/Use of Action Area
Columbia Headwaters	Lake Koocanusa	2	Stable	Year-round use. Documented entrainment through Libby Dam at unknown quantities.
	Kootenai	8	Depressed	Year-round use. Access to spawning areas impacted by dam operations.
	Hungry Horse Reservoir	10	Stable	Year-round use. Large numbers of bull trout utilize reservoir and entrainment through the dam is likely, annual catch and harvest records total over 7000 individuals between 2004 and 2010.
	Flathead Lake	17	Depressed	Year-round use. Populations declining. Data indicates between 1300 and 1600 adults within reservoir.
	Swan River	9	Stable	Entrained into Action Area at low numbers, unable to return to Core Area due to natural and manmade barriers.
	Bull Lake	1	Stable	Entrained into Action Area at low numbers, unable to return to Core Area due to natural and manmade barriers.
	Lake Pend Oreille (LPO) A	15	Depressed	Entrained into Action Area at low numbers over Cabinet Gorge Dam
	LPO B	19	Stable	All life stages are present year round
	LPO C	1	Depressed	Up to 150 individuals, within mainstem Pend Oreille River entrained over Albeni Falls Dam. Passage barrier until construction in 2030 for sub-adults and adults.
	Priest Lake	5	Depressed	Occasional entrainment into Action Area, unable to return to Core Area due to natural and manmade barriers.
Mid-Columbia	NE WA RNA	0	Depressed	Occasional adult individuals present, likely entrained from upstream Core Areas, but source populations are unknown. Fewer than 25 observed over last 10 years.
	Methow	10	Depressed	Regular year-round use of mainstem Columbia River. Observed at most mainstem non-federal dams.
	Entiat	2	Depressed	Regular year-round use of mainstem Columbia River. Observed at most mainstem non-federal dams.
	Wenatchee	7	Stable	Regular year-round use of mainstem Columbia River. Observed at most mainstem non-federal dams.
	Yakima	15	Depressed	Potential for downstream movement into Columbia River through entrainment. Historical use was likely, no current observations. If present, likely at very low numbers due to small population size.
	NF Clearwater	12	Stable	Year-round use of Dworshak Reservoir. Low levels of entrainment at Dworshak Dam documented.
	SF Clearwater	5	Stable	Likely seasonal migratory use of mainstem Clearwater below Dworshak Dam at unknown levels.

Recovery Unit	Core Areas	# of Local Populations	Status (Stable/ Depressed)	Presence/Use of Action Area
Mid-Columbia (continued)	Selway	10	Stable	Likely seasonal migratory use of mainstem Clearwater below Dworshak Dam at unknown levels.
	Lochsa	17	Stable	Likely seasonal migratory use of mainstem Clearwater below Dworshak Dam at unknown levels.
	Imnaha	8	Stable	Regular year-round use of the Snake River upstream of Action Area. Estimates of 800 to 1200 individuals from Basin in Snake River per year.
	Grande Ronde (4 Core Areas)	17	Stable	No documented use of Snake River; however, 7 of 17 local populations support migratory life histories that may use Action Area at low numbers.
	Asotin	1	Depressed	Documented movement to Snake River at low numbers, due to small population size.
	Tucannon	5	Depressed	Regular use of Snake and Columbia rivers, presence expected year-round at unknown quantities. Documented passage at all four Snake River dams and McNary Dam.
	Walla Walla	3	Depressed	Documented movements to Columbia River year-round, peaking in September through February.
	Touchet	3	Stable	Not documented leaving Touchet/Walla Walla Basin. No barriers to movement into Action Area, some use expected at very low numbers.
	Umatilla	1	Depressed	Occasional observations at Columbia River Dams, low use likely due to small population size and seasonal barriers.
	MF John Day	3	Depressed	Limited information on use of mainstem Columbia River, but likely at very low numbers based on observations at mainstem dams.
	Up Main John Day	2	Depressed	Limited information on use of mainstem Columbia River, but likely at very low numbers based on observations at mainstem dams.
	NF John Day	7	Depressed	Limited information on use of mainstem Columbia River, but likely at very low numbers based on observations at mainstem dams.
Upper Snake River	Salmon River (10 Core Areas)	123	Stable	No documented use of mainstem Snake River, however, no barriers to downstream movement into Action Area. Presence likely at very low numbers.
Coastal	Lower Deschutes	5	Stable	Not well documented, but use of the Columbia River is likely at low numbers based on occasional observations at mainstem dams.
	Klickitat	1	Depressed	Low likelihood of presence based on resident life history and small population numbers.
	Hood River	1	Depressed	Not well documented, but use of the Columbia River is likely at low numbers based on occasional observations at mainstem dams and Clear Branch Dam.
	Lewis River	3	Depressed	Occasional entrainment into Action Area possible, unable to return to Core Area due to natural and manmade barriers.

Green cells: documented use or high likelihood of presence in Action Area

Table 9. Summary of Baseline Conditions for designated bull trout critical habitat by Critical Habitat Unit within the Action Area.

Recovery Unit	Critical Habitat Unit	# of Subunits	Justification for Essential (USFWS 2010b)	Physical or Biological Features (PBF) Status in Action Area
Columbia Headwaters	Kootenai River Basin CHU 30	2	Supports strongest adfluvial populations across the range in Lake Koocanusa and largest spawning run of bull trout in the Wigwam River in British Columbia, Canada.	1. **Present and Functioning at Risk**. Lake Koocanusa functioning well. Lost floodplain connectivity and wetland development due to dam operation and shoreline development through entire CHU, especially downstream of Libby.
				2. **Present and Not Properly Functioning**. Dam construction and operation created partial/seasonal migration barriers to spawning areas.
				3. **Present and Functioning at Risk**. High levels of forage in Lake Koocanusa Subunit, however, reduced nutrient inputs in Kootenai River limit growth and productivity.
				4. **Present and Functioning at Risk** due to some areas of cover and shelter. However, the regulated nature limits complexity and riparian function.
				5. **Present and Properly Functioning**. Reservoir habitat is stratified providing cold water refugia, flow management has cooled summer river temperatures in riverine portions of CHU
				6. **Not Present in Action Area**
				7. **Present and Not Properly Functioning**. Operation of Libby Dam altered hydrograph, modifying base, peak and low flows outside of historic ranges
				8. **Present and Functioning at Risk**. Healthy water quality and quantity in Lake Koocanusa, However, downstream areas are limited by elevated temperatures, high TDG, low nutrients, mining contaminants, and Didymo outbreaks
				9. **Present and Functioning at Risk**. Presence of non-native competitive and predatory species as well as hybridizing species throughout, though little indication of impacts to populations
	Clark Fork River Basin CHU 31	12	Considered evolutionary heart of adfluvial bull trout due to the large natural lakes (e.g. Flathead Lake and Lake Pend Oreille).	1. **Present and Functioning at Risk**. While tributaries and many areas in CHU are functioning, the Action Area has been significantly altered by lost floodplain connectivity.
				2. **Present and Not Properly Functioning**. Subunits divided by migratory barriers across entire CHU, where few have passage facilities.
				3. **Present and Properly Functioning**. High levels of native and non-native forage across the CHU
				4. **Present and Functioning at Risk** due to some areas of cover and shelter. However, the regulated nature limits complexity and riparian function
				5. **Present and Functioning at Risk**. Lake Pend Oreille and Flathead Lake provide stratified coldwater habitat. In the summer, regulated flows from Hungry Horse using selective withdrawals provides water temperatures to match local natural stream temperatures. However, the Pend Oreille and Clark Fork rivers experience elevated summer water temperatures.
				6. **Not Present in Action Area**

Recovery Unit	Critical Habitat Unit	# of Subunits	Justification for Essential (USFWS 2010b)	Physical or Biological Features (PBF) Status in Action Area
Columbia Headwaters (continued)	Clark Fork River Basin CHU 31 (continued)	12 (continued)	Considered evolutionary heart of adfluvial bull trout due to the large natural lakes (e.g. Flathead Lake and Lake Pend Oreille).	7. **Present and Not Properly Functioning**. Operation of Hungry Horse, Cabinet Gorge, Albeni Falls, Box Canyon, and Boundary dams (as well as dams outside the Action Area) significantly altered hydrograph, modifying base, peak and low flows outside of historic ranges across the entire CHU
				8. **Present and Not Properly Functioning**. Small areas of good water quality, primarily in tributaries. Across CHU, water quality is impacted by elevated sediment and turbidity, elevated nutrients, mining contaminants, high water temperatures, and elevated TDG.
				9. **Present and Not Properly Functioning**. Presence of non-native competitive and predatory species as well as hybridizing species throughout entire CHU in the Action Area. Northern pike, brook trout and lake trout represent significant threats across the CHU.
Mid-Columbia	Clearwater River CHU 21	5	Essential for maintaining bull trout distribution within this unique geographic region of the MCRU	1. **Present and Functioning at Risk**. Transportation corridors, channel straightening, and reservoir operation has reduced or limited floodplain connectivity, wetland formation, and thermal refugia areas. Reservoir provides some thermal refugia due to stratification.
				2. **Present and Functioning at Risk**. Dworshak Dam significantly influences migration throughout North Fork Clearwater, however, other areas in CHU have few barriers to movement.
				3. **Present and Functioning at Risk**. Variety of native and non-native prey species, however, loss/decline of native salmonid decreases functionality of PBF.
				4. **Present and Functioning at Risk**. Mainstem Clearwater River has reduced complexity and low wood recruitment due to dam. Above Dworshak Dam and in tributaries, habitat complexity is functioning properly.
				5. **Present and Functioning at Risk**. Elevated temperatures throughout from altered flow regime and shoreline development.
				6. **Not Present in the Action Area**.
				7. **Present and Functioning at Risk**. Dworshak Dam alters flows and the hydrograph in the North Fork Clearwater and mainstem Clearwater rivers. Tributary hydrographs are generally similar to historic conditions.
				8. **Present and Functioning at Risk**. Elevated water temperatures and TDG influence much of the CHU.
				9. **Present and Functioning at Risk**. Presence of brook recognized as a concern in the CHU.

Recovery Unit	Critical Habitat Unit	# of Subunits	Justification for Essential (USFWS 2010b)	Physical or Biological Features (PBF) Status in Action Area
Mid-Columbia (continued)	Mainstem Upper Columbia River CHU 22	N/A (single unit, no subunits)	Essential for conserving the fluvial migratory life history types exhibited by many of the populations from adjacent Core Areas.	1. **Present and Not Properly Functioning**. Lost floodplain connectivity and wetland development due to dam operation and shoreline development through entire CHU.
				2. **Present and Functioning at Risk**. Most dams have some level of passage (except Chief Joseph and Grand Coulee), though it is likely insufficient for bull trout.
				3. **Present and Functioning at Risk**. Variety of native and non-native prey species, however, loss/decline of native salmonid populations decreases functionality of PBF.
				4. **Present and Not Properly Functioning**. Dam operations and shoreline development have removed complexity through entire CHU.
				5. **Not Present per Critical Habitat Designation**. Temperatures are seasonally not properly functioning for migratory bull trout use.
				6. **Not Present in the Action Area**.
				7. **Present and Not Properly Functioning**. Dam operation within and outside the CHU highly influence the hydrograph through entire CHU.
				8. **Present and Not Properly Functioning**. Water quality impairments throughout entire CHU from elevated temperatures, agricultural runoff, and TDG. Irrigation withdrawals throughout likely influence total water quantity.
				9. **Present and Not Properly Functioning**. Numerous non-native competitive and predatory species found throughout the CHU.
	Mainstem Snake River CHU 23	N/A (single unit, no subunits)	Conserves migratory life history expression, facilitates genetic exchange, and ensures connectivity between adjacent populations and Core Areas.	1. **Present and Not Properly Functioning**. Lost floodplain connectivity and wetland development due to dam operation and shoreline development through entire CHU.
				2. **Present and Functioning at Risk**. All facilities include some level of passage, but likely insufficient for bull trout. In addition, elevated temperatures throughout seasonally impede passage between dams and into tributaries.
				3. **Present and Functioning at Risk**. Variety of native and non-native prey species, however, loss/decline of native salmonid populations decreases functionality of PBF.
				4. **Present and Not Properly Functioning**. Dam operations and shoreline development have removed complexity through entire CHU.
				5. **Not Present per Critical Habitat Designation**. Temperatures are seasonally not properly functioning for migratory bull trout use.
				6. **Not Present in the Action Area**.

Recovery Unit	Critical Habitat Unit	# of Subunits	Justification for Essential (USFWS 2010b)	Physical or Biological Features (PBF) Status in Action Area
Mid-Columbia (continued)	Mainstem Snake River CHU 23 (continued)	N/A (single unit, no subunits)	Conserves migratory life history expression, facilitates genetic exchange, and ensures connectivity between adjacent populations and Core Areas.	7. **Present and Not Properly Functioning**. Dam operation within and outside the CHU highly influence the hydrograph through entire CHU. 8. **Present and Not Properly Functioning**. Water quality impairments throughout entire CHU from elevated temperatures, agricultural runoff, and TDG. Water withdrawals throughout likely influence total water quantity. 9. **Present and Not Properly Functioning**. Numerous non-native competitive and predatory species found throughout the CHU.
Coastal	Mainstem Lower Columbia River CHU 8	N/A (single unit, no subunits)	Provides essential foraging, migrating and overwintering habitat for extant tributary populations and connectivity between these Core Areas, as well as facilitating the potential reestablishment of a population within the White Salmon River	1. **Present and Not Properly Functioning**. Lost floodplain connectivity and wetland development due to dam operation and shoreline development through entire CHU. 2. **Present and Functioning at Risk**. Most dams have some level of passage (except Chief Joseph and Grand Coulee), though it is likely insufficient for bull trout. 3. **Present and Functioning at Risk**. Variety of native and non-native prey species, however, loss/decline of native salmonid populations decreases functionality of PBF. 4. **Present and Not Properly Functioning**. Dam operations, navigation channel maintenance, and shoreline development have removed complexity through entire CHU. 5. **Not Present per Critical Habitat Designation**. Temperatures are seasonally not properly functioning for migratory bull trout use. 6. **Not Present in the Action Area**. 7. **Present and Not Properly Functioning**. Dam operation within and outside the CHU highly influence the hydrograph through entire CHU. 8. **Present and Not Properly Functioning**. Water quality impairments throughout entire CHU from elevated temperatures, industrial and agricultural runoff, and TDG. 9. **Present and Not Properly Functioning**. Numerous non-native competitive and predatory species found throughout the CHU.

1) Groundwater sources; 2) Migration corridors; 3) Forage Base; 4) Habitat complexity; 5) Water temperatures; 6) Spawning gravels; 7) Natural hydrograph; 8) Water quality and quantity; 9) Low non-native populations.

10 EFFECTS OF THE ACTION

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

10.1 Kootenai River White Sturgeon And Designated White Sturgeon Critical Habitat

The following analysis evaluates the effects of the Proposed Action on Kootenai sturgeon and its designated critical habitat, which evaluates all future consequences to the species and critical habitat that are reasonably certain to be caused by the Proposed Action, including the consequences of other activities that are caused by the Proposed Action, and how those impacts are likely to influence the conservation role of the Action Area for the Kootenai sturgeon and its designated critical habitat.

10.1.1 Consequences of the Action on the Kootenai Sturgeon

10.1.1.1 Libby Dam Operations

The proposed strategy related to operation of Libby Dam to improve the recruitment of juvenile Kootenai sturgeon into the population involves flow augmentation from Libby Dam for sturgeon spawning and incubation. The proposed sturgeon flow operation is a combination of three approaches: 1) releases from Libby Dam during the Kootenai sturgeon spawning season and in coordination with the Flow Plan Implementation Protocol (FPIP) process; 2) use of the selective withdrawal facilities to achieve appropriate downstream river temperatures; and 3) a tiered volume approach as described in Figure 3. The tiered flow approach varies the volume of water available for sturgeon conservation each year depending on the May 1 forecast of total volume into Koocanusa Reservoir expected during the April through August period. Based on this approach there is no flow augmentation during low water years.

As described in the Proposed Action section, Libby Dam will be operated consistent with VARQ FRM procedures. VARQ provides greater assurance that Koocanusa Reservoir will refill in medium runoff years. The Variable December Flood Control Curve recommendation was developed and procedures for its application were first implemented in 2004. This operation has the potential of expanding spring and summer storage volumes by up to 300 maf when early runoff forecasts predict lower than normal runoff volumes. The Proposed Action modifies the VARQ FRM procedure to provide water managers more flexibility to incorporate local conditions in the draft rate and account for planned releases during refill, such as the Sturgeon Volume. These modifications improve water management flexibility to respond to local FRM conditions and increase the chances of refill.

The Proposed Action also involves limited seasonal ramping rates that are unchanged from the 2006 Opinion.

As described in the *Effects of Libby Dam on Kootenai Sturgeon Habitat* sub-section (9.3.2.6) of the Environmental Baseline section, the operation of Libby Dam has significantly altered conditions in the Kootenai River, by reducing river depth, maximum river stage, and the duration and extent of the annual spring freshet. Libby Dam operations have also altered the thermal regime and nutrient transport in the Kootenai River. Under the Proposed Action these effects are expected to continue.

Prior to the construction and operation of Libby Dam, the natural hydrograph of the Kootenai River downstream of the dam consisted of a spring freshet (elevated river flows from rain or meltwater) with high peak flows, followed by a rapid drop in flows into August (Figure 2). Tetra Tech (2004) found that the primary changes in hydrology from Libby Dam operations included a decrease in annual peak discharges on the order of 50 percent, a decrease in the duration of high and low flows, an increase in the duration of moderate flows, and a redistribution of seasonal flow characteristics. Together, these changes have affected the stage, velocity, depth, temperature, and shear stress within the river, which in turn have altered sediment and nutrient transport conditions and have greatly reduced the physical forces needed to produce and maintain physical habitat diversity and complexity (Anders et al. 2002; Burke et al. 2009, KTOI 2009). Despite the dam's water temperature control structure, hydropower generation and necessary flood control operations preclude winter river temperatures from being as cold as they were prior to dam construction. Under the Proposed Action these effects are expected to continue. Further, pre-dam fisheries investigations and inventories stated that prior to the construction of Libby Dam, Kootenai sturgeon spawned in the roughly 1-mile stretch of the Kootenai River downstream of Kootenai Falls (Corps 1971; MFWP 1974). The reductions in peak spring flows and associated altered river conditions (stemming from Libby Dam operations under the Proposed Action) during the Kootenai sturgeon spawning period are likely to continue to cause Kootenai sturgeon to spawn over unsuitable sand and silt substrates downstream of Bonners Ferry, rather than over the suitable rocky substrates that exist from Bonners Ferry upstream to Kootenai Falls.

Additionally, average water temperatures in the Kootenai River are typically warmer in the winter and colder in the summer than they were prior to the construction and operation of Libby Dam (Corps 2005). Current average spring temperatures tend to be cooler than under pre-dam conditions (Figure 4), and the differences may be increased even more when flow from Libby Dam dominates the total river flow (Corps 2005). These temperature alterations may affect Kootenai sturgeon in multiple ways. For example, warmer winter river temperatures may cause juveniles to engage in foraging behavior at a time when food availability is low (Kynard et al. 2009). Additionally, cooler river temperatures in the spring may delay the onset of spawning in adults and/or slow rates of development in larvae and juveniles.

To date, flow releases from Libby Dam have not resulted in documented reproduction of a single year-class of Kootenai sturgeon at levels which are considered significant to the survival of the species per the Revised Recovery Plan downlisting and delisting criteria (USFWS 2011a; 2019, pg. 17; Anders 2017, pg. 16). This includes releases of maximum powerhouse capacity and tests of releases above powerhouse capacity in 2010-2012. Under the Proposed Action these effects may continue. However, recent adjustments to the management of sturgeon flows from Libby Dam have produced encouraging results. Specifically, during the 2017 spawning season, approximately 47 percent of the sonic-tagged adult sturgeon that were expected to spawn were detected in the braided reach upstream of the Highway 95 Bridge (RM 153) (IDFG 2017, pg. 14). During the 2018 spawning season, approximately 40 percent of the sonic-tagged spawning sturgeon were detected in the braided reach, including seven individuals that migrated well upstream of the Highway 95 bridge (IDFG 2018, pg. 14). These results represent an increase in the percentage of sonic-tagged adult spawners detected upstream of the bridge in previous years (33 percent in 2016, 24 percent in 2015, and 30 percent in 2014 (IDFG 2016, pg. 8). A statistical analysis by IDFG showed a positive relationship between the likelihood of tagged spawners migrating upstream of Bonners Ferry and the recent adjustments to sturgeon flows (IDFG 2018, pg. 19). Additionally, in 2018 a fertilized sturgeon egg was collected in the braided reach, indicating that some sturgeon spawning had occurred in the more suitable habitat present in that reach (IDFG 2018, pg. 15).

As described in the *Effects of Libby Dam on Kootenai Sturgeon Habitat* sub-section (9.3.2.6), operation and maintenance of Libby Dam will result in effects to the larger Kootenai River ecosystem, including loss of floodplain and riparian functions, which will result in reductions in nutrient and food availability in the reaches downstream of Libby Dam. Koocanusa Reservoir will also continue to act as a nutrient sink, decreasing the productivity and overall carrying capacity of the system downstream (Tetra Tech 2004; Burke et al. 2009). Additionally, winter power peaking at Libby Dam will alter winter flows and river temperatures, and increase downstream erosion and scour. Aquatic and terrestrial vegetation that would have normally provided secure riparian habitat along river margins will continue to be lacking, as will stabilized soils that are needed to fully reestablish each summer. As a result, fine sediment materials will be more easily eroded and swept back into the channel. The result of these changes will continue to be significant negative impacts to the food web, including periphyton, aquatic macroinvertebrates, and fish populations (Hoyle et al. 2014; Minshall et al. 2014). These changes will continue to negatively affect Kootenai sturgeon via reductions in prey items that are important for early life stages, and reduction in overall ecosystem productivity, which negatively affects all life stages.

Implementation of the Proposed Action is also likely to continue to result in substantially decreased suspended sediment levels in the Kootenai River. Suspended sediment records for the Libby Dam era show that the only one notable, multi-week suspended sediment transport event with streamflow that approached pre-Libby Dam conditions took place from April 24 to July 5, 1974, during the Kootenai sturgeon spawning season (Barton 2004, Corps 2005). Suspended sediment and turbidity may be a critical component of flow that allows for Kootenai sturgeon egg and larvae survival. Reductions in sediment loading following the construction of Libby Dam are also directly associated with reductions in downstream nutrient loading, which has significantly reduced biological production through reduced nutrient and food availability for Kootenai sturgeon (Hoyle et al. 2014; Minshall et al. 2014).

Further, from 2005 to 2010, over one million fertilized sturgeon eggs or free-embryos were annually released into reaches of the Kootenai River that have suitable rocky substrates. However, subsequent field sampling failed to show an increase in the capture of unmarked juvenile sturgeon (Anders 2017, pg. 15). These data have led sturgeon managers to hypothesize that Kootenai sturgeon are experiencing a second early life stage survival bottleneck due to lack of nutrients and food (USFWS 2011c, pg. 18) and, in combination with the information in the above paragraphs, indicate that implementation of the Proposed Action is likely to suppress in-river production of juvenile Kootenai sturgeon.

As discussed, the effects from the proposed operation and maintenance of Libby Dam will include significantly altered river conditions such as reductions in river depth, maximum river stage, duration and extent of the freshet, floodplain interactions, riparian function, and other fundamental ecosystem functions. This, in turn, will disrupt normal sturgeon spawning behavior by limiting spawning site selection within the braided reach of the Kootenai River that is likely to limit significant natural recruitment of the Kootenai sturgeon. Spawning in unsuitable habitats with sandy substrate and low water velocity will adversely affect Kootenai sturgeon through high levels of embryo and free embryo mortality. Additionally, the loss of essential ecosystem functions and nutrient inputs in the Kootenai River will adversely affect Kootenai sturgeon by creating an environment where larval sturgeon lack sufficient food and prey items necessary for survival.

However, as noted throughout this opinion, several actions have been undertaken by the Action Agencies to help reduce the effects described above, and recent data indicates those actions are beginning to show encouraging results. For example: 1) adjustments to Libby Dam releases during the Kootenai sturgeon migration and spawning period, in combination with habitat restoration projects in the Meander Reach are positively related to an increase in the proportion of tagged spawners migrating into suitable habitat in the braided reach; 2) releases of hatchery-origin Kootenai sturgeon have minimized the demographic effects of recruitment failure as well as maintained the genetic diversity of the wild population; 3) injection of nutrients into the Kootenai River and Kootenay Lake have replaced some of the nutrient losses stemming from Libby Dam operations and helped to increase primary productivity; and, 4) multiple large-scale habitat restoration projects have been implemented that address the effects described above, such as bank stabilizations, floodplain creation, reconnection and enhancement, riparian enhancement, side-channel restoration, and tributary restoration. All of these activities will continue under the Proposed Action.

10.1.1.2 Kootenai River Habitat Restoration Project

The effects to Kootenai sturgeon and its designated critical habitat from construction of restoration projects under the Kootenai River Habitat Restoration Program were consulted on in the Service's opinion for the Kootenai River Habitat Restoration Program (USFWS 2013b). However, because the Proposed Action includes continued annual implementation of habitat restoration projects, and given the suite of habitat restoration projects that have been implemented to date, the effects to Kootenai sturgeon from all restoration projects in the Kootenai Basin, in relation to the effects from CRS operations, must be considered in this Opinion.

From 2011 to 2019, 12 habitat restoration projects have been successfully implemented in the Braided, Straight, and Meander reaches of the Kootenai River. The major treatment types that have been implemented include: construction of pools and pool-forming structures; construction of in-river and bank structures; side-channel reconnection and restoration; floodplain creation, reconnection, and enhancement; riparian enhancement; tributary restoration; and placement of rocky substrates in known spawning areas. Under the Proposed Action, the Action Agencies have committed to funding and implementing a minimum of one major habitat restoration project per year through at least 2025 (after 2025 additional projects may continue to be implemented, pending the results of an assessment of implemented restoration projects). Together, these projects have produced, and are expected to continue to produce, increased river depth and complexity, reduced bank erosion, increased available sturgeon spawning and rearing habitat, and enhanced fundamental ecosystem processes, which have and will continue to reduce effects to Kootenai sturgeon from CRS operations.

10.1.1.3 Conservation Aquaculture Program

The effects to Kootenai sturgeon and its designated critical habitat from implementation of the Kootenai River Native Fish Conservation Aquaculture Program were consulted on in the Service's opinion for the Kootenai River Native Fish Conservation Aquaculture Project (USFWS 2013c), and as such will not be discussed in detail in this opinion. However, because the Proposed Action includes continued implementation of the aquaculture program, and given the number of hatchery-origin sturgeon that have been released to date (over 300,000), the effects to Kootenai sturgeon from the aquaculture program, in relation to CRS operations, must be considered in this Opinion.

Over 300,000 hatchery-origin Kootenai sturgeon have been released into the Kootenai basin since 1990. As noted previously in this opinion, monitoring data indicate that these hatchery-origin sturgeon are surviving at high rates and the program has successfully captured between 70 and 80 percent of the genetic diversity in the wild population, which has and will continue to help reduce effects to Kootenai sturgeon from CRS operations.

10.1.1.4 Kootenai River Nutrient Enhancement

The effects to Kootenai sturgeon and its designated critical habitat from implementation of the Kootenai River Nutrient Enhancement Project were consulted on in the Service's letter of concurrence on the Kootenai River Nutrient Enhancement Project (USFWS Reference: 14420-2011-I-0252), and as such will not be discussed in detail in this opinion. However, because the Proposed Action includes continued implementation of the nutrient enhancement project, the effects to Kootenai sturgeon from the program, in relation to CRS operations, must be considered in this Opinion.

The nutrient addition project in the Kootenai River has been ongoing since 2005. Field monitoring shows the project has increased beneficial algal production, the abundance, biomass and diversity of invertebrate food items for fish, and overall biological productivity in the Kootenai River, which has and will continue to reduce effects to Kootenai sturgeon from CRS operations.

10.1.1.5 Development of the Flood Plain

Prior to the construction of Libby Dam, the Kootenai River would occasionally breach levees in some diking districts and over-top its natural banks. The flooding constrained human development of the floodplain. The threat of flooding was a deterrent to development in flood-prone areas. Without flood control operations at Libby Dam, the Kootenai Valley would likely be far less developed than it is now. This threat was one of the primary reasons for construction and operation of Libby Dam, which has successfully decreased the risk of flooding in the Kootenai Basin. Consequently, development in the floodplain has occurred, and with implementation of the Proposed Action will continue to occur. Increased development in the floodplain may create a need for more conservative FRM (as occurred in 1996 (Corps 1999, pg. 11)), which in turn would contribute to the lack of suitable river conditions necessary for significant natural recruitment.

More conservative flood control measures would mean less water available to help restore sturgeon spawning and recruitment. The Bonners Ferry target flow elevation of 1,764 ft and management of Kootenay Lake to current elevations would not be reasonably achievable, but for the present and proposed future operations of Libby Dam, and its indirect effects on the management of Kootenay Lake during higher runoff years. The FRM component of the Proposed Action will lead to reduced spring freshets, both in terms of extent and duration, than would otherwise occur (i.e. pre-dam) in the Kootenai River during the sturgeon migration and spawning period. These altered conditions have multiple effects to the Kootenai River ecosystem and sturgeon behaviors. Most notable among these effects is sturgeon spawning in unsuitable habitats. However, as described previously in this Opinion, telemetry data shows there has been a recent increase in the proportion of tagged spawning sturgeon migrating to suitable habitats in the braided reach, as well as the capture of a fertilized egg in the braided reach (for the first time). The proportional increase in tagged spawners migrating into the braided reach is positively related to recent adjustments to management of spring flows from Libby Dam and the implementation of habitat restoration projects.

10.1.1.6 Kootenay Lake/Kootenai River Stage

Kootenay Lake peak stages currently average nearly 8 ft lower than pre-dam conditions due to the presence of Grohman Narrows, a natural channel constriction on the Kootenay River at the outlet of Kootenay Lake near Nelson, British Columbia, which governs lake stage during the spring freshet of the higher runoff years. Under high runoff conditions, this change in stage is not a discretionary operational decision of FortisBC, the operators of Corra Lynn Dam, which is located downstream of Grohman Narrows. Reduced peak stage at Kootenay Lake causes reduced river stages in the Kootenai River during the sturgeon migration and spawning period, leading to effects to the ecosystem (as described in detail in this Opinion), which are associated with lack of successful production of juvenile Kootenai sturgeon.

10.1.1.7 Increasing the Primary Productivity of Kootenay Lake

Impacts that occur to Kootenai sturgeon indirectly from adding nutrients to Kootenay Lake include increased food (in the form of macroinvertebrates) for juvenile sturgeon inhabiting Kootenay Lake, and increased food (in the form of kokanee carcasses) for adult sturgeon inhabiting Kootenay Lake. Based on the results of this program to date, a beneficial effect on the Kootenai sturgeon is anticipated because this fertilization program has and is likely to continue to increase food available to the life stages of sturgeon that occupy Kootenay Lake.

The nutrient addition project in Kootenay Lake has been ongoing since 2004. Field monitoring shows the project has increased beneficial algal production, the abundance, biomass and diversity of invertebrate food items for fish, and overall biological productivity in the Kootenay Lake, which has and will continue to reduce effects to Kootenai sturgeon from CRS operations.

10.1.2 Summary of Effects of the Action on the Kootenai Sturgeon

As proposed, the operation of Libby Dam is likely to adversely affect habitat conditions and ecosystem functions within the only known breeding area for Kootenai sturgeon. As described in the above sections, effects to Kootenai sturgeon include alterations to the hydrograph, alterations to the thermograph, reductions to river depths in suitable spawning habitat during sturgeon spawning season, and degradation of multiple ecosystem functions. These effects have resulted in poor reproductive success and the steep decline of the adult breeding population in the wild. Although millions of fertilized sturgeon eggs are produced and released in the wild each year, it is estimated that, on average, only between 13 and 85 juvenile sturgeon are naturally reproduced each year in the wild, which is insufficient to sustain the population. This extremely low level of natural reproduction is due to low rates of successful embryo incubation, and low rates of free-embryo and larval survival, all of which are attributed to poor habitat conditions created by Libby Dam operations.

However, recent modifications to management of Libby Dam spring flows for Kootenai sturgeon spawning, addition of nutrients into the Kootenai Basin, and implementation of multiple large-scale habitat restoration projects have shown signs of addressing some of the limiting factors behind the decline of wild Kootenai sturgeon (e.g., increased numbers of sturgeon migrating to suitable habitats during spawning season, spawning taking place in suitable habitats, and increased primary productivity). Additionally, the annual production and release of hatchery-origin Kootenai sturgeon (starting in 1990) funded by Bonneville has been very successful, both in terms of capturing the genetic diversity present in the wild population as well as in significantly supplementing the population. Given that: 1) Kootenai sturgeon generally reach sexual maturity between 15 and 30 years of age, 2) the high survival rates of hatchery-origin Kootenai sturgeon after release, and 3) the number of hatchery-origin Kootenai sturgeon released (~300,000) to date, the in-river spawning population of Kootenai sturgeon is expected to increase dramatically within the duration of this consultation. The combined effects of management of Libby Dam spring flows, habitat restoration, nutrient addition, and the conservation aquaculture program—all of which will continue under the Proposed Action—are expected to be beneficial to Kootenai sturgeon.

10.1.3 Consequences of the Proposed Action on Designated Critical Habitat for Sturgeon

10.1.3.1 Libby Dam Operations

The Action Agencies propose to provide flow augmentation during the sturgeon migration and spawning season using a set of tiered water volumes, with actual annual flow releases determined by in-season management. The Action Agencies will also manage the spring flows to avoid a sudden drop of more than 3.6 °F from Libby Dam during sturgeon incubation, hatching, and larval development phases. Temperature targets at Bonners Ferry will be 50 °F minimum for sturgeon spawning, increasing to no more than 64 °F in July and August for larval development.

PCE 1: Water Depth within Critical Habitat

Meander Reach

With implementation of the Proposed Action, water depths of greater than 23 ft are expected to remain widely available during the spring spawning season, within the lower end of the Meander Reach. However, implementation of the Proposed Action will not achieve water depths of 23 ft or greater in the upper 0.6 mile of the Meander Reach (Corps and Bonneville 2019, pg. 23). USGS modeling (Berenbrock 2005) indicated that with average (50th percentile) stage conditions of Kootenay Lake, present channel morphology, a river stage of 1,765 ft mean sea level (MSL), and total flows at Bonners Ferry of approximately 50,000 cfs, water depths of only 18.0 ft may occur in the upper section of the Meander Reach. The Proposed Action does not allow for river stages above 1,764 ft MSL, which precludes achieving the 23 ft target in the upper section of the Meander Reach.

Braided Reach

As noted in the Braided Reach section above, Libby Dam operations have reduced river depths in the braided reach to an extent that may cause Kootenai sturgeon to avoid migrating through and/or spawning in areas upstream of Bonners Ferry that are more suitable for successful recruitment. The Action Agencies have funded multiple habitat restoration projects in the braided reach, several of which are specifically designed to increase river depth (e.g., constructed pools, pool-forming structures). To date, 27 ac of pool habitat has been excavated and 10 pool-forming structures have been constructed in the braided reach. However, while these projects have certainly increased the average river depth in the braided reach, the extent to which they have done so has not been quantified. In their 2018 Annual Report on Implementation of the Service's (2006) Opinion, the Action Agencies stated that the 23-foot depth attribute in the braided reach "is not achievable below Kootenai River flood stage of 1,764 ft MSL at Bonners Ferry" (Corps and Bonneville 2019, pg. 23). On the other hand, as noted previously in this opinion, the increased depth in the braided reach from implementation of the habitat restoration projects is positively related to a recent increase in the proportion of tagged, spawning Kootenai sturgeon migrating into the braided reach.

PCE 2: Water Velocity for Cover during Embryo and Free-Embryo Incubation

<u>*Meander Reach*</u>

Cover from predation for embryos and free-embryos is achieved through water velocities of 3.3 ft/s or greater. A total flow of at least 40,000 cfs throughout the incubation period is required to meet this velocity criterion within the lower portion of the Meander Reach where most sturgeon now spawn (Barton et al. 2005).

With implementation of the Proposed Action, adequate cover for sturgeon embryos (provided they become attached to some fixed object) and free-embryos will not be provided through the incubation period within most of the Meander Reach under most circumstances because flows in this area are insufficient to sustain water velocity of at least of 3.3 ft/s throughout the incubation period. The exception to this occurs within the upstream most 0.6 mile of the Meander Reach (Berenbrock 2005), where water velocity sufficient for cover (mean water column velocity of 3.3 ft/s) may be sustained throughout the incubation period under volume runoff tiers 5 and 6 (and perhaps some under-forecasted tier 4 years). When flows can be maintained at or greater than 3.3 ft/s attached embryos are afforded cover through predator exclusion (Parsley et al. 1993, Parsley and Beckman 1994, Anders et al. 2002).

<u>*Braided Reach*</u>

The Proposed Action is likely to meet the 3.3 ft/s need in much of the braided reach during the incubation period.

PCE 2: Water Velocity for Normal Free-embryo Redistribution Behavior

White sturgeon free-embryos may enter the water column and be passively transported downstream for one to six days, depending upon water velocity (Brannon et al. 1985, Kynard and Parker 2005). The duration of this redistribution period is inversely related to water velocity (Brannon et al. 1985). With adequate water velocity free-embryos may promptly enter their hiding phase, which: (1) reduces their risk of predation; (2) precludes passive transport further downstream to risk suffocation in shifting sandy substrate; and (3) conserves energy for normal development (Brannon et al. 1985, Kock et al. 2005).

When exposed to low near-substrate water velocities, free-embryos increase the duration of passive downstream redistribution prior to entering the hiding phase (Brannon et al. 1985). This increases vulnerability to predation, results in losses of energy otherwise contributing to development, loss of fitness at the onset of foraging, and may result in free-embryos being redistributed into unsuitable habitats with sandy substrate and without rocky substrate for shelter and cover. Mean water column velocities of 3.3 ft/s or greater are needed to meet this aspect of PCE 2 to avoid these effects.

Meander Reach

As described in the Meander Reach section for PCE 1, with implementation of the Proposed Action, mean water column velocities of 3.3 ft/s or greater will not be achieved during late incubation within the Meander Reach, with the possible exception of the upstream-most 0.6 mile of the Meander Reach during volume runoff tiers 5 and 6.

Braided Reach

Under the Proposed Action, this velocity criterion is likely to be sustained throughout the incubation period in much of the braided reach during medium and high runoff years based on the findings of Berenbrock (2005).

PCE 3: Stable Water Temperature

The Proposed Action commits to maintaining stable water temperatures during the spawning season (May through June) to the extent possible with the existing selective withdrawal facilities at Libby Dam. In most years, these facilities have maintained stable water temperatures in both the meander and braided reaches. Therefore, under the Proposed Action, this criterion is expected to be achieved in both the meander and braided reaches.

PCE 4: Presence of Approximately 5 Miles of Rocky Substrate

Meander Reach

The substrate in the lower Meander Reach is predominately lacustrine clay overlain with sand and was historically so prior to the construction of Libby Dam (Barton et al 2004). As part of the Habitat Restoration Project, small patches (approximately 0.5 to 1.0 ac each) of gravel and cobble have been placed in known spawning areas in the Shorty's Island and Myrtle Creek areas. The sites for these substrate enhancement pilot projects were specifically selected due to the presence of exposed lacustrine clay, and as such the substrate was less likely to become inundated with sand and silt. However, these types of areas (exposed lacustrine clay overlapping with known sturgeon spawning) may be limited within the Meander Reach. Thus, it is unclear if the opportunity exists to expand these pilot projects to create 5 continuous miles of rocky substrate.

The upper 0.6 mile of the Meander Reach does contain some rocky substrate (including patches of rocky substrate added as part of the Habitat Restoration Program), but does not meet the linear extent criterion for this PCE. However, when combined with the existing rocky substrate within the adjacent braided reach, this criterion is currently fulfilled and expected to be maintained under the Proposed Action.

Braided Reach

Approximately 5 miles of continuous rocky substrate exists in the braided reach and is expected to be maintained under the Proposed Action.

PCE 5: Maintenance of Rocky Substrate and Inter-Gravel Spaces

As described in the Rocky Substrate (PCE 4) section above, rocky substrates and associated inter-gravel spaces provide both structural shelter and cover for egg attachment, embryo incubation, and normal free-embryo incubation, as well as facilitate downstream redistribution of free-embryos.

With the exception of the substrate enhancement sites associated with the habitat restoration program, and the upper 0.6 mile of the Meander Reach, rocky substrates are generally lacking in the Meander Reach, which reflects pre-Libby Dam conditions. Opportunities to expand on the substrate enhancement sites are uncertain. As noted in the PCE 4 section above, adequate rocky substrates exist within the braided reach. Implementation of the Proposed Action is expected to maintain the existing rocky substrates and inter-gravel spaces within both the Braided and Meander reaches.

10.1.4 Summary of Effects of Libby Dam Operations on Designated Critical Habitat for the Kootenai Sturgeon

Although implementation of the Proposed Action is expected to limit the co-occurrence of PCEs at the same place and time during the critical period of sturgeon breeding, the Proposed Action also contains measures specifically designed to reduce the effects to critical habitat during the sturgeon spring migration and spawning period. Specifically, the Proposed Action includes management of Libby Dam flows to increase river depth and velocity and provide stable river temperatures during sturgeon migration and spawning. Also, rocky substrates are present in the upper 0.6 mile stretch of the Meander Reach and throughout the braided reach, and implementation of the Proposed Action is expected to maintain this substrate.

In the Service's Opinion, implementation of the Proposed Action is likely to produce a mixture of beneficial, neutral, and negative effects to Kootenai sturgeon critical habitat.

10.1.4.1 Other Effects on Designated Critical Habitat

Increasing the Primary Productivity of Kootenay Lake

Direct effects on designated Kootenai sturgeon critical habitat from fertilization of Kootenay Lake are not anticipated, primarily because the action occurs well outside critical habitat.

10.2 Bull Trout And Designated Bull Trout Critical Habitat

In this section, we examine the response of bull trout to the various stressors and determine the effects these may have on individual bull trout, local populations, the Core Area, and ultimately the Recovery Unit. First, we examine bull trout exposure to the stressors. Then we assess the operational consequences of the actions, while acknowledging and isolating the consequences of non-discretionary actions, baseline and outside influences, where possible. In some cases, the consequences may result in beneficial impacts or insignificant and/or discountable effects. The majority of the discussion will revolve around the expected and foreseeable adverse effects of the action.

10.2.1 Exposure Analysis

Bull trout are found throughout the Action Area and represent individuals from as many as 46 Core Areas across the range of the DPS. In most portions of the Action Area, bull trout adults and sub-adults are overwintering, or during any time of the year, can be found foraging and migrating. Spawning and juvenile rearing areas are located outside of the Action Area and unlikely to be affected by the Proposed Action.

Across the Action Area, specific numbers of bull trout are difficult to quantify, and the use of the entire Action Area by bull trout is not fully understood. For example, the Service considers the reservoir areas above Grand Coulee and Chief Joseph dams, as a research needs area for bull trout where observations are rare and, in most cases, the source populations of individuals observed are unknown. In contrast, in the Mid-Columbia River or Pend Oreille River Basins, bull trout use is well documented and occurs year-round. The following sections describe the exposure risk for bull trout within each Recovery Unit in the Action Area.

In addition, in many cases, there are few studies on the specific effects hydropower operations may have on bull trout. In situations where information specific to bull trout is lacking or insufficient to make quantitative conclusions, the Service uses data related to surrogate species where life histories or habitat needs are similar enough to make quantitative or qualitative assessments. In the Lower Columbia River or Snake River Basins, information about effects of the CRS operations on Spring/Summer Chinook can be used as a surrogate due to the similar spawning migration timing and mainstem river habitat needs as those required by bull trout. For example, the upstream migration timing of spring/summer Chinook occurs at approximately the same time of year adult bull trout may be moving upstream to spawning areas. Therefore, information on upstream passage at the dams may be relevant when bull trout specific data is not available. In other situations, quantification of habitat impacts are used to represent an overall impact that may occur to an unknown number of individuals. For example, a geographic area of substrate disturbance or linear stream segment that riparian vegetation is disturbed.

10.2.2 Consequences of the Action on Bull trout and Bull trout Critical Habitat

The following analysis is organized based on the consequences to bull trout individuals and designated critical habitat. In the following sections, the breakdown of effects focus on categories of "stressors." Here we define a stressor as a category or topic known to influence the habitat and/or the persistence of bull trout individuals, populations, and Core Areas. These categories loosely coincide with PBFs/PCEs defined in the critical habitat designation. The expected stressors are related to migration and passage barriers including stranding; entrainment; habitat quantity or quality; water quality and quantity; underwater noise; natural hydrograph; prey base or forage resources; interactions with non-native species; and directed handling associated with research, monitoring, biological evaluations, surveys and/or rescue or salvage operations (i.e., for maintenance projects).

Given that stressors and general impacts to bull trout from the hydropower system are similar across Basins and Recovery Units, each stressor section describes the various stressor and how operations of the CRS may alter or affect bull trout individuals and their habitat. Following the overarching description of impact, specific details within each Recovery Unit and specific to certain dams are described. The effects of past operations, the existence of the structures, and related activities which have previously been consulted on are included within the Environmental Baseline (Section 9), but may be discussed briefly here as they relate to the Proposed Action.

10.2.2.1   Upstream Migration Barriers and Connectivity Consequences

As described in the Status of Species and Environmental Baseline sections, migratory corridors link seasonal habitats for all bull trout life histories, and the ability to migrate or disperse is important to the persistence and recovery of bull trout (Rieman and McIntytre 1993, p.2; USFWS 2015a; Barrows et al. 2016, entire; Paluch et al. 2020, in Draft). Migration allows bull trout to access more abundant and larger prey, facilitates growth and reproduction, and provides opportunities for dispersal and long-term genetic persistence (Rieman and Allendorf 2001; Ardren et al. 2011). Barriers can eliminate the migratory life history forms within watersheds leading to population isolation, genetic bottlenecks, increased risk of hybridization and genetic drift due to the severe reduction in population size, changing their genetic composition (Kanda 1998, p. 14; Kahler et al. 2001 cited in Taylor et al., 2014, p. 1086; Dehaan and Bernall 2013 p. 1270; Ardren et al. 2011 p. 521; Rieman and Allendorf 2001 p. 761). Mechanisms influencing genetic variation among and within populations include historical processes of glacial refugia, colonization, gene flow, natal stream fidelity, life history form, natural and anthropogenic barriers, habitat complexity, spatial connectivity, and effective population size (Whitesel et al. 2004).

Bull trout return to their natal spawning grounds with high precision, which results in low genetic variability within and among local populations, indicating that gene flow rarely occurs among major river Basins (Ardren et al. 2011). There is high genetic variation between local populations (Whitesel et al. 2004). Even when connectivity exists between local populations, both between adjacent watersheds as well as within the same stream, reproductive isolation may occur that minimizes genetic variation (Whitesel et al. 2004). Loss of phenotypic characteristics associated with decreased genetic variation may include differences in migratory and homing behavior and age and size at maturity (Laikre et al. 1999).

All life history stages and forms of bull trout including resident, fluvial, adfluvial/allacustrine and anadromous, can be impacted by barriers as fish try migrating either upstream or downstream to forage, spawn or complete some aspect of their life cycle. Life history traits may also be influenced by the lack of free movement throughout the system. Bull trout that may have exhibited an adfluvial (river to lake) life history pattern may not be able to adapt to a fluvial (river to river) life history pattern after changes in environmental conditions (USFWS 2012c p. 163). For nearly all bull trout Core Areas within the Action Area, connectivity and passage barriers are identified as a threat to the persistence of the populations (USFWS 2015a, b, c, e).

Adverse impacts to bull trout and their habitat related to connectivity and migration are expected from the Proposed Action. The structure of the dams is the most commonly understood barrier to movement and migration of bull trout. In some cases, the structural element is the single cause for the barrier to movement. This impact is considered in the baseline and the long-term historical impact on population trends was considered earlier and will not be discussed in further detail in the following analysis.

However, dam operations can create a second level of barrier to movement not specifically related to the physical structure. Operations of existing passage facilities may also result in seasonal or temporary barriers to movement. Dam operations can also create barriers to movement through hydraulic and velocity changes in the tailrace (e.g. hydraulic vortices and trapping eddies), reduce access to tributaries by creating areas of subsurface flow (e.g. stream or reservoir elevation changes), create stranding pools due to sudden reservoir or tailrace elevation changes, develop temperature gradients (e.g. discharges of warm water into cold water), or elevate TDG, sediment, and/or chemicals that block or hinder olfactory senses or change behaviors. Operational impacts to water quality elements (i.e. temperature, TDG, sediment and contaminants) are discussed below under Water Quality Consequences. In this section, the upstream passage impacts of operations are considered.

Short-term impacts to movement that result in delays to spawning migrations or access to quality forage are expected at all facilities or dams. In many cases, the short-term impacts will not result in direct mortality of bull trout individuals. However, over time, the compounding annual effect of multiple non-lethal impacts over the duration of the action may reduce long-term persistence or recovery of populations, especially when the impacts occur to an existing depressed population. For example, at dams where upstream passage is available, some adverse impacts to bull trout may still occur. Effects to bull trout may include physical injury from contact with fishway structures. A number of indirect effects may stem from temporary fatigue, which is a function of ladder length, approach velocities, ladder water velocity, depths and other factors. Temporary fatigue may increase susceptibility to predation, and decrease ability to compete for cover or forage. In addition, increased susceptibility to infection caused by scale loss or non-lethal wounds incurred during fishway negotiation may also result.

For many existing upstream passage facilities across the range of the bull trout, delays in comparison to other salmonids have been observed. Since most passage facilities across the region are designed primarily for upstream passage of adult salmon and steelhead, it could be expected that facilities may be less effective for bull trout who exhibit different movement patterns, life history strategies, and water column placements. Bull trout move upstream in passage facilities at much smaller sizes (e.g. 8 inches to14 inches) than occurs with salmon and steelhead as well. Studies have documented lower swimming burst speeds and endurance in bull trout than other salmonids (Mesa et al. 2004; Mesa et al. 2008; Taylor et al. 2014a, b) and bull trout tend toward bottom dwelling based on observations of bull trout swimming in tunnels (e.g. Mesa et al., 2004) and in the wild by snorkeling. These behaviors are likely strategic methods to conserve energy between foraging or movement bursts. Several studies at non-project facilities have documented bull trout taking longer periods of time to ascend ladders, or displaying delays in passage (Bumgarner and Engle 2020; Barrows et al. 2016; Murauskas et al. 2014; Giorgi and Stevenson 2017).

Seasonal closures of passage facilities for maintenance or during high or low water events can delay bull trout migrations or foraging movements for significant periods of time. This Opinion assumes all bull trout entering fishways may experience some level of behavioral or non-lethal impacts as they negotiate the fishways. It may be possible for a sick, injured, or otherwise stressed bull trout to be killed as a result of the additive effect of injury from ascending or descending fishways or fish ladders, as well as from the need to pass multiple dams.

Other short-term effects to migration or upstream movements are expected from sudden changes to velocities, discharge, or water surface elevations. Due to the presence of low-gradient gravel bars, side channels, large amounts of submerged macrophytes, and aggradation at tributary mouths in many of the reservoirs and mainstem rivers, stranding of bull trout or seasonal passage barriers can occur related to fluctuations in river and reservoir surface elevations. The majority of these affects arise from deep drafts during flow operations which can result isolated pools, shallow shorelines, tributary subsurface flows, or raised gravel bars where bull trout and other fish become trapped, exposed, or completely blocked from habitat. A more in-depth look at the impacts of hydrology and changes to the hydrograph occurs later in this Opinion; here we focus on the impact to migration from isolated pools or subsurface flows at tributaries.

Ramping rates at many of the projects minimize the risk for stranding or water disconnection (e.g. isolated pools) by reducing the rate at which water is drawn down and providing the opportunity for fish to escape pools isolated from the main channel. Few studies across the Action Area have been completed to identify areas where stranding or trapping pools occur. During field studies in 2007 and 2008 in the Boundary Reservoir, large numbers of minnow (e.g. Cyprinids) fry were observed stranded during major draw-down events during the summer (USFWS 2012d, p.156). Other trapped fish included suckers, perch, and smallmouth bass fry. No native salmonids were observed. Few fish were observed in the areas prone to trapping and stranding during the winter (FERC 2011 cited in USFWS 2012d p. 156). Most studies at other reservoirs (FERC 2011 cited in USFWS 2012d p. 156; Paluch et al. 2020 *in Draft*) indicate mostly small fish, minnow fry, suckers, and juvenile warmwater fish are observed trapped or stranded. While this was a description of impacts at a non-CRS dam, similar operations and habitat impacts occur at dams in the CRS. State and Tribal biologists across the CRS have observed stranding, shallow and/or subsurface areas related to operations of the CRS dams, specifically in Lake Roosevelt above Grand Coulee Dam and in Lake Pend Oreille above Albeni Falls Dam. Bull trout are typically located in deeper waters. Therefore, the Service expects the risk of stranding and potential impacts to bull trout individuals is very low. The largest and most likely impact to bull trout from stranding is reduced forage availability.

However, subsurface flow and sediment accumulation at tributary mouths both up and downstream of the dams have been documented (Marotz et al. 1988; Zelch 2003; Hauer et al. 2016; Andonaegui 2003; Tetra Tech 2004; Paluch et al. 2020 *in Draft*). The timing of pool elevations or altered flow regimes can lead to modified sediment transport and accrual of substrates at tributary confluences. Depending on migration timing, mainstem river flows and elevations, tributary water depths, and distance of sediment accumulation upstream, bull trout migration to spawning grounds may be hindered, delayed or completely prevented.

In all cases described above, passage delays or barriers are expected to result adverse impacts to bull trout individuals and populations. The ability to quantify the exact impact is difficult at best due to few studies within the Action Area. However, historical population trend data, surrogate data from other projects, and estimated impacted habitat (e.g. stranding areas) can be quantified. Long-term compounding impacts of the Proposed Action, existing baseline conditions, and outside influences are expected and may include late arrival at spawning locations, decreased spawning success, missed spawning, higher rates of redd superimposition, increased predation or delayed mortality, reduced genetic distribution between Core Areas, and in some cases, extirpation of local populations.

10.2.2.1.1 Columbia Headwaters Recovery Unit

For all three CRS dams in the CHRU (Albeni Falls, Libby, and Hungry Horse dams), there are currently no upstream passage facilities. The existence of the dams has resulted in the physical impediment to passage and contributed to the current condition and status of bull trout populations within the Action Area. In the CHRU portion of the Action Area, both adfluvial and fluvial life histories are exhibited. Above the dams, the most common migratory pattern of bull trout exhibited is adfluvial, meaning that a lake or reservoir provides a significant portion of their habitat needs throughout the year. Historically, some of these areas had fluvial life histories. However, with construction of the dams, new lake habitat was formed upstream allowing populations to expand related to added forage benefits. Downstream populations contracted, becoming more dependent on the mainstem river for forage. In addition to the structural barriers, operations at the dams have led to seasonal passage barriers at some spawning tributaries.

Albeni Falls Dam

A subset of the adfluvial life history that is rarer across the range, but expressed in the CHRU is allacustrine, where adult fish move downstream from a lake system into a mainstem river and spawn in tributaries of the downstream river (Dupont et al. 2007; R2 Resource Consultants 2010). This downstream migration pattern still occurs in the Pend Oreille River Basin in Idaho and historically in northeastern Washington (DuPont et al. 2007; USFWS 2002b; USFWS 2012d; USFWS 2005a; USFWS 2018a; USFWS 2015b). Adult bull trout would migrate out of Lake Pend Oreille, down the Pend Oreille River and then into a tributary stream to spawn, with the progeny returning upstream to the lake. This migration pattern was eliminated in the Washington portion of the Pend Oreille River after construction of Albeni Falls Dam in 1952, which does not provide fish passage. This migration pattern is still found in Priest River where bull trout leave the Priest River and migrate upstream into Lake Pend Oreille. In addition, bull trout from populations upstream of Albeni Falls Dam are entrained below the dam and unable to return to natal spawning tributaries upstream. Upstream passage at Albeni Falls Dam is currently proposed and the Corps received full funding to complete the design in Fiscal Year 2020 (Corps 2020a, b). In addition, the Service consulted in 2018 on the construction and operation of the passage facility with the assumption of an operationally complete date of 2022. Although that date will not be met, the effects of that construction and long-term operation of the facility were addressed in the previous consultation, and will not be further addressed in this Opinion (USFWS 2018a). Current proposed (Kalispel 2018) and other expected funding sources for construction are anticipated to be available by the year 2025. Given construction timelines of other passage projects in the Columbia River Basin, the Service conservatively assumes upstream passage will occur within 10 years of the date of this Opinion, or the year 2030. In this Opinion, the Service is assessing impacts of operations on bull trout without the benefits of upstream passage until 2030, when operation of the passage facility is expected. If passage is not in place by 2030, then that would be a change in the information and assumptions used in this Opinion and operations would then be outside the analysis contained in this Opinion.

Bull trout have been documented in the Pend Oreille River in the vicinity of Albeni Falls Dam, both upstream and downstream of the dam (Ashe and Scholz 1992, p. 8; Dupont and Horner 2004, p. 11; Scholz et al. 2005, p. 6; Paluch et al. 2020 *in Draft*). To estimate numbers of bull trout impacted by Albeni Falls Dam, the Service took a conservative approach based on various surveys and telemetry data and expected capture/observation efficiencies of the methods. In 1991 and 1992, IDFG conducted gill netting (15,743 hours) and electrofishing (23.7 hours) surveys of the Pend Oreille River between the outlet of Lake Pend Oreille and Albeni Falls Dam, though it is unclear when the timing of these surveys occurred. Of the over 45,000 fish sampled, 5 bull trout were collected (Bennett and Dupont 1993, as cited in Scholz et al. 2005, p. 6). Between 2007 and 2014, 21 bull trout have been relocated upstream of Albeni Falls Dam by tribal and university biologists (Paluch et al. 2020 in draft; Geist et al. 2004, p. 3; Scholz et al. 2005, p. 18). In all cases the bull trout were determined to have originated from tributaries to Lake Pend Oreille or the Clark Fork River. In addition, during Box Canyon Dam and Boundary Dam studies, another 25 to 30 bull trout were captured between 2007 and 2014. Given known capture efficiencies and effectiveness, we expect that up to 150 bull trout could be in the immediate vicinity of Albeni Falls Dam at any time. As populations expand across the Core Area, and implementation of upstream passage at Albeni Falls Dam, Cabinet Gorge Dam upstream (approximately 2022) and Box Canyon Dam downstream (2021), this number is expected to increase over the duration of the Proposed Action.

Given the information above, we expect all bull trout entrained over Albeni Falls Dam are lost to the upstream populations until passage facilities at Albeni Falls and Box Canyon dams are operational (by approximately 2030). In addition, populations of bull trout downstream will be limited in growth and fitness, and risk increased mortality related to summer river temperatures, water quality impacts, and non-native species predation without access to higher-quality habitat in Lake Pend Oreille. These impacts are described more in later sections.

In addition to the structural barrier, migration and connectivity impacts at tributary mouths are occasionally observed as a result of flow operations at Albeni Falls Dam. Paluch et al. (2020 *in Draft*) observed seasonal subsurface flows at Lightening Creek that may pose a partial or seasonal barrier to movement of bull trout. Lateral erosion near the mouth of Johnson Creek has led to an accumulation of LW in the channel, which reduces freshet flow velocity and has created a gravel sill near the mouth. During low lake levels, the creek flows beneath the gravel sill, and fish passage is blocked (Bouwens in litt 2020). Strong Creek also goes sub-surface near the mouth during low and high lake levels, so may not be directly related to lake level management (Bouwens in litt 2020).

Migration impacts from operations of Albeni Falls Dam through 2030, when passage is available, is expected to result in increased mortality of bull trout individuals and unlikely recovery of populations downstream of the dam. Slight decreases in population abundance upstream of the dam are expected as a result of entrained individuals unable to return to natal spawning tributaries, spawn, and contribute to populations through 2030. After 2030 and construction and implementation of passage facilities at Albeni Falls, coupled with facilities constructed at Box Canyon, and Cabinet Gorge dams, populations are expected to increase and new populations colonize as a result of increased available migration habitat across the entire Lake Pend Oreille Core Area. Seasonal impacts of barriers at tributary mouths (e.g. Lightening, Johnson, and Strong creeks) will continue to limit reproductive success over the duration of the Proposed Action.

Hungry Horse Dam

Similarly to Albeni Falls Dam, Hungry Horse Dam represents a complete barrier to movement of bull trout populations upstream of the dam and downstream entrianment occurs. It is unknown what level of entrainment occurs at the dam nor what impact entrainment has on populations upstream of the dam (USFWS 2015b). Unlike the situation at Albeni Falls Dam, populations downstream of the dam have suitable habitat and forage below the dam, as well as access to Flathead Lake. Invasive species are identified as the primary threat to recovery of bull trout populations downstream of the Hungry Horse Dam (USFWS 2015b) and Hungry Horse dam would continue to protect the populations upstream of the dam from this threat. The South Fork Flathead River below Hungry Horse Dam is only transitional habitat for bull trout as very few from Hungry Horse Reservoir populations are entrained through the dam downstream into this reach. Bull trout from the Flathead River wander into this reach occasionally, but there has been no documentation of spawning by bull trout in this reach. The few juvenile and subadult bull trout may use this transitory habitat more frequently due to improved temperatures after the installation and operation of a selective withdrawal- temperature control device at Hungry Horse Dam. This reach of the South Fork Flathead River is not designated critical habitat for bull trout. Fish that are entrained from upstream populations would be unable to reascend past the dam to their suitable habitats upstream.

Proposed operations at Hungry Horse Dam may alter the timing and depths of drawdowns of the reservoir. Higher reservoir elevations in the fall of dry years would improve tributary access and decrease the risk and exposure to predation and angling pressure for upstream migrating bull trout.

Upstream migration impacts at Hungry Horse Dam are not expected to significantly reduce recovery potential for bull trout populations in the Hungry Horse Reservoir or Flathead Lake Core Areas. While some individuals may not return and contribute to upstream populations, this effect is currently not measureable at the Core Area scale based on existing population trend data and relatively unknown low numbers of bull trout entrained; and the dam will continue to isolate upstream populations from non-native species downstream of Hungry Horse. Individuals from the Flathead Lake Core Area will continue to not have access to quality habitat upstream of Hungry Horse Dam. This impact is considered in the Environmental Baseline. Higher fall reservoir elevations, implementation of ramping rates and local coordination for drawdowns is expected to reduce migration impacts related to seasonal passage barriers that may occur at tributaries in both Hungry Horse Reservoir and Flathead Lake Core Areas. Therefore, this impact is also not expected to measurably diminish recovery in the two Core Areas.

Libby Dam

As with Albeni Falls and Hungry Horse dams, Libby Dam eliminates the migration and connectivity between populations and Core Areas upstream and downstream of the dam. Quality habitat and forage base in Lake Koocanusa and current strong bull trout population status indicates the loss of individuals through entrainment has had limited impact to the overall health of populations upstream of Libby Dam. However, Paragamian et al. (2010, p.16) found that population fragmentation from both Libby Dam and Kootenai Falls limit recruitment of bull trout in the Idaho and Montana portions of the Kootenai River by isolating entrained fish from natal spawning locations. Their study found that approximately 67 percent of adult bull trout in the Kootenai River thought to be entrained from Lake Koocanusa were concentrated below Kootenai Falls during the spawning season and likely did not spawn. Paragamian et al. (2010), and Sylvester and others (2009) surmised that operations of Libby Dam altered flow patterns in the Kootenai River, increasing the frequency that Kootenai Falls acts as a partial to full barrier to spawning migrations. Further, Dunnigan et al. (2003) found 22 of 65 (38 percent) radio tagged bull trout captured above the falls migrated downstream below the falls with only one female returning to navigate the falls and successfully spawn in Quartz Creek. Although the falls appear to be at least a seasonal barrier to migration, fish have been shown to navigate the falls in their quest to return to their natal spawning areas (Dunnigan et al. 2003). The combination of a partial barrier at Kootenai Falls and the structural barrier further exacerbates the impacts of movement barriers for spawning populations in the Kootenai River (Paragamian et al. 2010, p.18). Existing depressed populations downstream of the dam will continue to be limited by reduced habitat quality, forage base, and water quality impacts without access to quality habitat in Lake Koocanusa (described in detail later).

Passage barriers at tributaries as a result of Libby Dam operations are well documented in the Kootenai River. Operations of Libby Dam for FRM have significantly altered the natural hydrograph in the Kootenai River from historic. Tetra Tech (2004, p. 65) and Zelch (203, p. 86) found that the primary changes in hydrology from Libby Dam operations included a decrease in annual peak discharges on the order of 50 percent to 75 percent, a decrease in the duration of high and low flows, an increase in the duration of moderate flows, and a redistribution of seasonal flow characteristics. Together, these changes have affected the stage, velocity, depth and shear stress within the river, which in turn have altered sediment transport conditions. The lack of seasonal peak flows has allowed large delta formation at the mouths of all bull trout spawning streams. Some streams have been aggrading at a rate of approximately 0.06 m to 1.1 m per year below Libby Dam since the impoundment of Lake Koocanusa (Zelch 2003 p. 24), and aggraded portions of the channels can extend as far as half a mile upstream (Hoffman pers. comm. 2019). Zelch (2003, p. 83) determined current operational discharges from the dam have been ineffective at moving the particle size necessary to remove aggraded materials.

Currently, Libby Dam operations provide discharge of 20 kcfs or greater for 11 to 16 days (25th to 75th percentile) during the spring freshet, a mean flow rate of 18.2 to 20.8 kcfs, and a peak discharge of 23.1 kcfs to 26.9 kcfs (Corps et al. 2020a, p. 3-526-536). This would support seasonal flow objectives for flushing and sorting sediments and gravels, but is not considered sufficient to mobilize existing build up at tributary deltas. It is unclear what frequency and level of flood flows would naturally mobilize substrate at this point. Maximum high flows greater than or equal to 20 kcfs are needed seasonally during the spring freshet period to flush and sort fine sediments and gravels (Corps et al. 2020a, p. 3-526-536). Cumulatively, watershed activities including forest practices, mining operations, and transportation infrastructure have further exacerbated the delta formation and are discussed more in the Environmental Baseline and Cumulative Effects.

As described in the Environmental Baseline, known populations of bull trout in the Kootenai River Core Area are declining (Paragamian et al. 2010; Watkins et al. 2018; MFWP 2020a; Dux pers. comm. 2019). Bull trout from populations in the Kootenai River Core Area migrate to spawning areas in tributaries of the Kootenai River between late June and September. Aggradation of substrate at tributary mouths likely delay timing or completely block passage of bull trout to spawning grounds, depending on flows in the Kootenai River combined with tributary flows (Marotz et al. 1988; Sylvester et al. 2015; Dunnigan et al. 2017). Bull trout typically return to the Kootenai River in late October after spawning.

Under the Proposed Action, operations at Libby Dam would provide discharge of 20 kcfs or greater for 12 days, on average, during the spring freshet, which is one day less than the mean for the current operations (Corps et al. 2020a, p. 3-526-536). The proposed mean flow rate from May 15 to June 15 would continue to be insufficient to mobilize or reshape tributary deltas and improve bull trout passage in the late summer and early fall. The Proposed Action includes measures to address aggradation at two tributary deltas based on a collaborative process with regional stakeholders. Additional tributary projects may be possible in the future but are not reasonably certain to occur due to funding limitations (Corps et al. 2020a p. 2-117). The Action Agencies propose to implement two tributary projects by 2025. However, given the uncertainty of the stakeholder process and design and construction timelines, the Service anticipates the two projects will be fully implemented by 2028. Full implementation of these projects will improve access to spawning areas and is expected to improve spawning success. If the proposed projects are not in place by 2028, it would be a change in the information and assumptions used in this Opinion and operations would then be outside the analysis contained in this Opinion.

The upstream baseline barrier at Libby Dam operations will continue to block entrained individuals from populations in the Lake Koocanusa Core Area from returning and contributing to their natal populations. Given the current strong population status of populations in the Lake Koocanusa Core Area, this impact is not expected to reduce recovery potential of populations in the Core Area. The continued baseline condition of lost access to quality habitat upstream of Libby Dam, combined with operational impacts increasing entrainment below Kootenai Falls, is expected to significantly impact the long-term viability and recovery potential for populations in the Kootenai River Core Area. In addition, operational impacts resulting in seasonal passage barriers at tributary mouths may reduce spawning success, population viability and potential recovery downstream of Libby Dam but at unknown levels. Proposed implementation of tributary habitat projects by 2028 is expected to improve spawning success in two tributaries after implementation. The Service estimated trend lines for redd counts in all known spawning tributaries within the Kootenai River Core Area (Table 10). These trends are expected to continue in all spawning tributaries until implementation of tributary delta habitat projects. Based on this, the Service anticipates that by 2028, up to 4 populations will be considered functionally extirpated with fewer than 5 redds annually. Upon implementation of the tributary habitat projects, trends in two tributaries are expected to improve and increase long-term persistence of the Core Area over current conditions.

Table 10. Estimated bull trout redd count trends in Kootenai River tributaries in 2028.

Stream	Percent decline 1999-2019	Percent decline 2009-2019	Redd Count Range (2009-2019)	Estimated Redd Count Year 2028
Callahan	100.0%	100.0%	0 - 11	0
W. Fisher	88.9%	75.0%	2 - 14	1
Libby	88.9%	33.3%	4 - 11	3
O'Brien	27.0%	32.5%	27 - 40	18
Pipe	97.2%	88.9%	0 - 16	0
Quartz	71.6%	6.5%	13 - 29	27

10.2.2.1.2 Mid-Columbia Recovery Unit

As with the dams in the CHRU, Grand Coulee, Chief Joseph, and Dworshak dams do not have fish passage and are structural barriers to migration. However, both up and downstream passage facilities are available at Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary and John Day Dams, though downstream passage is limited outside of the juvenile passage season. Across the MCRU within the Action Area, bull trout exhibit a fluvial life history, except in Dworshak Reservoir where an adfluvial life history is exhibited. Bull trout in this Recovery Unit evolved with salmon and steelhead, and connectivity between Core Areas is vital to genetic exchange. In addition, bull trout in this Recovery Unit tend to travel long distances for forage.

Grand Coulee and Chief Joseph

It is unclear the extent of impacts migration barriers have had or will have on bull trout in Lake Roosevelt or Lake Rufus Woods. There are no known spawning populations of bull trout within these reservoirs; however individual bull trout are observed annually, including adults and sub-adults. As with the dams in the CHRU, bull trout entrained are unable to return and are permanently lost to upstream populations. Bull trout from populations downstream of Chief Joseph Dam will continue to have reduced access to foraging habitat upstream of Chief Joseph and Grand Coulee dams as occurs in the baseline conditions.

Proposed Grand Coulee Dam operations are expected to result in deep drawdowns during some portions of the year. Depending on the timing of drawdowns, there is an increased potential for stranding or tributary passage issues. Anecdotal observations of shallow tributary deltas, subsurface flows, gravel build up or aggradation, and areas of potential stranding have been noted on tributaries to the Kettle River, Barnaby Island, Spring Creek and Evans Creek by state and tribal biologists. Given the very low numbers of bull trout observed in Lake Roosevelt and tendency for bull trout to reside in deeper waters, direct impacts to bull trout individuals from tributary passage barriers and stranding is unlikely. However, the impact of deep drawdowns and fluctuating reservoir levels may pose more significant impacts to forage species such as kokanee. Deep drawdowns that drop water levels below existing kokanee redds or prevent migration into spawning tributaries have the potential to reduce survival, reproductive success and populations of bull trout forage species. The Action Agencies have proposed to provide 100 acres of gravel augmentation or habitat modifications, should kokanee redds be impacted by operations to minimize this effect on bull trout forage species.

The geographic area affected by Grand Coulee and Chief Joseph dams is considered a RNA for bull trout due to limited information on presence, population structure, and use of the area for foraging, migrating, and overwintering. While small numbers of individuals may be entrained below the dams, and unable to contribute to or establish populations upstream, this impact is not expected measurable at the Core Area scale for any known Core Area.

Dworshak

In the Bull Trout Recovery Plan (USFWS 2015c, p. C-258), the effects of entrainment and lack of passage at Dworshak Dam were identified as needing more research. While unknown, the Service conservatively estimates that low numbers of bull trout are likely entrained through Dworshak Dam during high flows and spill operations, as is the case at other dams across the Action Area. These entrained fish, as well as bull trout downstream of the dam, will continue to be unable to access suitable habitat upstream as currently occurs under the baseline condition.

Proposed operations at Dworshak Dam, may alter the timing and depths of drawdowns for power generation and flood control across the CRS. Depending on the timing of drawdowns, the potential for stranding or tributary passage issues may increase. However, due to the presence of large amounts of deepwater habitat and the tendency for bull trout to be located in deeper waters, the potential for stranding of bull trout is unlikely. The impact of deep drawdowns may pose more significant impacts to forage species, such as kokanee, who are shoreline spawners. Deep drawdowns that drop water levels below existing redds or create partial barriers to spawning tributaries may result in missed spawning, desiccation of eggs or fry mortality.

Upstream migration impacts at Dworshak Dam are not expected to significantly reduce recovery potential for bull trout populations in any Clearwater Basin Core Area. While some individuals may not return and contribute to upstream populations, this effect is currently not measureable at the Core Area scale based on existing population trend data. In addition, there are no known areas where stranding or barriers to tributary access occur in relation to operational reservoir drawdowns. Isolated instances where stranding or temporary passage barrier may occur are not expected to result in affects observable at the Core Area scale. Individuals from Core Areas downstream of Dworshak Dam or entrained from upstream of the dam will continue to not have access to quality habitat upstream of the dam. This impact is considered in the Environmental Baseline. Therefore, impacts related to upstream migration and stranding are not expected to measurably diminish recovery in the Core Areas of the Clearwater River.

Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, and John Day

All of these dams have at least one upstream passage facility, which are generally designed for salmon and steelhead passage (Corps et al. 2020a). The proposed operation and maintenance of the fish passage facilities at each dam is expected to result in both positive and negative impacts to bull trout individuals. As there is some level of passage opportunity at the CRS dams in the Snake and Columbia rivers, the full impact to populations and Core Areas is not well understood. Passage designs do not always factor in the smaller size or energetic needs of bull trout compared to anadromous salmon and steelhead. Due to the differences in life history strategies of bull trout and salmon and steelhead, operation of adult fishways likely results in some level of impact to migratory bull trout. In addition, bull trout often pass through facilities many times over a single year compounding impacts of each pass versus single passage attempts per year for salmon and steelhead.

Fish passage facility operations can lead to delays in the upstream movement of adult bull trout, impeded upstream passage of sub-adults, and result in injury (abrasions, crowding, stress) or mortality of adults due to contact with structures within the fishway and due to fallback (USFWS 2012c p.145). During maintenance of the fishways, bull trout upstream movement past dams is temporarily eliminated (when there is one fishway), or limited to only one fish ladder (when there are two fishways). In addition, the maintenance period for passage facilities occur during work windows (December to February) that avoid impacts to salmon and steelhead migrations, but bull trout may be present year-round and experience effects of passage closures.

Delays in migration and movement of bull trout are expected from operation and maintenance activities at passage facilities annually. Impacts of salvage and fish handling for dewatering activities is discussed later. During passage facility maintenance, the passage facilities are dewatered and there is a barrier to movement for bull trout. Maintenance closures will result in complete passage barriers at Lower Granite and Little Goose dams annually for up to two months. In addition, a single upstream passage facility at each of the other dams will close for annual maintenance for up to two months. It is unknown if bull trout prefer north or south side passage facilities. At other projects across the region, attraction flow to passage facilities is key to use by bull trout. It could be assumed that depending on the combination of passage facility source flows and spillway or turbine flows (such as during zero generation operations), bull trout may have lowered abilities to locate passage facilities during annual maintenance or during zero generation operations (Corps et al 2020a p. 2-54; 7-37). Since bull trout are using the river primarily for foraging and overwintering during annual fish passage maintenance (December through February) or zero generation operations (Ocotber through February), the Service expects non-lethal behavioral impacts in the form of delayed movements and reduced access to forage areas for all bull trout in the river at that time.

Daily operations of the fish passage facilities are expected to result in injury to bull trout individuals as a result of contact with the structure. As described earlier, bull trout may experience impacts from temporary fatigue and increased susceptibility to infection from scale loss or injuries sustained during negotiation of the passage facility. Within passage facilities, impacts to sub-adults may be even more pronounced as a result of enclosed proximity to large non-native predators (e.g. smallmouth bass), increased bioenergetics needed to ascend the ladders, and lack of protective cover. These impacts are generally assumed to be non-lethal in nature, and low levels of mortality are expected as a result of increased predation or delayed mortality from injuries. These affects would be expected for all bull trout within the passage structures annually.

Project passage facilities also may result in behavioral impacts that may elevate to delayed migration, missed spawning, and lost reproduction. Bull trout in the Snake and Columbia rivers typically spend more than half of the year in the mainstem river foraging and migrating (Barrows et al. 2016; BioAnalysts, Inc. 2004, 2007 and 2008; Service 2006b as referenced in USFWS 2012c p.149; Schaller et al. 2014). The frequency, timing, and routes of upstream and downstream passage by bull trout are not well understood. In the multi-year study conducted at PUD dams, some radio-tagged bull trout were regularly observed entering the lower portions of fishways, residing there over variable time frames, then egressing through the fishway entrances and migrating downstream and into tributaries (Stevenson et al. 2009; Giorgi and Stevenson 2017). Giorgi and Stevenson (2017 p. 10) identified that bull trout ascending upstream passage facilities in the Mid-Columbia averaged approximately 6 hours per fishway while Chinook and sockeye salmon averaged 1-3 hours. On average, bull trout spent approximately one day (range of 0.04 days to 3.43 days) in the tailrace before attempting to ascend the ladder at Rock Island Dam (Barrows et al. 2016 p. 136). Fish moved into and out of the ladder for an average of 6.42 days (range of 0.02 days to 18.40 days) before migrating through the ladder (Barrows et al. 2016 p. 136). Migration time through the ladder averaged 0.26 days (range of 0.07 days to 0.47 days). Overall migration past Rock Island Dam from first entering the tailrace to exiting the fishway averaged 5.24 days and ranged from a minimum of 0.29 days to 18.93 days (BioAnalysts, Inc. 2009 as cited in Barrows et al. 2016 p. 136). At Mill Creek (tributary to Walla Walla River), bull trout were predicted to require less water depth to ascend the flood control channel than steelhead, but stamina was reduced and insufficient for passage at higher flows, turbulence and velocities that were predicted to be passable by steelhead and Chinook (Burns et al. 2009, p. 40). BioAnalysts, Inc. (2004) and LGL and Douglas PUD (2008) both concluded that while passage was provided, the dams delayed or slowed migration times for bull trout (Barrows et al. 2016 p. 144).

This behavior is often associated with bull trout locating and taking advantage of structural and hydraulic cover while staging and foraging at sites within the fishway. Alternatively, these fish may be rejecting the fishway as a passage route and vacate the facility volitionally. Whatever the cause, the resultant behavior in the fishway complicates calculating representative estimates of fishway passage success for this species, and may explain the absence of such estimates in the literature. Studies at mid-Columbia non-CRS projects have generally assumed that the delays do not appear to affect the ability for bull trout to reach spawning areas (BioAnalysts, Inc. 2004, 2009; Giorgi and Stevenson 2017; Barrows et al. 2016). However, this may not be the case for bull trout in the Walla Walla, Umatilla, Tucannon, and Asotin Core Areas where habitat conditions in the tributaries further delay spawning migrations as a result of irrigation diversions, low flow barriers, and elevated temperatures during the late spring and early summer months (Barrows et al. 2016, p. 190; Barrows et al. 2014; Schaller et al. 2014). These conditions usually develop by late June, but in some subbasins (e.g., Walla Walla River) during low flow years, these conditions can develop as early as late May. Even a short passage delay at a mainstem dam may affect the ability of a bull trout to migrate to the mouth and through the lower reaches of a given subbasin and reach upstream spawning areas before the window of passage opportunity closes (Barrows et al. 2016 p. 190).

Proposed operations under Flex Spill (Corps et al. 2020a p. 49) are expected to compound known delays observed during involuntary and intentional spill at one of the passage facilities for bull trout during operations from April 3 through June 20 at the Lower Snake River projects.

During juvenile passage operations in 2018 and 2019, delays in passage of adult Spring/Summer Chinook were observed at Little Goose Dam, likely as a result of hydraulic eddies that formed in the tailrace when spill is over 30 percent of total river flow. It is unknown to what extent migrating bull trout were also impacted by the operations. Due to similar migration timing as Spring/Summer Chinook, the Service assumes that bull trout also experienced migration delays at Little Goose Dam. The Proposed Action includes an adaptive management program and collaborative adjustments to operations when passage delay is observed during Flex Spill operations and when significant numbers of adult Chinook salmon are detected at Lower Monumental Dam. The Service anticipated that some bull trout at Little Goose Dam will experience added delays during spring spill operations that may result in delayed or missed spawning opportunities.

Included with the anticipated delays at passage facilities, bull trout often need to ascend multiple ladders and may experience levels of “fall back” where they are entrained back through the dam and are required to attempt to ascend the ladder again. There are no known studies on the rates of fallback for bull trout. Therefore, the Service assumes a similar rate as observed with Chinook salmon at the dams. The mean annual fallback rate for fall Chinook at lower Columbia and Snake Rivers dams is estimated at 11.6 percent over 4 years of study from 1998 to 2002 (Keefer et al. 2004 cited in Corps et al 2020a p 3-63). The Proposed Action, specifically the Flex Spill operation, will have the potential to increase the rate of fallback at CRS dams and bull trout may experience compounding impacts described above during multiple attempts to pass the dams.

Over the life of the Proposed Action, existing declining population trends observed in the Umatilla, Walla Walla, and Asotin Core Areas (described in the Environmental Baseline) as a result of upstream migration barriers related to the Proposed Action are expected to continue or worsen. Added migration delays as a result of Flex Spill Operations combined with other passage delays may result in slight decreases to spawning success and reproduction in the Tucannon Core Area. A few individuals from the John Day Core Area are expected to experience effects described above, but the impacts are not expected to be measurable at the Core Area scale, based on the low levels of observations at the dams. Bull trout from Entiat, Methow, and/or Wenatchee Core Areas may experience individual impacts resulting from passage delays or injuries as well. However, these effects are expected to be indistinguishable over effects experienced at the non-federal mid-Columbia dams. Based on existing video and visual counts as well as occasional observations during salmon and steelhead broodstock collections and smolt sampling, which are not comprehensive of the entire year, as many as 500 bull trout could experience behavioral (i.e. avoidance, stress, etc.) and sublethal (i.e. abrasions, scale loss, wounds, etc.) impacts from ascending the adult fish ladders per year. Mortality of no more than 10 percent of bull trout using the passage facilities is anticipated. The Service expects the potential for reduced mortality and improved passage to occur through coordination with regional forums that address impacts to bull trout and other species, implementation of actions to reduce identified threats, and monitoring of bull trout passage efficiency.

There are no known areas of stranding and/or tributary access issues identified in the Lower Snake River, McNary Reservoir, or John Day Reservoir on the Columbia River.

10.2.2.1.3 Coastal Recovery Unit

Bonneville and The Dalles dams are within the CRU for bull trout. Both have passage facilities that provide passage upstream and downstream.

Over the last two decades, spring and summer spill operations have been modified substantially to facilitate safer fish passage at each of the lower Snake and lower Columbia dams. The installation of spillway weirs and other surface passage routes have reduced the percentage of fish that pass through powerhouse turbines, decreased fish travel time, and increased the overall survival of migratory species through the system. Importantly, effective locations for surface passage at each dam were selected based on detailed analysis involving hydraulic modeling and site-specific fish monitoring studies. With the addition of spillway weirs and other improvements, new spill patterns were developed using the expertise of regional scientists and engineers. Powerhouse surface passage through an ice/trash sluiceway (ITS) is available also at The Dalles Dam and the first powerhouse of Bonneville Dam. In addition, the Corner Collector (B2CC), another surface passage route, was installed at the second powerhouse of Bonneville Dam in 2004. A direct injury and survival study of adult salmon carried out at Bonneville Dam showed direct survival rate of 98 percent at the Bonneville ITS and B2CC, with most mortality caused by pinnipeds in the tailrace (Normandeau 2011 p.5).

Screened juvenile bypass systems have been incorporated into powerhouses at seven CRS fish-passage dams to guide fish away from turbine intakes and into bypass channels. Additional juvenile bypass modifications have been made at Bonneville Dam. The Corps continued field investigations and design of fish survival upgrades to the Bonneville Dam second powerhouse juvenile bypass system. Previous modifications to that system resulted in an increase in the percentage of juvenile fish going through the bypass system rather than the turbines, but also increased the incidence of injury to juvenile fish, particularly to smaller juveniles when the turbines were operated at the upper end of the one percent peak efficiency range. Upgrades at Bonneville Dam are still underway at the second powerhouse to finish the work deemed necessary for additional survival benefits of downstream passing fish.

Ladder passage times for Chinook salmon and steelhead moving upstream of Bonneville Dam are similar to estimates at The Dalles Dam (Keefer et al. 2004 p. 1422, Keefer et al. 2008a p.9-15). While passage studies have been limited with bull trout in the Columbia River System, there are currently no identified problems related to crowding or impediments to passage for salmonids at Bonneville Dam.

At The Dalles Dam, adult salmon consistently use the Oregon ladder more than the Washington ladder, which has raised concerns regarding crowding at times when large abundances of fall Chinook salmon are passing in September, or when the shad run overlaps with sockeye or summer Chinook salmon. Bull trout would be expected to move through the mainstem Columbia primarily in late fall and winter months when ladder crowding should be less of a problem.

John Day Dam ladders were a concern in the past due to adult fish dropping back out into the tailrace after entering the ladders and long passage times; a radio tag study indicated that delay in the tailrace before entering the ladder represented the greatest component of delay, and exceeded that at Bonneville and The Dalles Dam (Frick et al. 2008 p.19-28, Keefer et al. 2003 p.2-5, 2006 p.9-17, 2008b p. 15-17). Modifications to the John Day Dam were completed at the north and south lower entrance areas including a non-mechanical keyhole weir entrance and removal of lower weirs. An evaluation showed improved passage efficiency and shorter times after modifications were completed (Frick et al. 2015 p.47-62).

No studies of bull trout fallback have been conducted at the lower Columbia dams. For spring/summer Chinook salmon, rates of fallback followed by re-ascension are typically moderate at Bonneville Dam (Crozier et al. 2016 p. 43-48). Flow and spill are the environmental variables with the strongest correlation with fallback for Chinook salmon at Bonneville Dam (Crozier et al. 2017 p. 16-17). Fallback of sockeye at Bonneville Dam has varied substantially by year, ranging between 0-33 percent and averaging at 7 percent between 2008 and 2013 (Crozier et al. 2014 p. 20). Spill volume was moderately correlated with fallback at Bonneville Dam and adults that fell back had similar conversion rates to those that did not (Boggs et al 2004 p.943).

As described in the section above, similar effects related to negotiating the passage facilities, injuries, and fallback after passage are likely, as are the impacts from facility closures for maintenance. However, given the very low numbers of bull trout documented in the lower Columbia dams, it is unlikely that the impact could be measurable at the population level or Core Area. In more than 25 years of data, fewer than 10 bull trout have been observed in passage facilities at these two dams or in the mainstem. In addition, few studies have determined the frequency or use of the Lower Columbia River by bull trout. Mortality of no more than 10 percent of bull trout using the passage facilities is anticipated. Monitoring of passage efficiency for salmon and steelhead, coordination with Regional Forums to address impacts to bull trout and other species, and implementation of actions to reduce the potential for mortality and improve passage efficiency at the dams will further reduce the long-term impacts associated with operational migration barriers at Bonneville and The Dalles.

There are no known areas of stranding and/or tributary access issues identified in the Lower Columbia River.

10.2.2.2 Entrainment/Downstream Passage

Entrainment and downstream passage occurs at all dams; however, the level, quantification, and timing of impacts is variable between facilities, routes of downstream passage or entrainment, and size of the fish entrained. Entrainment or downstream passage occurs as a result of spill operations, deep drawdowns, storage reservoir evacuations, hydropeaking operations, and intentional downstream migration of bull trout. Downstream passage or entrainment can occur through the spillways, turbines, navigation locks, juvenile transportation barges and downstream passage facilities.

Turbines are typically the most hazardous route for downstream passage. Operation of the turbines are expected to result in injury and mortality of bull trout as a result of downstream movement. These effects may include physical injury or mortality from pressure changes, cavitation, and contact with turbine structures including wicket gates, turbine runners, or the scroll case. Turbine intakes are often low in the water column and located at the furthest downstream location where bull trout are more likely present or approach the dam as well. Injuries are commonly shear-related, including eye injuries, gill and operculum damage, and decapitations, as well as strike-related injuries such as head trauma and hemorrhaging. Delayed injuries may include increased susceptibility to predation caused by disorientation following turbine passage or increased susceptibility to infection caused by scale loss or non-lethal wounds incurred during turbine passage.

Turbine studies on anadromous fish (Eicher Associates, Inc. 1987) found that, in general, smaller fish survive at a higher rate than do larger fish in turbine passage. To estimate mortality caused by turbine passage, we typically use other salmonids as surrogates for bull trout. Bull trout adult mortality is expected to be higher than for sub-adults due to size differences (USFWS 2000, 2012c, 2012d). Mortality estimates ranging between 22 percent and 41 percent for adult steelhead that passed through turbines were reported in a summary of adult fish fallback rates and mortality (Wagner and Ingram1993 cited in USFWS 2000 p.37); and a 14 percent to 26 percent mortality estimate was reported for fallback through turbines at CRS projects on the Snake River (Mendel and Milks 1993). However, since the time of these studies, turbines have been upgraded, reducing the mortality and injury rates at many of the dams. Where entrainment injury and mortality has been studied recently, current rates of sublethal and lethal injury for bull trout or surrogate species (typically rainbow trout) falls between 1 percent and 20 percent through the turbines (Normandeau 2014b; Skaar et al. 1996; Keefer et al. 2016; Corps et al. 2020a). Smaller sub-adult bull are expected to have slightly higher survival rates and reduced injury rates than larger adults.

Downstream passage and entrainment also occurs over spillways, through downstream juvenile passage facilities or transportation barges, through sluice gates, and possibly through navigation locks. Each of these routes has some level of injury, mortality, or behavioral impacts that are not well understood for bull trout. For example, there are no known studies of the use of the navigation locks for fish passage in the Columbia Basin. It is anticipated to be low, due to boat and human activity and lack of attraction flows; however, the locks may provide some level of fish passage as had been observed in navigation locks in the Ohio River Basin.

Spill occurs at most, if not all dams, annually during high spring flows and runoff. The CRS operations limit spill particularly at upper Basin dams when possible due to elevated TDG impacts. TDG specific impacts are discussed later under water quality. In the Lower Snake and Columbia rivers, spring and summer spill operations are used to increase juvenile salmon passage. Spill operations for fish passage occurs during the juvenile salmon outmigration season, generally from April through August. During these spill operations, it is expected that bull trout entrainment may occur at higher rates. As described earlier, fallback rates may be higher during spill. The mean annual fallback rate for fall Chinook at lower Columbia and Snake Rivers dams is estimated at 11.6 percent over 4 years of study from 1998 to 2002 (Keefer et al. 2004 cited in Corps et al 2020a p 3-63). Similar fall back rates could be expected for bull trout. The Proposed Action, specifically the Flex Spill operation, will have the potential to increase the rate of fallback for bull trout as well at CRS dams. Physical and behavioral injuries are expected to bull trout during downstream migration and entrainment from all downstream passage routes as a result of interactions with the physical structures of the dams. Injuries may include descaling or scale loss, disorientation, bruising, and open wounds resulting in increased risks of predation, infection, or direct mortality. At many of the dams, entrainment also results in lost connectivity with quality upstream habitat. The level of impact or number of individuals impacted depends on existing passage facilities, routes of passage, and presence of large amounts of suitable habitat.

10.2.2.2.1 Columbia Headwaters Recovery Unit

Libby Dam

Entrainment at Libby Dam occurs primarily through the turbines and seasonally during spill operations. Spill at Libby Dam occurs infrequently due to concerns over TDG and high mortality rates of fish over the spillway. In 2006, water was released through the spillways at Libby Dam from June 8 to 27, causing gas supersaturation in the Kootenai River downstream, resulting in total TDG levels of 131.48 percent (Marotz et al. 2007). During the spill, fish were captured and physically examined for external symptoms of GBT, after 4 days of spill physical symptoms were observed, and after 11 days of spill all bull trout and westslope cutthroat trout exhibited GBT (Marotz et al. 2007). In Skaar et al. (1996), abrasions were found on approximately 81 percent of entrained kokanee. In addition, other injuries included internal bleeding of unidentified source (40 percent of fish), inflated gas bladder (26 percent), eye damage (18 percent), contusions (l0 percent), soft and pulpy tissues (9 percent), lacerations (9 percent), body-cavity rupture (5 percent), pitation (4 percent), ruptured or bleeding of spleen (2 percent) (Skaar et al. 1996, p. 63). It is expected that bull trout individuals entrained will experience similar impacts.

Over a 501 hour sampling period between 1992 and 1994, 0.05 percent of 13,186 fish entrained during the Skaar et al. (1996) study were bull trout. The Service applied the 0.05 percent to the high (4.47 million fish) and low (1.15 million fish) estimates of fish entrained during the January 1992-January 1993 period from Skaar et al. (1996). This resulted in an estimate of between 575 and 2,235 bull trout being entrained during that same time period. Of these, it is expected that the majority of individuals were entrained through the turbines. Based on information presented by Skaar et al. (1996), the Service conservatively estimates that approximately 99 percent of entrained bull trout will experience non-lethal injuries and up to 11 percent will die. These rates would equate to between 569 and 2,213 bull trout were injured and mortality of between 63 and 246 bull trout occurred between 1992 and 1993. These estimates are expected to be conservative annual injury and mortality rates for entrainment at Libby Dam.

While bull trout entrainment does occur at Libby Dam, it appears to be low compared to population numbers in the Lake Koocanusa Core Area, but significant enough to contribute genetically to downstream populations. Arden and DeHaan (2007), DeHaan et al. (2008), and DeHaan and Adams (2011) found genetic markers from Lake Koocanusa bull trout populations in Kootenai River tributary bull trout progeny. Genetic information from the local populations in the downstream reach below Libby Dam indicates that roughly half the population originates from natal tributaries upstream of the dam (Corps et al. 2020a, p. 3-526-536). Paragamian et al. (2010, p. 18) suggests that entrained bull trout do not spawn as frequently when they are unable to return to natal waters. Survival of entrained bull trout (sub-adults and adults alike) may artificially increase abundance of bull trout in the Kootenai River Core Area downstream of the dam. Adult bull trout tagged in British Columbia (upstream of Libby Dam) were/are periodically re-captured in spawning tributaries downstream of Libby Dam.

Injuries and mortality from entrainment of bull trout are anticipated as a result of annual operations of Libby Dam. Conservative estimates indicate that up to 2,235 bull trout may be entrained annually through both turbine and spillway routes. As many as 246 may die as a result of injuries incurred during entrainment. Existing population numbers and trends in the Lake Koocanusa Core Area suggest that these numbers are not significantly impacting the recovery of the Core Area. As well, entrainment of these individuals may be providing supplemental individuals to depressed populations downstream of the dam.

Albeni Falls

Bull trout entrainment is well documented at Albeni Falls Dam. Genetic analysis of individuals captured downstream of the dam has determined that the majority of individuals originated from spawning populations upstream from Albeni Falls Dam, including tributaries to Lake Pend Oreille, Priest River, and the Clark Fork River (DeHaan and Ardren 2007). Capture data from Paluch et al. (2020 *in draft*) and USFWS (*unpublished data*) was used to develop a conservative estimate of individuals entrained at Albeni Falls Dam. Since bull trout are present in the Pend Oreille River year-round, it is assumed that as many as 35 bull trout could be entrained or near the dam at any time (USFWS 2018a). Based on this information and reductions of presence during summer high water temperatures, the Service conservatively estimates as many as 150 individuals are entrained annually at Albeni Falls Dam.

Normandeau (2014a) assessed direct mortality and sublethal injury from entrainment at Albeni Falls Dam on two size classes of rainbow trout. Normandeau's (2014a) results showed a relatively high survival rate of sub-adult (99.4 percent) and adult rainbow trout (97.6 percent) that passed through a spillway, and a high survival rate for sub-adults (99.5 percent) and adults (90.1 percent) that passed through a turbine. Therefore, based on estimated survival rates, few bull trout are expected to experience injuries leading to death. It is expected that no more than five bull trout per year will die from entrainment. Until fish passage is provided at dams in the Basin (by 2030), the Service expects these rates of entrainment will continue and entrained individuals will be lost to upstream populations. However, after construction of fish passage occurs and downstream populations recover, it is expected that number of individuals entrained may increase, but not significantly within the duration of the Proposed Action.

Recent estimates of bull trout abundance and population structure in the Lake Pend Oreille Core Area upstream of Albeni Falls Dam indicate the population is stable and consists of over 10,000 individuals within the lake (Meyer et al. 2014; USFWS 2015b). Entrainment estimates above are not expected to significantly impact the recovery or persistence of bull trout populations upstream of the dam. In addition, entrainment may provide some level of recovery supplementation to downstream populations. Therefore, while individual bull trout are expected to experience adverse effects and mortality from entrainment at Albeni Falls Dam, the impact is not expected to be measurable at the Core Area scale.

Hungry Horse

Currently, there are no known studies regarding entrainment at Hungry Horse Dam. Using data from Libby and Albeni Falls dams as a surrogate, the Service estimates that entrainment rates range between 150 and 2,500 individuals annually. Since Hungry Horse Dam operates similar to Libby Dam but given bull trout observation frequency downstream of the dam, the Service expects rates of injury and mortality are likely lower than expected at Libby. Therefore, conservative estimates indicate that up to 1,500 subadult and adult bull trout may be entrained annually through both turbine and spillway routes. As many as 165 may die as a result of injuries incurred during entrainment. Existing population numbers and trends in the Hungry Horse Reservoir Core Area suggest that these numbers are not significantly impacting the recovery of the Core Area. As well, entrainment of these individuals may be providing supplemental individuals to populations downstream of the dam.

10.2.2.2.2 Mid-Columbia Recovery Unit

Grand Coulee and Chief Joseph

During a 42-month investigation, Simmons et al. (2002, p iii) concluded that entrainment at Grand Coulee Dam ranged from 211,685 to 576,676 for all species annually. Further analysis revealed that 85 percent of the entrainment occurred at the dam's third powerplant. In more than 25 years, fewer than 10 bull trout have been documented in Lake Rufus Woods or downstream of Chief Joseph Dam, indicating that some level of bull trout entrainment occurs at these two dams. However, it is considered very low, and it is unknown what the relative survival and sublethal injury rates may be for bull trout through downstream passage routes (spillways or turbines). It is expected survival rates are similar to those observed at other CRS dams. There has been no known entrainment of bull trout through the John Keys Pumping Plant, which is located adjacent to Grand Coulee Dam. Given the relatively low numbers of bull trout observed in Lake Roosevelt and Lake Rufus Woods, it is expected that no more than 10 to 15 bull trout are entrained annually at these dams. Without specifics on injury and mortality rates, the Service conservatively assumes that up to 25 percent of these individuals will die as a result of entrainment related injuries. Currently, this region is considered a RNA, without specific population or habitat recovery goals. The anticipated level of entrainment is not expected to significantly impact recovery potential of the area.

Dworshak

There is limited information on the relative entrainment of bull trout below Dworshak Dam. Maiolie et al. (1996) observed low rates of entrainment of kokanee during high flow volumes in summer 1995, but significant entrainment during mid-winter flooding in 1996. Hanson et al. (2006) suggested entrainment rate may be low because they documented only two radio-tagged adult bull trout (out of 706) entrained through Dworshak Dam during a telemetry study conducted from 2000 to 2006. They found that some adult bull trout use the forebay during March, when discharge and entrainment risk can be high. They also use similar depths as the turbine intakes. Juvenile bull trout may rear in Dworshak Reservoir for 1 to 3 years (Erhardt and

Scarnecchia 2016) but their distribution and entrainment risk is unknown. Entrainment at Dworshak Dam is likely highly dependent on bull trout migration timing and levels and duration of high flows. Due to the similarity of Libby Dam and Dworshak physical structure, and similar bull trout population status for both areas, the Service is using estimated entrainment rates at Libby as a surrogate for Dworshak Dam. Therefore, conservative estimates indicate that up to 2,235 bull trout may be entrained annually through both turbine and spillway routes. As many as 246 may die as a result of injuries incurred during entrainment. Existing population numbers and trends in the North Fork Clearwater Core Area suggest that these numbers are not significantly impacting the recovery of the Core Area. As well, entrainment of these individuals may be providing supplemental individuals to populations downstream of the dam.

Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, and John Day
Entrainment of bull trout at mainstem Snake and Columbia River dams primarily occurs related to spill operations and intentional downstream migration of individuals through the spillway, turbines, juvenile passage facilities (bypass or transport barges) and navigation locks. Each route poses a different level of injury, behavioral impact, or mortality rate.

The Action Agencies have implemented turbine operations designed to increase juvenile fish survival. All powerhouse units are operated within a range that is intended to reduce injury and mortality. Some locations have made physical modifications and/or installed new turbines to further increase passage survival. At Bonneville Dam, the turbine runners in all 10 units at the first powerhouse were replaced in 2010 with a “minimum-gap” design which reduces both shear and impact injuries. At Ice Harbor Dam, the turbine runners are being replaced with new runners specifically designed to reduce injury and increase survival, and increase turbine efficiency. The runner in Unit 2 was replaced (2016−2019) and operational in the spring 2019. Unit 3 replacement is underway with a tentative scheduled completion in 2021 and Unit 1 replacement will follow (tentative completion in 2022). Preliminary biological studies of passage at the improved fish passage turbine Unit 1 have indicated high passage survival (greater than 98 percent) and low injury rates with no passage injuries associated with changes in pressure (Deng 2019). Although the proportion of juveniles salmon passing through turbines has decreased throughout the system with the installation of surface passage routes at all eight dams, these upgrades at Bonneville Dam and Ice Harbor Dam reduce the risk of injury or mortality for those remaining fish of various sizes that pass the dam through the turbines.

In early 2018, the Corps completed a major overhaul of the juvenile bypass system at Lower Granite Dam. The upgrades included replacing 10-inch gatewell orifices with larger 14-inch orifices, widening the collection channel, daylighting the transport channel, adding new primary dewatering structures, and constructing new primary and emergency bypass outfall structures. These upgrades are expected to increase juvenile fish survival by providing more efficient control of flow, improving the removal and passage of debris, increasing attraction flow for juvenile fish and reducing risk of predation at the outfall release point.

The suite of actions implemented after 2008 have reduced the proportion of fish passing through the powerhouse (i.e., turbines and bypass systems), and increased the proportion going through routes such as spillways and surface passage. The combined proportion of juvenile fish passing through non-turbine routes is known as fish passage efficiency (FPE). FPE has increased significantly since 2008 and is now on average above 90 percent for spring migrants and above

85 percent for summer migrants at all dams. FPE estimates are generally higher at lower Snake River dams than those in the Columbia River. With the installation of spillway weirs and other surface passage structures coupled with increased spill for juvenile fish passage, less salmon are passing through powerhouses and as a result, juvenile fish are passing less frequently through screened juvenile bypass systems. While passage proportions vary by location, in general, passage at bypass systems at all locations has decreased from pre-BiOp levels of at or below 41 percent to typically less than 25 percent.

Normandeau et al. (2014b) determined there was high downstream survival of adult salmonids passing through the various routes available. At McNary Dam, direct survival was estimated to be approximately 98 percent through the temporary spill weir. Conversely, direct survival through the McNary turbines was estimated to be approximately 91 percent. During periods of operation, juvenile bypass facilities may provide increased downstream passage survival of bull trout over turbine routes. However, bull trout are very substrate-oriented fish and may not be as easily directed to the juvenile surface passage routes as compared to salmon and steelhead. PIT-tag detections provide limited information on the rates of downstream movement of bull trout through the juvenile bypass systems in the Snake and Columbia rivers. A total of 16 PIT-tagged bull trout were detected in juvenile bypass systems at CRS dams by 2015 (Barrows et al 2016, p. 189). Barrows et al (2016 p. 189) documented downstream migration delays for 25 percent of PIT-tagged bull trout at juvenile bypass facilities, related to holding in raceways and separators. In many cases, the passage delays were several hours to several days, and as much as 16 days in one case. The delayed individuals were documented on the full flow bypass PIT antennas in May 2010, and early July in 2009 and 2011, at times when bull trout are expected to be migrating to tributaries to spawn. Adult bull trout delayed on separators not only experience delayed migration, but likely experience increased stress and non-lethal injuries related to holding at the facilities. Because there are few bull trout PIT-tagged in the Snake and Columbia rivers, it is difficult to estimate the total number of bull trout impacted by the juvenile bypass systems.

In addition, juvenile transport programs likely have the most significant impact on bull trout individuals of all downstream passage routes. The number of bull trout incidentally transported during these operations is unknown, but as there is no separation of species, all bull trout that are routed into transport barges will be transported. Bull trout transported are fluvial bull trout. They do not exhibit anadromy and are not adapted to saltwater. It is unknown what effect or survival rates could be expected for bull trout released downstream of Bonneville Dam and well outside known migrations patterns. The Service does not expect these bull trout can or will return to natal waters. Therefore, bull trout individuals transported are removed from the population and unable to contribute to recovery. Based on the few PIT-tag detections of bull trout at juvenile bypass facilities and within the holding/sampling raceways combined with the timing of potential transport (April through October), the Service estimates the total number of bull trout transported over time has been and could be significant into the future. Fish sampling is conducted prior to transportation, but given the low relative abundance of bull trout in the Snake and Columbia rivers in comparison to juvenile salmon, the likelihood of observing bull trout in the samples is very low (Barrows et al. 2016 p. 191). From 1983 to 2011, a total of 24 bull trout were observed in condition samples at the three Lower Snake River transport projects. Any bull trout that are entrained into the bypass system at Lower Granite and Little Goose [mid-

April thru October] and at Lower Monumental [mid-April thru September] and not removed on the separator or during condition sampling will be transported. Proposed spring and summer spill operations may reduce the potential exposure of bull trout to transport operations.

Bull trout individuals attempting to migrate downstream in the Columbia and Snake rivers have several methods to do so. From approximately April through August during the spill season, downstream migrants can pass over the spillways or through various removable spillway weirs, top spill weirs, enhanced ice and trash sluiceways, navigation locks, or through the turbines. In all cases, bull trout individuals may experience some level of non-lethal injuries and based on known survival rates for other salmonids, few will die as a result. However, from April through December 15, juvenile bypass systems are also available for downstream passage, where migration delays are documented. If this occurs during elevated temperatures or for lengthy periods of time (up to 16 days), migration delays can result in mortality, missed spawning, and reduced potential for population recovery. When juvenile transport occurs, the Service anticipates a significant loss of individuals from populations. From November or December through February or March, downstream passage is limited to the fish ladders or turbines. Bull trout move downstream throughout the mainstem Columbia and Snake Rivers during fall and winter months when fish ladders or turbines are the primary passage routes. Specific numbers of individuals impacted by each downstream passage route is difficult to quantify, given the relative presence of bull trout to other salmonids and lack of bull trout specific studies.

Over the duration of the Proposed Action, the Service anticipates a few individuals from the Touchet, Yakima, and John Day Core Areas may be affected by impacts of downstream entrainment as described above. However, the impacts are not expected to be measurable at the Core Area scale based on low levels of observations at the dams or within the Action Area. In addition, individuals from the Entiat, Methow, and/or Wenatchee Core Areas may experience impacts resulting from passage delays or injuries should they migrate downstream to McNary or John Day dams. However, these effects are expected to be indistinguishable over effects experienced at the non-federal mid-Columbia dams.

10.2.2.2.3 Coastal Recovery Unit

Entrainment at Bonneville and The Dalles dams is expected to be similar to descriptions provided for the Snake River, McNary and John Day except as related to transport. Most downstream passage occurs through the turbines, however, some passage occurs at the sluiceway or corner collector. At Bonneville Dam, direct survival tests using rainbow trout as a surrogate revealed that for fish passing downstream of the dam via the B1 sluiceway and the B2 corner collector, survival was greater than 98 percent (after 48 hours) (Keefer et al. 2016). Given the extremely low numbers of bull trout observed at these dams and the high rates of survival, impacts of entrainment are not expected to be measurable at the population or Core Area scale.

10.2.2.3 Habitat and Prey Impacts

As described in the status of the species, all life history stages of bull trout are associated with, and dependent on, complex forms of ecological (i.e., vegetative) and structural cover, including LW, undercut banks, boulders, deep pools, and riffles (Fraley and Shepard 1989, p. 137; Goetz 1989, p. 19; Rieman and McIntyre 1993, pp. 5-6). The natural stability of stream channels, maintenance of natural flow patterns or natural hydrograph, and development of riparian corridors and floodplain connectivity helps bull trout habitat remain complex and intact (Rieman and McIntyre 1993, pp. 5-6). Juvenile, subadult, and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable vegetative cover for protection and rearing (Sexauer and James 1997, p. 364). Bull trout evolved to capture prey species in complex habitats, not necessarily in open, non-complex areas (ambush versus open water). Therefore, bull trout are also likely to have more foraging opportunities in ecologically and structurally complex environments, because those environments support a more diverse range of forage or prey species.

In general, structurally complex river subhabitats include pools, riffles, and runs that support a variety of aquatic and semi-aquatic species. Carrying capacity, or the maximum number of individuals in a population that can be supported by available resources (e.g., food), is influenced by the relative diversity and complexity of the available habitat (Ricklefs 1990; Cain et al. 2014 as cited in Corps et al 2020a, p. 3-5). Populations that are near to, or exceed, carrying capacity can experience diminished individual growth, decreases in abundance as a result of competition, and reduced survival rates. Density-dependent factors, such as availability for food resources and disease, become more influential as populations reach, and sometimes exceed, a habitat's carrying capacity. Thus, even small populations can exceed their carrying capacity in the presence of degraded habitat, which is unfit to support large numbers of individuals. ISAB (2015 p. 57) determined that many of the tributaries where critical spawning occurs for salmon, but also bull trout, are at carrying capacity as a result of degraded habitat quality and lower productivity. For bull trout in all life history stages, connectivity between complex habitats is necessary to minimize the impacts of reaching carrying capacity in local areas and reduce population declines or extirpations of local populations (Kahler et al 2001, as cited in Taylor et al 2014 p. 1079).

CRS operations have largely altered the structure and function, and reduced the complexity, of rivers, tributaries, and streams apart from the few existing unimpounded reaches including: the Columbia River Estuary below Bonneville Dam; the Hanford Reach below Priest Rapids Dam; the Pend Oreille River below Albeni Falls Dam; the Kootenai River below Libby Dam; the Flathead River below Hungry Horse Dam; and the Clearwater River, a tributary of the Snake River (USFWS 2020, P. G-4). Operations influence sediment transport, vegetation growth, and erosion, which can lead to increased levels of bank armoring. Approximately 13 percent of river habitats in the Columbia River and 58 percent of river habitats in the Snake River upstream of Hells Canyon Dam remain relatively unaltered by hydropower operations (Dauble et al. 2003, p. 641; USFWS 2020, P. G-4). All riparian habitat in the Snake River within the Action Area is altered. Even where relatively unaltered river stretches remain, habitat is still impacted by altered flows.

Proposed Action operations are expected to continue to degrade and alter the natural hydrograph and flow regime of the Action Area. Altered flows and hydrograph restrict the development of riparian corridors essential for protective cover and providing allochthonous sources of forage for bull trout. Proposed operations for FRM and power generation are anticipated to further degrade riparian and forage conditions over baseline into the future. Changes from the pre-dam hydrograph have led to fluctuations in pool and river elevation, water velocity, and peak and base flows. Reservoir operations are closely aligned with hydrograph variation. The timing, frequency, and magnitude of peak and base flows across the Action Area have the effect of moderating the intensity of flow fluctuations, which in turn alters development of riparian corridors, shoreline complexity, floodplain connectivity, and tributary connectivity essential for bull trout growth and survival (Muhlfeld et al. 2012, p. 940, 943; Person 2013, entire; Taylor 2013, entire). In many cases, tributary connections have widened and substrate aggraded, creating broad, shallow areas devoid of cover for migrating bull trout, resulting in increased predation and/or migration delays. For example, the interface between the mainstem and the Walla Walla River is wide, shallow, no cover and migratory bull trout are seasonally exposed to predators as they are funneled through this altered/degraded pinch point. An examination of PIT detection histories suggests that predation of bull trout occurs in the lower Walla Walla River or in the Columbia River, likely as a result of poor habitat, exposing them to predation.

A pre-dam hydrograph would have had the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation and vegetative growth patterns. As a result of the Proposed Action, a highly modified hydrograph with altered peak and base flows will continue. The impacts resulting from an altered hydrograph in the Proposed Action are additive to the existing baseline conditions and the long-term impacts of climate change. This impairs a number of natural ecosystem processes, including sedimentation, recruitment and transport of LW, vegetation growth, and other key functions (USFWS 2012c p.175; Taylor 2013; Taylor et al. 2014, p. 1079; Nilsson and Berggren 2000). In addition, changes in timing, velocities, and magnitude of flows may alter cues for migration timing for bull trout and other aquatic species (Muhlfeld and Marotz 2005; Taylor 2013; Homel and Budy, 2008; Baxter et al. 2003). For example, spring freshets (e.g., as a habitat forming or restoring event), which help maintain ecosystem processes, are also key triggers for both upstream and downstream fish migration. Moderation of the pre-dam hydrograph has had the effect of limiting, or completely eliminating, this key ecosystem process and its function for bull trout critical habitat (PBF #7) in all CHUs within the Action Area.

Changes in pool elevations, including the impounding of water and elevation fluctuations, can lead to a variety of negative effects on bull trout habitat. These effects include: increased bank erosion and sedimentation (observed as increased turbidity); increased proportion of deep-water habitat; and inundation or drying of habitat used by bull trout and their prey (i.e., macroinvertebrates) (Taylor 2013). Habitat access and availability (especially off-channel habitat) and the percent coverage, and species composition of riparian vegetation (i.e., LW) could also decrease. Past consultations within the Action Area, indicate increased levels of bank armoring (riprap) where hydropower operations have influenced erosion, wave action, and limited vegetation growth.

The effects of hydrologic variation on adult bull trout are likely to be sublethal because adult bull trout are more tolerant of a wide range of environmental conditions and are more mobile than juvenile and subadult bull trout. Sudden changes in flow or relatively high changes in magnitude of discharge can depress movement and migration (Taylor et al. 2014, p. 1084). While bull trout can maintain position in fluctuating velocities and flows, they are unlikely to make forward movements during large changes in discharge (Taylor et al. 2014, p. 1084). Sub-adult bull trout are more likely susceptible to environmental conditions, less mobile, more prone to predation, and, thus, may experience a greater level of mortality or sublethal effects. Using estimates from Mid-Columbia dam assessments and anticipated use of bull trout in nearshore/riparian areas, the Service estimates that 10 percent of sub-adult and adult bull trout in a particular population may experience a significant disruption in their normal behavior as a result of hydraulic variations at each of the dams that alter riparian habitat and forage conditions, and 5 percent may die as a result due to increased risk of predation or reduced forage availability (USFWS 2012c).

The variability of hydraulic changes from dam operations also negatively impacts riparian habitat development, shoreline stability, and side channels, which have a compounding effect on bull trout cover, shelter, and foraging opportunities. Riparian areas are transition zones between aquatic and upland habitat along rivers, streams, and other watercourses, and are typically characterized by frequent disturbances from flooding, erosion, and deposition, which create a mosaic of plant community ages and seral stages (Bentrup 2008, p. 110; Brinson et al. 1981, p. 23; Gregory et al. 1991, p. 540; USFWS 2019b, p. 5). However, in much of the Action Area, riparian corridors are converted to armored levees as a result of wave action or fluctuating water levels.

Large segments of quality riparian conditions are rare in portions of the Action Area. For example, in the Snake River portion of the Action Area, nearly all riparian habitat is isolated to tributary mouths, and a few small areas upstream of Lower Granite Dam. As a result, the loss and continued degradation of remaining riparian habitat have a disproportionate impact on the diversity and abundance of semi-aquatic and terrestrial species that rely on functioning riparian conditions for portions of their life history and support bull trout growth and survival (Brinson et al. 1981, pp. iv, 87). Thus, habitat complexity and ecosystem function decrease when riparian habitat is lost or converted to more common upland forest, grassland, sagebrush subhabitats through the loss of river function (Fierke and Kauffman 2005, p. 160). Decreases in habitat complexity and function reduce the diversity and abundance of wildlife the region can support (Naiman et al. 1998, p. 289). The current hydrograph, altered by dam operations, and the lack of normal flood regimes have resulted in loss of native riparian vegetation, increased embeddedness, and reduced productivity, which can result in major declines in habitat diversity and complexity and forage or prey species that support bull trout (Hauer et al. 2016, p. 9; Muhlfeld et al. 2012, p. 943).

Bull trout are opportunistic feeders, but there is variation in their food habits depending on their size and life history strategy. Fish growth depends on the quantity and quality of their food and, as they grow, their foraging strategies change as their food changes in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout are primarily piscivorous and feed on various fish species (Fraley and Shepard 1989, pp. 135, 138). NMFS (2008; 2019) describe the long-term effects that operations of the CRS have had on salmon and steelhead populations and recovery potential. In both cases, NMFS concluded the operations of the dams resulted in mortality and injury of salmon and steelhead. Therefore, this impact to a main forage resource of bull trout is also factored into the long-term impact to forage and habitat from operations of CRS. 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 and habitat.

As a result of continual operations in the Proposed Action that alter the natural hydrograph, it is expected that riparian habitat will continue to degrade over the baseline. Based on rates of conversion of riparian areas to armored shorelines across the Action Area (see Consulted on Effects) and water level fluctuations that limit development of riparian vegetation (e.g. cottonwood/willow galleries), we expect up to 8 percent of existing riparian habitat will be lost over the 15-year duration of the project. This reduction is expected to have cascading effects on habitat complexity (i.e. cover, large woody debris, and off channel areas) and forage species.

Reservoir storage projects can have both negative and positive impacts on bull trout populations and their habitat. As described previously, fluctuations in hydrology and reservoir elevations can impact access to tributaries, floodplain connectivity, riparian and shoreline habitat development, and the forage base for bull trout. However, in some areas of the CRS, reservoirs (e.g. Dworshak, Lake Pend Oreille, Lake Koocanusa, Hungry Horse Reservoir, and to some extent Lake Roosevelt) have increased habitat availability for bull trout and provided greater opportunities for more diverse and larger, more nutritious forage species (e.g., kokanee). Bull trout in Dworshak Reservoir, Lake Pend Oreille, Lake Koocanusa, and Hungry Horse Reservoirs have thrived with expansion or creation of large water storage and available lake-like habitat. Populations in these reservoirs are considered bull trout strongholds (USFWS 2015b, c). Based on all expected effects described above as a result of the Proposed Action, the Service assumes that the comprehensive impacts of an altered hydrograph, reduced or degraded riparian habitat and diversity, changes in forage resources and availability, diminished habitat complexity, and direct impacts to bull trout individuals from flow fluctuations will occur in some capacity at all dams.

Conservatively, the Service estimates that up to 10 percent of bull trout individuals present in the Action Area will experience sublethal effects (e.g., altered behaviors, reduced health, growth and condition, reduced fecundity) from these impacts, and up to 5 percent may be killed over time as a result. Depending on where in the Action Area the effects of riparian habitat loss occurs, the number of individual bull trout impacted may vary. In most cases this will be a small number of individuals from multiple populations. Since it would be difficult to measure or quantify estimates of direct loss of bull trout individuals, the Service anticipates, as a habitat surrogate for impacts, that up to 8 percent of riparian habitat will be lost due to operations that limit growth of shoreline vegetation, input of allochthonous debris and nutrients, and changes in forage and cover availability. The Service considers the direct non-lethal and lethal impacts to bull trout individuals are encompassed within the riparian habitat losses.

10.2.2.3.1 Columbia Headwaters Recovery Unit

Albeni Falls

Within the Lake Pend Oreille Core Area, habitat availability, forage resources, and status and trend of populations varies between Lake Pend Oreille and the Pend Oreille River downstream of Albeni Falls Dam. Upstream of the dam, the comprehensive impacts of an altered hydrograph, reduced or degraded riparian habitat and diversity, changes in forage resources and availability, diminished habitat complexity, and direct impacts to bull trout individuals from flow fluctuations that result in predicted sublethal and lethal effects to bull trout individuals are likely not measurable at the population scale. Extensive available habitat and forage resources in Lake Pend Oreille limit the long-term effects.

Population estimates in Lake Pend Oreille range between 10,000 and 15,000. Under the assumption that up to 10 percent may be impacted by hydrologic impacts to riparian habitat, it could be assumed that up to 1,500 individuals may be within riparian habitat affected. This is likely a very conservative estimate. Few individuals would be within the riparian habitat impacted, given the large lake environment and bull trout behaviors would preferentially choose the deeper parts of the lake. However, in the Pend Oreille River portions, the current population is less than 150 individuals and there is not the same availability of deep, cold water refugia. The loss of just one individual reduces spawning success and may result in further depression or extirpation of the population, and hindered or reduced potential for recolonization of tributaries. With hydropower operations and subsequent bank stabilizing and armoring, and reduced vegetation survival, the Service anticipated further degraded riparian conditions as described above resulting in loss of up to 8 percent of existing functioning riparian and shoreline habitat across the Action Area. The expected number of individuals impacted within the 8 percent loss of habitat is small in relation to total population status and only significant when populations are too small to accommodate the loss of a few spawning individuals. The Proposed Action does not include habitat improvement projects that may reduce this impact. As a whole, the Service expects that impacts to habitat, forage, and the natural hydrograph will reduce recovery potential in the Lake Pend Oreille Core Area over the long term, especially downstream of Albeni Falls Dam.

Libby

Hydropower operations and the variable hydrograph at Libby Dam will result in similar impacts to bull trout from variable flows as predicted for Albeni Falls Dam. The impacts are anticipated to result in up to 5 percent mortality and 10 percent sublethal impacts to bull trout within the Koocanusa and Kootenai River Core Areas. In upstream areas of Lake Koocanusa, this impact is likely minor when considering the overall availability of habitat, forage resources, and status and trend of bull trout populations. However, in the Kootenai River portions, this level of impact likely results in hindered or reduced potential for recolonization of tributaries, unlikely spawning success, and further depressed populations. Because of implementation of VARQ, local flow coordination, sturgeon flow augmentation, and ramping rates, the anticipated effects are expected to be greatly minimized, especially in the Kootenai River. Therefore, estimates of up to 5 percent mortality and 10 percent sublethal impacts to bull trout are likely very conservative.

Burke et al. (2009) found that Libby Dam is responsible for the majority of first and second-order impacts that diminish cottonwood recruitment and riparian habitat. In addition, hydropower operations and subsequent bank stabilizing, armoring, and reduced vegetation survival are anticipated to further degrade riparian conditions as described above resulting in loss of up to 8 percent of existing functioning riparian and shoreline habitat. The expected number of individuals impacted within the 8 percent loss of habitat is small in relation to total population status and only significant when populations are too small to accommodate the loss of a few spawning individuals. The Proposed Action includes habitat restoration, cottonwood gallery/riparian habitat, and tributary delta projects that are expected to improve overall riparian conditions within the Kootenai River Core Area. Therefore, it is unlikely that over the life of the project, the full 8 percent of riparian impacts as described in the general habitat impacts section will be realized.

Combined, the Service anticipates that impacts to habitat, forage, and the natural hydrograph combined with proposed beneficial actions will not appreciably reduce recovery potential in the Koocanusa or Kootenai River Core Areas over the long term.

Hungry Horse Dam

Hydropower operations and the variable hydrograph are anticipated to result in up to 5 percent mortality and 10 percent sublethal impacts to bull trout within the Hungry Horse Reservoir and Flathead Core Areas. The impact is likely minor when considering the overall availability of habitat, forage resources, and status and trend of populations in both Core Areas.

In addition, hydropower operations and subsequent bank stabilizing, armoring, and reduced vegetation survival are anticipated to further degrade riparian and shoreline conditions as described above resulting in loss of up to 8 percent of existing functioning riparian and shoreline habitat. Power generating operations will continue to interfere with cottonwood gallery growth and shoreline vegetation. The expected number of individuals impacted within the 8 percent loss of habitat is small in relation to total population status and only significant when populations are too small to accommodate the loss of a few spawning individuals. While the Proposed Action does not include habitat improvement projects that could minimize the effects of lost habitat value, measures that reduce the summer reservoir drawdown in dry years, ramping rates and local coordination of flows are expected to minimize the impacts to riparian and shoreline habitat. In addition, much of the area is located on federal lands, reducing the potential for armoring and bank stabilization associated with fluctuating water elevations.

Combined, the Service anticipates that impacts to habitat, forage, and the natural hydrograph combined with proposed beneficial actions will not appreciably reduce recovery potential in the Hungry Horse Reservoir and Flathead Core Areas over the long term.

10.2.2.3.2 Mid-Columbia Recovery Unit

Across the entire MCRU impacts from hydropower operations, variable flow and diversion from the natural hydrograph are expected to have similar impacts regardless of facility, except for Dworshak Dam. Hydropower operations and the variable hydrograph are anticipated to result in up to 5 percent mortality and 10 percent sublethal impacts to bull trout within the Action Area of the mainstem Columbia and Snake Rivers. Given that bull trout within this Recovery Unit spend much of their lives in the tributaries, the anticipated impacts at the population scale are not expected to be measurable and impacts to individuals limited to the small percentage that use the Action Area. Impacts may be slightly more significant to existing depressed Core Areas adjacent to the Action Area (e.g. Umatilla, Walla Walla, and Asotin). However, for all facilities except Grand Coulee and Dworshak, operations are close to run-of-river and will not be measureable over existing conditions.

As described for Hungry Horse, impacts of variable flows and divergence from the natural hydrograph will result in up to 5 percent mortality and 10 percent sublethal impacts to bull trout within the Dworshak Reservoir and the Clearwater River. The impact is likely minor when considering the overall availability of habitat, forage resources, and status and trend of populations in Core Areas.

In addition, hydropower operations and subsequent bank stabilizing, armoring, levee maintenance and reduced vegetation survival are anticipated to further degrade riparian and shoreline conditions as described above resulting in loss of up to 8 percent of existing functioning riparian and shoreline habitat. Power operations will continue to interfere with cottonwood gallery growth and shoreline vegetation. The expected number of individuals impacted within the 8 percent loss of habitat is small in relation to total population status and only significant when populations are too small to accommodate the loss of a few spawning individuals. The Proposed Action includes previously consulted on tributary habitat actions that may alleviate some of this impact, if implemented in the mainstem or within inundated areas of tributaries. However, it is still expected that no further recruitment of riparian habitat will occur and some level of reduction will continue to occur.

Combined, the Service anticipates that impacts to habitat, forage, and the natural hydrograph will not appreciably reduce recovery potential in the Core Areas of the Clearwater River, Entiat, Methow, Yakima, John Day, Touchet, and/or Wenatchee Core Areas over the long term. Limited or reduced habitat availability and impacts from an altered hydrograph are expected to result in reductions of recovery potential of some populations in the Umatilla, Walla Walla, Tucannon, and Asotin Core Areas.

10.2.2.3.3 Coastal Recovery Unit

In the Lower Columbia River Basin, there has been an estimated loss of approximately 70 percent of historical floodplain subhabitat in the Columbia River Estuary due to conversion to agriculture and urban development protected by dikes (Marcoe and Pilson 2013, p. 1). Many of these dikes include tide gates that restrict exchange between the floodplain and river. Due to the low numbers of bull trout observed in this portion of the Basin, the anticipated effects of altered hydrology and declining riparian conditions are unlikely to impact bull trout individuals. Bull trout abundance may increase as a result of their colonization of the recently restored White Salmon River or reintroduction efforts in other Basins.

As with the other CRS projects, hydropower operations and subsequent bank stabilizing, armoring, levee maintenance and reduced vegetation survival are anticipated to further degrade riparian and shoreline conditions as described above resulting in loss of up to 8 percent of existing functioning riparian and shoreline habitat. Power operations will continue to interfere with cottonwood gallery growth and shoreline vegetation. The expected number of individuals impacted within the 8 percent loss of habitat is small in relation to total population status and only significant when populations are too small to accommodate the loss of a few spawning individuals. The Proposed Action includes previously consulted on tributary habitat actions that may alleviate some of this impact, if implemented in the mainstem or within inundated areas of tributaries. However, it is still expected that no further recruitment of riparian habitat will occur and some level of reduction will continue to occur.

Combined, the Service anticipates that impacts to habitat, forage, and the natural hydrograph combined will not appreciably reduce recovery potential of populations or Core Areas in the Lower Columbia River below John Day Dam.

10.2.2.4 Water Quantity

Across the Action Area, water quantity is largely driven by annual snowpack and runoff, particularly for summer months. Storage reservoirs can only hold approximately 40 percent of the average annual runoff. Current operations fill and draft various amounts of water from storage reservoirs. In all but the highest water years, the impact of large flow changes related to storage reservoir discharge are attenuated by operations of run-of-river and non-federal projects in the Lower Columbia River, Mid-Columbia River, and the Lower Snake River. The amount, timing and distribution of water throughout the Action Area can negatively impact migration and accentuate water quality impacts (Stanford and Ward 2001, p. 308; Nilsson and Berggren 2000, p. 783; Ward and Stanford 1983, pp. 29-30). For example, because of the hydropower system, temperature regimes are not consistent with natural seasonal regimes throughout the Basin. In the Upper Basin, the current operation of storage reservoirs, which contain varying amounts of water at different times during the year, result in fluctuations in water temperature. These fluctuations negatively affect aquatic species (e.g. freshwater mussels, white sturgeon) that rely on environmental cues such as temperature to complete critical life-history stages (Ward 2002, p. 58). Impacts to water quality parameters are discussed in more detail in the next section.

The implementation and operation of the CRS projects has altered the timing and amount of water in the Action Area (Figure 11). In areas where minimum flows are required for fish and wildlife resources (e.g., Pacific salmon, bull trout, sturgeon), the projects release water from storage reservoirs. In addition, as part of the operations, flows are managed to provide minimum operating levels of reservoirs to allow uninterrupted installation and operation of pumping stations for irrigation and municipal water supplies across the region. While the operations of specific water withdrawal projects are not included in the Proposed Action, the operations factor in the return flows of federal tributary irrigation projects in calculating water quantity and hydraulic modeling across the Action Area (Corps et al. 2020a, p 2-69).

Generally, operations for minimum flow for listed species and irrigation withdrawals are not anticipated to have impacts on bull trout that rise to the level of sublethal or lethal effects. In most cases, these operations are intended to benefit bull trout or their forage species, or occur when bull trout presence in the mainstem rivers is low (e.g. summer months) and the impact of changes to water quantity is likely not measureable to the individual.

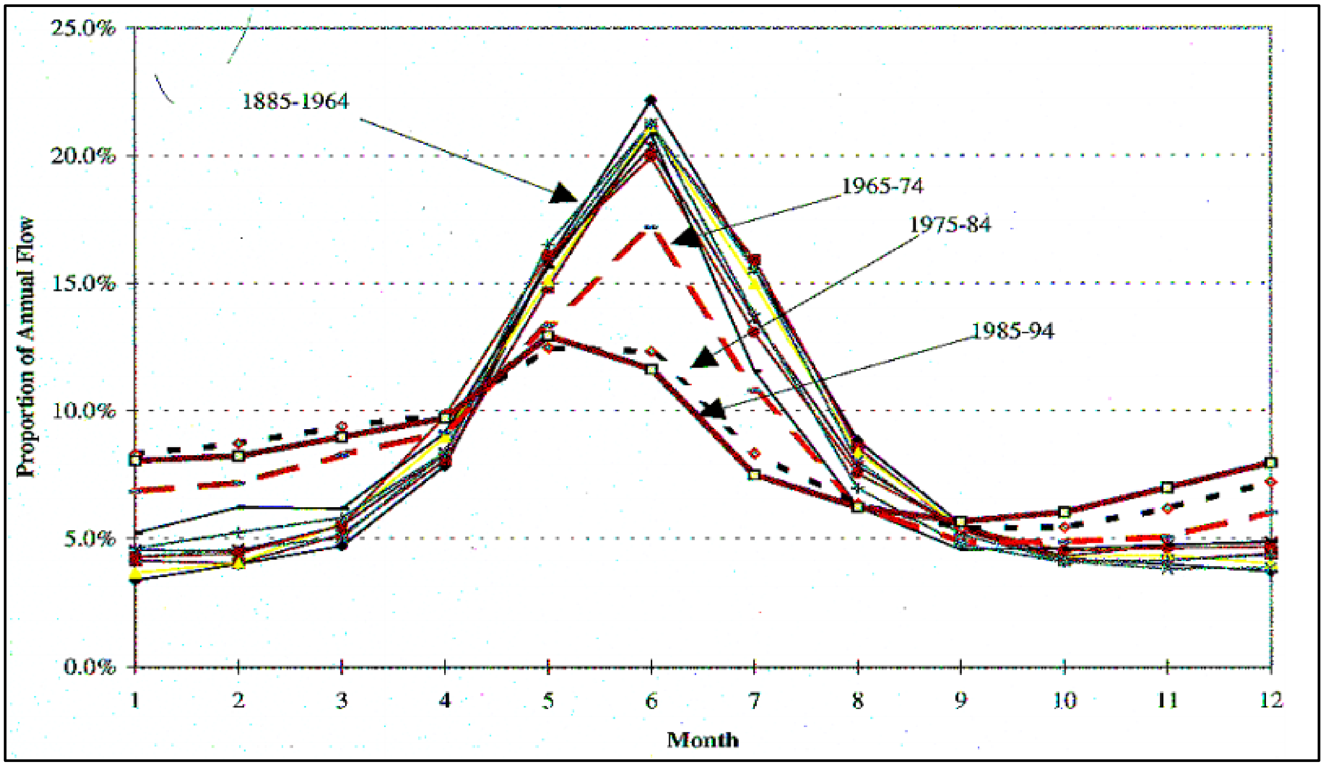

Figure 11. Historic magnitude of flows and peak flows at The Dalles Dam
(Source: Volkman 1997, p. 31)

10.2.2.4.1 Columbia Headwaters Recovery Unit

All three CRS dams in the CHRU are operated to reduce flood risk. These operations allow timing of high flows to be delayed for when water quantity downstream is low. These operations can provide some level of benefit to downstream areas during low water years, depending on the size of the annual snow pack and annual precipitation.

Albeni Falls

Albeni Falls is operated to meet maximum water elevations in Lake Pend Oreille for kokanee spawning by November 15. This operation allows kokanee spawning to occur without the risk of winter power operations to impact redds. Bull trout benefit from improved survival of kokanee, a primary forage species. In addition, water storage at Albeni Falls in November also contributes to flow augmentation for chum salmon in the Lower Columbia River.

There are no known operations for irrigation or water withdrawals at Albeni Falls Dam that may impact water quantity.

Minor non-lethal and beneficial impacts to bull trout are expected from changes in water quantity in the Lake Pend Oreille Core Area, related primarily to elevation changes. The impact is not expected to be measurable over impacts related to natural hydrograph and forage described above nor result in impacts measurable at the Core Area scale.

Libby

Libby Dam is operated to provide minimum flows for bull trout and sturgeon, and to provide flows for mainstem salmon based on reservoir elevation targets at critical times of the year. Between July and September each year, Libby Dam releases are managed to provide flows for the benefit of salmon and steelhead outmigration in the Lower Columbia River as well as maintain required minimum bull trout flows. From May 15 through the end of the sturgeon flow augmentation operation and from September 1 through September 30, the Corps manages a minimum flow for bull trout habitat inundation of 6,000 cfs (Corps et al 2020a p. 2-16). From the end of the sturgeon pulse through August 31, the minimum flow for bull trout is 6,000 cfs to 9,000 cfs, based on the final May WSF (Corps et al 2020a, p. 2-16). While these flows do not alleviate the passage barriers occurring at tributaries to the Kootenai River (described earlier), they do provide benefits that maintain water levels suitable for foraging and migrating throughout the Kootenai River itself.

There are no known operations for irrigation or water withdrawals at Libby Dam that may impact water quantity.

Minor non-lethal and beneficial impacts to bull trout are expected from changes in water quantity in the Lake Koocanusa and Kootenai River Core Areas, related primarily to elevation changes and proposed operations for minimum streamflows. The impact is not expected to be measurable over impacts related to an altered natural hydrograph or forage resources described above nor result in impacts measurable at the Core Area scale.

Hungry Horse

After refill, Hungry Horse Dam is operated to end-of-September draft objectives to provide increased summer flows for anadromous fish in the Columbia River, as determined by the Hungry Horse inflow WSF. In some below average water years, the project will continue to draft below the objectives to meet the minimum flow requirements intended to benefit bull trout. For bull trout, operations will maintain minimum flows all year using a sliding scale based on the forecast to meet minimum flows of 3,200 cfs to 3,500 cfs at Columbia Falls on the mainstem Flathead River and 400 cfs to 900 cfs in the South Fork Flathead River (Corps et al. 2020a p. 2-19).

There are no known operations for irrigation or water withdrawals at Hungry Horse Dam that may impact water quantity.

Minor non-lethal and beneficial impacts to bull trout are expected from changes in water quantity in the Hungry Horse Reservoir and Flathead River Core Areas, related primarily to elevation changes and proposed operations for minimum streamflows. The impact is not expected to be measurable over impacts related to an altered natural hydrograph or forage resources described above nor result in impacts measurable at the Core Area scale.

10.2.2.4.2 Mid-Columbia Recovery Unit

Grand Coulee, Chief Joseph, McNary, John Day

While water withdrawals or river depletions due to tributary irrigation projects are considered as part of the baseline, water quantity and contaminants effects from return flow from the CBP are considered as part of the Proposed Action. As described in the baseline section, the sum of the depletions from the Chief Joseph, Yakima, Umatilla projects, Deschutes Project, Crooked River Project, and The Dalles Project as compared to river flows at Bonneville Dam vary from 1 percent during winter and early spring, to 4 percent during May (Corps et al. 2020a, Appx C Table C-2). If the depletions from the CBP were added and compared to Bonneville flows, the highest percent of depletions would amount to 6 percent of flows in April, May, and July (Corps et al. 2020a, Appx C Table C-2 and C-3). Based on that comparison, effects from irrigation depletions and quantity of irrigation return flows are insignificant relative to total river flows and result in insignificant effects to bull trout individuals. Water quality impacts are discussed later in this Opinion.

Grand Coulee is operated to provide flow augmentation for salmon in the Lower Columbia River periodically through the year, especially during low flow years. Grand Coulee Dam may release water in the fall for spawning of chum below Bonneville Dam, and in the winter and spring for protection flows for both chum below Bonneville Dam and for fall Chinook in the Hanford Reach below Priest Rapids Dam (Vernita Bar) (Corps et al. 2020a p. 2-45). During dry water years, these releases may result in increased potential for stranding or shallowed tributary deltas as described previously. Given the low numbers of bull trout in Lake Roosevelt, it is unlikely that bull trout will experience the effects.

The Service does not expect impacts to water quantity resulting from the Proposed Action in the Columbia River will reach a measurable level for bull trout individuals or at the Core Area scale.

Dworshak

Dworshak Dam provides summer flow augmentation to improve water quality (moderating river temperatures) and increase water velocities in the Lower Snake River (Corps et al. 2020a p. 2-46). The summer temperature moderation and flow augmentation releases from Dworshak Dam are intended to maintain water temperatures at or below 68 °F at the Lower Granite Dam tailrace. However, it is unclear how the thermal changes from Dworshak Dam affect spawning migrations of bull trout in the Clearwater and Lochsa Rivers. Hanson et al. (2006) surmised that these cool water releases have the potential to disrupt natural cues for bull trout to migrate to spawning locations. Therefore, some level of disruption to migrating individuals may occur, but is unknown to what extent at this time.

There are no known operations for irrigation or water withdrawals at Dworshak Dam that may impact water quantity.

The Service does not expect impacts to water quantity in the Clearwater River will reach a measurable level for bull trout individuals or at the Core Area scale. Flow releases downstream will result in beneficial impacts to bull trout, populations and Core Areas downstream of the dam.

Lower Snake River Projects

Irrigation withdrawals in the Lower Snake River occur in the baseline condition as a result of agricultural, municipal, and industrial withdrawals. The Proposed Action operates minimum pool elevations so water levels are maintained in the Lower Snake River to keep irrigation diversions, and their associated fish screens, inundated. Irrigation operations in the Lower Snake are incidental to project operations and are not included in the Proposed Action. Effects of maintenance of minimum pool elevations on bull trout are considered in the section on habitat earlier.

As a result of the Proposed Action, the Service does not expect measurable impacts to bull trout individuals or their Core Areas from altered water quantity in the Snake River.

10.2.2.4.3 Coastal Recovery Unit

As described in the MCRU, water withdrawals or river depletions from tributary irrigation projects are part of the baseline, but water quantity and contaminants effects from return flow from the CBP are part of the Proposed Action. As described in the baseline section, the sum of the depletions from the Chief Joseph, Yakima, Umatilla projects, Deschutes Project, Crooked River Project, and The Dalles Project as compared to river flows at Bonneville Dam vary from 1 percent during winter and early spring, to 4 percent during May (Corps et al. 2020a, Appx C Table C-2). If the depletions from the CBP were added and compared to Bonneville flows, the highest percent of depletions would amount to 6 percent of flows in April, May, and July (Corps et al. 2020a, Appx C Table C-2 and C-3). Based on that comparison, effects from irrigation depletions and quantity of irrigation return flows are insignificant relative to total river flows and result in insignificant effects to bull trout individuals. Water quality impacts are discussed later in this Opinion.

As a result of the Proposed Action, the Service does not expect measurable impacts to bull trout individuals or their Core Areas from altered water quantity in the Lower Columbia River.

10.2.2.5 Water Quality

The requirements for cold, clean water and complex and interconnected habitat for bull trout is well documented. The impacts from the Proposed Action to habitat elements for complex and connected were discussed previously. Habitat elements for cold and clean water are discussed within this section. Water quality parameters were included or incorporated into the PCEs or PBFs for bull trout critical habitat due to the importance for persistence and health of populations. Impacts to water quality can occur from several elements of the Proposed Action including flow operations, irrigation water storage and returns, maintenance activities, and through the existence of the dams themselves (i.e. greases and oils used). Each of these activities or project elements can result in adverse changes to river temperatures, TDG levels, sediment disturbance or turbidity, nutrient transport, or contaminant content, and are discussed separately in the following sections.

10.2.2.5.1 Temperature

As described in the status of species, cold water is required in spawning habitats, but cold water is also necessary for other life stages. Although bull trout are found primarily in cold streams, bull trout are also 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, connectivity and proximity of cold water patches (refugia) and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002, pp. 6 and 13). Selong et al. (2001 p. 1026) determined that the upper thermal limit for significant periods of time was 20.9 °C. At temperatures of 22 °C and above, feeding ceased (Selong et al. 2001, p. 1026). Short durations of exposure to temperatures above 22 °C were tolerated, but full mortality occurred at 28 °C. Taylor et al. (2014 p. 1084) and Howell et al. (2010) determined that elevated temperature was a significant factor in movement predictions and swimming abilities were reduced at temperatures above and below optimal levels (Selong et al. 2001 p.1026; Jones and Moffitt 2004 p. 10).

In addition, other studies on temperature impacts to bull trout determined that sensitivity to disease and pathogens increased under temperature stress (Jones et al. 2007 p. 695). McMahon et al. (2006 p. 1320-1322) found bull trout growth slowed in warm temperatures and brook trout growth improved. In all studies, bull trout were found to have an optimal thermal range of 8 °C to 18 °C, with the ability to tolerate levels up to 22 °C for short durations when cold water refugia was accessible.

Water velocity is often slowed behind (i.e., upstream of) dams, typically increasing water temperatures which can facilitate habitat conditions that may favor competitors and predators of native fishes including the bull trout. In shallow reservoirs (e.g. upstream of Lower Snake River dams), where stratification of water temperatures does not occur or is very limited, the impact of elevated temperatures can be enhanced. Water temperature modelling in the Snake River indicate that short durations of very high temperatures would be observed if the dams were removed depending on air temperatures, but would decline quickly (Corps et al. 2020b). However, the same model showed that in the impounded system, temperatures remained higher for longer periods (Corps et al. 2020b).

These effects to temperature from current and future flow management will be additive to those described as a result of global climate change over the duration of the action.

10.2.2.5.2 Columbia Headwaters Recovery Unit

Albeni Falls

The decline of Bull Trout in the Pend Oreille River and its tributaries, compared to historical levels, can be attributed to a variety of factors, primarily migration barriers and competition from introduced species, but also including mainstem flows and temperatures (Andonaegui 2003; Pickett 2004). Bull Trout are believed to have used the Pend Oreille River for an adfluvial life stage, migrating into Lake Pend Oreille or into cooler tributaries to avoid high summer water temperatures. Andonaegui (2003) states: "Only holding pools in tributary streams, pockets of cooler water in the vicinity of tributary mouths, and areas of groundwater influence along the shoreline of the mainstem Pend Oreille River could sustain migratory adult bull trout." The report also notes: "The extent to which limited, available, cold-water rearing habitat in the Pend Oreille River system between Albeni Falls Dam and Boundary Dam is a result of natural conditions or exacerbated by human induced alterations to the environment, is unknown."

The harmful effects of large reservoirs created by dams consist of reduced velocities and can result in higher water temperatures. Temperatures in the Pend Oreille River can range from 0 °C to 25 °C (Bennett and DuPont 1993 p. 1; Paluch et al. 2020 *in Draft*; Andonaegui 2003). An independent water temperature study conducted on behalf of Pend Oreille PUD indicated that current summer water temperatures are similar to those prior to construction of Box Canyon Dam downstream of Albeni Falls Dam (Framatone 2002). However, prior to construction of Albeni Falls Dam and Box Canyon Dam, connectivity between cold water refugia in tributaries and in Lake Pend Oreille reduced any impact to bull trout from elevated summer temperatures. Changes in the hydrograph (discussed earlier), as expressed in peak flows and low flows, caused large-scale vegetation change (e.g., decreased cottonwood recruitment in the Project Area) that further increased water temperatures and the duration of elevated temperatures. Removing the connection to the floodplain reduced the capacity of the riparian zone to store water and contribute to base flow later in the season. Degraded reaches of the river provide little if any productive fish habitat due to their lack of complexity and a functional riparian zone.

Mejia et al. (2020) determined that small cold water refugia areas are present in the Pend Oreille River downstream of Albeni Falls Dam. In most cases, these areas of refugia are located near tributary deltas or in areas of seeps and springs and may provide short-term refuge for bull trout in the summer months. Increased risks of predation and direct mortality are anticipated from elevated temperatures downstream of Albeni Falls Dam. As temperatures increase, bull trout swimming performance and endurance decreases (Selong et al. 2001 p.1026; Jones and Moffitt 2004 p. 10). Temperature data for the last 25 years in the Pend Oreille River indicated that elevated temperatures occur for portions of July, August and September. Lethal and sublethal (reduced swimming performance, feeding, and altered behavior) impacts are expected for all bull trout downstream of Albeni Falls Dam when temperatures are above 18 °C. Over time, the effects of elevated temperatures in the Pend Oreille River are expected to limit recovery at the Core Area scale, especially prior to construction of fish passage. The impact to bull trout and the Core Area by elevated temperatures in the river will be minimized when passage is provided at Albeni Falls Dam by 2030, and bull trout individuals are able to migrate out of the Pend Oreille River and avoid elevated temperature.

Libby/Hungry Horse

The operations at Libby and Hungry Horse dams alter river temperatures in the Kootenai and Flathead rivers. However, selective water withdrawals at these projects allow specific water temperatures to be released downstream of the dam. For example, in summer when water temperatures are normally high, selective withdrawals provide lower water temperatures downstream, which can occur at Libby Dam. At Hungry Horse, in summer when water temperatures are normally higher in the unregulated tributary streams, selective withdrawals provides warmer water temperatures to better match local natural stream temperatures. Without selective withdrawal, colder water would be released from deeper in the reservoir. In winter months, selective withdrawals can regulate temperatures that are optimal for bull trout and other resident species. As a result, operations are expected to provide benefits to bull trout with regard to temperature parameters of water quality.

10.2.2.5.3 Mid-Columbia Recovery Unit

Dworshak

Dworshak Dam is operated to provide cold water downstream during summer months when river temperatures are elevated. As a result, operations are expected to provide benefits to bull trout individuals that do not migrate into tributary headwaters before water temperatures in the mainstem Clearwater and Snake rivers elevate above 18 °C. It is expected that over the long term, temperature effects (both beneficial and adverse) as a result of the Proposed Action will not be measurable over existing conditions in Core Areas of the Clearwater Basin.

Grand Coulee, Chief Joseph, McNary, John Day and Lower Snake River Dams

Operations at the mainstem Columbia and Snake Rivers are expected to continue influencing water temperatures in the rivers through flow operations that limit vegetation growth as well as through creation of reservoirs that warm surface waters. Reservoirs act as heat reservoirs with higher temperatures occurring earlier and longer as a result of operations (Corps et al. 2020a p. 3-541) than would occur without the CRS dams. Some CRS operations can sometimes mitigate harmful baseline temperature conditions; for example, cold water releases from Dworshak Dam occur from about early July through mid-September and can help to increase flow and reduce high temperatures of water entering the Snake River above Lower Granite Dam. These benefits may be experienced in Little Goose Reservoir as well. However, as water moves further downstream through the Snake River, no measurable difference in water temperature are expected below Little Goose Dam.

Annual impacts of elevated seasonal temperature are expected to reduce survival, feeding abilities and persistence of bull trout unable to find cold water refugia during the months of July, August and September. Lethal and sublethal (reduced swimming performance, feeding, and altered behavior) impacts are expected for all bull trout downstream of the dams when temperatures are above 18 °C. In addition, temporary or partial passage barriers may form at tributary mouths as a result of temperature gradients reducing access by bull trout individuals to tributaries and coldwater refugia. The combined impact of the Proposed Action with anticipated warming related to climate change are expected to further degrade (elevate) water temperatures in the Snake and Columbia rivers and access to suitable habitat for bull trout. The Service anticipates the long-term effects will be most impactful to migratory bull trout and existing populations and Core Areas that are already depressed across the Basin. Therefore, reduced recovery potential and declining population trends are expected in the Asotin, Tucannon, Walla Walla, Umatilla, Entiat, and John Day Core Areas.

10.2.2.5.4 Coastal Recovery Unit

Operations on the mainstem river are expected to continue influencing water temperatures in the rivers through flow operations that limit vegetation growth as well as through creation of reservoirs that warm surface waters. Reservoirs act as heat reservoirs with higher temperatures occurring earlier and longer as a result of operations (Corps et al. 2020a p. 3-541) than would occur without the CRS dams. Annual impacts of elevated seasonal temperature are expected to reduce survival, feeding abilities and persistence of bull trout unable to find cold water refugia during the months of July, August and September. Lethal and sublethal (reduced swimming performance, feeding, and altered behavior) impacts are expected for all bull trout downstream of the dams when temperatures are above 18 °C. In addition, temporary or partial passage barriers may form at tributary mouths as a result of temperature gradients reducing access by bull trout individuals to tributaries and coldwater refugia. The combined impact of the Proposed Action with anticipated warming related to climate change are expected to further degrade (elevate) water temperatures in the Snake and Columbia rivers and access to suitable habitat for bull trout. The Service anticipates the long-term effects will be most impactful to migratory bull trout and existing populations and Core Areas already depressed across the Basin. Therefore, reduce recovery potential and declining population trends could be expected in the Hood River, White Salmon, and Lewis Core Areas. However, since few bull trout are observed in this portion of the Columbia River, the Service anticipates this impact will not be measurable over existing conditions and trends.

10.2.2.6 TDG Supersaturation

TDG is the summation of the partial pressures of individual gases in solution. The gas content in water bodies is a function of the partitioning of gases between the atmosphere and hydrosphere. The atmosphere is composed primarily of nitrogen (78 percent) and oxygen (21 percent). These two elements, with minor contributions of carbon dioxide, comprise the components of TDG measured in water. When gases in the atmosphere and water are in equilibrium, TDG pressure is 100 percent. EPA's national TDG water quality standard is 110 percent which was developed to protect aquatic species. The entrainment of gases in water from the plunging of highly aerated spill water can trap air in water, forming bubbles, facilitating the dissolution of gases into water. The solubility of gases is a function of temperature, atmospheric pressure, and hydrostatic pressure. The solubility of gases increases with water depth due to greater hydrostatic pressure, thus the deeper the plunge of water, the greater dissolution of gases. The portion of gases not dissolved beneath the water will rise to the surface.

Degasification occurs in the aeration zone, where gases are removed from the water column. The expanse of the aeration zone can vary depending on bathymetry of the river, temperature, wind speed, barometric pressure, climate, water plunge depth, and dam structure. In the area below the aeration zone, gases can remain in the water column due to hydrostatic pressure, resulting in persistently high TDG concentrations. As the pressure of water increases, the capacity of the water to hold dissolved gases also increases (Weitkamp and Katz 1980). Therefore, the level of supersaturation decreases with depth at a rate of approximately 10 percent per 1 m of depth (Weitkamp et al. 2003a), this is typically referred to as depth compensation. For example, a TDG saturation level of 130 percent at the surface will be 110 percent at a depth of 2 m. Conversely, the capacity of water to hold dissolved gas is inversely related to temperature. Increasing water temperature will produce supersaturation in water that was initially saturated (Weitkamp and Katz 1980).

The primary risk to bull trout from elevated TDG levels is gas bubble trauma (GBT). GBT refers to the development of gases in a fish's bloodstream. This can occur when water is supersaturated with gases. Common signs of GBT include bubbles or blisters under the skin, especially between the fin rays, but also in the head, lining of the mouth, and gills (Weitkamp and Katz 1980; Marotz et al. 2007; Weitkamp et al. 2003a, b). Adverse effects to fish with GBT include sudden loss of ability to swim against a current, inability to avoid obstacles, increased predation, loss of equilibrium, loss of direction, or violent movement and then periods of inactivity (Dawley and Ebel 1975; Weitkamp and Katz 1980). In addition, behavioral responses to elevated TDG may be exhibited such as area avoidance and sounding (heading for deeper water) (Weitkamp et al. 2003a). In laboratory experiments without depth compensation, long-term exposure to low levels of increased supersaturated waters (115 percent) results in decreased feeding, reduced growth, and mortality. Mortality from GBT generally occurs from anoxia resulting from slowing or stoppage of blood flow. Sublethal effects such as blindness, stress, fungal infection, and decreased lateral line sensitivity can lead to death (Weitkamp and Katz 1980). Table 11 provides a summary of effects to salmonids from exposure to supersaturation conditions (Weitkamp and Katz 1980).

Table 11. Effects of various supersaturation levels on different species

Species	Supersaturation Level (Percent)	Effect	Depth (m)
Cutthroat trout	131-139	100% mortality, 3.8 days	0.6
	125-131	100% mortality, 6 days	
		50% mortality, 2.2 days	
	110-127	50% mortality, 14 days	
	116-122	No mortality, 12 days	
	102-128	No mortality, 12 days 25% signs of GBT	
	131-139	50% mortality, 17 days	3.0
		55% mortality, 24 days	
Mountain whitefish	131-139	100% mortality, 1.5 days	N/A
	116-127	50% mortality, 12 days	
	113-122	40% mortality, 17 days	
	107-12	1 mortality, 17 days, 75% signs of gas bubble disease	
Steelhead subadults	120	100% mortality, 2 days	0.25
	115	57% mortality, 7 days	
	110	<5% mortality, 7 days	
	127	25% mortality, 7 days	2.5
	120	5% mortality, 7 days	
	115	<5% mortality, 7 days	

(Source: Weitkamp and Katz 1980)

Ryan et al. (2000) reported that 3.9 percent of all resident non-salmonid fish sampled in the lower Snake and Mid-Columbia rivers, Washington, showed signs of GBT. More recently, Weitkamp et al. (2003a, b) and Marotz et al. (2007) studied the effects of supersaturation on fish behavior and the incidence of GBT on bull and other resident freshwater fish during elevated TDG periods in the Lower Clark Fork River, Idaho, and Kootenai River, Montana. During spill periods in 1999, TDG levels ranged between 120 percent and 130 percent of saturation continuously for nearly two months in May and June in the Clark Fork River (Weitkamp et al. 2003a, b). Only 5.9 percent of all fish sampled (2,709) showed any signs of GBT. Eight bull trout captured by electrofishing (sampling efficient to only 6 ft to 7 ft of depth) during this period showed no signs of GBT; the highest incidence of GBT was observed in large scale suckers (14.3 percent) and yellow bullhead (11.4 percent) in 1999 (Weitkamp et al. 2003a,b). During the 2000 spill season, TDG commonly spiked from 115 percent to 130 percent of saturation for a few hours on a daily basis; three bull trout captured in this period showed no signs of GBT. Very few (0.1 percent) of the fish sampled during the 2000 spill season showed any signs of GBT (Weitkamp et al. 2003b). Biological monitoring within the CRS shows that the incidence of GBT in both migrating smolts and adult salmon remains between 1 percent to 2 percent when TDG concentrations in the upper water column do not exceed 125 percent of saturation (Antcliffe et al. 2002; Backman et al. 2002; NMFS 2019). When those levels are exceeded, however, there is a corresponding increase in the incidence of signs of GBT symptoms. McGrath et al. (2006) determined that new research supports previous research indicating that short-term exposure to up to 120 percent TDG does not produce significant effects on juvenile (or adult) salmonids when compensating water depths are available (Beeman and Maule 2006; NMFS 2019).

The compensation rate or percent reduction in TDG at depth is about 10 percent of saturation per 1 m of depth (Maynard 2008). For example, a fish swimming at a depth of 2 m when surface water TDG levels are 120 percent would experience a saturation level of 100 percent, while a fish at the surface would experience 120 percent TDG. Vertical movement of aquatic life within the water column is therefore an important consideration when evaluating risks related to TDG. The figure below by Weitkamp et al. (2003a) depicts the concept of hydrostatic depth compensation (Figure 12). Bull trout are present in the Action Area year-round in most locations, with fewer in the vicinities of Grand Coulee, Bonneville and The Dalles dams.

Although the presence of bull trout in the mainstem of the Columbia and Snake rivers are observed throughout the year, the number of bull trout exposed to elevated TDG is likely low. The Proposed Action for voluntary spill up to 125 percent TDG in the Columbia and Snake rivers would increase the exposure of migrating and foraging bull trout during operations in spring and summer. In addition, involuntary seasonal spill occurring across all projects during spring runoff may result in as much as 135 percent TDG for short durations (e.g., upper Basin projects). The Action Agencies propose monitoring to determine impacts to species of elevated TDG during spill operations. Studies of acoustic-tagged individuals in the mainstem Columbia River indicate bull trout use deep, slow water habitat. This suggest that bull trout will ‘depth compensate’ to elevated TDG levels at the surface. Migratory and foraging bull trout within the river during spill operations will typically be at depth, where the potential for exposure to elevated TDG in lower. The Service anticipates that across the Action Area, bull trout individuals may be exposed to variable ranges of TDG and long term compounding effects of multiple years of exposure.

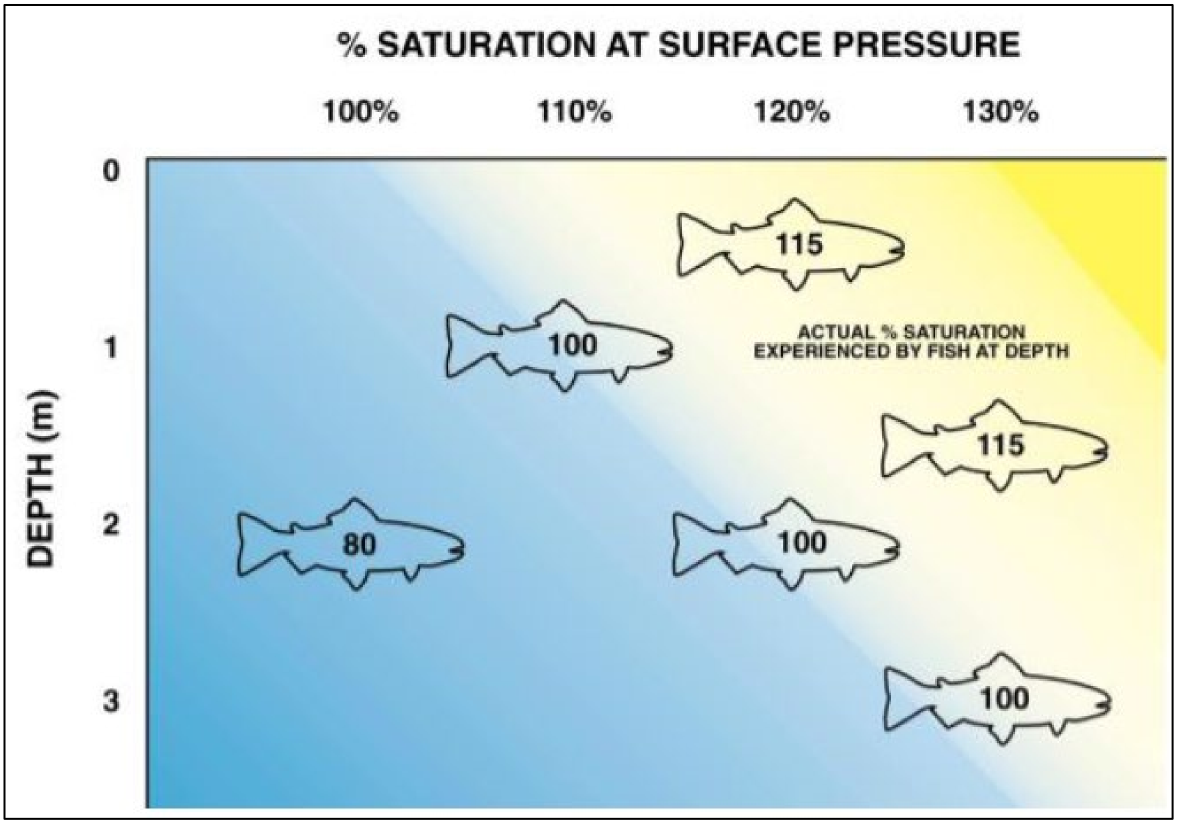

Figure 12. Hydrostatic depth compensation of gas supersaturation
(Source: Weitkamp et al. 2003a)

10.2.2.6.1 Columbia Headwaters Recovery Unit

Involuntary spill operations at Libby, Hungry Horse and Albeni Falls significantly elevate TDG downstream. In all cases, high levels of supersaturation are observed at the next dam downstream when spill is occurring at these projects. Marotz et al. (2007) studied the effects of elevated TDG levels during a spill event from Libby dam from June 8 to June 27 in 2006. TDG has exceeded Montana's gas saturation standard of 110 percent for as many as 20 consecutive days. After four days, symptoms of GBT were observed in trout and increased in frequency as spill continued (Marotz et al. 2007). Following 11 days of spill, all bull trout and westslope cutthroat trout suffered from GBT (Marotz et al. 2007). The direct mortality to bull trout is unknown due to a lack of studies on GBT in bull trout; however impacts are likely similar to other salmonids. Due to the known impact spill operations have in the water column downstream, flow is managed to reduce the amount and duration of spill at Libby, Hungry Horse and Albeni Falls. To the extent possible, the dams are operated to release water through the turbines or store water for later release.

Annually, the Corps expects spill resulting in TDG levels above 110 percent for as many as 35 days each year at Libby Dam. However, spill resulting in TDG levels to impact bull trout (> 120 percent) are expected to occur fewer than 2 days in any year (Corps et al. 2020b Appendix D). Since 2010, the Corps has voluntarily spilled, during spill tests for sturgeon flows, three times, which are not expected to occur in the future (Corps et al. 2020a p. 2-16). The frequency of spill resulting in levels of above 110 percent TDG at Hungry Horse Dam is expected to be less. The Action Agencies anticipate fewer than 10 days per year where TDG levels will be above 110 percent. The Service expects fewer than 2 of these days will exceed 120 percent TDG. Spill occurs at Albeni Falls Dam annually between the months of April and June when flows are greater than powerhouse capacity and less than 60 kcfs. Levels of TDG to impact bull trout (> 120 percent) are expected to occur as much as 50 percent of the time.

Operations of VARQ at Libby and Hungry Horse dams significantly reduce the potential for spill impacts. In the extremely rare occurrence of spill operations that elevates TDG to above 120 percent where bull trout may be less able to depth compensate, the Service anticipates few to no bull trout will experience impacts. At Albeni Falls Dam, spill occurs much more frequently and for longer durations. As a result, the Service expects bull trout present in the Pend Oreille River downstream during spring spill to experience some level of behavioral (avoidance) and/or sublethal effects (disorientation). However, since bull trout can avoid the area, no direct mortality is anticipated.

Effects from elevated TDG are not expected to reach measurable levels in the Flathead Lake, Kootenai River, and Lake Pend Oreille Core Areas.

10.2.2.6.2 Mid-Columbia Recovery Unit

The Proposed Action includes increasing spill to improve juvenile salmon outmigration survival in addition to high spring flow spill operations (Corps et al. 2020a p. 3-11). Spill occurs at Dworshak Dam in April, July and August and can result in TDG levels above 110 percent (Corps et al. 2020b Appx D). Fewer days will result in elevated TDG levels above 120 percent where depth compensation is less effective. The direct impact to bull trout is unknown due to lack of studies on GBT in bull trout; however impacts are likely similar to other salmonids. Proposed monitoring of resident and anadromous fish for GBT is expected to indicate potential impacts to bull trout. Coordination at regional forums to reduce spill operations when impacts are observed will further reduce potential to bull trout individuals. Bull trout present in downstream rivers during spill operations are expected to experience minor behavioral (avoidance) or sublethal effects (disorientation). However, since bull trout can avoid the area in tributaries or go to depth, no direct mortality is anticipated.

Effects from elevated TDG are not expected to reach measurable levels at the Core Area scale in the Clearwater, Entiat, Methow, Yakima, Wenatchee, Asotin, Touchet/Walla Walla, Umatilla, and/or John Day drainages.

10.2.2.6.3 Coastal Recovery Unit

The Proposed Action includes increasing spill to improve juvenile salmon outmigration survival in addition to high spring flow spill operations (Corps et al. 2020a p. 3-11). The direct impact to bull trout is unknown due lack of studies on GBT in bull trout; however impacts are likely similar to other salmonids. Proposed monitoring of resident and anadromous fish for GBT is expected to indicate potential impacts to bull trout. Coordination at regional forums to reduce spill operations when impacts are observed will further reduce potential to bull trout individuals. Bull trout present in downstream rivers during spill operations are expected to experience minor behavioral (avoidance) or sublethal effects (disorientation). However, since bull trout can avoid the area in tributaries or go to depth, no direct mortality is anticipated.

Effects from elevated TDG are not expected to reach measurable levels in the Hood River, White Salmon, Deschutes, and Lewis Core Areas.

10.2.2.7 Nutrients

Operation and maintenance of CRS has resulted in changes to the distribution of aquatic nutrients, sediment transport, and food availability across the Action Area. In most cases, the reservoirs operate as a nutrient sink, decreasing the productivity and overall carrying capacity in the river downstream by holding back allochthonous inputs and sediment. With a decline in salmonid production and the subsequent decline in spawners within natal streams, the availability of nutrients has also decreased over the last century and a half (Corps et al. 2020a p. 3-34). Gresh et al (2000) estimated that, since 1882, the transport of marine-derived nitrogen and phosphorus loads has declined to only about 6 percent to 7 percent of historical levels. Nutrients in streams are important for salmonid production (Bisson and Bilby 1998;Naiman et al. 2000). Due to the link between the hydrograph, riparian conditions and nutrient presence/transport, the impact on bull trout individuals is a subset of impacts described earlier in habitat and forage effects. The Service estimates that up to 10 percent of bull trout individuals present in the Action Area will experience sublethal effects (e.g. altered behaviors, reduced health, growth and condition, reduced fecundity) from these impacts, and up to 5 percent may be killed over time as a result. In addition, as a habitat surrogate for impacts, the Service anticipates that up to 8 percent of riparian habitat will be lost due to operations that limit growth of shoreline vegetation.

10.2.2.7.1 Columbia Headwaters Recovery Unit

Albeni Falls, Libby, and Hungry Horse

Studies have shown that Lake Koocanusa acts as a nutrient sink, retaining approximately 63 percent of total phosphorus and 25 percent of total nitrogen entering the system (Woods and Falter 1982). Consequently, the Idaho portion of the Kootenai River has been considered nutrient-poor (ultra-oligotrophic) and phosphorus-limited. In addition, loss of floodplain connectivity to the entire Kootenai River valley has reduced riparian function and natural nutrient inputs. In the Idaho portion of the Kootenai River, the diminished nutrients have reduced primary productivity over the past two decades (Ross et al. 2015; 2018). It is expected that similar impacts are present in relation to Albeni Falls and Hungry Horse dams. The existence of nearby downstream dams on the Flathead and Pend Oreille rivers may mitigate the effects downstream as they store nutrients within those reservoirs.

Another result of the low-nutrient (primarily phosphorus) conditions below the dam has been increased success of the nuisance algae *Didymosphenia geminata* (Didymo) in the Kootenai River below Libby Dam in Montana in the early 2000s. Didymo forms dense mats on the river bottom and may negatively affect bull trout abundance because of reduced abundance of desirable large invertebrate prey (e.g., *Ephemeroptera, Plecoptera, and Trichoptera*) (Sylvester and Stephens 2011). Altered nutrient transport across the upper Basin has likely altered all levels of the food web. The result of these changes has caused significant negative impacts to the food web, including periphyton, aquatic insects, and fish populations (Hoyle et al. 2014; Minshall et al. 2014). Continued operations that withhold nutrients will continue to alter downstream food web communities. Impacts of lost nutrients to bull trout individuals are expected to be similar to those described under the natural hydrograph discussion.

As described earlier, within the Lake Pend Oreille, Flathead Lake and Kootenai River Core Areas, habitat availability, forage resources, nutrient availability, and primary productivity are reduced as a result of the long-term and continued future operations of the dams. This level of impact in combination with impacts from the altered hydrograph likely results in mortality of a few adult bull trout, reduced spawning success, further depressed or extirpated populations, and reduced fitness of individuals. Restoration and nutrient projects are proposed for the Kootenai River may reduce this impact associated with Libby Dam. The Proposed Action does not include habitat improvement or nutrient projects at Albeni Falls Dam or Hungry Horse Dam. As a whole, the Service expects that continued impacts to nutrient transport in combination with impacts related to the natural hydrograph and habitat will reduce recovery potential in the Lake Pend Oreille, Kootenai and Flathead Lake Core Areas over the long-term.

10.2.2.7.2 Mid-Columbia Recovery Unit

In the mainstem Columbia and Snake Rivers, the greatest impact to nutrient transport and distribution has occurred as a result of lost marine derived nutrients from anadromous salmon carcasses. Construction and historic operations of the CRS dams, either reduced salmon and steelhead populations significantly, or completely blocked populations upstream of Chief Joseph and Dworshak dams (NMFS 2008; 2019). NMFS (2008; 2019) describe the long-term effects that operations of the CRS have had on salmon and steelhead populations and recovery potential. In both cases, NMFS concluded the operations of the dams resulted in mortality and injury of salmon and steelhead. Therefore, this impact to a main forage resource of bull trout is also factored into the long-term impact to forage, nutrients and habitat from operations of CRS. Continued operations are expected to have similar impacts over the next 15 years. Impacts of lost nutrients (both marine derived and allochthonous) to bull trout individuals are expected to be similar to those described under the natural hydrograph discussion. Combined, the Service anticipates that impacts to nutrient transport, habitat, forage, and the natural hydrograph combined will not appreciably reduce recovery potential in the Core Areas of the Clearwater River, Entiat, Methow, Yakima, John Day, Touchet, and/or Wenatchee Core Areas over the long term due to low exposure risk for bull trout individuals. However, where bull trout exposure risk is higher, limited or reduced habitat availability and impacts from an altered hydrograph are expected to result in reduce recovery potential of existing depressed populations in the Umatilla, Walla Walla, Tucannon, and Asotin Core Areas.

10.2.2.7.3 Coastal Recovery Unit

In the mainstem Columbia and Snake Rivers, the greatest impact to nutrient transport and distribution has occurred as a result of lost marine derived nutrients from salmon carcasses. Construction and historic operations of the CRS dams reduced salmon and steelhead populations significantly (NMFS 2008; 2019). NMFS (2008; 2019) describe the long-term effects that operations of the CRS have had on salmon and steelhead populations and recovery potential. In both cases, NMFS concluded the operations of the dams resulted in mortality and injury of salmon and steelhead. Therefore, this impact to a main forage resource of bull trout is also factored into the long-term impact to forage, nutrients and habitat from operations of CRS. Continued operations are expected to have similar impacts over the next 15 years. Impacts of lost nutrients both marine derived and allochthonous) to bull trout individuals are expected to be similar to those described under the natural hydrograph discussion. Combined, the Service anticipates that impacts to habitat, forage, and the natural hydrograph combined will not appreciably reduce recovery potential of populations or Core Areas using the Lower Columbia River below John Day Dam.

10.2.2.8 Contaminants or Altered Water Chemistry

While dam operations result in few water chemistry impacts, impacts can occur indirectly from the maintenance of the structures (e.g. oils, greases and hydraulic fluids), construction activities (associated with maintenance and operation of the system), and from return flows associated with irrigation withdrawals and diversions. The degree of impact of each of these sources is in direct proportion to existing water quality conditions, measures implemented to reduce potential exposure, and the timing of discharge.

Across the Action Area, there are 303(d) listings for water quality contaminant and chemical parameters including pH, pesticides and herbicides, PCBs, and petrochemicals. Chemical exposure to bull trout can alter fecundity, increase susceptibility to disease, reduce their overall health, and shift biotic communities. Elevated levels of contaminants in waterways can adversely affect aquatic species and bull trout through direct lethal or sublethal toxicity, through effects to their food supply, or through interactions with other compounds present in the water. Agricultural or urban practices associated with irrigation also have the potential to adversely affect aquatic environments. Water withdrawals and irrigation runoff contain residual constituents of pesticides, herbicides and fertilizers can contribute excessive nutrients, elevated levels of chemicals, and substantial amounts of sediment to natural waterways further degrading the water quality and quantity within the river systems throughout the broader region.

Construction projects and the use of oils, greases, and other lubricating fluids related to operations and maintenance of the dams have the potential to discharge chemical contaminants into the waterways. Construction projects can expose waterways to altered pH from uncured concrete. It is expected that all projects involving new concrete will be isolated from the waterways and therefore exposure by bull trout to this activity is unlikely. Similarly, bull trout are not expected to be exposed to oils, greases, and other lubricating fluids used in dam structures. The Action Agencies proposes to continue a program of best management practices to avoid accidental releases of oil and grease, and to minimize any adverse effects from equipment in contact with the water. The Action Agencies will also implement oil accountability plans with enhanced inspection protocols and prepare annual oil accountability reports. The adoption of these practices should minimize potential exposure by bull trout. Any impacts, given dilution, are likely to be very small, if not negligible. All construction projects will be expected to have a Spill Response Plan in place reducing the potential for accidental discharge of chemicals to the rivers.

Ongoing and future irrigation and municipal use associated with the Proposed Action are likely to continue at baseline levels. We do not have information on how much irrigation outflow returns to the rivers as an indirect effect of the individual pump intakes permitted by the Action Agencies, or the chemicals in the outflow. We assume they will be the same as occur under existing conditions.

10.2.2.8.1 Columbia Headwaters Recovery Unit

Because of the rationale above, exposure to chemical contaminants related to dam maintenance are expected to be unlikely. There are no known impacts to water quality from irrigation returns related to the Proposed Action in the CHRU.

10.2.2.8.2 Mid-Columbia Recovery Unit

Reclamation operates the CBP. The CBP is a large irrigation project, and the effects to bull trout from the project are addressed in more detail as follows. The CBP encompasses about 3,900 mi^2 in central Washington within portions of Grant, Lincoln, Adams, Franklin, and Walla Walla counties (Reclamation 2011b p.1). The CBP lands stretch from Franklin D. Roosevelt Reservoir behind Grand Coulee Dam in the north, from which it receives Columbia River water, southward across the Columbia Plateau to Pasco, Washington, at the confluence of the Columbia and Snake Rivers. The water in the CBP canal system runs through over 300 miles of main canals, 2,000 miles of laterals, and 3,500 miles of drains and wasteways. Multiple return flows enter the Columbia River at locations starting west of Quincy, Washington, and extending downstream to Pasco. The primary source of water for the CBP comes from Lake Roosevelt through John Keys III Pumping Plant; in addition approximately 22,000 ac-ft are pumped for CBP irrigation use from the Columbia and Snake Rivers near Pasco, Washington. There are many small drainages, both intermittent and perennial, in the CBP area that also augment the water from Lake Roosevelt.

The original incoming water sources generally have good water quality, but quality tends to degrade with use and reuse as it moves through the CBP conveyance system (Reclamation 2011b). Many compounds and microorganisms are readily adsorbed to soil particles including (but not limited to) pesticides, heavy metals, phosphorous, organic nitrogen, and bacteria. Excess irrigation water runs off the fields as tailwater, which invariably carries soil particles and contaminants into drains and wasteways as part of the erosion process. Localized sections of the CBP have moderate to severe alkaline soils that contribute to salinity and altered pH in some return flows (Reclamation 2011b).

Pesticides and herbicides are found in agricultural and residential runoff, usually during periods of extended wet weather or after intense precipitation events when overland flow is most likely (Reclamation 2011b p.7-8). The use of pesticides, herbicides, and fertilizers has declined as farming techniques have improved and Best Management Practices have been implemented. In the 1980s, with the crossover from flood irrigation to sprinkler irrigation, water conservation brought about a decline of contaminates leaving agricultural fields in runoff. Excess nutrients from agricultural activities stimulate aquatic growth in the canal system. Due to the nature of the conveyance system and the entry points of wastes and contaminants from point and nonpoint sources, the aquatic growth would be unmanageable without the use of chemicals to control them and maintain flow in the system.

Return flows from the CBP enter the Columbia River over a 92-mile-long stretch (Reclamation 2011b p.17). Sand Hollow Wasteway drains into the Wanapum Pool; Red Rock /Crab Creek Wasteway drains into the tailrace of Wanapum Dam; Priest Rapids Wasteway drains into the Priest Rapids Pool; and the remaining six wasteways drain into a 70-plus-mile-long reach of the free-flowing Columbia River below Priest Rapids Dam. Since there are no major tributaries (inflows) that enter the river in this stretch and both Wanapum and Priest Rapids are run-of-river projects, the flows at Priest Rapids are considered to be representative of the Columbia River for the entire reach. At their maximum, the total flows of the CBP return flows contribute less than 1 percent of the total Columbia River flows at Priest Rapids Dam (Reclamation 2011b p.10). The maximum occurs from September to October when the return flows are at their peak and the Columbia River flows are at their lowest.

In compliance with the NMFS' 2000 FCRPS Opinion, Reclamation collected water quality samples from 9 wasteways (Reclamation 2011b): the Esquatzel Wasteway, Pasco Wasteway, PE16.4 Wasteway, WB 5 Wasteway, WB10 Wasteway, Mattawa Drain, Priest Rapids Wasteway, Red Rock Wasteway, and Sand Hollow Wasteway from March 2002 through October 2007. These nine return flow channels represent 98 percent of the CBP annual return flows to the Columbia River. Reclamation determined that only two wasteways, the Sand Hollow Wasteway and the Red Rock Wasteway, are accessible to fall Chinook or steelhead, and focused their discussion on those wasteways, however bull trout are not known to use, nor are they expected to use, those wasteways.

Reclamation monitors water sampling sites five times a year (Reclamation 2011b p.14-16) for water temperature, DO, pH, turbidity/total suspended solids and aquatic chemicals used to control aquatic weed growth in the CBP conveyance system. These chemicals include acrolein, xylene, and copper (Reclamation 2011b p. 50-53). Reclamation reviewed the water quality parameters, and focused their discussion on the Sand Hollow and Red Rock wasteways. Acrolein and xylene were detected at concentrations lower than the National Pollutant Discharge Elimination System or NPDES Permit limitations. Monitoring results suggest that acrolein application in the CBP return flows have minimal impacts, and the concentrations of xylene detected were well below the negative impact level for salmonids (Reclamation 2011b p.82).

Concentrations of copper sulfate were found to be primarily under the standard mortality threshold for salmonid species; however, the fish-bearing wasteways experienced spikes in concentrations in late summer and early fall. The spikes could cause detectable mortality on salmonids in the wasteways if they occur with more frequency and duration. Reclamation concluded both Sand Hollow and Red Rock wasteways provide marginal conditions for fall Chinook salmon, and may not meet minimal requirements to support steelhead (Reclamation 2011b p.80-82).

There has been a reduction in sediment concentrations in the return flows, most likely due to the conversion of irrigation delivery systems from flood to sprinkler, resulting in less soil erosion from the agricultural lands (Reclamation 2011b p. 48). There were occasional spikes in total suspended solids (TSS) concentrations in the non-fish-bearing return flows, but the magnitude, duration and seasonality of the TSS and turbidity events indicated sediment and turbidity do not affect water quality (Reclamation 2011b p.49) in the wasteways, and would be even less when diluted in the Columbia River.

Air temperature, size of flows in the wasteways, ground water and ponding all affect water temperatures in the wasteways. Temperatures rise warm in the system, and temperatures in the summer in the wasteways at times exceeds 24 °C (Reclamation 2011b p.70). However, since the return flows are less than 1 percent of the Columbia River flows, the temperature effects on the river are expected to be immeasurable and insignificant.

Dissolved oxygen is necessary to maintain aerobic conditions in surface waters, and is considered a primary indicator when assessing the suitability of surface waters to support aquatic life. The oxygen content of natural waters varies with temperature, turbulence, photosynthetic activity, and atmospheric pressure (Deas and Orlob 1999 as referenced in Reclamation 2011b p.71). While DO levels measured in the wasteways are lower than preferred for salmonid spawning or rearing, because the return flows are a small percentage of the Columbia River, the effects to the river are expected to be immeasurable and insignificant.

While there are parameters within the wasteways unfavorable for aquatic life (Reclamation 2011b p.82), monitoring results show the return flows make up a very small percentage (1 percent) of the total flow in the Columbia River, and the constituent loads from the wasteways would be diluted in the river to the point that they would be undetectable by themselves. Bull trout are not expected to use the wasteways. While bull trout use the Columbia River and could be near the wasteway outlets, they are unlikely to be adversely affected from the water quality parameters because: a) the wasteway water is less than 1 percent of the total flow, and would quickly be diluted in river water; b) bull trout in the river are adult or subadult and are larger than incubating or rearing steelhead or fall chinook, and therefore less likely to be affected by the exposure; and c) bull trout can move away from the area. Therefore, effects to water quality from contaminants derived from the Proposed Action are not likely measurable over background conditions related to CBP return flows and are unlikely to result in reduction of recovery potential for Core Areas in the MCRU.

10.2.2.8.3 Coastal Recovery Unit

Because of the rationale above, exposure to chemical contaminants from maintenance and construction projects are expected to be unlikely. Furthermore, the rarity of bull trout in the Lower Columbia River also reduces any potential exposure. Water quality from irrigation returns related to the Proposed Action are expected to be even further diluted at the CRU, and continue at baseline conditions.

10.2.2.9 Elevated Turbidity and Sedimentation

Proposed maintenance and construction related to the ongoing operations of the CRS are expected to alter sedimentation and turbidity when they occur. Although few studies have specifically examined the issue as it relates to bull trout, increases in suspended sediment affect salmonids including bull trout in several recognizable ways. The variety of effects of suspended sediment may be characterized as lethal, sublethal, or behavioral (Bash et al. 2001, p. 10; Newcombe and MacDonald 1991, pp. 72-73; Waters 1995, pp. 81-82). Lethal effects include gill trauma (physical damage to the respiratory structures) (Curry and MacNeill 2004, p. 140). Sublethal effects include physiological stress reducing the ability of fish to perform vital functions (Cederholm and Reid 1987, pp. 388, 390), severely reduced respiratory function and performance (Waters 1995, p. 84), increased metabolic oxygen demand (Servizi and Martens 1991, p. 497), susceptibility to disease and other stressors (Bash et al. 2001, p. 6), and reduced feeding efficiency (Newcombe and MacDonald 1991, p. 73). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash et al. 2001, p. 7). Fish may be forced to abandon preferred habitats and refugia, and may enter less favorable conditions and/or be exposed to additional hazards (including predators) when seeking to avoid elevated concentrations of suspended sediment.

In many instances the likelihood of exposure to elevated sedimentation and turbidity across all CRS projects is low, given the timing, work area isolation, or low potential for sediment disruption.

10.2.2.9.1 Columbia Headwaters Recovery Unit

The Proposed Action identifies several annual maintenance and construction projects that may occur over the duration of the action. It is also expected that unscheduled or emergency projects similar to the actions described may occur over the next 15 years. Table 12 summarizes the anticipated projects, limits of impacts, and timing analyzed in this consultation based on identified projects in the BA and historical projects the Service has consulted on over the last 15 years. Anything outside of these parameters will be coordinated with FPOM or require added coordination or consultation with the Service. Any proposed fish handling will follow procedures identified in the annual Fish Passage Plan.

For projects described in the Table 12, it is expected that work areas will be isolated from flowing water, be located within the dam structure, and/or result in elevated turbidity levels above background conditions no more than 500 ft downstream of project activities, and not extending across the whole river. Each project will include site specific monitoring plans and reporting requirements that will be provided to the Service.

It is expected that bull trout within the vicinity of sediment disturbing activities will experience behavioral and sublethal impacts from avoidance, displacement, gill irritation, or short term reduced feeding rates. In rare cases, lethal effects from gill trauma or direct mortality/predation may occur. Within the area of potential impacts (500 ft), the Service expects few bull trout are likely present during any one activity. Projects typically occur within shallower river margins and/or within the dam structure itself, where habitat is less suitable for bull trout. Given that, and existing population structures, it is expected that fewer than ten to fifteen bull trout will experience effects of increased sedimentation or turbidity and fewer than two will experience effects leading to death. In small populations (i.e. downstream of Albeni Falls Dam or Kootenai River Core Area), the impact may be more significant, reducing the spawning success or health of the population.

Table 12. Anticipated maintenance projects, limits of impacts, and timing analyzed in this consultation for Libby, Hungry Horse and Albeni Falls Dams.

Dam	Activity	Actions	Timing	Duration	Frequency
Libby	Routine Maintenance	Power plant – Turbine inspection and maintenance. Within structure, no fish handling, minimum flows maintained.	Jan 1-April 15, July 15 to November 15	Up to 30 days per event	Each unit (5) once per year
		Power plant – Extended turbine inspection and maintenance. Within structure, fish handling possible if draft tubes fully unwatered and fish observed, minimum flows maintained.	Jan 1-April 15, July 15 to November 15	Up to 3 days per event (typically 2 days/event)	Up to 2 per year (typically 1 unit/year)
	Non-Routine Maintenance	Power plant – Turbine unit overhaul. Within structure, fish handling possible if draft tubes fully unwatered and fish observed, minimum flows maintained.	July 1 to April 30	6-9 months	5 times in 10 years
	Unscheduled Maintenance	Various projects. Within structure of dam, fish handling possible, minimum flows maintained.	Any	Up to 6 weeks	Up to 1 project per year
		Various projects. External to structure of dam, fish handling possible, minimum flows maintained.	Any	Up to 6 weeks	Up to 1 project per year

Dam	Activity	Actions	Timing	Duration	Frequency
Hungry Horse	Routine Maintenance	Power plant maintenance. Within structure, no fish handling, minimum flows maintained, Maintain temperature control.	July-April (periodically May-June)	up to 6 weeks	Annually
		Selective withdrawal structure maintenance. Exterior of structure, no fish handling, minimum flows maintained.	November to May	2-3 weeks	1 time per 3 years
	Non-routine Maintenance	Various projects. Within structure, no fish handling, minimum flows maintained, maintain temperature control.	Any	Up to 12 months	4 times in 10 years
		Various projects. Within or external to structure, fish handling possible, minimum flows maintained, maintain temperature control.	Any	up to 6 weeks	Up to 1 per year
Albeni Falls	Routine Maintenance	Power plant – Turbine inspection and maintenance. Within structure, no fish handling, minimum flows maintained.	Fall Drawdown/ Spring Spill	Up to 3 weeks	Each unit (3) once per year
		Power plant – Extended turbine inspection and maintenance. Within structure, fish handling possible if fish observed in draft tubes.	Fall Drawdown/ Spring Spill	up to 4 weeks	Up to 3 times every 6 years (each unit once every 6yrs)
	Non-routine *or* Unscheduled Maintenance	Various projects. Within structure of dam, fish handling possible, adhere to WCM for elevations and flow changes	Any	up to 6 weeks	1 project per year
		Various projects. External to structure of dam, fish handling possible, adhere to WCM for elevations and flow changes.	Any	up to 6 weeks	1 project per year

(Source: Corps et al. 2020a, pp. 2-73-76; Tackley pers. comm)

In addition, the Proposed Action includes mainstem restoration projects for sturgeon and tributary delta restoration projects for bull trout that will involve substrate disturbance and create elevated turbidity. The impacts from these restoration projects on bull trout or their critical habitat are not evaluated in this consultation as there is not enough information on location, timing, and extent of impacts to complete an analysis of effects.

The anticipated impacts described above will result in sublethal impacts to individual bull trout each year, and a few may die. These relatively low numbers of individuals impacted will likely not measurably impact the recovery of Core Areas in combination with other non-project and non-federal actions occurring in the Action Area.

10.2.2.9.2 Mid-Columbia Recovery Unit

The Proposed Action identifies several annual maintenance and construction projects that may occur over the expected duration of the action (Table 13). It is also expected that unscheduled or emergency projects similar to the actions described may occur over the next 15 years. The following table summarizes the anticipated projects, limits of impacts, and timing analyzed in this consultation based on identified projects in the BA and historical projects the Service has consulted on over the last 15 years. Anything outside of these parameters will be coordinated with FPOM or require added coordination or consultation with the Service. Any proposed fish handling will follow procedures identified in the annual Fish Passage Plan.

For projects described in Table 13, it is expected that work areas will be isolated from flowing water, be located within the dam structure, and/or result in elevated turbidity levels above background conditions no more than 500 ft downstream of project activities, and not extending across the whole river. Each project will include site specific monitoring plans and reporting requirements that will be provided to the Service.

It is expected that bull trout within the vicinity of sediment disturbing activities will experience behavioral and sublethal impacts from avoidance, displacement, gill irritation, or short term reduced feeding rates. In rare cases, lethal effects from gill trauma or direct mortality/predation may occur. Within the area of potential impacts (500 ft), the Service expects few bull trout are likely present during any one activity. Projects typically occur within shallower river margins and/or within the dam structure itself, where habitat is less suitable for bull trout. Given that, and existing population structures, it is expected that fewer than fifty bull trout will experience effects of increased sedimentation or turbidity and fewer than two will experience effects leading to death. In small or very depressed populations (i.e. Asotin, Walla Walla, Umatilla), the impact may be more significant, reducing the spawning success or health of the population.

The anticipated impacts described above will result in sublethal impacts to individual bull trout each year, and a few may die. These relatively low numbers of individuals impacted will likely not measurably impact the recovery of Core Areas in combination with other non-project and non-federal actions occurring in the Action Area.

Table 13. Anticipated maintenance projects, limits of impacts, and timing analyzed in this consultation for Lower Columbia and Snake River Dams.

Dam	Activity	Actions	Timing	Duration	Frequency
Grand Coulee (including John Keys III PP and Banks Lake)	Routine Maintenance	Power plant maintenance. Within structure, no fish handling, minimum flows maintained	July-April (periodically May-June)	up to 6 weeks	Annually
		Drumgate maintenance. Within structure, no fish handling.	Mar-May	Up to 8 weeks	Annually
		John Keys Pumping Plant maintenance. Within structure, dewatered, no fish handling.	October - March	Varies	Annually
		Banks Lake maintenance. External to structure, up to 35-foot drawdown, no fish handling.	October – March	Varies	Infrequent, approx. 20-year interval
	Non-routine Maintenance	Pumping Plant Modernization. Within structure, dewatered, no fish handling.	October - March	up to 12 weeks	Annually
		Power plant - Third Power Plant overhaul (modernize turbine units G-19 through G-21). Within structure, dewatered, no fish handling.	Any	12 months per unit	One unit out of service at a time over ten year period (2020-2030)
		Power plant – Repair and restore/overhaul Left and Right (turbine units 1-18). Within structure, dewatered, no fish handling.	Any	12 months per unit	One unit out of service at a time over ten year period (2019-2029)
Chief Joseph	Routine Maintenance	Power plant – Turbine inspection and maintenance. Within structure, fish handling possible if fish observed in draft tubes	Any	up to 4 weeks per unit	Each unit (27 units) once per year
		Power plant – Extended turbine inspection and maintenance. Within structure, fish handling possible if draft tubes fully unwatered and fish observed	Any	up to 12 weeks per unit	Each unit (27) once every five years
	Non-routine *or* Unscheduled Maintenance	Various projects. Within structure, fish handling possible	Any	up to 6 weeks	1 project per year
		Various projects. External to structure, fish handling possible.	Any	up to 6 weeks	1 project per year

Dam	Activity	Actions	Timing	Duration	Frequency
Dworshak	Routine Maintenance	Power plant – Turbine inspection and maintenance. Within structure, fish handling possible if unit fully dewatered and fish observed in draft tube.	September 15 through February	up to 6 weeks per unit (typically 2-4 weeks)	Each unit (3) once per year
		Power plant – Turbine unit cavitation repair. Within structure, fish handling possible.	September 15 through February	up to 6 weeks (typically 4-6 weeks)	1 unit per year
	Non-routine *or* Unscheduled Maintenance	Various projects. Within structure, fish handling possible; FRM, flow and temperature targets maintained.	Any	up to 6 weeks	1 project per year
		Various projects. External to structure, fish handling possible; FRM, flow and temperature targets maintained.	Any	up to 6 weeks	1 project per year
Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day	Routine Maintenance	Power plant – Turbine inspection and maintenance. Within structure, fish handling possible if unit fully dewatered (not typical) and fish observed in draft tube.	July-November (typically)	up to 4 weeks per unit (typically 2-4 weeks)	Each unit once per year, at each dam
		Power plant – Turbine unit cavitation repair and other extended maintenance, fish handling possible if draft tubes fully dewatered and fish observed.	Any (July-November is typical for shorter projects)	up to 9 months per unit	Each unit once every 6 years
		Navigation locks maintenance. Within structure, fish handling during dewatering.	March (typically)	up to 4 weeks	1 project per year, per dam
		Adult fish ladder inspection and winter maintenance. Within structure, fish handling during dewatering.	December through February (JDA, MCN, IHR, LMN); January through February (LGS, LWG)	JDA, MCN, IHR, LMN: up to 3 months per ladder but no more than 3 months total; LGS, LWG: up to 2 months	Annual winter maintenance of each fishway; One ladder operating at all times except LGS and LWG
		Juvenile fish bypass and holding facilities inspection and winter maintenance. Within structure, fish handling during dewatering.	December through February or March	Up to 12 weeks, each passage facility	Annual winter maintenance of each facility

Dam	Activity	Actions	Timing	Duration	Frequency
Lower Granite, Little Goose, Lower Monumental, Ice Harbor, McNary, John Day (continued)	Non-routine Maintenance	Power plant – Install Improved Fish Passage (IFP) turbine units at Ice Harbor, McNary and John Day dams. Within structure, fish handling during dewatering.	Any	7-14 months per unit	Approximate schedule: Ice Harbor: 2020 - 2022 (2 units) McNary: 2024 - 2033 (14 units) John Day: 2029-2040 (14 units; options for additional 2 units).
		Repair Little Goose Dam jetty and retaining wall. External to structure, elevated sediment disturbance up to 1000 ft, fish handling unlikely	December through February	In development	2 projects in total
	Unscheduled Maintenance	Power plant – Unanticipated issues with turbines, pumps, transmission systems. Fish handling possible if a turbine is dewatered fully and fish are observed in draft tubes.	Any, but generally December through February	up to 12 weeks	up to 1 event per year per dam
		Various projects – Spillway, navigation lock, fish passage facilities. Within structure, fish handling possible if fish-bearing structures dewatered.	Any, but generally December through February	up to 12 weeks	up to 3 projects per year, per dam
		Various projects. External to structure but within 1000 ft of dam/navigation structures, work area isolation, fish handling possible.	Any, but generally December through February	up to 12 weeks	up to 4 projects per dam per year

(Source: Corps et al. 2020a, pp. 2-76-84, Appx A; Tackley pers. comm. 2020)

10.2.2.9.3 Coastal Recovery Unit

The Proposed Action identifies several annual maintenance and construction projects that may occur over the expected duration of the action. It is also expected that unscheduled or emergency projects similar to the actions described may occur over the next 15 years. Table 14 summarizes the anticipated projects, limits of impacts, and timing analyzed in this consultation based on identified projects in the BA and historical projects the Service has consulted on over the last 15 years. Anything outside of these parameters will be coordinated with FPOM or require added coordination or consultation with the Service. Any proposed fish handling will follow procedures identified in the annual Fish Passage Plan.

For projects described in Table 14, it is expected that work areas will be isolated from flowing water, be located within the dam structure, and/or result in elevated turbidity levels above background conditions no more than 500 ft downstream of project activities. Each project will include site specific monitoring plans and reporting requirements that will be provided to the Service.

It is expected bull trout within the vicinity of sediment disturbing activities will experience behavioral and sublethal impacts from avoidance, displacement, gill irritation, or short term reduced feeding rates. In rare cases, lethal effects from gill trauma or direct mortality/predation may occur. Within the area of potential impacts (500 ft), the Service expects few bull trout are likely present during any one activity. Projects typically occur within shallower river margins and/or within the dam structure itself, where habitat is less suitable for bull trout. Given the very small area impacted in comparison to available habitat and the rare observations of bull trout in the Lower Columbia River, it is conservatively expected fewer than ten bull trout will experience effects of increased sedimentation or turbidity and, on average, no more than one will experience effects leading to death.

The anticipated impacts described above will result in sublethal impacts to individual bull trout each year, and a few may die. These relatively low numbers of individuals impacted likely will not measurably impact the recovery of Core Areas in combination with other non-project and non-federal actions occurring in the Action Area.

Table 14. Anticipated maintenance projects, limits of impacts, and timing analyzed in this Opinion for The Dalles and Bonneville dams.

Dam	Activity	Actions	Timing	Duration	Frequency
The Dalles and Bonneville	Routine Maintenance	Power plant – Turbine inspection and maintenance. Within structure, fish handling possible if unit fully dewatered (not typical) and fish observed in draft tube.	July-November (typically)	up to 4 weeks per unit (typically 2-4 weeks)	Each unit once per year, at each dam
		Power plant – Turbine unit overhaul or extended maintenance, fish handling possible if draft tubes fully dewatered and fish observed.	Any (July-November is typical for shorter projects)	up to 9 months per unit	Each unit once every 6 years
		Navigation locks maintenance. Within structure, fish handling during dewatering.	March (typically)	up to 2 weeks	1 project per year, per dam
		Adult fish ladder inspection and winter maintenance. Within structure, fish handling during dewatering.	December through February	up to 3 months per ladder but no more than 3 months total;	Annual winter maintenanc e of each fishway; One ladder operating at all times
		Bonneville Dam juvenile fish bypass and holding facilities inspection and winter maintenance. Within structure, fish handling during dewatering.	December through March	Up to 12 weeks	Annual winter maintenanc e
		Forebay dredging at Bonneville Bradford Island Fish Ladder exit area). External to structure, elevated sediment disturbance up to 1000 ft, fish handling possible.	December through February	One week	Once every 1-2 years
		Forebay dredging at Bonneville Washington Shore fish units area. External to structure, elevated sediment disturbance up to 1000 ft, fish handling possible.	December through February	One week	Once every 1-2 years
		Bonneville Dam Spillway – Spill apron hydro-survey and rock removal. External to structure, no fish handling.	December through February	One week	up to 1 project per year

Dam	Activity	Actions	Timing	Duration	Frequency
The Dalles and Bonneville (continued)	Unscheduled Maintenance	Power plant – Unanticipated issues with turbines, pumps, transmission systems. Fish handling possible if a turbine is dewatered fully and fish are observed in draft tubes.	Any, but generally December through February	Varies, but up to 12 weeks	up to 1 event per year per dam
		Various projects – Spillway, navigation lock, fish passage facilities. Within structure, fish handling possible if fish-bearing structures dewatered.	Any, but generally December through February	Varies, but up to 12 weeks	up to 3 projects per year, per dam
		Various projects. External to structure but within 1000 ft of dam/navigation structures, work area isolation, fish handling possible.	Any, but generally December through February	Varies, but up to 12 weeks	up to 4 projects per dam per year

(Source: Corps et al. 2020a, pp. 2-80-84; Tackley pers. comm)

10.2.2.10 Elevated Noise

As described for sedimentation and turbidity, impacts from noise are expected primarily during maintenance and construction projects implemented in relation to operational needs of the dam structures and associated passage facilities. The majority of effects of human disturbance and noise are not expected to be measureable to bull trout over existing background conditions. Beyond habitat effects, the response of the bull trout to disturbance (e.g., human presence, noise) is not well understood. However, it is known fishes, like other animals, can detect a wide range of external stimuli. Environmental factors that most often affect fish behavior are sound, light, chemicals, temperature, and pressure. For instance, the response of salmonids to sounds is the “startle” or “start” behavior (Moore and Newman 1956; Burner and Moore 1962; VanDerwalker 1967; Popper and Carson 1998). Such behaviors involve sudden bursts of swimming that are short in duration and length and are characterized as “startle” or general avoidance of the site (McKinley and Patrick 1986). This could result in the disruption of normal bull trout feeding (USFWS 2004b).

It is likely the main source of elevated noise will occur as a result of piling installation for coffer dams and work area isolation. All piles placed below the ordinary high water line will be installed with a vibratory hammer to the fullest extent practicable. If site conditions require the use of an impact pile hammer, the project will implement a sound attenuation system (i.e., bubble curtain) and underwater sound monitoring plan.

We do not expect underwater sound produced when installing piles with a vibratory hammer to measurably affect normal bull trout behaviors. Vibratory drivers produce, on average, underwater peak pressures that are approximately 17 decibels lower than those generated by impact hammers (Nedwell and Edwards 2002). Underwater sound produced by vibratory and impact hammers differs not only in intensity, but also in frequency and impulse energy (i.e., total energy content of the pressure wave). This may explain why no documented fish kills have been associated with the use of vibratory hammers. Most of the sound energy produced by impact hammers is concentrated at frequencies between 100 Hertz (Hz) and 800 Hz, across the range thought to be most harmful to exposed aquatic organisms, while sound energy produced by vibratory hammers is concentrated between 20 Hz and 30 Hz. In addition, sound pressures produced by impact hammers rise much more rapidly than do the sound pressures produced by vibratory hammers (Carlson et al. 2001; Nedwell and Edwards 2002). We expect underwater sound produced when installing piles with a vibratory hammer will not be detectable to a significant distance and bull trout present within the Action Area will not be measurably affected.

Pile driving and proofing with an impact hammer has the potential to kill or injure a limited number of subadult and adult bull trout. Elevated underwater sound pressure levels or SPLs resulting from pile driving and proofing with an impact hammer may also significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). Pile driving and proofing with an impact hammer may cause bull trout to temporarily avoid the area, may impede or discourage free movement through the area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. In this analysis, the Service anticipates all piling placement will be done with vibratory hammers and associated with coffer dams for work area isolation. Therefore, the Service does not expect impacts from impact piling driving.

10.2.2.10.1 Columbia Headwaters Recovery Unit

Based on the Proposed Action and historical maintenance projects, the Service anticipates a number of annual maintenance and construction projects that may occur over the expected duration of the action (Table 12). Elevated underwater noise from increased human presence during construction projects and installation of coffers dams is expected to impact up to 500 ft from project activities. Within the area of potential impacts (500 ft), the Service expects few bull trout are likely present during any one activity. Projects typically occur within shallower river margins and/or within the dam structure itself, where habitat is less suitable for bull trout. Given that, and existing population structures, it is expected that fewer than ten to fifteen bull trout will experience effects of elevated noise and disturbance and fewer than two will experience effects leading to death. In small populations (i.e. downstream of Albeni Falls Dam or Kootenai River Core Area), the impact may be more significant, reducing the spawning success or health of the population.

10.2.2.10.2 Mid-Columbia Recovery Unit

Based on the Proposed Action and historical maintenance projects, the Service anticipates a number of annual maintenance and construction projects that may occur over the expected duration of the action (Table 13). Elevated underwater noise from increased human presence during construction projects and installation of coffers dams is expected to impact up to 500 ft from project activities. Within the area of potential impacts (500 ft), the Service expects that few bull trout are likely present during any one activity. Projects typically occur within shallower river margins and/or within the dam structure itself, where habitat is less suitable for bull trout.

Given that, and existing population structures, it is expected that fewer than fifty bull trout will experience effects of elevated noise and disturbance and fewer than two will experience effects leading to death. In small or very depressed populations (i.e. Asotin, Walla Walla, Umatilla), the impact may be more significant, reducing the spawning success or health of the population.

10.2.2.10.3 Coastal Recovery Unit

Based on the Proposed Action and historical maintenance projects, the Service anticipates a number of annual maintenance and construction projects that may occur over the expected duration of the action (Table 14). Elevated underwater noise from increased human presence during construction projects and installation of coffers dams is expected to impact up to 500 ft from project activities. Within the area of potential impacts (500 ft), the Service expects that few bull trout are likely present during any one activity. Projects typically occur within shallower river margins and/or within the dam structure itself, where habitat is less suitable for bull trout. Given that, and existing population structures, it is expected that fewer than ten bull trout will experience effects of noise and disturbance and no more than one will experience effects leading to death.

10.2.2.11 Direct handling

Trapping, capture, tagging, handling, and transport of bull trout are associated with a variety of activities included in the Proposed Action. Also, it is anticipated some level of monitoring and evaluation activities will be necessary to assess project impacts over time. The majority of activities will be coordinated with the Service during regional team discussions. Specific measures to minimize injury and mortality to bull trout will be implemented, as necessary, through those discussions.

Fish capture and handling of bull trout is expected during construction (Tables 12, 13, and 14), maintenance and operations of fish passage facilities, and during structural dewatering or maintenance. In addition, some specific bull trout surveys or studies may be necessary to determine impacts of elements of the Proposed Action, or bull trout may be handled during salmon and steelhead sampling procedures (e.g. smolt monitoring program). Activities may include different methods to capture bull trout such as electrofishing, fyke, hoops, gill, cast, and dip nets, and screw traps and angling. As well, bull trout are expected to be handled at the dams during salmon survival and passage studies. Tagging studies would require both capture and handling of individual bull trout, with additional handling time and more invasive surgical methods to insert/apply tags to individual fish.

The handling (including trapping, capture, tagging, handling, and transport) of bull trout has some potential to result in injury or death. Mortality may be immediate or delayed. Handling of fish increases their stress levels and can reduce disease resistance, increase osmotic-regulatory problems, decrease growth, decrease reproductive capacity, increase vulnerability to predation, and increase chances of mortality (Kelsch and Shields 1996). Fish may suffer from thermal stress during handling, or may receive subtle injuries such as de-scaling, abrasions, and loss of slime layer. Handling can contribute directly or indirectly to disease transmission and susceptibility, or increased post-release predation. Fish that have been stressed are more vulnerable to predation (Mesa et al. 1994; Mesa and Schreck 1989). Large bull trout may prey on smaller bull trout if both are held in the same container.

Studies investigating acute, sublethal physiological stress in captured and handled salmonids consistently document induced changes in blood chemistry (e.g., cortisol, corticosteroid, and blood sugar levels; lymphocyte numbers) (Barton and Iwama 1991, p. 3; Frisch and Anderson 2000, p. 23; Hemre and Krogdahl 1996, p. 249; Pickering et al. 1982, p. 229; Wydoski et al. 1976, p. 602). Even short and mild bouts of handling have been shown to induce protracted changes, lasting hours or days (Frisch and Anderson 2000, p. 23; Hemre and Krogdahl 1996, p. 249; Wydoski et al. 1976, p. 604). Stress induced effects to blood chemistry may have consequences for metabolic scope, reproduction (i.e., altered patterns or levels of reproductive hormones), and immune system function or capability (Barton and Iwama 1991, p. 3; Frisch and Anderson 2000, p. 29; Pickering et al. 1982, p. 229). Pickering et al. (1982, p. 231) reports a marked reduction in feeding activity lasting three days after handling. Pickering and others (1982, p. 229) state that fish need a minimum of two weeks to fully recover from stress associated with handling. Barton and Iwama (1991, p. 3) and Frisch and Anderson (2000, p. 23) both point to the possibility of increased disease susceptibility attributable to handling related physiological stress.

Different types of tags installed in a fish result in variable types of injury. Some tagging, such as fin clips, results in no injury. Surgical implantation of tags results in injury due to the opening of the abdominal cavity, increased stress associated with handling, and increased risk of infection from the wound, but typically results in low rates of mortality. Mortality from PIT- and radio tags placed in steelhead and post-tag mortality was less than 1 percent (Axel et al. 2005). PIT tagging in juvenile Chinook salmon resulted in post-tagging mortality of eight percent (Achord 2001). All tagged bull trout experience minor injury due to the tagging, resulting in some significant behavioral changes as the bull trout heals. The number of bull trout tagged depends on the activity. Based on comparisons of mortality rates in other species, the Service expects tag related mortality not to exceed 5 percent.

Electrofishing will occur through a variety of activities with the Proposed Action, typically when an area that may contain fish needs to be dewatered for maintenance or construction activities. Electrofishing is typically employed only as a last resort, after all other means of fish capture and removal have been exhausted (e.g. herding with block nets, seining, dip nets in conjunction with dewatering, etc.). Electrofishing involves passing an electrical current through water to immobilize fish and facilitate their capture and removal from the in-water work area. The process of running an electrical current through the water can cause a range of effects, including annoyance, startle, or avoidance behavior; temporary immobility; physical injury; and, mortality. The amount of unintentional (or incidental) injury or mortality attributable to electrofishing can vary widely, depending upon the equipment used, settings used, site conditions (e.g., clarity of water and visibility), and the expertise of the operator. Accidental contact with the electrodes is a frequent cause for physical injury or mortality.

When fish capture operations use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, shocked fish normally revive quickly. Electrofishing can more severely affect adult salmonids because of their larger size and surface area. Injuries, which may cause or contribute to delayed mortality, can include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns (Dalbey et al. 1996; Hollender and Carline 1994; Thompson et al. 1997). The long term effects of electrofishing on juvenile and adult salmonids are not well understood, but long experience with electrofishing indicates that most measurable effects occur at the time of fish capture operations and are of relatively short duration.

The actual number of bull trout affected by handling under the Proposed Action is difficult to anticipate. In most cases, the handled bull trout would be released shortly after their capture, minimizing stress. However, many of these same bull trout may be injured or have increased stress associated with other project activities such as electrofishing. Depending on the number of bull trout that need to be handled during the operation, some injury or even deaths may occur during the handling and/or transfer process. The majority of impacts of handling are expected to reduce impacts to bull trout by removing them from an affected area, or data obtained from handling will provide information valuable to bull trout recovery through minimization of project impacts. Table 15 summarizes anticipated handling of bull trout per project. The estimates provided are high due to expected recovery potential in regions and future increased numbers of bull trout as more information is available.

Table 15. Expected sublethal and lethal effects to bull trout individuals resulting from handling activities occurring at or adjacent to the dams as estimated from historic observations.

Dam	Total Number Individuals Handled per project or research activity	Mortality per project or research activity (no more than)
Libby	Up to 25	2
Hungry Horse	Up to 30	2
Albeni Falls	Up to 35	5
Grand Coulee, John Keys III	Up to 5	0
Chief Joseph	Up to 5	0
Dworshak	Up to 25	2
Lower Granite	Up to 25	2
Little Goose	Up to 50	5
Lower Monumental	Up to 45	5
Ice Harbor	Up to 20	2
McNary	Up to 35	3
John Day	Up to 20	2
The Dalles	Up to 10	1
Bonneville	Up to 10	1

10.2.2.11.1 Columbia Headwaters Recovery Unit

Handling is expected during maintenance activities, monitoring and sturgeon propagation activities. The capture of wild sturgeon for the hatchery program could result in incidental capture of bull trout from the Kootenai River Core Area population, as bull trout may be harmed when captured in gill nets, set lines, or by angling gear used for collecting sturgeon broodstock. Even if immediately released, the stress of handling could also result in bull trout mortality. IDFG has reported that one to three bull trout are caught annually during the sturgeon collection operations (USFWS 2006). The impacts to bull trout from sturgeon monitoring and hatchery program activities was described and authorized in the consultation completed for the sturgeon hatchery operations (USFWS 2013c).

Anticipated impacts to bull trout individuals from handling during maintenance projects or research and monitoring projects related to quantifying impacts of operations may result in altered bull trout behaviors and in rare cases mortality (Table 15). Information obtained regarding bull trout presence, use of the Action Area, and other information for recovery efforts will be obtained as a result of handling. As well, in many cases, the actions are intended to reduce overall impact to bull trout individuals. Therefore, the Service does not anticipate that expected impacts will result in the reduction of recovery potential at the Core Area scale across the Action Area.

10.2.2.11.2 Mid-Columbia Recovery Unit

Anticipated impacts to bull trout individuals from handling during maintenance projects or research and monitoring projects related to quantifying impacts of operations may result in altered bull trout behaviors and in rare cases mortality (Table 15). Information obtained regarding bull trout presence, use of the Action Area, and other information for recovery efforts will be obtained as a result of handling. As well, in many cases, the actions are intended to reduce overall impact to bull trout individuals. Therefore, the Service does not anticipate that expected impacts will result in the reduction of recovery potential at the Core Area scale across the Action Area.

10.2.2.11.3 Coastal Recovery Unit

Anticipated impacts to bull trout individuals from handling during maintenance projects or research and monitoring projects related to quantifying impacts of operations may result in altered bull trout behaviors and in rare cases mortality (Table 15). Information obtained regarding bull trout presence, use of the Action Area, and other information for recovery efforts will be obtained as a result of handling. As well, in many cases, the actions are intended to reduce overall impact to bull trout individuals. Therefore, the Service does not anticipate that expected impacts will result in the reduction of recovery potential at the Core Area scale across the Action Area.

10.2.3 Bull Trout Critical Habitat Effects

Below, we list each critical habitat PCE/PBF, and discuss the long-term impact of the Proposed Action on each by CHU. Detailed impacts occurring to the elements are discussed above in relation to bull trout individuals.

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

Kootenai River CHU 30

Under the Proposed Action, the floodplain will continue to be disconnected from the main channel of the Kootenai River as a result of baseline conditions including historic diking and dam operations. Proposed habitat restoration projects may improve subsurface water connectivity in site specific locations over the duration of the action. Therefore, it is expected that conditions of this PCE/PBF will be maintained.

Clark Fork River CHU 31

Across the CHU, cold water resources are properly functioning in the reservoirs and in the Flathead River Basin, and it is expected this trend will be maintained under the Proposed Action. Under baseline conditions, the South Fork Flathead River hyporheic flows have been impaired by development, and the Flathead River is connected to a shallow alluvial aquifer. Areas with high groundwater influence provide overwintering habitat for bull trout in the Flathead River Basin.

It is expected that ongoing operations of Albeni Falls Dam will reduce floodplain connectivity, result in increased bank stabilization, and result in reductions of riparian habitat that plays a role in maintaining cold water refugia and subsurface connection. Albeni Falls Dam operations may influence shallow groundwater exchange as well. Downstream of Albeni Falls Dam, cold-water habitat is limited, but some patches persist in tributaries (e.g., LeClerc Creek and Indian Creek (Box Canyon pool), Sullivan Creek (Boundary Pool), and others) (USFWS 2002b). An inventory of these and other cold-water areas has been completed (Mejia et al. 2020).

It is expected that this PCE/PBF may experience declines in function over the long-term of the action across the CHU as a result of the Proposed Action.

Clearwater CHU 21

Across the CHU, cold water resources are properly functioning in the Dworshak reservoir. In the Clearwater River Basin, coldwater releases from Dworshak Dam may alter natural water temperatures in the river downstream. It is unknown what the effects may have on migratory bull trout. However, we expect the operations will maintain coldwater availability, and the existing condition of this PCE/PBF will be maintained under the Proposed Action.

Mainstem Upper Columbia River CHU 22
It is expected that baseline conditions and ongoing operations at Grand Coulee and Chief Joseph Dams will reduce floodplain connectivity, result in increased bank stabilization, and result in reductions of riparian habitat that plays a role in maintaining cold water refugia and subsurface connection. It is expected that this PCE/PBF may experience declines in function over the long-term of the action.

Mainstem Snake River CHU 23
It is expected that baseline conditions and ongoing operations will reduce floodplain connectivity, result in increased bank stabilization, and result in reductions of riparian habitat that plays a role in maintaining cold water refugia and subsurface connection. It is expected that this PCE/PBF may experience declines in function over the long-term of the action.

Mainstem Lower Columbia River CHU 8
It is expected that baseline conditions and ongoing operations will reduce floodplain connectivity, result in increased bank stabilization, and result in reductions of riparian habitat that plays a role in maintaining cold water refugia and subsurface connection. It is expected that this PCE/PBF may experience declines in function over the long-term of the action.

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

Kootenai River CHU 30
While migration habitat is functional in the Lake Koocanusa subunit, the overall status of migration habitat in the Action Area portion of the CHU is not properly functioning. Migration barriers from Libby Dam, bedload deposition at tributary mouths, and seasonal temperature barriers have resulted in altered connectivity between local populations and delayed spawning. Restoration projects proposed in two tributaries are expected to improve migratory passage conditions in the Kootenai River over existing conditions. The long-term function of this PCE/PBF will improve as a result, but the overall function in the Kootenai River sub-unit will remain not properly functioning.

Clark Fork River CHU 31
Existing migration barriers at Hungry Horse Dam and other dams across the CHU will continue to impact bull trout migration and movement. The reservoir, South Fork Flathead River, and Flathead River would continue to provide FMO habitat and connection to high-quality spawning and rearing habitat for bull trout. Hungry Horse Dam would remain a physical barrier to upstream and downstream migration, as a continuation of the baseline condition. In addition, the barrier of Hungry Horse Dam limits or eliminates the movement of non-native fish upstream. Reservoir operations implemented in 2009 to reduce water level fluctuation during the summer and fall would continue to reduce habitat fragmentation along migratory corridors.

Proposed passage at Albeni Falls Dam is expected to significantly improve connectivity and the function of this PCE/PBF in the long-term, after expected implementation in 2030.

Clearwater CHU 21

The existing barrier from Dworshak Dam will continue to impact bull trout migration and movement in this CHU and continue the baseline condition of reduced connectivity between the North Fork Clearwater and other Core Areas in the Basin. It is unknown if seasonal coldwater releases from Dworshak Dam impact or alter migratory movements or passage of bull trout. The Proposed Action is expected to maintain the existing function of this PCE/PBF in the CHU.

Mainstem Upper Columbia River CHU 22

The Proposed Action will continue to maintain the baseline conditions of the existing passage barrier at Chief Joseph Dam. The operations of fish passage facilities at McNary and John Day Dams will continue. During maintenance closures at those dams, short-term migration barriers will occur, as has occurred in the past. Minor impacts to bull trout in the passage facilities (described in bull trout effects) may result is biological or physical impediments to movement. Spill operations may impede upstream movement of bull trout, if flow and hydraulics impact bull trout ability to locate passage facility entrances. Coordination at regional forums will result in modifications to operations when passage delays are observed for salmon, steelhead, or bull trout. Over the long-term, the existing degraded function of this PCE/PBF will be maintained.

Mainstem Snake River CHU 23

The operations of fish passage facilities at Lower Granite, Little Goose, Lower Monumental and Ice Harbor Dams will continue. During maintenance closures, short-term migration barriers will occur, as has occurred in the past. Minor impacts to bull trout in the passage facilities (described in bull trout effects) may result in biological or physical impediments to movement. Spill operations may impede upstream movement of bull trout, if flow and hydraulics impact bull trout ability to locate passage facility entrances. Coordination at regional forums will result in modifications to operations if/when passage delays are observed for salmon, steelhead, and/or bull trout. Over the long-term, the existing degraded function of this PCE/PBF will continue.

Mainstem Lower Columbia River CHU 8

The operations of fish passage facilities at The Dalles and Bonneville dams will continue. During maintenance closures, short-term migration barriers will occur, as has occurred in the past. Minor impacts to bull trout in the passage facilities (described in bull trout effects) may result in biological or physical impediments to movement. Spill operations may impede upstream movement of bull trout, if flow and hydraulics impact bull trout ability to locate passage facility entrances. Coordination at regional forums will result in modifications to operations when passage delays are observed. Over the long-term, the existing degraded function of this PCE/PBF will continue.

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

Kootenai River CHU 30

Across this CHU, abundant food base is functioning at risk due to operations that impair riparian habitat, floodplain connectivity, nutrient inputs, and connectivity barriers that impact native forage species. These impacts are expected to continue to degrade under the Proposed Action, with the exception of habitat projects proposed for sturgeon and tributary delta projects. Under the Proposed Action, an abundant seasonal supply of entrained kokanee and other species will continue to supplement the diets of bull trout in the Kootenai River immediately downstream of Libby Dam. In addition, Libby Dam operations have been adaptively managed to reduce impacts to varial zone productivity. Proposed habitat restoration actions, such as those that increase primary production or habitat complexity in sturgeon spawning reaches, will have a positive effect on the PCE/PBF by encouraging the development of a more complex food chain. Trapping of nutrients in Lake Koocanusa has altered nutrient availability downstream so as to reduce primary and food web productivity. Current and proposed nutrient additions will help to minimize this effect. Over the life of the action, this PCE/PBF is expected to continue to function at risk.

Clark Fork River CHU 31

The availability of abundant forage is not considered limiting to bull trout survival across this CHU and forage may be further improved by operational measures that would increase forage due to higher reservoir elevations through the summer in dry years. The Proposed Action would continue operations that have improved this PCE/PBF in Hungry Horse Reservoir. Changes in reservoir operations that reduced deep power drafts have increased the consistency of water levels during primary vegetation growth periods, improving habitat conditions for terrestrial organisms that rely on riparian vegetation. Stable water surface elevations also benefits aquatic macroinvertebrates. Impacts to habitat, water quality, and connectivity are expected to degrade conditions for native forage species in the CHU. However, existing high levels of non-native forage are expected to continue with current operations.

Operations at Albeni Falls Dam to protect kokanee spawning and reduced lake levels over the summer are expected to provide forage for bull trout. It is expected that the overall function of this PCE/PBF will be maintained over the duration of the action across the CHU.

Clearwater CHU 21

*Operations are not anticipated t*o substantially alter prey base in the Clearwater Drainage. It is expected that the overall function of this PCE/PBF will be maintained over the duration of the action across the CHU.

Mainstem Upper Columbia River CHU 22

Proposed operations that limit riparian development, nutrient transport, water quality, and connectivity for forage species will impact overall quality and quantity of forage for bull trout across the CHU. In addition, impacts to salmon and steelhead that result in reduced spawning and juvenile recruitment will reduce forage for bull trout.

Overall, the Proposed Action is expected to maintain the existing degraded condition of this PCE/PBF.

Mainstem Snake River CHU 23

Proposed operations that limit riparian development, nutrient transport, water quality, and connectivity for forage species will impact overall quality and quantity of forage for bull trout across the CHU. In addition, impacts to salmon and steelhead that result in reduced spawning and juvenile recruitment will reduce forage for bull trout.

Overall, the Proposed Action is expected to maintain the existing degraded condition of this PCE/PBF.

Mainstem Lower Columbia River CHU 8

Proposed operations that limit riparian development, nutrient transport, water quality, and connectivity for forage species will impact overall quality and quantity of forage for bull trout across the CHU. In addition, impacts to salmon and steelhead that result in reduced spawning and juvenile recruitment will reduce forage for bull trout.

Overall, the Proposed Action is expected to maintain the existing degraded condition of this PCE/PBF.

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

Kootenai River CHU 30

The Proposed Action will have no effect on this PCE in Lake Koocanusa, and the lake will continue to provide FMO habitat for bull trout. Reservoir habitat complexity is unlikely to be altered by limiting the extent of summer or winter drafts.

Habitat restoration actions in the sturgeon spawning reaches and proposed tributary delta restoration projects will improve bull trout FMO habitat quality in the Kootenai River downstream of Libby Dam over existing conditions. However, flow operations will continue to result in declines to riparian conditions, reduced complexity, and altered floodplain connections. The Proposed Action is expected to maintain existing function of this PCE/PBF.

Clark Fork River CHU 31

The Proposed Action would have minor effects during seasonal reservoir drawdowns in the Flathead River drainage. In Hungry Horse Reservoir, the water depth, thermal stratification, and shallow shoreline habitat provide the most significant habitat complexity and contribution to FMO habitat. The South Fork Flathead River provides deep pools that serve as refugia, and the lower Flathead River provides deep runs with cobble and boulder substrate, as well as pools with LW.

In Lake Pend Oreille, habitat complexity consists of water depth, thermal stratification, and shallow shoreline habitat. PCE 4 is impaired in the Pend Oreille River downstream of Albeni Falls Dam due to historic land management practices. The river between Albeni Falls and Box Canyon dams consists mainly of shallow, slow-moving water, numerous sloughs, and backwater areas.

Continued operations under the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Clearwater CHU 21

In the Dworshak Reservoir, the water depth, thermal stratification, and shallow shoreline habitat provide the most significant habitat complexity and contribution to FMO habitat. Function of this PCE/PBF is limited in reaches downstream of Dworshak Dam. Proposed operations are not expected to change the existing function. Therefore, continued operations under the Proposed Action would maintain the existing functioning at risk condition of this PCE/PBF.

Mainstem Upper Columbia River CHU 22

Complex habitat is limited in the CHU and not properly functioning as a result of ongoing hydropower operations. The Proposed Action will continue to result in reductions of habitat complexity and riparian and shoreline vegetation that contribute to the function of this PCE/PBF.

Continued operations under the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Mainstem Snake River CHU 23

Complex habitat is limited in the CHU and not properly functioning as a result of ongoing hydropower operations. The Proposed Action will continue to result in reductions of habitat complexity and riparian and shoreline vegetation that contribute to the function of this PCE/PBF.

Continued operations under the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Mainstem Lower Columbia River CHU 8

Complex habitat is limited in the CHU and not properly functioning as a result of ongoing hydropower operations. The Proposed Action will continue to result in reductions of habitat complexity and riparian and shoreline vegetation that contribute to the function of this PCE/PBF.

Continued operations under the Proposed Action will continue to degrade the existing function of this PCE/PBF.

PBF 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.

Kootenai River CHU 30

No impact to function is expected for this PCE/PBF in Lake Koocanusa.

The Proposed Action will continue to manage water temperatures in the Kootenai River to benefit sturgeon and bull trout. Under the current operation, May through June water temperature goals have been achieved for almost all days. These temperatures are protective of adult and subadult bull trout as well as sturgeon and will continue under the Proposed Action.

Overall the function of this PCE/PBF will be maintained in the CHU.

Clark Fork River CHU 31

The Hungry Horse Core Area is one of three that is projected to contain significant cold-water refugia for bull trout with respect to climate change. The South Fork Flathead River below Hungry Horse Dam contains water temperatures suitable for all ages of bull trout, contributing to FMO habitat in this reach. The Proposed Action would continue operations that are contributing to maintaining cold-water refugia for bull trout. Furthermore, following the installation of the selective withdrawal system at Hungry Horse Reservoir in 1995, temperatures have more closely approximated pre-dam temperatures, and PCE 5 is likely to continue to contribute substantially to FMO within this CHU.

At Albeni Falls, it is expected the function of this PCE will continue to degrade as a combined impact of operations and environmental conditions. Because the dam withdraws water from a relatively shallow portion of the impoundment, the ability of the dam to influence downstream temperature conditions is limited. Temperatures in the main body of the lake range from 36 °F to 72.5 °F, and in the nearshore areas range from 36 °F to 79.7 °F (Tetra Tech and Tri-State Water Quality Council 2002). Operations that limit formation of the riparian and habitat complexity will continue to limit improvements to temperatures in the Pend Oreille River downstream of the dam.

Overall the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Clearwater CHU 21

Operational releases from Dworshak Dam are used to moderate water temperatures in the mainstem Clearwater River and Snake River to improve aquatic habitat conditions. Summer temperature moderation and flow augmentation releases from Dworshak Dam are intended to maintain water temperatures at the Lower Granite tailrace at or below 68 °F (20 °C) during summer to protect migrating salmonids. While the coldwater releases provide improved conditions in the Snake River, it is unclear what the impact to migrating bull trout individuals in the Clearwater River may be from the coldwater releases. Therefore, the Proposed Action is expected to maintain the existing function of this PCE/PBF.

Mainstem Upper Columbia River CHU 22

Reservoirs act as heat reservoirs with higher temperatures occurring earlier and longer than would occur otherwise so the temperatures exceed this range. Overall the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Mainstem Snake River CHU 23

Reservoirs act as heat reservoirs with higher temperatures occurring earlier and longer than would occur otherwise so the temperatures exceed this range. Overall the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Mainstem Lower Columbia River CHU 8

Reservoirs act as heat reservoirs with higher temperatures occurring earlier and longer than would occur otherwise so the temperatures exceed this range. Overall the Proposed Action will continue to degrade the existing function of this PCE/PBF.

PBF 6: In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo over-winter survival, fry emergence, and young-of-the-year and juvenile survival.

Kootenai River CHU 30
This PCE/PBF is not present in the Action Area.

Clark Fork River CHU 31
This PCE/PBF is not present in the Action Area.

Clearwater CHU 21
This PCE/PBF is not present in the Action Area.

Mainstem Upper Columbia River CHU 22
This PCE/PBF is not present in the Action Area.

Mainstem Snake River CHU 23
This PCE/PBF is not present in the Action Area.

Mainstem Lower Columbia River CHU 8
This PCE/PBF is not present in the Action Area.

PBF 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.

Kootenai River CHU 30
The Proposed Action is expected to have a neutral effect on this PCE/PBF, although conditions are altered during the high and variable winter flows. The Kootenai River hydrograph is significantly altered from its historical state due to the existence and ongoing operation and maintenance of Libby Dam, combined with downstream land and water uses that have changed the hydrograph. Operations of VARQ FRM procedures, as well as tiered volume-based sturgeon augmentation flows, salmon augmentation flows, and bull trout minimum flows, all of which mimic a more normative river hydrograph will continue to degrade the existing function of this PCE/PBF.

Clark Fork River CHU 31
Downstream of Hungry Horse, habitat conditions for bull trout have improved following Reclamation's implementation of more natural flow regimes under VARQ (Muhlfeld et al. 2011). The baseline condition of altered peak flows will be maintained under the Proposed Action.

Continued operations at Albeni Falls Dam will continue to degrade the existing function of this PCE/PBF.

Clearwater CHU 21

Although the hydrograph varies from the natural hydrograph, continuing operations under the Proposed Action will continue to degrade the existing function of this PCE/PBF.

Mainstem Upper Columbia River CHU 22

The baseline condition of altered peak flows will be maintained under the Proposed Action. Chief Joseph Dam and non-federal dams downstream are run-of-river, and inflow is controlled by operations at Grand Coulee and the upstream dams in British Columbia.

The future operations of Reclamation irrigation projects (Columbia River Basin Project, Yakima Project, and Umatilla Phase II Project) is expected to have an insignificant hydrologic effect to Columbia River flows downstream of Chief Joseph Dam. During the months of July, August, and September, flows in the Columbia River would be diminished by up to 10 percent (of approximately 150,000 cfs to 70,000 cfs) by the irrigation projects as measured at Priest Rapids Dam, and by up to 4 to 6 percent from May through September (of approximately 300,000 to 78,800 cfs) (Corps et al. 2020a Appendix C). In addition, future operations of Reclamation irrigation projects (inclusive of Columbia River Basin, Yakima, Umatilla Phase I and II, Deschutes, Crooked River, and Wapinitia projects) is expected to have an insignificant hydrologic effect to Columbia River flows in the McNary Dam to John Day Dam Reach. The average estimated change in discharge by month due to Reclamation tributary irrigation project operations on Columbia River flows at key points are summarized in Appendix C. These data include the effects of storage delivery of water for multiple purposes. Typically, from April through September, flows in the Columbia River would be diminished by up to 4 percent (inclusive of The Dalles, which is downstream of this reach) of up to approximately 310,000 cfs as measured at Bonneville Dam.

Overall, irrigation withdrawals would not have a significant effect on this PCE/PBF in this reach or downstream reaches or on any bull trout present in the mainstem at that time. The Proposed Action will continue to degrade the existing function of this PCE/PBF.

Mainstem Snake River CHU 23

Generally, the hydrograph of the mainstem Snake and Columbia Rivers is highly regulated; storage dams (Dworshak and non-CRS dams) have dampened the natural hydrograph, with decreased high flows during the summer and increased low flows during the winter. The Lower Snake River dams are operated as run-of-river and have little influence on the hydrograph. Overall, the Proposed Action is expected to continue to degrade the existing condition of this PCE/PBF.

Mainstem Lower Columbia River CHU 8

Generally, the hydrograph of the mainstem Snake and Columbia Rivers is highly regulated; storage dams in the Columbia River Basin have dampened the natural hydrograph, with decreased high flows during the summer and increased low flows during the winter. The Lower Columbia River dams are operated as run-of-river and have little influence on the hydrograph. However, operations for power generations and spill operations for juvenile salmon may alter the hydrograph within this CHU. Overall, the Proposed Action is expected to continue to degrade the existing condition of this PCE/PBF.

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

Kootenai River CHU 30

As described in effects to bull trout, the Proposed Action is expected to have minor impacts on most elements of water quantity and quality in this CHU. Increased TDG as a result of spill operations has the potential to result in altered water quality that results in degraded function of this PCE/PBF seasonally. Therefore, the function of this PCE/PBF will be maintained.

Clark Fork River CHU 31

As described in effects to bull trout, the Proposed Action is expected to have minor impacts on most elements of water quantity and quality in the CHU. Increased TDG as a result of spill operations has the potential to result in altered water quality that results in degraded function of this PCE/PBF seasonally. Therefore, the function of this PCE/PBF will be maintained.

Clearwater CHU 21

As described in effects to bull trout, the Proposed Action is expected to have minor impacts on most elements of water quantity and quality in the CHU. Increased TDG as a result of spill operations has the potential to result in altered water quality that results in degraded function of this PCE/PBF seasonally. Continued operation under the Proposed Action is expected to maintain the existing condition of this PCE/PBF.

Mainstem Upper Columbia River CHU 22

The Proposed Action would have infrequent adverse effects on PCE 8 in the Chief Joseph Dam Reach. Primary water quality concerns in this area include the potential for TDG (in excess of state standards of 110 percent), which can harm fish, but at lesser levels and lower frequency than in the baseline.

The Corps and Reclamation investigated a range of potential methods to reduce TDG in the Columbia River mainstem below Chief Joseph Dam. The Corps and Reclamation determined that a combination of operational modifications at Grand Coulee and structural and operational modifications at Chief Joseph provided the most effective solution. Spillway deflectors were completed at Chief Joseph Dam in 2008 and have proven to be effective at reducing TDG during spill operations. A post-deflector study showed reduced TDG exchange in spillway flows with TDG saturations ranging from about 110 percent to 120 percent (Schneider 2012 as cited in Corps et al 2020a p. 3-542). For example, in May 2011 when Grand Coulee Dam was releasing 144 percent TDG and the Chief Joseph forebay TDG levels were 140 percent, the flow deflectors reduced TDG levels to 123 percent in the Chief Joseph tailwater (Corps et al 2020a p. 3-542).

Implementation of the flexible spill program will result in higher TDG levels of 125 percent in 2020. That program will be implemented April 3 through June 20 at the Lower Snake River projects, and April 10 through June 15 at the Lower Columbia River projects. Bull trout within the John Day and McNary Pools would potentially be exposed to the higher TDG levels resulting from the Proposed Action. However, GBT is not typically observed when TDG levels do not exceed state water quality standards for the juvenile fish passage spill period of 120 percent in the tailrace, and generally do not become more pronounced until TDG levels exceed 125 percent of saturation (NMFS 2019).

Other project elements are expected to result in minor changes in water quality as described in the effects to bull trout. Overall, the Proposed Action will result in declining condition and function of this PCE/PBF over the duration of the project.

Mainstem Snake River CHU 23

The Proposed Action would have potential infrequent adverse effects on PCE 8 in the Lower Snake River. Water quality in the mainstem Snake River is also limited by sediment, bacteria, DO, nutrients, pH, mercury, pesticides, and TDG (ODEQ 2020; Ecology 2020). Implementation of the flexible spill program will result in higher TDG levels of 125 percent in 2020. That program will be implemented April 3 through June 20 at the Lower Snake River projects, and April 10 through June 15 at the Lower Columbia River projects. Bull trout within the Lower Snake River Dams and Reservoirs reach would potentially be exposed to the higher TDG levels resulting from the Proposed Action. However, GBT is not typically observed when TDG levels do not exceed state water quality standards of 120 percent, and generally do not become more pronounced until TDG levels exceed 125 percent of saturation (NMFS 2019). Other project elements, including irrigation water returns, are expected to result in minor changes in water quality as described in the effects to bull trout. Overall, the Proposed Action will result in declining condition and function of this PCE/PBF over the duration of the project.

Mainstem Lower Columbia River CHU 8

The Proposed Action will increase allowable TDG levels up to 125 percent of saturation beginning in 2021. However, GBT is not typically observed in salmonids when TDG levels do not exceed 120 percent of saturation, and generally does not become more pronounced until TDG levels exceed 125 percent of saturation (NMFS 2019). Other project elements are expected to result in minor changes in water quality as described in the effects to bull trout. Overall, the Proposed Action will result in declining condition and function of this PCE/PBF over the duration of the project.

PBF 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.

Kootenai River CHU 30

The Proposed Action is expected to maintain the existing function of this PCE/PBF.

Clark Fork River CHU 31

Hungry Horse Dam will continue to provide a barrier to lake trout or other non-native species to prevent access to upstream high quality habitat. Below the dam, PCE 9 would continue to be impaired by the presence of northern pike and lake trout. Existing operations of Hungry Horse Dam are not expected to increased populations of these species. Lake trout are common and represent the primary threat to bull trout in the FMO habitat in Lake Pend Oreille and Flathead

Lake. Northern pike are of considerable concern in the river downstream of Albeni Falls, and hybridization of bull trout and brook trout can occur in tributary streams. Proposed operations in conjunction with operations at Box Canyon Dam will continue to alter flows, decrease coldwater areas, and decrease riparian habitat formation. These altered conditions encourage and support pike survival and spawning. Efforts by the state and Kalispel Tribe to control these species, ongoing under the baseline, are expected to continue to occur separate from the Proposed Action. Therefore, the Proposed Action will maintain the existing degraded function of this PCE/PBF.

Clearwater CHU 21

The Proposed Action is expected to maintain the existing function of this PCE/PBF.

Mainstem Upper Columbia River CHU 22

Proposed operations have the potential to increase suitable habitat for non-native predatory species including smallmouth bass and northern pike. Expansion of northern pike in Lake Roosevelt, Lake Rufus Woods and in the Columbia River downstream is expected to continue. Increased spill operations that entrains pike and flow management that creates shallow, warm water spawning areas suitable for northern pike are expected to continue into the future. As a result, it is expected that the function of this PCE/PBF will decline over the duration of the Proposed Action.

Mainstem Snake River CHU 23

The Proposed Action is expected to maintain the existing function of this PCE/PBF.

Mainstem Lower Columbia River CHU 8

The Proposed Action is expected to maintain the existing function of this PCE/PBF.

10.2.4 Summary of Consequences to Bull Trout and Bull Trout Critical Habitat in the Action Area

10.2.4.1 Columbia Headwaters Recovery Unit

Long-term adverse effects to bull trout individuals within the Columbia Headwaters Recovery Unit are expected as a result of baseline upstream passage barriers, operational passage barriers, entrainment, and ongoing habitat degradation from an altered hydrograph. Some of these effects are partially offset by beneficial effects of isolation from non-native species and improved reservoir levels in the summer of dry years, namely at Hungry Horse Dam. While upstream passage barriers at the dams are considered in the baseline conditions, the long-term impact will likely result in slight declines in recovery success for populations upstream of the dams. In addition, operational impacts resulting in barriers to tributary movements are expected in the Kootenai River and Lake Pend Oreille Core Areas that reduces spawning success for some populations over the long term. Significant declines in recovery potential are expected in the Kootenai River Core Area until habitat restorations are implemented by 2028. Construction of Albeni Falls Dam fish passage by 2030 will also reduce the impact of passage, entrainment, and other impacts over the long-term.

Long-term riparian habitat degradation, particularly related to the continued and ongoing altered natural hydrograph and reduced habitat complexity, is expected to result in losses of individual bull trout from all populations within the Action Area. Since it is difficult to estimate the number of individuals impacted, the Service anticipates an ongoing loss of 8 percent of riparian habitat over the duration of the Proposed Action. Proposed riparian habitat projects in the Kootenai River Basin for both sturgeon and bull trout are expected to reduce some of this impact in that Core Area over the long-term.

Short-term impacts from maintenance and monitoring will likely result in impacts to individuals related to direct handling, short-term elevated noise or short-term altered turbidity and sedimentation. Due to the few individuals impacted annually, on the whole, these impacts are not expected to reach levels impacting recovery potential within Core Areas of the CHRU.

10.2.4.2 Mid-Columbia Recovery Unit

Long-term adverse impacts to bull trout are expected in the MCRU as a result of baseline upstream passage barriers, operational passage barriers, entrainment, and ongoing habitat degradation from an altered hydrograph. Entrainment at all dams will result in injury or mortality of bull trout individuals that results in lost spawning contributions to populations upstream of the dams, particularly at Grand Coulee, Chief Joseph, and Dworshak dams. At Columbia and Snake River dams, this impact is expected to be minimized by the operations of passage facilities allowing upstream migration. However, some long-term impacts are still expected related to passage delays, incidental transport, and added stress or behavioral impacts related to passage facilities. Small numbers of bull trout may be impacted seasonally from tributary barriers as a result of operational water elevation changes. However, the level of impact is difficult to quantify or unknown especially in Lake Roosevelt and Dworshak Reservoirs.

Long-term riparian habitat degradation, particularly related to the continued and ongoing altered natural hydrograph, is expected to result in losses of individual bull trout from all populations within the Action Area. Since it is difficult to estimate the number of individuals impacted, the Service anticipates an ongoing loss of 8 percent of riparian habitat over the duration of the Proposed Action.

Short-term impacts from handling in the passage facilities, monitoring or research activities and for rescue operations during maintenance activities are expected to impact individuals annually. The overall goal of most of these activities is for improved understanding of bull trout populations in the Action Area or minimize effects of maintenance actions. Additional short-term impacts from elevated sediment, turbidity or noise may impact a few individuals annually. Due to the few individuals impacted annually, on the whole, these impacts are not expected to reach levels impacting recovery potential within Core Areas of the CHRU.

10.2.4.3 Coastal Recovery Unit

On the whole, while a few bull trout individuals may experience adverse impacts from the operation and maintenance of The Dalles and Bonneville dams in the CRU, the overall impact is not expected to be measurable at the Core Area scale. Very few bull trout have been documented in the Action Area. Entrainment at all dams will result in injury or mortality of bull trout individuals that results in lost spawning contributions to populations upstream of the dams. This impact is expected to be minimized by the operations of passage facilities allowing upstream migration. However, some long-term impacts are still expected related to passage delays and added stress or behavioral impacts related to passage facilities. Long-term riparian habitat degradation, particularly related to the continued and ongoing altered natural hydrograph, is expected to result in losses of individual bull trout from all populations within the Action Area. Since it is difficult to estimate the number of individuals impacted, the Service anticipates an ongoing loss of 8 percent of riparian habitat over the duration of the Proposed Action.

Short-term impacts from handling in the passage facilities, monitoring or research activities and for rescue operations during maintenance activities are expected to impact individuals annually. The overall goal of most of these activities is for improved understanding of bull trout populations in the Action Area or minimize effects of maintenance actions. Additional short-term impacts from elevated sediment, turbidity or noise may impact a few individuals annually. Due to the few individuals impacted annually, on the whole, these impacts are not expected to reach levels impacting recovery potential within Core Areas of the CHRU.

10.2.4.4 Critical Habitat

Adverse impacts to elements in Critical Habitat Units are anticipated as a result of ongoing operations and maintenance of the CRS. A summary of adverse effects per CHU is in Table 16.

Table 16. Summary of impacts to critical habitat expected from operations and maintenance of the CRS.

Recovery Unit	CHU	PBF's	BPF Baseline in AA	PBF Outcome in AA	CHU Outcome in AA Narrative
Columbia Headwaters	Kootenai River Basin CHU 30	1 - Seeps, Springs, Coldwater	Not Properly Functioning	Maintain	Passage barriers at tributaries in the Kootenai River and existing entrainment and passage barrier at Libby dam as well as long-term altered riparian conditions from the altered hydrograph will degrade existing conditions in this CHU
		2 - Migration Corridors	Not Properly Functioning	Short-term Degrade; Long-term Improve	
		3 - Food Base/Forage	Functioning at Risk	Maintain	
		4 - Habitat Complexity	Functioning at Risk	Degrade	
		5 - Water Temperatures	Properly Functioning	Maintain	
		6 - Spawning Substrate	Not Present	NP	
		7 - Natural Hydrograph	Not Properly Functioning	Degrade	
		8 - Water Quality/Quantity	Functioning at Risk	Maintain	
		9 - Low Non-Natives	Functioning at Risk	Maintain	
	Clark Fork River Basin CHU 31	1 - Seeps, Springs, Coldwater	Functioning at Risk	Degrade	Ongoing operations that alter the natural hydrograph and impact riparian habitat, water temperatures, floodplain connections, and create habitat suitable for non-natives fish will further degrade elements of this CHU. Proposed passage at AFD will improve migratory conditions over the long-term.
		2 - Migration Corridors	Not Properly Functioning	Short-term Degrade; Long-term Improve	
		3 - Food Base/Forage	Properly Functioning	Maintain	
		4 - Habitat Complexity	Functioning at Risk	Degrade	
		5 - Water Temperatures	Functioning at Risk	Degrade	
		6 - Spawning Substrate	Not Present	NP	
		7 - Natural Hydrograph	Not Properly Functioning	Degrade	
		8 - Water Quality/Quantity	Not Properly Functioning	Maintain	
		9 - Low Non-Natives	Not Properly Functioning	Degrade	
Mid-Columbia	Clearwater River CHU 21	1 - Seeps, Springs, Coldwater	Functioning at Risk	Maintain	The natural hydrograph will continue to be altered into the future.
		2 - Migration Corridors	Functioning at Risk	Maintain	
		3 - Food Base/Forage	Functioning at Risk	Maintain	
		4 - Habitat Complexity	Functioning at Risk	Maintain	
		5 - Water Temperatures	Functioning at Risk	Maintain	
		6 - Spawning Substrate	Not Present	NP	
		7 - Natural Hydrograph	Functioning at Risk	Degrade	
		8 - Water Quality/Quantity	Functioning at Risk	Maintain	
		9 - Low Non-Natives	Functioning at Risk	Maintain	

Recovery Unit	CHU	PBF's	BPF Baseline in AA	PBF Outcome in AA	CHU Outcome in AA Narrative
Mid-Columbia (continued)	Mainstem Upper Columbia River CHU 22	1 - Seeps, Springs, Coldwater	Not Properly Functioning	Degrade	Ongoing operations that alter the natural hydrograph and impact riparian habitat, water temperatures, floodplain connections, and create habitat suitable for non-natives fish will further degrade elements of this CHU. Increased spill operations will negatively impact water quality conditions.
		2 - Migration Corridors	Functioning at Risk	Maintain	
		3 - Food Base/Forage	Functioning at Risk	Maintain	
		4 - Habitat Complexity	Not Properly Functioning	Degrade	
		5 - Water Temperatures	not properly functioning	Degrade	
		6 - Spawning Substrate	Not Present	NP	
		7 - Natural Hydrograph	Not Properly Functioning	Degrade	
		8 - Water Quality/Quantity	Not Properly Functioning	Degrade	
		9 - Low Non-Natives	Not Properly Functioning	Degrade	
	Mainstem Snake River CHU 23	1 - Seeps, Springs, Coldwater	Not Properly Functioning	Degrade	Ongoing operations that alter the natural hydrograph and impact riparian habitat, water temperatures, floodplain connections, and create habitat suitable for non-natives fish will further degrade elements of this CHU. Increased spill operations will negatively impact water quality conditions.
		2 - Migration Corridors	Functioning at Risk	Maintain	
		3 - Food Base/Forage	Functioning at Risk	Maintain	
		4 - Habitat Complexity	Not Properly Functioning	Degrade	
		5 - Water Temperatures	Not properly functioning	Degrade	
		6 - Spawning Substrate	Not Present	NP	
		7 - Natural Hydrograph	Not Properly Functioning	Degrade	
		8 - Water Quality/Quantity	Not Properly Functioning	Degrade	
		9 - Low Non-Natives	Not Properly Functioning	Maintain	
Coastal	Mainstem Lower Columbia River CHU 8	1 - Seeps, Springs, Coldwater	Not Properly Functioning	Degrade	Ongoing operations that alter the natural hydrograph and impact riparian habitat, water temperatures, floodplain connections, and create habitat suitable for non-natives fish will further degrade elements of this CHU. Increased spill operations will negatively impact water quality conditions.
		2 - Migration Corridors	Functioning at Risk	Maintain	
		3 - Food Base/Forage	Functioning at Risk	Maintain	
		4 - Habitat Complexity	Not Properly Functioning	Degrade	
		5 - Water Temperatures	not properly functioning	Degrade	
		6 - Spawning Substrate	Not Present	NP	
		7 - Natural Hydrograph	Not Properly Functioning	Degrade	
		8 - Water Quality/Quantity	Not Properly Functioning	Degrade	
		9 - Low Non-Natives	Not Properly Functioning	Maintain	

11 CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this Opinion. Future Federal actions unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

Many of the cumulative effects are similar for bull trout, Kootenai sturgeon, and their critical habitat. Below we discuss the common cumulative effects, and follow up with specific cumulative effects for each species and their critical habitat.

11.1 Cumulative Effects Common to the Species

Future trends or changes in land- and water-use patterns, including ownership, development, and intensity could affect bull trout and Kootenai sturgeon and their respective designated critical habitat. Modifications to state, tribal, and local government land and water uses are likely to be implemented in the form of legislation, administrative rules, or policy initiatives. The cumulative effects of ongoing non-Federal activities in conjunction with the Action Agencies' Proposed Action are difficult to quantify, considering the broad geographic landscape covered by this consultation, the geographic and political variation in the Action Area, the uncertainties associated with government, tribal, and private actions, and ongoing changes to the region's economy. Based on current land management practices, population and growth trends, and indications from climate change models, adverse cumulative effects are likely to increase in the future. Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult, if not impossible, to distinguish between the Action Area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline and Consequences of the Action sections. The potential cumulative effects of current land uses, water uses, and the Proposed Action are described in the sections below.

11.1.1 Residential, Commercial, and Infrastructure Development

Population growth results in increased residential and commercial development. Improvements and upgrades to infrastructure (including roads, highways, other transportation facilities, pipelines, power lines, recreational facilities, and power plants) will generally increase as a consequence of residential and commercial development. Primary pathways of potential effects of land and infrastructure development on bull trout, Kootenai sturgeon, and their respective designated critical habitat includes the following: riparian vegetation removal and habitat loss, decreased water quality, sediment loading, contaminants in waterways, changes to runoff patterns, floodplain conversion, habitat fragmentation, isolation of populations (e.g., through use of human-made barriers such as perched culverts or water diversions), and loss of habitat diversity. Based on past trends and types of development, future residential, commercial, recreational, and infrastructure development is likely to increase in the Action Area. State and local regulations, as well as conservation plans, are expected to mitigate some of the potential effects of development and may reduce the impacts to listed species and riparian habitat.

As the human population in and around the Action Area continues to grow, residential growth and demand for dispersed and developed recreation is likely to occur. This trend is likely to result in increasing habitat degradation from riparian road construction, levee building, bank armoring, and campsite development on private lands. These activities tend to remove riparian vegetation, disconnect rivers from their floodplains, interrupt groundwater-surface water interactions, reduce stream shade (and increase stream temperature), reduce off-channel rearing habitat, and reduce the opportunity for LW recruitment. Each subsequent action by itself may have only a small incremental effect, but taken together they may have a substantive effect that would further degrade the watershed's condition and resiliency, and undermine efforts to improve the habitat conditions necessary for listed species to survive and recover.

Watershed assessments and other restoration and education programs may reduce these adverse effects by continuing to raise public awareness about the potentially detrimental effects of residential development and recreation on salmonid habitats and by presenting ways in which a growing human population and healthy fish populations can co-exist. The Service assumes that future non-Federal activities in the area of the Proposed Action will continue into the immediate future at present or increased intensities. Accordingly, these actions will contribute to maintenance of degraded baseline conditions in the Action Area.

11.1.2 Agricultural and Floodplain Conversion

Although Federal, tribal, state, and local actions seek to improve riparian habitat and reconnect floodplains with rivers for habitat restoration purposes throughout the Proposed Action Area, it is expected that the majority of existing impacts from isolation of floodplains and conversion to farmland will continue. Additional riparian impacts from infrastructure development, road construction, levee building, and bank armoring on private lands will likely occur in the future. As in the past, these activities will remove riparian vegetation, disconnect rivers from their floodplains, interrupt groundwater-surface water interactions, reduce stream shade (and thereby increase stream temperature), reduce off-channel rearing habitat, and reduce the opportunity for large woody debris recruitment. Watershed assessments and other education programs may reduce these adverse effects by continuing to raise public awareness about the potentially detrimental effects of agricultural-related development on fish habitats and by presenting ways in which a growing human population and healthy fish populations can co-exist.

11.1.3 Timber Harvest and Road Construction

Private timber harvest and similar activities, including road maintenance, new road construction, and logging, are expected to continue within the proximity of portions of the Action Area, which may decrease bank stability, increase sediment loading, and affect riparian vegetation and spawning reaches. These actions, while generally occurring in upland areas well outside the Action Area, may increase sediment discharge upstream of reservoirs of dams that can contribute to turbidity and reduced water quality in the reservoirs/lakes. Below the dams, high flows can wash significant amounts of sediment due to timber harvest from tributaries into rivers, such as the Fisher River, which is surrounded by numerous privately-owned timber holdings, into the mainstem Kootenai River. This can create turbidity in the rivers that may have some benefits, such as providing cover from predators for sturgeon eggs and larvae. However, the negative effects of excessive sediment loading can include suffocation of bull trout and sturgeon eggs. Sediment from logging or multiple-use dirt roads and timber harvest can also wash downstream in tributaries and deposit sediments at their confluences with mainstem rivers or reservoirs, which may result in connectivity issues if sediment build up hinders tributary-mainstem migrations. The impacts could be exacerbated by Proposed Action operations that alter and reduce flushing or peak flows, as well as future patterns of run-off flow as a result of climate change.

11.1.4 Mining

There are historic and current mining activities in the Action Area, including silver, gold, and gravel mining. Much of the historic activity contributes to the baseline condition of water quality and substrates, but mining continues in some areas, and continues to affect water quality through turbidity, pollutants, connectivity, and substrate changes. Mining activities have impacted both the mainstems and the tributaries in the Action Area.

Coal mining activities in the Elk River drainage in British Columbia has led to increased levels of selenium contamination in Lake Koocanusa and the Kootenai River (Kennedy et al. 2000). Elevated selenium concentrations have been detected in some bull trout in Lake Koocanusa. USFWS (2015b) recommends continued monitoring of the selenium levels in the Kootenai River system and research on the impact of selenium on bull trout, particularly with respect to potential reproductive impairment (including adult reproductive failure and early life stage teratogenicity and mortality) (Lemly 2002), because this threat is not well understood. Use of ammonium nitrate in blasting for coal mining in British Columbia upstream of Lake Koocanusa is also thought to have raised total nitrogen and NO3 levels in Lake Koocanusa (G. Hoyle, KTOI, pers. comm., 2015; K. Easthouse, Corps Seattle District, pers. comm., 2015 both cited in Corps et al 2020a). The use of ammonium nitrate blasting is expected to continue, and conservatively 25 percent of these constituents will be trapped in Lake Koocanusa, while the remainder travels downstream. The effects from coal mining may affect both bull trout and Kootenai sturgeon within the Action Area upstream and downstream of Libby Dam.

11.2 Cumulative Effects Specific To Kootenai Sturgeon

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 unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

11.2.1 Kootenai Sturgeon

1938 IJC Order

Cumulative beneficial effects to sturgeon habitat may occur if the 1938 IJC Order on Kootenay Lake operations is reinterpreted to be implemented based upon hydrologic conditions as they existed in 1938. This would result in additional water being stored in Kootenay Lake in the spring. Storing more water in Kootenay Lake during the spring freshet would extend the backwater effect further upstream, likely providing increased water depth during the sturgeon spawning and incubation periods within the braided reach of the Kootenai River. This could possibly increase the likelihood of Kootenai sturgeon migrating to, and spawning over, the more suitable rocky substrate present in the Kootenai River upstream of Bonners Ferry.

Human Population Growth

As the human population in the State of Idaho continues to grow, residential growth and demand for dispersed and developed recreation is likely to occur. This trend is likely to result in increasing habitat degradation from riparian road construction, levee building, bank armoring, and development on private lands. These activities tend to remove riparian vegetation, disconnect rivers from their floodplains, interrupt groundwater-surface water interactions, reduce stream shade (and increase stream temperature), reduce off-channel rearing habitat, and reduce the opportunity for LW recruitment. Each subsequent action by itself may have only a small incremental effect, but taken together they may have a substantive effect that would further degrade the watershed's environmental baseline and undermine the improvements in habitat conditions necessary for listed species to survive and recover. Watershed assessments and other education programs may reduce these adverse effects by continuing to raise public awareness about the potentially detrimental effects of residential development and recreation on sturgeon habitats and by presenting ways in which a growing human population and healthy fish populations can co-exist.

The Service is not aware of any other future actions that are reasonably certain to occur in the Action Area that are likely to contribute to cumulative effects on Kootenai sturgeon. For this description of cumulative effects, the Service assumes that future non-Federal activities in the area of the Proposed Action will continue into the immediate future at present or increased intensities. Accordingly, these actions will contribute to maintenance of at-risk and not properly functioning habitat indicators.

11.2.2 Kootenai Sturgeon Critical Habitat

1938 IJC Order

Cumulative beneficial effects to sturgeon critical habitat may occur if the 1938 IJC Order on Kootenay Lake operations is reinterpreted to be implemented based upon hydrologic conditions as they existed in 1938. This changed operation may provide for increased water depth during the sturgeon spawning and incubation periods within the braided reach of the Kootenai River by intentionally increasing Kootenay Lake stage and the backwater which extends well into the Braided Reach, and allow for increased potential for floodplain inundation that would enhance primary and secondary productivity in the Kootenai basin.

11.3 Cumulative Effects Specific To Bull Trout

Cumulative effects from a variety of activities are likely to adversely or beneficially affect bull trout and their habitat. These actions include, but are not limited to, industrial and residential development, road construction and maintenance, mining, forest activities, fish management activities, irrigation, agriculture, grazing, and fire management.

Potential impacts that may contribute to cumulative effects include water flow fluctuations, degraded water quality, migration barriers, habitat degradation, resource competition, and introduction of non-native invasive species. Effects to bull trout in and near the Action Area are primarily the result of urban development, agriculture, and associated water diversion and water control activities. Urban and rural land uses for residential, commercial, industrial, and recreational activities, such as boating and golf courses, often require water withdrawals and can further contribute pollutants and sediments to surface waters. Irrigation is ongoing throughout the Action Area. There may be potential new water development such as storage projects, ongoing private water withdrawals, and ground-water wells. The water resource agencies in the respective States in the Action Area (Oregon, Washington, Idaho, and Montana) regulate the quantity of water withdrawals.

Many impacts from non-Federal activities in the Action Area that have degraded or hindered the conservation of listed species, specifically bull trout and its designated critical habitat, will continue in the foreseeable future at similar intensities as in the recent past. Information on specific planned or foreseeable non-Federal activities is uncertain. The types of ongoing non-Federal activities and land uses expected to continue to affect listed species and critical habitat within the Action Area include development, coal mining, agriculture, recreation, timber harvest, and climate change as a result of human activities. We are not aware of any specific, significant new or changes to existing state, tribal, local, or private activities within the Action Area.

12 INTEGRATION AND SYNTHESIS OF EFFECTS/CONCLUSION

The Integration and Synthesis section is the final step in assessing the risks and benefits posed to listed species and critical habitat as a result of implementing the Proposed Action taken together with cumulative effects. In this section, in accordance with the implementing regulations for Section 7, we "…add the effects of the action and cumulative effects to the environmental baseline and in light of the status of the species and critical habitat, formulate our Opinion as to whether the Proposed Action is likely to jeopardize the continued existence of the listed species or to destroy or adversely modify critical habitat" [50 CFR 402.14(g)(4)].

12.1 Kootenai Sturgeon and Kootenai Sturgeon Critical Habitat

As proposed, the operation of Libby Dam is likely to adversely affect habitat conditions and ecosystem functions within the only known breeding area for Kootenai sturgeon. Effects to Kootenai sturgeon likely to be caused by the Proposed Action include alterations to the hydrograph and thermograph, reductions in river depths within suitable spawning habitat during sturgeon spawning season, and degradation of multiple ecosystem functions. These effects are likely to cause poor reproductive success, over time, of the adult breeding population in the wild.

Although millions of fertilized sturgeon eggs are produced and released in the wild each year, it is estimated that, on average, only between 13 and 85 juvenile sturgeon are naturally reproduced each year in the wild, which is insufficient to sustain the population. This extremely low level of natural reproduction is due to low rates of successful embryo incubation, and low rates of free-embryo and larval survival, all of which are attributed to poor habitat conditions created by Libby Dam operations. As discussed below, these effects are likely to be tempered by the suite of measures in the Proposed Action that are specifically designed to reduce adverse effects to Kootenai sturgeon and its designated critical habitat.

The Proposed Action includes the following measures to reduce adverse effects of project operations on Kootenai sturgeon and its designated critical habitat. Specifically, the action agencies will: (1) continue to manage river flow and water temperature from Libby Dam in a manner that is likely to create improved river depth and water velocities in areas important for sturgeon migration, spawning and rearing, as well as to provide stable water temperatures during sturgeon migration and spawning periods; (2) continue to implement a habitat restoration program, which is likely to increase spawning sturgeon access to river reaches that have sufficient amounts of rocky substrate, and is likely to address other habitat-related threats to Kootenai sturgeon; (3) continue to implement nutrient enhancement projects, which are likely to replace lost nutrients in the basin; (4) continue to implement research and monitoring, which is likely to inform adaptive management actions; and (5) continue to implement the conservation aquaculture program, which is likely to maintain the distribution, genetic diversity, age-class structure, and abundance of Kootenai sturgeon in the wild over the term of the action and allow time for the habitat restoration and other four beneficial measures to become fully functional. As noted previously in this opinion, the effects of these measures are beginning to show positive results.

Importantly, implementation of these beneficial measures listed above effectively constitutes implementation of both the full recovery strategy outlined in the Service's 2019 *Revised Recovery Plan for the Kootenai River DPS of the White Sturgeon* (USFWS 2019, pgs. 12-17), as well as the full suite of actions called for in the 2008-clarified RPA from the 2006 *Opinion on the Effects of Libby Dam Operations on the Kootenai River White Sturgeon, Bull Trout, and Kootenai Sturgeon Critical Habitat* (USFWS 2008d).

The elements of the 2008 RPA are now part of the Proposed Action. Regulations (at 50 CFR 402.02) implementing Section 7 of the ESA define RPAs as "alternative actions, identified during formal consultation, that…would, the Service believes, avoid the likelihood of the Federal action jeopardizing the continued existence of listed species or destroying or adversely modifying critical habitat." As the Service previously determined in developing the 2008-clarified RPA, "implementation of the RPA…is likely to avoid jeopardy and adverse modification because it will address the survival and recovery needs of the Kootenai sturgeon." We arrive at the same conclusion today. The Proposed Action also effectively implements the recovery strategy in the 2019 Revised Recovery Plan, and as such represents the current best available science on the most effective means to address threats to, and recover, Kootenai sturgeon. As described in the *Effects of the Proposed Action* section (12.2.4), the Proposed Action's beneficial measures are beginning to benefit Kootenai sturgeon and thus reduce the severity of the Proposed Action's adverse effects on Kootenai sturgeon. Over time and considering the aggregate factors affecting the species, we expect these beneficial measures will improve the survival of sturgeon. Therefore, the best available science therefore shows that implementation of the Proposed Action is likely to avoid jeopardizing the continued existence of Kootenai sturgeon.

The conservation role of Kootenai sturgeon critical habitat is to provide habitat conditions necessary for successful sturgeon recruitment at levels that will provide for the persistence of the species. Appropriate water depths, water temperature, flow velocities, rocky substrate, and inter-gravel spaces (all PCEs) are essential for successful sturgeon spawning. Although past and present operations of Libby Dam have degraded the above habitat elements to the extent that, currently, the co-occurrence of these PCEs at the same place and time during the critical period of sturgeon breeding is limited, as described above, the Proposed Action includes measures that are specifically designed to improve the co-occurrence of these elements (i.e., management of river flow and water temperature from Libby Dam, implementation of habitat restoration projects). Also, as noted above, the Proposed Action constitutes implementation of the Service's 2008-clarified RPA from the previous consultation on the effects of Libby Dam operations on sturgeon critical habitat, as well as implementation of the recovery strategy from the 2019 Revised Recovery Plan (USFWS 2019c). For these reasons, implementation of the Proposed Action is likely to avoid adverse modification of sturgeon critical habitat.

12.1.1 Section 7(a)(2) Determinations for the Kootenai Sturgeon and its Critical Habitat

After reviewing the current status of the Kootenai sturgeon, the environmental baseline for the Action Area, the effects of the Proposed Action and cumulative effects, it is the Service's Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the Kootenai sturgeon and is not likely to destroy or adversely modify designated critical habitat for this species.

12.2 Bull Trout and Bull Trout Critical Habitat

The Proposed Action involves the ongoing operation and maintenance of 14 Federal dams across the Columbia River Basin. Included within the action are operational measures (e.g., FRM, navigation, fish passage, and hydropower generation) and non-operational measures (e.g., predation management, habitat improvement actions, and RM&E programs) that will adversely and beneficially impact the bull trout. Some of the operational and non-operational measures are specifically designed to benefit or reduce the adverse impacts of the Proposed Action on the bull trout and its critical habitat. In addition, related actions included in the baseline (i.e. previously consulted on and implemented in relation to this action) will further reduce the impact of the Proposed Action over the long-term for bull trout and bull trout critical habitat.

In 1999, the Service listed all populations of the bull trout in the coterminous U.S. under a single DPS as threatened. Although wide-ranging in parts of Oregon, Washington, Idaho, and Montana, the bull trout presently occurs in about 45 percent of its historical range in the Columbia River Basin (USFWS 2015a). In the Bull Trout Recovery Plan, bull trout populations were segregated into six Recovery Units across the range of the species, which encompasses 109 Core Areas, 6 Historic Areas, and one RNA (USFWS 2015a). The Action Area for CRS, which covers the vast majority of the Columbia River Basin in Montana, Washington, Oregon and Idaho, overlays three of the six established Recovery Units and includes all or parts of 46 Core Areas, four historic areas and one RNA representing about 45 percent of the bull trout's range within the coterminous U.S.

Most of the bull trout populations in the Action Area currently face threats from diminished connectivity, habitat degradation, poor or impacted water quality, and introduced non-native species. These threats have resulted in declines in the bull trout's distribution and abundance. In more than half of the Core Areas within the Action Area, the main threat to the stability and long-term viability of bull trout populations is diminishing connectivity between Core Areas and local populations caused by passage and migration barriers. In some areas, bull trout populations are stable (e.g., the Clearwater River Core Areas). However, many local and Core Area populations within the Action Area are depressed and declining (e.g., the Kootenai River, Yakima River, and Umatilla River Core Areas). Sixteen of the 46 Core Areas (41 percent) representing at least 84 local populations that may interact within the Action Area are considered depressed. Of the 30 Core Areas considered stable, 18 have minimal interactions within the Action Area. Those interactions are primarily caused by entrainment of bull trout into the Action Area and then the inability of those individuals to return to natal waters as a result of factors not associated with the Proposed Action (e.g., natural or man-made barriers). In most portions of the Action Area, adult and sub-adult bull trout are overwintering and can be found foraging and migrating at any time of the year. Spawning and juvenile-rearing areas are located outside of the Action Area and are unlikely to be affected by the Proposed Action.

The specific number of bull trout likely to be affected by the Proposed Action is difficult to quantify. In addition, in many cases, there are few studies on the specific effects hydropower operations may have on bull trout. In situations where information specific to the bull trout is lacking or insufficient to make quantitative conclusions, the Service uses data related to surrogate species whose life histories or habitat needs are similar enough to the bull trout to inform quantitative or qualitative assessments of effects. In other situations, quantification of habitat impacts are used to represent an overall impact that may occur to an unknown, but qualified, number of individual bull trout.

Bull trout critical habitat in the Action Area includes portions of six of 31 designated CHUs. The Action Area occurs within important FMO habitat for the bull trout. In all six of the affected CHUs, PCE/PBFs have been degraded or are not properly functioning due to past impacts of CRSO on migratory corridors, natural hydrographs, water quality, habitat complexity and temperature, and the presence of introduced species. Past actions have reduced the function of critical habitat in the Action Area to provide adequate forage and migratory corridors to support the non-spawning life stages of the bull trout.

12.2.1 Columbia Headwaters Recovery Unit

The CHRU is considered a stronghold for the bull trout because many of the headwater tributaries provide coldwater refugia, and are located in high elevation wilderness or protected areas where suitable habitat is expected to persist even under climate change scenarios (USFWS 2015b, P D-33). The Action Area within the CHRU encompasses 5 of the 15 Complex Core

Areas for the bull trout. These include Lake Pend Oreille, Flathead Lake, Kootenai River, Hungry Horse Reservoir, and Lake Koocanusa; three of these Core Areas (Flathead Lake, Hungry Horse Reservoir, and Lake Koocanusa) are considered strongholds and likely resilient into the future, but two are at risk from ongoing threats, connectivity issues and climate change. In addition, individual bull trout from three other Core Areas (Swan River, Bull Lake, and Priest Lake) are entrained into the Action Area annually, but are unable to return to natal waters as a result of factors (e.g., non-federal dams) outside of the Action Area. In addition, the Action Area falls within two of the three CHUs designated within the CHRU.

12.2.1.1 Swan River/Bull Lake/Priest Lake Core Areas

Current baseline conditions for bull trout in the Bull Lake and Priest Lake Core Areas are depressed due to low population sizes, the presence of non-native species, and the presence of barriers that impair or preclude the connectivity of bull trout populations. Currently, the status of bull trout populations in the Swan River Core Area is declining due to the presence of invasive species. A few individuals from all three Core Areas may be entrained into the Action Area over barriers within tributary streams. These barriers, located outside of the Action Area and unrelated to the Proposed Action, also block the return of affected bull trout to their natal spawning tributaries. Bull trout that have been entrained into the Action Area may experience some adverse effects from CRS operations. However, the Proposed Action will have no impact on recovery of these specific Core Area populations, because the affected bull trout are unable to contribute to these populations once they are entrained into the Action Area.

12.2.1.2 Lake Koocanusa/Hungry Horse Reservoir Core Areas

Existing baseline conditions within the Lake Koocanusa and Hungry Horse Reservoir Core Areas consist of stable, stronghold populations that are expected to persist under long-term climate change scenarios (USFWS 2015b p. D-33). No threats have been identified for these two Core Areas (USFWS 2015b D-22, D-24). The loss of individual bull trout from these Core Areas as a result of entrainment over Libby and Hungry Horse dams and the lack of upstream passage are likely to reduce the number of spawning adult bull trout contributing to populations upstream of the dams. In addition, the Proposed Action will alter the natural hydrograph resulting in fluctuating water levels that limit growth of riparian and shoreline vegetation, limit forage availability and alter nutrients in a way that may reduce the overall health and fitness of affected bull trout. The future effects of CRS operations on these bull trout Core Areas are not likely significantly different nor are they likely to result in greater entrainment than has occurred in recent years. To date, no measureable impact of CRS operations on the bull trout at the population scale has been detected, nor was entrainment identified as a primary threat to bull trout recovery in these Core Areas. Although adverse impacts to individual bull trout caused by the Proposed Action in these Core Areas (in the form of an altered hydrograph and the loss of riparian and shoreline habitat) are likely to occur to an extent similar to baseline conditions, these impacts are likely to be localized and not result in population-level effects. This is because, there is extensive available foraging habitat for bull trout within the reservoirs that is likely to offset these impacts on affected bull trout. To date, CRS operations are not known to cause population-level effects to bull trout in these Core Areas. Therefore, the Service does not anticipate that impacts of the Proposed Action will result in measurable declines in the survival and recovery of bull trout in the Koocanusa or Hungry Horse Reservoir Core Areas.

12.2.1.3 Kootenai River/Lake Pend Oreille/Flathead Lake Core Areas

Connectivity barriers, past and current land management activities, non-native species impacts (i.e. competition and predation), and past hydropower operations have caused bull trout population declines and, in some cases, the extirpation of bull trout populations within these three core areas. Bull trout use the Action Area primarily for foraging, overwintering, and migration. In Lake Pend Oreille and Flathead Lake proper, bull trout have substantial forage resources that offset the above impacts, including from CRS operations, in this portion of the Action Area. Bull trout populations directly associated with these two lakes tend to be stronger, more stable, and resilient to the adverse effects of CRS operations. However, downstream of Albeni Falls Dam, Hungry Horse Dam, and Libby Dam, bull trout populations are significantly impacted by altered hydrographs for flood risk management and power generation operations caused by the Proposed Action. In most cases, the affected bull trout populations are declining in these areas. The Proposed Action is likely to perpetuate or worsen ongoing alterations of the natural hydrograph, continue to cause declines in the survival of riparian vegetation, bull trout forage availability, and water quality conditions (e.g., elevated/altered temperatures and TDG), increased erosion and bank armoring, and increase the availability of habitat for non-native species that compete with or predate on bull trout. In addition, the impacts of existing structures and ongoing operational impacts to tributaries to the Kootenai River continue to prevent bull trout access to high quality habitat upstream of the dams and to spawning tributaries. Over the 15-year duration of the Proposed Action, moderate declines in the survival and recovery of bull trout in several local populations within these three Core Areas are likely to occur.

However, the Proposed Action, as well as some activities considered in the baseline, include measures to improve bull trout populations in the Lake Pend Oreille and Kootenai River Core Areas. The Action Agencies propose construction of an upstream fish passage facility at Albeni Falls Dam. While the construction and operation of the passage facility was consulted on in 2018 and is included in the baseline conditions, the timeline and future benefits of the passage facility are recognized as they relate to ongoing impacts of the Proposed Action. The Service anticipates that the benefits to bull trout in the Lake Pend Oreille Core Area of providing fish passage at Albeni Falls Dam will likely be achieved by 2030. Over the long-term (i.e. 15-year duration of the Proposed Action and longer), the benefits of providing bull trout passage at Albeni Falls Dam is likely to significantly improve conditions for survival and recovery of bull trout in the Pend Oreille River through increased access to extensive, high quality forage areas and cold-water refugia found in Lake Pend Oreille.

In the Kootenai River Core Area, two habitat restoration projects at tributary delta sites are included in the Proposed Action. The benefits of these projects are anticipated by 2028. In addition, under the Proposed Action, habitat improvement projects to support Kootenai sturgeon recovery in downstream portions of the Kootenai River, proposed minimum stream flows released out of Libby Dam, and selective withdrawals operations at Libby Dam are further expected to minimize Project-related adverse impacts to bull trout in the Kootenai River Core Area, particularly as they relate to long-term impacts in the region associated with climate change. In the Kootenai River Core Area, the Service anticipates some bull trout populations may be temporarily extirpated in the short-term before the benefits of the habitat improvements can be realized. Although short-term declines in bull trout populations in this portion of the Action Area are likely to occur under the Proposed Action, habitat improvement projects proposed for both bull trout tributaries and the Kootenai sturgeon are likely to substantially increase bull trout access to tributary spawning habitat and forage availability in the river.

Some bull trout from local populations downstream of Hungry Horse Dam may experience adverse impacts from the proposed dam operations in the form of an altered hydrograph that reduces riparian habitat formation and function, bull trout forage availability, and water quality. However, these impacts were not identified as threats to bull trout in the Flathead Lake Core Area, and there is extensive high quality bull trout habitat available throughout the Core Area. Threats identified in the Flathead Lake Core Area relate to fisheries management and the presence of non-native species (USFWS 2015b p. D-18-19). Although operations of Hungry Horse Dam may influence the hydrograph downstream of the dam, operations of SKQ Dam have the most influence on the development of non-native fish habitat within Flathead Lake. In addition, ongoing non-Project-related actions are occurring to manage non-native fish populations in the Flathead Lake Core Area. In addition, the Proposed Action includes selective withdrawals and ramping rates at Hungry Horse Dam to further minimize overall impacts of operations on bull trout in the Flathead Lake Core Area. For these reasons, no Core Area-scale effects of the Proposed Action are likely to occur in this portion of the Action Area.

Over time, the above proposed restoration and passage projects in combination with operational benefits (ramping rates, minimum flows and selective withdrawals) are likely to improve the survival, fitness and recovery of the affected bull trout local populations, increase bull trout spawning success, and lead to population increases in the Lake Pend Oreille and Kootenai River Core Areas. Until some projects (passage and tributary restoration) are fully implemented, the Service expects continued declines in bull trout populations downstream of Libby and Albeni Falls dams and minimal measurable impacts to populations in the Flathead Lake Core Area.

12.2.1.4 Clark Fork River Basin/Kootenai River Basin CHUs

Critical habitat within the Action Area in the CHRU has been altered historically by operations of dams across the region, land management activities, and mining operations. Most PCEs/PBFs in the Kootenai River Basin and Clark Fork River Basin CHUs are functioning at-risk or not properly functioning within the Action Area. The Proposed Action is likely to cause the continued decline in the function of migratory corridors, alter the natural hydrograph, and reduce riparian habitat for both CHUs within the Action Area, particularly in the short-term as a result of ongoing flow management, flood risk management, and power generation. However, as described in the Consequences of the Action section above, implementation of the proposed fish passage facility at Albeni Falls Dam and tributary habitat projects on the Kootenai River are likely to significantly reduce the adverse impacts of migration barriers in these CHUs, and over the long-term maintain or improve the recovery function of these CHUs for bull trout population connectivity and FMO habitat for the bull trout. These benefits are likely to be achieved by 2030 at Albeni Falls Dam and by 2028 at tributary habitat project sites on the Kootenai River following full implementation of these conservation measures. Ongoing project operations that alter the natural hydrograph, increase habitat conditions suitable for non-native predators, and limit riparian vegetation growth are expected to continue through the duration of the Proposed Action within the Action Area. However, the impact is likely to be limited in scale, and affected areas of FMO habitat are likely to function, albeit in a degraded state. As tributary and mainstem restoration actions are implemented across the CHUs, both as part of the Proposed Action and as a result of other Federal and non-Federal actions, the recovery function in these two CHUs will be maintained.

12.2.1.5 CHRU Summary

The effects of the Proposed Action, when added to baseline conditions and cumulative effects, are likely to cause adverse impacts to bull trout within as many as eight Core Areas in the CHRU. These impacts are not expected to measurably impact six of the Core Areas because: they are located outside of the area likely to be affected by the Proposed Action; existing conditions are functional in these Core Areas (e.g., strong, stable populations with no threats); extensive areas of other suitable habitat is available; and no identified threats related to Project operations have been documented. However, in two Core Areas (Kootenai River and Lake Pend Oreille), significant adverse effects to individuals and populations are expected as a result of the Proposed Action, particularly in the first 10 years of operations. After the first 10 years, habitat and passage conditions for bull trout are expected to improve substantially over existing conditions to an extent that minimizes or offsets the long-term influence of adverse impacts of Project operations. Construction of fish passage at Albeni Falls Dam is likely to facilitate bull trout access to extensive areas of high quality foraging and refugia habitat, and is likely to improve spawning access and success for bull trout in populations both up and downstream of Albeni Falls Dam. Under the Proposed Action, restoration actions at tributary mouths are also likely to beneficially affect bull trout in the Kootenai River Core Area. Although it will take time for the restoration actions to mature and provide full habitat benefits, over the long-term, improved tributary access is likely to result in more successful bull trout spawning in at least two tributary populations. These effects are likely to enhance the potential for long-term population recovery. Providing for fish passage at Albeni Falls Dam, and implementation of tributary restoration and sturgeon habitat actions address identified threats to the recovery of bull trout in the affected Core Areas (USFWS 2015b, D-16-17, D-24). Therefore, although significant Project impacts to two bull trout Core Areas in the CHRU are expected from Proposed Action, especially in the short-term, these impacts are expected to be substantially minimized/offset within the full 15-yr duration of the Proposed Action.

As discussed above, the benefits to bull trout habitat from proposed Project fish passage and restoration actions is also likely to improve the PCEs/PBFs and recovery function of critical habitat in the Action Area over the long-term. Critical habitat in the Action Area provides FMO habitat for the bull trout.

12.2.2 Mid-Columbia Recovery Unit

The status of bull trout populations within the MCRU is variable across the Action Area. Some populations are small and increasingly threatened due to reduced habitat availability, barriers to inter-population connectivity, the presence of invasive species, and declining native food resources (USFWS 2015c p. C-9-34). Other areas in the Action Area with intact riverine habitat are located within wilderness areas or protected forestlands and support more robust bull trout populations. Within the Action Area, the MCRU includes 21 Core Areas, two historically occupied areas, and one RNA (the Northeastern Washington RNA). Bull trout in nearly all (19 of 21) of the Core Areas in the MCRU overlap the Action Area year-round in some capacity of bull trout foraging, migratory, or overwintering activities. Bull trout populations within this recovery unit evolved with anadromous salmon and steelhead, which are a primary prey base for bull trout in this recovery unit. For most Core Areas in the MCRU, declining or depressed salmon and steelhead populations have led to a reduced or altered food base and ultimately reduced health and fitness of bull trout populations in the MCRU.

Bull trout populations within the MCRU are subject to ongoing adverse impacts caused by Federal and non-Federal dam operations on the mainstem Columbia River, Lower Snake River, and the Clearwater River. The effects of barriers on bull trout migration, historical land management activities, elevated water temperatures, the presence of non-native fish, and low habitat complexity are recognized as threats to the bull trout in most of the Core Area populations in this recovery unit (USFWS 2015c p. C-9-34). The presence and operation of dams in this recovery unit have adversely affected river flow, water quality, and water temperature regimes, to an extent that is limiting the survival of affected bull trout in all life stages, as well as adversely impacting the availability of native food sources (e.g., salmon and steelhead) for bull trout.

12.2.2.1 NE Washington RNA/Yakima/Touchet/Grande Ronde Core Areas

For the Grande Ronde, Touchet and Yakima Core Areas and the Northeast Washington Research Needs Area, only very small numbers of bull trout are likely to use this portion of the Action Area. While downstream movement into the Action Area is possible, the quantity of bull trout moving upstream into the Action Area is either unknown or undocumented. Bull trout populations in the Yakima and Touchet Core Areas are depressed, and bull trout in these areas are not likely to migrate into the Action Area due to their low numbers and to habitat factors. While the Grande Ronde Core Area bull trout populations are more stable, there is little evidence they migrate into the Snake River. Lastly, as described above, information on bull trout populations is generally unknown or extremely lacking upstream of Chief Joseph Dam and Grand Coulee Dam to the Canadian border. A few bull trout are observed in this area annually, however, the source populations are unknown and there is no documented spawning occurring in the area.

In all cases for the three Core Areas and the Research Needs Area, a very small number of bull trout may be present in the Action Area at any time and may experience adverse impacts caused by the Proposed Action, such as elevated water temperatures or TDG, reduced habitat complexity, entrainment, passage barriers, or reduced food resources. These impacts are likely to occur as a result of power generation, flood risk management, and spill operations that alter the magnitude and timing of flows and water elevations or during maintenance and construction projects. However, given the very low numbers of bull trout present in this portion of the Action Area from any of these Core Areas, it is unlikely that the adverse impacts likely to occur will be measureable at the Core Area scale. If bull trout populations increase in these Core Areas over the term of the action, more bull trout may be exposed to these stressors. However, the Proposed Action is not expected to influence positively or negatively the survival and recovery of these Core Areas because only a portion of these Core Areas is located within the Action Area and only low numbers of bull trout are likely to be adversely affected.

12.2.2.2 Methow/Entiat/Wenatchee/Walla Walla/Umatilla/John Day/Imnaha/Asotin/ Tucannon Core Areas

The status and trend of bull trout populations within these Core Areas varies substantially from stable (e.g., Imnaha, Methow and Wenatchee) to stable but very small (e.g., Asotin) to depressed and declining (e.g., Walla Walla, Umatilla, Tucannon, John Day and Entiat). Bull trout from these Core Areas interact and are present in the Action Area year-round. Telemetry and PIT-tag data indicate the migratory corridors located in the Snake and Columbia rivers are important to the survival, distribution and abundance of bull trout in these Cores Areas and to genetic exchange among and across the Core Areas. The Proposed Action is expected to have adverse impacts on bull trout at a scale that is measureable at the population and Core Area level, except in John Day and Imnaha Core Areas. Bull trout from the three Core Areas in the John Day River Basin are likely to use the Action Area, but the extent of that use is not well understood or documented. There is substantial available habitat within the John Day Basin that likely limits the need for bull trout to use the Columbia River for foraging. Given the few observations of bull trout from John Day Core Areas in the Columbia River portion of the Action Area, the population status of bull trout in the Basin, and the limited changes in Project operations proposed at John Day and McNary dams, adverse effects to bull trout from the John Day Core Areas are not likely to impair survival and recovery of the bull trout in the John Day Core Areas.

Similarly, while bull trout from the Imnaha Core Area are well documented in the Snake River, few are observed downstream at the dams and most bull trout tend to stay upstream of the Action Area. Altered habitat conditions upstream of Lower Granite Dam and downstream of Dworshak Dam, and reduced or altered native food sources (e.g., salmon and steelhead) may adversely impact a few bull trout from the Imnaha Core Area annually. However, the function of the habitat to provide for bull trout foraging and overwintering is not likely to be impaired to an extent that is measureable at the Core Area scale.

For bull trout originating in the Methow, Entiat, Wenatchee, Walla Walla, Umatilla, Asotin, and Tucannon Core Areas, the combined impacts of the Proposed Action, baseline conditions, and cumulative effects (e.g., future impacts of non-Federal dam operations) on the bull trout with respect to passage delays, entrainment, degraded water quality, reduced habitat complexity, altered food sources and availability, and direct handling are expected to: reduce the health and fitness of affected bull trout; delay or result in missed spawning opportunities; and cause injury and mortality of affected bull trout. Within these seven Core Areas, the impacts of the Proposed Action are expected to affect migratory forms of the bull trout the most because migratory forms of the bull trout use the Snake and Columbia rivers for foraging, requiring them to move back and forth throughout the system. Multiple passes through the dams expose these bull trout to injury and mortality during each pass.

In addition, altered hydrology, which reduces habitat complexity, limits riparian vegetation growth, and increases water temperatures, further exposes migratory bull trout to potential predation, reduced native food sources (e.g., salmon and steelhead), and to sublethal or lethal impacts from these stressors. The Proposed Action, in combination with ongoing climate change impacts and other Federal and non-Federal actions, is likely to further diminish habitat quality, decrease forage availability, cause migration delays, and increase the risk of injury and/or mortality of bull trout to an extent that is likely to impair bull trout recovery in these Core Areas. For all of these Core Areas, loss of migratory bull trout is likely to reduce genetic resilience and magnify the threats related to the connectivity of mainstem bull trout populations (USFWS 2015c). Migratory bull trout are larger, more fecund, and provide for a higher likelihood of bull trout persistence and survival in these Core Areas over the long-term. Small Core Areas, such as those located in the Umatilla and Asotin, are likely to lose many of their migratory life forms.

While reduced numbers of migratory bull trout are expected as a result of the ongoing Proposed Action, resident populations of the bull trout within these Core Areas are not likely to be affected by the Proposed Action and are likely to persist into the future. The Proposed Action also includes tributary restoration actions within salmon and steelhead habitat (typically downstream of bull trout spawning habitat), hatchery programs that release additional food sources for bull trout, and monitoring and adaptive management programs to identify and minimize the impacts to migratory bull trout, salmon and steelhead. These measures are likely to minimize the overall impact of the Proposed Action on the bull trout and provide for the survival of bull trout in these Core Areas.

12.2.2.3 Clearwater Core Areas

Bull trout populations in the five Clearwater Core Areas are currently considered stable and strong (i.e., resilient). The Proposed Action is likely to adversely affect a small number of bull trout in these areas via entrainment, and a reduction in riparian habitat function as a result of flow operations and an altered hydrograph that may reduce the overall health and fitness of affected bull trout. However, to date, no measurable impacts of CRS operations on the bull trout at the population scale have been detected, and entrainment is not considered to be a major threat to bull trout recovery in these Core Areas. Similarly, impacts to bull trout from the altered hydrograph and riparian and shoreline habitat losses are also not expected to have population-level effects which have not been documented to date. There is also extensive foraging habitat available to bull trout within the reservoirs located in these Core Areas that is likely to minimize Project impacts to the bull trout in this portion of the Action Area. Future impacts of the Proposed Action on the bull trout in these Core Areas are likely to be consistent with past Project impacts that have not led to declining populations. The number of bull trout impacted in these Core Areas is likely to be low in comparison to the total bull trout populations within the five Core Areas. For that reason, this impact is not likely to be measureable at the Core Area scale. Coldwater releases from Dworshak are expected to provide benefits to downstream habitat areas, especially as they relate to warming waters and climate change. In Dworshak Reservoir and the

Clearwater River downstream of the dam, riparian habitat is expected to be reduced by an altered hydrograph that limits vegetation growth and development. However, due to the large amount of functional riparian habitat that is likely to be available with implementation of the Proposed Action, these impacts to the bull trout are not likely to be detectable at the population or Core Area scales.

12.2.2.4 Clearwater River CHU

PCEs/PBFs in the Clearwater River CHU (#21) are functioning at risk. Upstream of Dworshak Dam and in most of the area encompassed by this CHU, riparian habitat is relatively intact apart from some developed areas with passage barriers (e.g., culverts). Ongoing operations of the Proposed Action are expected to continue to adversely impact habitat complexity and the natural hydrograph within this CHU but particularly downstream of the dam. However, extensive amounts of high quality habitat elements are present in this unit outside of the Action Area and will not be impacted by the Proposed Action. In addition, the release of coldwater from Dworshak Reservoir is likely to improve water quality conditions downstream of the dam when they are critical for bull trout survival. Therefore, in light of the small amount of this CHU likely to be adversely affected by the Proposed Action, and considering the likely benefit of coldwater releases from the dam on the function of this habitat, the Clearwater CHU is likely to continue to provide for bull trout recovery in this portion of the Action Area.

12.2.2.5 Mainstem Upper Columbia River CHU #22/Mainstem Snake River CHU #23

In general, these two CHUs are essential for maintaining bull trout distribution patterns, providing access to FMO habitat, and ensuring connectivity (i.e., conserving critical migratory corridors) between Core Areas. Due to a variety of environmental and anthropogenic factors (e.g., elevated TDG levels and water temperature, lack of fish passage at Grand Coulee and Chief Joseph dams) or undetermined fish passage effectiveness (at Snake and Columbia river dams), an altered hydrograph that limits or reduces riparian habitat growth, reduced and altered native food sources (e.g., salmon and steelhead) and habitat fragmentation within the Action Area, bull trout critical habitat in the MCRU is generally considered either "at risk" or not functional for all PCE/PBFs, except spawning substrate, which is not present. The Proposed Action includes monitoring and adaptive management to minimize adverse effects to the bull trout from passage barriers and water quality. However, the existing degraded function of critical habitat will continue under the Proposed Action. As described above (see Table 16), the Proposed Action is expected to maintain or worsen the existing degraded function of critical habitat within these two units.

12.2.2.6 MCRU Summary

When the effects of the Proposed Action on the bull trout and its critical habitat, and cumulative effects are added to the baseline, minor to significant adverse impacts in twelve of the 24 Core Areas and two CHUs within this portion of the Action Area are likely to occur. The Proposed Action is also likely to cause adverse effects to bull trout in 10 other Core Areas and one RNA. However, these impacts to the species and its critical habitat are not expected to reach a level that is measurable at the Core Area and critical habitat range-wide scales over the 15-year duration of the Proposed Action because: (1) few bull trout are likely to be exposed to these stressors in this portion of the Action Area or it is uncertain the extent to which individuals from these Core Areas use the Action Area; and (2) only a small portion of bull trout critical habitat is likely to be exposed to these stressors.

The two affected CHUs are likely to continue to be degraded as a result of ongoing flow management, an altered hydrograph, and the presence of barriers to bull trout migration. The two affected CHUs provide important FMO habitat but do not provide for bull trout spawning and rearing. The FMO function within these two CHUs is expected to continue to function with implementation of the Proposed Action but at a reduced level for the full duration of the Proposed Action. Resident bull trout populations in the affected Core Areas are not likely to be affected by the Proposed Action. The Proposed Action includes monitoring and adaptive management that is expected to reduce adverse impacts to the bull trout in this Recovery Unit and to the CHUs. In addition, the Action Agencies are implementing tributary habitat restoration actions and hatchery production in relation to forage species that will contribute to the survival and recovery of bull trout in the MCRU.

12.2.3 Coastal Recovery Unit

The CRU includes the estuary, and the mainstem Columbia River downstream of John Day Dam to the Pacific Ocean. In general, aquatic habitat within the CRU in the Action Area is diverse and provides for the unimpeded movement of bull trout during migration, and plentiful opportunities for foraging and rearing. Of the total number of Core Areas (22) and historic areas (4) in the CRU, seven Core Areas (Lewis River, Klickitat River, Hood River, Upper Willamette River, Odell Lake, Clackamas River, and the Lower Deschutes River) and two historic areas (White Salmon and Upper Deschutes) are located adjacent to the Action Area. Manmade and natural barriers prevent bull trout from traveling to and from some Core Areas (e.g., Lewis River and the Upper Willamette River), thereby limiting their accessibility to spawning areas and the Action Area. Within the Klickitat and Hood River Core Areas, existing populations are very small and depressed. In addition, the use of the Action Area by bull trout from these Core Areas and the impact of historical dam operations are unknown.

The Proposed Action is likely to adversely impact water quality and access to otherwise available habitat for bull trout that enter the mainstem Columbia River from the Hood River, Klickitat, and Lower Deschutes Core Areas. Impacts to bull trout caused by the Proposed Action may reduce their capability to support recovery in these Core Areas. However, over the 15-yr term of the Proposed Action, it is unlikely these effect will be measurable at the Core Area scale because there are so few bull trout likely to be impacted in relation to their total population size. Very few bull trout (<10) have been documented within the mainstem Columbia River downstream of John Day Dam in last 20 years. This suggests that while the mainstem may provide foraging habitat and connectivity between Core Areas, it is not likely vital to the overall survival and recovery of bull trout in these Core Areas.

One CHU (Mainstem Lower Columbia River CHU #8) is present within the Action Area. The existing functioning of the unit is degraded and not properly functioning for most PCE/PBFs. This CHU provides important FMO habitat but does not provide for bull trout spawning and rearing. The FMO function is expected to continue to function with implementation of the Proposed Action but at a reduced level for the full duration of the Proposed Action. Resident bull trout populations in the affected Core Areas will not be affected by the Proposed Action. The continued operations of John Day, The Dalles, and Bonneville dams are expected to result in an altered hydrograph that limits or reduces riparian habitat growth, reduced and altered native food sources (e.g., salmon and steelhead), and undetermined passage effectiveness. As described above in the MCRU, while these affects are adverse, the ability of the CHU to provide forage and migration habitat will still exist, albeit in a degraded condition. Also, given the few individuals that utilize the Action Area, the function, even when degraded, will still provide the recovery function for these individuals.

While adverse effects are expected to a few individuals from three Core Areas and continuation of degraded conditions in one CHU are expected, these effects are not expected to appreciably reduce the likelihood of survival and recovery of bull trout in the CRU. The Proposed Action includes monitoring and adaptive management that is expected to reduce adverse impacts to the bull trout in this Recovery Unit and to the affected CHU. In addition, the Action Agencies are implementing tributary habitat restoration actions and hatchery production in relation to forage species that will contribute to the survival and recovery of bull trout in the CRU.

12.2.4 Summary of Effects of the Proposed Action on the Bull Trout at the Range-wide Scale

The Proposed Action is expected to result in adverse effects to the bull trout and its critical habitat in three of the six recovery units designated for the bull trout in the final recovery plan. In some cases, these adverse effects are not expected to impact Core Areas or CHUs significantly because few bull trout will experience the effects due to low documented use of the Action Area, existing populations are strong or there is substantial suitable habitat that is accessible, and/or impacts have not demonstrated measurable effects to Core Areas during historic operations. However, the Service does expect significant impacts to nine Core Areas and six CHUs within three Recovery Units (CHRU, MCRU, and CRU). Within the first 10 years of the Proposed Action, these effects are likely to result in diminishing conservation value of critical habitat and reduced populations, particularly in the Kootenai River and Lake Pend Oreille Core Areas. In at least seven Core Areas in the MCRU, the Service expects the Proposed Action will continue to reduce or significantly impact migratory bull trout and their forage base and continue to degrade migratory habitat. At the scale of the DPS, we expect these near term adverse impacts will not worsen the survival and recovery prospective for bull trout rangewide.

The Service, however, expects that elements of the Proposed Action, as well as ongoing tributary restoration actions, hatchery operations, and passage at Albeni Falls Dam considered in the baseline, will minimize the long-term impact to survival and recovery of all affected Core Areas over the duration of the Proposed Action. Proposed restoration projects both in tributaries and in mainstem rivers, minimum flow and selective withdrawal operations at Hungry Horse and Libby dams, and impact monitoring across the whole Action Area are likely to minimize the extent of the above adverse effects over the full duration of the Proposed Action with frequent coordination with the Services. Collectively, we expect the full effects of the proposed action, in combination with ongoing actions considered in the baseline, will maintain the survival of bull trout across the range and not reduce the long-term recovery of the species.

Therefore, as described in the above sections, while significant measurable impacts are expected in two Recovery Units, the Proposed Action, combined with ongoing activities in the baseline and cumulative actions, is not likely to appreciably reduce the likelihood of survival and recovery of the bull trout because, in most cases, bull trout will continue to persist in tributaries and strongholds (e.g. Lake Koocanusa, Hungry Horse Reservoir), resident populations of bull trout will be unaffected and maintain broad distribution, spawning habitats will be unaffected, and elements of passage and tributary habitat will be improved by the action (e.g. Lake Pend Oreille and Kootenai River). The Proposed Action will not appreciably diminish the conservation value of critical habitat as a whole because all impacted areas are related to foraging, migration and overwintering and not spawning or rearing habitats. This distinction is important because over the duration of the Proposed Action, bull trout spawning and rearing habitat will be unaffected and continue to provide for survival, reproduction, and recovery of bull trout. For the impacted critical habitats, some CHUs are expected to degrade over the full duration of the Proposed Action, others will likely improve due to implemented restoration actions and passage improvements. The declining function in some CHUs and expected beneficial impacts in others combined are likely to result in overall continued function of critical habitat as a whole.

12.2.5 Section 7(a)(2) Determinations for the Bull trout and Bull trout critical habitat

After reviewing the current status of bull trout, the environmental baseline for the Action Area, the effects of the Proposed Action and the cumulative effects, it is the Service's Opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the bull trout and is not likely to destroy or adversely modify bull trout critical habitat for the reasons discussed above.

13 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 Service in regulation as an act that actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the Service in regulation 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 a prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this ITS.

The measures described below are non-discretionary, and must be undertaken by the Action Agencies so that they become binding conditions of any activity authorized or funded by the Action Agencies, as appropriate, for the exemption in Section 7(o)(2) to apply. The Action Agencies have a continuing duty to regulate the activity covered by this ITS. If the Action Agencies 1) fail to assume and implement the terms and conditions or 2) fail to require any contractor to adhere to the terms and conditions of this 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 Action Agencies must report the progress of the action and its impact on the species to the Service as specified in this ITS Take Statement [50 CFR 402.14(i)(3)].

14 AMOUNT OR EXTENT OF TAKE

14.1 Kootenai River White Sturgeon

According to the most recent population estimate (Hardy and McDonnell 2019), there were 1,744 wild adult sturgeon remaining in 2017, with an estimated annual survival rate of approximately 96 percent. Based on those estimates, the wild adult population of Kootenai sturgeon is approximately 1,543 fish in 2020 and will be reduced to approximately 836 fish by 2035. Mark-recapture analyses estimate that between 13 and 85 wild juveniles (median: 49) are produced annually, representing an egg-to-juvenile mortality rate of approximately 99 percent (Note: estimating egg-to-juvenile mortality to a level of precision beyond 99 percent is not reasonable given the low annual sample size of wild eggs and juveniles). Combined with natural mortality and the fact that Kootenai sturgeon do not reach sexual maturity for 15-25 years, this means that should the current low levels of production of wild juveniles continue, the wild population is likely to continue to decline. Specifically, using the median of 49 wild juveniles produced annually, a 4 percent annual mortality rate, and 20 years to reach sexual maturity, approximately 22 wild Kootenai sturgeon would be recruited to the adult spawning population each year. This level of natural recruitment is insufficient to maintain the wild population over time.

Over the course of the 15 years in which this Opinion is in effect, take of 99 percent of sturgeon eggs, embryos, and free-embryos in the wild is expected to occur as long as conditions that are necessary for successful sturgeon in-river reproduction are not realized. It is important to note that sturgeon species naturally experience high mortality of eggs and young (Pine et al. 2001, pg. 1166; Caroffino et al. 2010, pg. 299), and therefore not all of the 99 percent morality of sturgeon eggs, embryos, and free-embryos will be caused by implementation of the proposed action. However, due to the relatively low number of sturgeon eggs annually collected (typically 200-300) it is not possible to differentiate between natural mortality and mortality attributable to implementation of the proposed action. Notwithstanding these anticipated effects, the Service reached a no-jeopardy determination regarding the Proposed Action on the basis that the following suite of beneficial measures to conserve Kootenai sturgeon will be implemented (and effective) under the Proposed Action: (1) continued management of outflows from Libby Dam to benefit sturgeon spawning and migration; (2) continued implementation of a sturgeon habitat restoration program to address habitat-related threats to Kootenai sturgeon as defined in the Proposed Action; (3) continued implementation of nutrient enhancement projects to replace lost nutrients in the basin; (4) continued implementation of research and monitoring activities to inform adaptive management as defined in the Proposed Action; and (5) continued implementation of the conservation aquaculture program to maintain the distribution, genetic diversity, and abundance of the Kootenai sturgeon in the wild over the term of the action (see *Conclusion* section above and the *Effect of the Take* section 15 below). NOTE: Measure 5 will allow time for the other four beneficial measures to become fully effective.

Natural, pre-dam mortality rates of Kootenai sturgeon eggs, embryos, and free-embryos in the wild are unknown, and the ultimate effectiveness of the Proposed Action in restoring natural recruitment is uncertain. For purposes of this analysis, the Service is using the best available science to estimate take. On the basis of that science, we anticipate that up to 228.94 million sturgeon eggs may be killed over the life of the project. The basis for this estimate is presented below:

The average number of female Kootenai sturgeon in spawning condition in 2020 is estimated at 772 (assuming half of the estimated 1,543 remaining wild adults are female). Most recent information indications that 4 percent of the remaining breeding Kootenai sturgeon (i.e., adults) are lost to natural mortality each year.

In order to estimate the number of wild female spawners per year during the next 15 years, we estimated the annual wild adult population starting with the estimated 1,543 wild adults in 2020. We then subtracted 4 percent per year (estimated annual mortality), divided the result by 2 (half females), and then multiplied by 0.25 (females spawn approximately every 4 years). Next, we multiplied the annual number of wild female spawners by 100,000 (estimated eggs per female) to get an estimate of the annual number of eggs produced, and then multiplied that by 0.99 to estimate the number of wild Kootenai sturgeon eggs that will be taken each year over the next 15 years (Table 17). The estimated 22 wild recruits added to the population were not included in the estimate, since it is unknown when that level of recruitment began, which means it is unknown when those sturgeon would begin to reach sexual maturity.

Table 17. Estimated number of Kootenai sturgeon eggs killed over the period 2020 to 2035.

Year	Adults	Females	Female Spawners	100,000 Eggs Per Female	Eggs Taken (99%)
2020	1,543	772	193	19,287,500	19,094,625
2021	1,481	741	185	18,516,000	18,330,840
2022	1,422	711	178	17,775,360	17,597,606
2023	1,365	683	171	17,064,346	16,893,702
2024	1,311	655	164	16,381,772	16,217,954
2025	1,258	629	157	15,726,501	15,569,236
2026	1,208	604	151	15,097,441	14,946,466
2027	1,159	580	145	14,493,543	14,348,608
2028	1,113	557	139	13,913,802	13,774,663
2029	1,069	534	134	13,357,249	13,223,677
2030	1,026	513	128	12,822,959	12,694,730
2031	985	492	123	12,310,041	12,186,941
2032	945	473	118	11,817,639	11,699,463
2033	908	454	113	11,344,934	11,231,485
2034	871	436	109	10,891,137	10,782,225
2035	836	418	105	10,455,491	10,350,936
				Total eggs taken	**228,943,158**

Based on these calculations, 228,943,158 wild Kootenai sturgeon eggs are likely to be lethally taken in the next 15 years. The Service anticipates that exceedance of this level of take would be difficult to detect for the following reasons:

- The size of the Kootenai River, plus the fact that Kootenai sturgeon spawn during peak river flows, making collection of fertilized sturgeon eggs difficult; and,
- Fewer than 500 fertilized eggs are typically collected each year (IDFG 2018, pg. 8; IDFG 2017, pg. 9), which is insufficient to identify a 1 percent decrease in egg survival.

Therefore, the Service used a surrogate as a means to determine if the estimated level of take is exceeded. Pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an ITS, provided three criteria are met: (1) measuring take impacts in terms of individuals of the listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard can be established using the surrogate for when the authorized level of take has been exceeded. In this case, the Service used the capture of wild juvenile Kootenai sturgeon as a surrogate means to determine if the level of take of eggs has been exceeded for the following reasons:

- As noted above, fertilized sturgeon eggs are not collected in sufficient quantities to detect a 1 percent decrease in survival;

- A 1 percent decrease in egg survival (from the 99 percent estimate) would constitute a 100 percent mortality rate of fertilized sturgeon eggs, which would necessarily lead to a total lack of production of wild juvenile sturgeon; and,
- Wild juvenile sturgeon have been collected annually since 1992 (IDFG 2018, pg. 33).

Therefore, the level of take of fertilized sturgeon eggs would be exceeded if the egg-to-juvenile mortality rate increased above the current estimate of 99 percent, which would be indicated by zero wild juveniles being captured over 3 or more consecutive years.

Notes:

- Given the low number of wild juveniles captured each year, three or more consecutive years of zero captures guards against take being exceeded due to a single anomalous year, such as a year with a low water supply.
- It is acknowledged that species with high fecundity, such as sturgeon, naturally experience high mortality of eggs and young (Pine et al. 2001, pg. 1166; Caroffino et al. 2010, pg. 299).
- Although some hatchery-origin Kootenai sturgeon are expected to reach sexual maturity and begin spawning over the next 15 years, the rate at which this will occur is uncertain and cannot be quantified.

14.2 Bull Trout

The Service anticipates incidental take of bull trout will be difficult to detect in most cases for the following reasons:

- The bull trout is wide-ranging within suitable habitat in the Action Area and is difficult to detect due to its preference for residing in fast-moving water near the bottom of the water column;
- Changes in bull trout numbers in the Action Area caused by take incidental from CRS operations are likely to be masked by natural, seasonal fluctuations in bull trout numbers or by other causes such as bull trout behavioral changes in response to changes in water quality or flow velocities;
- Finding dead or injured bull trout is unlikely because they are likely to be swept downstream or preyed on;
- Mortality may be delayed; and/or
- The relationship between habitat conditions and the distribution and abundance of individual bull trout is imprecise such that a specific number of affected individuals cannot be practically obtained.

In situations where take of individual bull trout can be measured and quantified, the Service anticipates the following form and amount of take of the bull trout as a result of the Proposed Action:

1. Incidental take in the form of harm of up to 500 adult and subadult bull trout per calendar year as a result of fish passage facility operations at 8 dams in the Snake and lower Columbia rivers. While the ultimate operation of fish passage facilities is beneficial, these operations create upstream seasonal and temporary migration barriers that significantly disrupt normal bull trout behaviors causing increased stress, reduced fitness, and delayed migration that is likely to result in mortality or injury (reduced or missed spawning opportunities).

2. Incidental take in the form of harm of all adult and subadult bull trout attempting to migrate from mainstem rivers (e.g., Kootenai, Pend Oreille, Flathead, Columbia, Snake and/or Clearwater rivers) into tributaries to spawn during FRM and power-generating operations that cause low or subsurface flows. These operations are likely to significantly disrupt normal bull trout behaviors and cause increased stress, reduced fitness, and delayed migration of affected fish. Such effects are likely to kill or injure all affected bull trout.

3. Incidental take in the form of harm of subadult and adult bull trout annually subject to increased stress, bodily injury, or mortality caused by entrainment of bull trout through turbines, sluiceways, or over dam spillways as a result of dam operations. The following numbers and percentages of bull trout are anticipated to be entrained (Table 18).

Table 18. Estimated number of bull trout entrained per CRS dam.

Dam	**Number of bull trout entrained annually**	**Percent Mortality of Entrained Bull trout**
Libby	Up to 2,235	< 11%
Hungry Horse	Up to 1,500	< 11%
Albeni Falls	Up to 100	< 5%
Dworshak	Up to 2,235	< 11%
Grand Coulee and Chief Joseph	Up to 15	< 25%
Lower Snake River dams, McNary and John Day	Up to 500	< 5%
Dalles and Bonneville	Up to 10	< 5%

4. Direct take in the form of capture (with some incidental injury or mortality) of bull trout for salvage purposes as quantified in the Table below. The direct take resulting from salvage operations will minimize the incidental take of individual bull trout from dewatering activities or during research activities. Direct capture and incidental lethal take of subadult and adult bull trout is likely to occur in conjunction with electrofishing, netting, trapping, handling, tagging, and transport of bull trout during fish salvage or removal activities, passage facility handling, or as needed related to research activities at Project dams (Table 19).

Table 19. Estimated number of individuals handled annually between 2020 and 2035 during maintenance and bull trout research projects occurring at or immediately adjacent to CRS dams.

Dam	Total Number Individuals Handled per project or research activity	Mortality per project or research activity (no more than)
Libby	Up to 25	2 individuals
Hungry Horse	Up to 30	2 individuals
Albeni Falls	Up to 35	5 individuals
Grand Coulee, John Keys III	Up to 5	0
Chief Joseph	Up to 5	0
Dworshak	Up to 25	2 individuals
Lower Granite	Up to 25	2 individuals
Little Goose	Up to 50	5 individuals
Lower Monumental	Up to 45	5 individuals
Ice Harbor	Up to 20	2 individuals
McNary	Up to 35	3 individuals
John Day	Up to 20	2 individuals
The Dalles	Up to 10	1 individual
Bonneville	Up to 10	1 individual

Pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an ITS, provided three criteria are met: (1) measuring take impacts in terms of individuals of the listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard can be established using the surrogate for when the authorized level of take has been exceeded. In this case, the extent of impacts to bull trout habitat caused by Project operations likely to actually kill or injure bull trout is a reasonable surrogate to express the amount of anticipated take (see discussion of surrogate use in the Effects Analysis). It is the Service's customary practice to rely on habitat impacts to inform the determination of bull trout take impacts. For this reason, quantifying and monitoring impacts to bull trout habitat caused by CRS operations is a scientifically credible and practical approach for expressing and monitoring the anticipated level of bull trout take in situations where monitoring of take impacts in terms of individual bull trout is not feasible or practicable.

The following levels of incidental take of the bull trout in the form of harm using a habitat surrogate are anticipated with implementation of the Proposed Action:

1. Loss and degradation of up to 8 percent of riparian habitat across the Action Area (defined in Section 5.9) every 5 years as measured by aerial mapping or geographic information system (GIS) analysis resulting from FRM and hydropower operations that are likely to cause reductions in nutrients, forage availability, primary productivity, and habitat complexity and altered water temperatures that result in altered bull trout behavior, decreased access to forage resources, and lowered fitness of affected bull trout to the extent individuals affected are subject to increased predation, stress, and mortality.

2. Habitat degradation within 500 ft of construction and maintenance activities resulting in elevated underwater noise and increased turbidity and sedimentation conditions at each project identified in Tables 12, 13, and 14 in Section 10.2.2 above.

15 EFFECT OF THE TAKE

15.1 Kootenai River White Sturgeon

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to Kootenai sturgeon or destruction or adverse modification of critical habitat when the Proposed Action is fully implemented, primarily because implementation of measures specific to Kootenai sturgeon effectively constitutes implementation of the full recovery strategy outlined in the Revised Recovery Plan for Kootenai sturgeon, and the full suite of actions in the 2008 Clarified RPA, from the 2006 Opinion on the Effects of Libby Dam Operations on Kootenai sturgeon. Together, these measures constitute the best available science on the means to avoid jeopardy to, and recover Kootenai sturgeon.

15.2 Bull Trout

In the accompanying Opinion, the Service determined that the above levels of anticipated take are not likely to result in jeopardy to the species or the destruction or adverse modification of its critical habitat.

16 REASONABLE AND PRUDENT MEASURES

16.1 Kootenai River White Sturgeon

The Service believes the following Reasonable and Prudent Measures (RPMs) are necessary and appropriate to minimize the impacts of the taking on the Kootenai sturgeon:

a) By December 31, 2025, the Action Agencies shall provide to the Service a comprehensive status report on the Kootenai River Habitat Restoration Program.

b) By December 31, 2021, the Action Agencies shall provide a report to the Service that evaluates the potential installation of one additional turbine at Libby Dam to provide redundancy in the event of turbine failure and/or extended maintenance, to increase the likelihood that spring releases for Kootenai sturgeon recovery can be achieved annually.

c) By December 31, 2023, the Action Agencies shall provide a report to the Service addressing sturgeon flow volume tiers, specifically focusing on the implications of accounting for the volumes as outflows above VARQ operations, rather than the current approach of accounting for the volumes as outflows above minimum flows (4,000 cfs).

d) By December 31, 2022, the Action Agencies shall provide an analysis to the Service examining opportunities to implement additional nutrient addition projects in the Kootenai River Basin.

e) By March 31 of each year over the term of the action analyzed in this Opinion, the Action Agencies shall provide an annual report to the Service summarizing the adverse and beneficial effects of the action on the Kootenai sturgeon.

16.2 Bull Trout

The Service believes the following RPMs are necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of the bull trout caused by the Proposed Action:

a) Minimize the impact of passage barriers and entrainment caused by CRS operations on bull trout.

b) Minimize reductions in riparian habitat losses and primary productivity resulting from an altered hydrograph and fluctuating water levels caused by CRS operations.

c) Minimize effects to bull trout from increased sedimentation input from CRS in-water maintenance project activities.

d) Minimize and monitor take of bull trout caused by handling from research, monitoring, and salvage operations.

e) Monitor and report on the effectiveness and impacts of implementing all of the above RPMs.

17 TERMS AND CONDITIONS

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

17.1 Kootenai River White Sturgeon

1. To implement RPM 16.1(a), the Action Agencies shall ensure that the status report on the Kootenai River Habitat Restoration Program includes the following elements:
    a. A comprehensive assessment of the performance of projects implemented through 2025, including (but not limited to) assessments of their durability, maintenance, effectiveness (e.g., addressing limiting factors for Kootenai sturgeon, restoring/enhancing ecosystem functions), and likelihood of long-term functionality;
    b. A full roster of the entities who provided input into the process; summaries of the recommendations from each entity on the implementation of future projects, which at a minimum specifies the types, locations, and relative priority of projects recommended to be implemented, or if the recommendation is to not implement additional projects, a comprehensive justification for that recommendation;
    c. A notification to the Service on how the Action Agencies will use the information and recommendations in the report, and the decision by the Action Agencies as to how they will proceed with regard to the restoration program for the duration of this Opinion.

2. To implement RPM 16.1(b), the Action Agencies shall ensure the evaluation of the possible installation of one additional turbine at Libby Dam includes a description of the feasibility of installing one additional turbine and a decision by the Action Agencies as to how they will proceed on the possible installation of an additional turbine.

3. To implement RPM 16.1(c), the Action Agencies shall ensure the report on reevaluation of how sturgeon volume tiers are accounted for, including alternatives for how sturgeon flow volume could be released under the alternative accounting, a description of the effects to FRM and hydropower operations, and a decision by the Action Agencies as to how they will proceed on the possible reevaluation of the sturgeon volume tiers.

4. To implement RPM 16.1(d), the Action Agencies shall ensure the report on opportunities for additional nutrient addition projects includes a description of the potential opportunities that were considered, a decision by the Action Agencies as to how they will proceed on each potential opportunity, and a rationale for decisions made.

5. To implement RPM 16.1(e), the Action Agencies shall ensure the annual report to the Service includes information on the implementation and status of: 1) the Kootenai sturgeon conservation aquaculture program; 2) the flow-planning protocol process; 3) the Kootenai River Habitat Restoration Program; 4) the nutrient addition programs; and 5) Kootenai sturgeon monitoring and reporting.

17.2 Bull Trout

1. To implement RPM 16.2(a), the Action Agencies shall implement the following:

   a. Snake and Lower Columbia River dams:

      i. By December 31, 2020, the Action Agencies, in coordination with the Service, will review the current fish count program, existing bull trout count/observation data, and clarify potential fish count program changes needed to inform CRS operations related to bull trout. If needed, shall develop a plan to increase video and visual monitoring at select Snake River and Lower Columbia River dam adult passage facilities for at least five years. The proposed plan will include the following elements:

         1. Increased winter (December through March) monitoring at Snake River and McNary Dams;
         2. Visual monitoring during primary bull trout migration periods and hours as identified by the Service, particularly in April, May and June; and
         3. Timelines for implementing additional monitoring.

      ii. At the end of five years (no earlier than June 2025), the Action Agencies shall prepare a summary of bull trout observations at the passage facilities (from 17.2(1)a(i)) that includes:

         1. Total observations
         2. Directional movement (i.e. number of bull trout observed moving upstream, number moving downstream)
         3. Month and timing (hours of the day) of passage
         4. A proposal for how monitoring may continue for remainder of the Proposed Action, based on observation data.

      iii. Within five years (June 2025), the Action Agencies shall, in coordination with USFWS, review existing information on physical and hydraulic conditions within the adult fish ladders (including approaches to fishway entrances), adult and subadult (10 inches in length or greater) bull trout swimming ability, bull trout distribution and migration behavior within the lower Snake River and lower Columbia River, and other studies (including, if appropriate, results of passage studies involving anadromous salmonids or studies at similar dam passage facilities (i.e. Mid-Columbia Public Utility District dams)) to identify key data gaps and opportunities that may inform operation and/or configuration changes to improve bull trout passage.

iv. Within two years of the issuance of this Opinion (i.e., by approx. July 2022), the Action Agencies shall convene, in coordination with the Service and NOAA Fisheries, a workshop to review existing information on seasonal passage routes used by adult and subadult bull trout for downstream passage at McNary and the lower Snake River dams. The workshop will include review of relevant downstream salmon and/or steelhead passage study results, data on PIT-tag detections of bull trout movements across the Snake and Columbia River region, and existing information on downstream bull trout passage routes at the five non-federal Mid-Columbia Public Utility District dams. Workshop participants shall identify data gaps, describe assumptions and analyses on comparative value of any surrogate species data used (i.e., what makes surrogate comparable and what makes surrogate inconsistent with bull trout), and assess the feasibility of using additional, targeted passage studies to address data gaps. Workshop results shall be summarized and shared with the Service and other regional sovereigns.

    Following completion of the workshop, the Action Agencies shall, in coordination with the Service, NMFS and appropriate Regional Forum work groups, determine if additional data collection is feasible and needed to inform operation and/or configuration changes to improve bull trout passage. The Action Agencies shall implement passage studies, if feasible and warranted. Study goals, objectives, and methods will be developed in coordination with the Service, NMFS and other regional sovereigns through the SRWG.

v. Within two years (i.e. by June 2022), the Action Agencies, in coordination with the Service, shall review and evaluate the PIT detection array infrastructure at mainstem dams and determine whether additional sites are needed to track movements of PIT-tagged bull trout through all downstream passage routes.

vi. The Action Agencies shall continue to assess and minimize the duration of maintenance closures to the greatest extent possible.

vii. The Corps shall continue to monitor for presence of bull trout in raceways and juvenile fish transport barges through the Smolt Monitoring Program. If bull trout are detected in the raceways or barges, the Action Agencies shall, in coordination with the Service and NMFS, propose methods to reduce, minimize or eliminate the incidental transport of bull trout in barges, if reasonable and feasible.

viii. Within five years of the issuance date of this Opinion (i.e. by approx. July 2025), the Action Agencies shall, in coordination with the Service, investigate the feasibility of using eDNA sampling procedures to assess the level of incidental bull trout transport occurring in juvenile transport barges. If eDNA sampling is determined to be an appropriate means of collecting the desired data that could inform changes to the transport program that would reduce or eliminate incidental bull trout transport, the Action Agencies shall implement an eDNA monitoring study. Results from this study will be reviewed with the Service and FPOM to determine if additional data collection is warranted.

b. Libby Dam: The Action Agencies shall work with local Federal, State and Tribal biologists, who are either elected members or employees specifically designated by an elected members, to ensure bull trout populations in tributaries to the Kootenai River do not decline - as a result of the Proposed Action - more than expected in this Opinion prior to proposed implementation of tributary habitat restoration projects. Annually, the Action Agencies shall participate in a broader regional discussion between the Service and Federal, State, and tribal biologists on measures and redd count surveys. If bull trout redd counts decline more than estimated in this Opinion (Table 10), the Action Agencies shall identify and implement additional measures, as practicable, consistent with the effects of our actions, and as part of a broader coordinated effort with the Service and Federal, State, and tribal biologists. These measures may include, but are not limited to, short-term supplementation of bull trout population from populations upstream of Libby Dam, adding nutrients to the river to improve productivity, working with the State to implement timing restrictions for fishing from the bridge downstream of Libby Dam, or dam operational changes to increase flows and improve bull trout passage conditions for access to tributaries, consistent with costs and biological effectiveness.

2. To implement RPM 16.2(b), the Action Agencies shall:

a. By July 2022, complete, in coordination with the Service, a baseline inventory of existing mainstem riparian habitat hydraulically-influenced by operation of the CRS within the Action Area (as defined in Section 5.9) using the latest GIS remote sensed and ground-truthed data sets, including, but not limited to, LANDFIRE or LF, the Service's Wetlands mapper, multi-resolution land characteristics or MRLC, and State riparian and wetland datasets. In addition, the Action Agencies and FWS may use or create new GIS imagery (e.g., using DigitalGlobe or other sources) and on-the-ground spot checks to further refine and assess existing riparian conditions.

b. Every five years following establishment of the baseline (described in 17.2(2)a), the Action Agencies shall evaluate riparian habitat in coordination with the Service, either at selected index sites identified in the baseline inventory, or by conducting a complete, comprehensive review of the Action Area using methods similar to those used in establishing the baseline, to determine if riparian losses due to operation of the CRS exceed the 8 percent threshold set forth in this Opinion. If said losses exceed the threshold, the Action Agencies shall work with the Service to identify measures that could be implemented to improve riparian conditions prior to the next five-year review.

c. The Action Agencies shall provide a report to the Service every five years summarizing projects completed under the Tributary Habitat Program that have resulted in benefits to bull trout populations. The reports shall include: A discussion of the tributaries or bull trout Core Areas where the projects occurred;

    i. Where in the tributaries the activities occurred (spawning and rearing habitat or FMO habitat),

    ii. The types of projects implemented; and

    iii. The action agencies shall share reporting submitted to NMFS with the Service including annual metrics reported and the more detailed 5-year report and analysis. A discussion of the potential value the projects completed have to bull trout will be included.

d. Within eight years of the date of this Opinion (i.e., July 2028), the Action Agencies shall assess existing research and available data (similar in scope to Torgersen et al 2012, EPA 2019 or Mejia et al 2020) to determine existing nearshore habitat and cold water refugia in the Snake River from the mouth of the Clearwater to Columbia River to identify opportunities for restoration and protection of those areas and/or operational actions to minimize loss of refugia areas. If data gaps are identified, then additional field studies may be required.

e. Within two years of the issuance date of this Opinion (i.e. July 2022), the Action Agencies shall work with the Service and MFWP to assess the benefit of adding nutrients to the Kootenai River near Libby Dam to improve primary productivity for bull trout forage and to develop and implement a plan for improving nutrient conditions in the Kootenai River through December 2025. Long-term (post 2025) actions to improve nutrient conditions shall be jointly agreed upon by the Service and the Action Agencies.

3. To implement RPM 16.2(c), the Action Agencies shall implement the following actions:

    a. The Action Agencies shall monitor turbidity levels during sediment-generating activities at construction sites as described below. If another regulatory agency requires more stringent monitoring, that requirement shall supersede these terms.

        i. Monitoring shall be conducted at a distance of 500 ft downstream of sediment-generating activities at 30 minute intervals.

        ii. If turbidity monitoring shows there is no increase in turbidity over background at a point 500 ft downstream of the construction site, no further turbidity monitoring will be needed for that activity. This determination will indicate that sediment control measures are being implemented correctly to minimize turbidity impacts.

    b. Over the timeframe of the Proposed Action, we anticipate construction, repair and/or maintenance projects may occur for which we do not currently have enough information to assess the amount or extent of localized incidental take of bull trout caused by the Proposed Action. For construction activities not identified in the Proposed Action or indicated in Tables 12, 13, and 14, that have the potential to affect the bull trout, the Action Agencies may need to complete project-specific Section 7 consultation and shall coordinate with the Service accordingly.

4. To implement RPM 16.2(d), the Action Agencies shall:

    a. Ensure all bull trout capture and removal operations are conducted by a qualified biologist, and all staff participating in the operation have the necessary knowledge, skills, and abilities to ensure safe handling of fish.

        i. Fish capture and removal operations shall take all appropriate steps to minimize the amount and duration of fish handling;

        ii. The operations shall ensure captured fish remain in water with appropriate temperatures to prevent and minimize stress to the maximum extent possible;

        iii. The Action Agencies shall ensure water quality conditions are adequate in the buckets or tanks used to hold and transport captured fish. The operations shall use aerators to provide for the circulation of clean, cold, well-oxygenated water, and/or shall stage fish capture, temporary holding, and release, to minimize the risks associated with prolonged holding;

        iv. Electrofishing methods, when necessary, shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish. Water conductivity shall be measured in the field before electrofishing to determine appropriate settings. Electrofishing equipment and methods shall comply with the electrofishing guidelines outlined by the NMFS (NMFS 2000c) or current equivalent; and

    v. Any bull trout encountered during salvage activities shall be reported and, when practical, collect biometric data (size, weight), PIT-tag and take a genetic clip. Bull trout captured during smolt monitoring sampling shall receive a PIT tag, have a genetic clip taken, and biometric data collected (size, weight). If the number of bull trout encountered is locally abundant, a subsample of captured and handled fish shall be PIT tagged with associated genetic and biometric data collected. All data will be reported annually.

b. The Action Agencies shall enter data for any PIT tagged bull trout (as described in 17.4.a.v above) into the PITAGIS database.

c. The Action Agencies shall provide genetic tissues collected during implementation of the Proposed Action or associated mitigation activities. This will aid in determining the populations of origin, possible effective breeding size, and genetic variance for bull trout within the Action Area. These data may be used to determine population level impacts of the Proposed Action. Genetic samples (e.g. fin clips) shall be submitted for analysis to the Service's Abernathy Fish Technology Center in Longview, Washington, or a genetics lab with equivalent processing and analysis capabilities; and,

d. All incidental mortalities of bull trout must be preserved in a fashion to best provide maximum scientific information to the extent possible. Any specimen killed shall be kept whole and put on ice or frozen when feasible. Such specimens shall be wrapped in aluminum foil rather than plastic to facilitate contaminant analysis. The collector shall label the specimen with appropriate information and notify the Service for disposition.

5. To implement RPM 16.2(e), the Action Agencies shall implement the following:

    a. The Action Agencies shall incorporate data into an existing site or database (s), or if necessary, develop a reporting site or database(s), for bull trout observations funded or implemented by the Action Agencies (including smolt monitoring programs, PIT arrays, and other monitoring programs) under the Proposed Action in association with dam operations, research, monitoring and evaluation. Database(s) shall be selected and/or updated with input from the Regional Forums for data to be queried by dam, date, passage facility or passage route (PIT arrays), source population (genetics, if available) or tagging location, and other information identified by the Service at FPOM; and

    b. Every five years by December 31, in combination with regular summary updates at regional forums, the Action Agencies shall provide a report of the above actions related to each dam to the appropriate Service field office below:

        i. Libby and Hungry Horse dams – Montana Field Office, Kalispell, Montana; Eastern Washington Field Office, Spokane, Washington.

ii. Albeni Falls and Dworshak dams – Northern Idaho Field Office, Spokane, Washington and Coeur d'Alene, Idaho; Eastern Washington Field Office, Spokane, Washington.

iii. Grand Coulee, Chief Joseph - Eastern Washington Field Office, Spokane, Washington; Mid-Columbia Fish and Wildlife Conservation Office, Leavenworth, Washington.

iv. Snake River and McNary dams – Eastern Washington Field Office, Spokane, Washington; Columbia River Fish and Wildlife Conservation Office, Vancouver, Washington.

v. John Day, The Dalles, Bonneville dams – Oregon Fish and Wildlife Office, Portland, Oregon; Columbia River Fish and Wildlife Conservation Office, Vancouver, Washington; Eastern Washington Field Office, Spokane, Washington.

The RPMs, with their implementing terms and conditions, are designed to minimize the impacts of take that might otherwise result from the Proposed Action. If, during the course of the action, the levels of authorized take of the bull trout are exceeded, such take represents new information requiring re-initiation of consultation and review of the RPMs provided herein. The Action Agencies must immediately provide an explanation of the causes of the taking and review with the Service need for possible modification of the RPMs.

The Service is to be notified within three working days if Action Agency staff or other authorized individuals locate a dead, injured or sick endangered or threatened species specimen. The initial notification shall be made to the nearest Service Law Enforcement Office. The notification shall include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care shall 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. Under such circumstances, the Action Agencies shall contact the Service's Law Enforcement Office at (425) 883-8122.

18 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to use 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.

18.1 Kootenai River White Sturgeon

The Service provides the following recommendations related to Kootenai Sturgeon:

- To assist the Service in evaluating the status of the wild adult population of Kootenai sturgeon as well as the effects of the Proposed Action on the population, we request that every 5 years the Action Agencies provide the Service a science-based/statistical estimate of the abundance of wild adult Kootenai sturgeon.
- To assist the Service in evaluating the effects to Kootenai sturgeon from implementation of the Kootenai sturgeon aquaculture program, we request that every 5 years the Action Agencies provide the Service a science-based estimate of the number of hatchery-origin Kootenai sturgeon in the Basin.
- Continue to fund data collection and research into Kootenai sturgeon genetics, with special emphasis on spontaneous autopolyploidy, overall genetic diversity of the population, and developing genetic markers to establish individual lineages.
- Cooperate and coordinate with relevant Canadian entities to ensure consistency among Kootenai sturgeon recovery efforts.
- Continue to implement actions consistent with the Memorandum of Understanding for the Kootenai River and Kootenay Lake Burbot Conservation Strategy (KVRI Burbot Committee 2005, entire).
- In cooperation with local diking districts, seek opportunities to improve levee conditions in the Kootenai Flats area. Increased levee stability would allow for greater flexibility in Libby Dam operations, and may aid in the restoration of river conditions needed for successful sturgeon spawning.

18.2 Bull Trout

The Service recommends the following measures for Bull Trout:

- Support ongoing regional discussions with sovereigns and stakeholders across the region to develop and implement future collaborative conservation approaches to rebuild salmon and steelheadlisted fish populations in the Columbia River Basin.

  The Service recommends that CRS action agencies factor in bull trout, lamprey, sturgeon and other native priority species into ongoing collaborative forums across the region where possible, such as the Columbia Basin Partnership Task Force or Salmon Recovery Boards. The goal is to promote ecological health and a comprehensive approach for all native species impacted by the operations of dams in the CRS within the Action Agencies statutory and regulatory responsibilities.

  As with the Task Force members, the Service sees great value in continuing comprehensive collaboration into the future, recognizing regional opportunities to advance species recovery, resiliency and sustainability. Together the groups should identify the importance of a path forward that would provide a unique venue for stakeholders to work collectively with federal, state, and tribal managers. Such a diverse membership can bring together expertise, knowledge, and wisdom m from across social, cultural, economic, and ecological interests across the Basin. The collaboration helps to form a critical bond among broader constituencies and communities in the Basin. Finally, the commitment to work together creates a powerful foundation for future collaboration. Therefore, the Service recommends that the action agencies continue to participate in regional discussions to develop and implement such a forum and include the Service in the broader discussions.

Within the regional forums above, the Action Agencies should continue to consider and discuss methods that improve migratory connectivity for the ecological benefit for bull trout and native bull trout forage species.

- The Action Agencies should work within their authorities and/or with local stakeholders to reconnect rivers and tributaries to their floodplains, side channels, and associated wetlands. Where possible, set back or remove structures such as levees, dikes, riprap, and bank stabilization that constrain lateral movement of rivers. Reconnect rivers and tributaries to floodplains, associated wetlands, side channels, and oxbows.

- The Columbia Estuary Ecosystem Restoration Program (CEERP), formalized in 2012, has further focused the Action Agencies estuary restoration program, identifying key actions such as restoring full tidal connectivity to historic floodplains, channels, and other shallow water habitats (BPA/Corps 2016). Since 2004, the Action Agencies have purchased, protected, and restored approximately 14,000 floodplain acres for juvenile salmonid habitat across 60 individual sites throughout the tidally influenced portion of the Lower Columbia River and Estuary. CEERP's most recent synthesis of actions taken (Johnson et al. 2018) to evaluate project effectiveness and provide future direction concluded:
    - "Action effectiveness monitoring data from 23 project sites collected in various years since 2004 indicated that restoration actions were reestablishing ecological processes by restoring hydrologic connectivity. Juvenile salmon, especially subyearling Chinook salmon, were present at all 13 restoration sites where researchers attempted to capture fish.
    - The findings did not support the general paradigm that yearling-sized fish migrate rapidly through the estuary, feed little, and make little use of wetlands. Data showed that yearling salmon fed in the mainstem and inhabited tidal wetland channels.

RM&E of the restoration actions mentioned above in the estuary is demonstrating that juvenile salmonids are using restored habitats prior to entry into the ocean. The completion of these actions and future restoration projects will benefit bull trout by increasing the function of estuarine and nearshore marine habitats. More specifically, these actions are supporting migratory, fluvial life history strategies with improvements to foraging habitat and increases in quantity and quality of forage fish within the essential migration corridor for the lower Columbia River region of the Coastal Recovery Unit. The Action Agencies should continue to participate in the program above and, where possible, purchase floodplain properties or easements to reconnect floodplain and side channel habitat in the Columbia River Estuary, thus creating and expanding shallow water habitat.

- The Action Agencies should work with regional irrigators to improve efficiencies, remove, and/or evaluate the need for irrigation withdrawals across the region and improve or install appropriate fish screens at diversions and irrigation ditches to prevent the entrainment of fish into irrigation systems. In areas where possible, facilitate ways to increase instream flow to improve water quality, decrease stream temperatures, and reduce long-term impacts from climate change. Restore connectivity and opportunities for migration by securing instream flows and/or water rights to increase water quantity. Continue to strategically identify water acquisitions that are targeted for the most benefit for Bull trout and other salmonids. Improve irrigation efficiencies and allow conserved water to be used for instream purposes. Reduce diversions where necessary and feasible.
- The Action Agencies should continue to work toward establishing flow regimes that mimic the pre-dam hydrograph in the following ways:
    - Allow seasonally appropriate high water events once or twice per decade (i.e., to achieve natural conditions suitable for successful riparian seedling establishment);
    - Provide flushing flows, channel maintenance flows, and sediment transport annually or biannually
    - During high flow years, drawdown and ramping rates should be no more than 1 inch per day, which will promote the growth and survival of newly established riparian seedlings;
    - Monitor riparian vegetation recruitment and respond to years of high cottonwood and willow recruitment. This could be accomplished by limiting winter water levels to not exceed the previous peak-flow water level associated with high riparian recruitment for at least two winters following the year of high riparian recruitment; and,
- The Action Agencies should work with City and County agencies to reduce or eliminate development of floodplain areas for any purpose except to dissipate flood water and energy or to perform restoration activities. Where possible, restore floodplain connectivity, remove or set-back levees, and increase off channel areas. Identify potential development concerns (e.g., conversions of farms/ranches to subdivisions) to county and city land use planning entities. Provide recommendations to minimize floodplain development.
- Bonneville should coordinate with other entities across the region to evaluate energy storage infrastructure and technology to minimize flow fluctuations in response to short-term changes in power demand. If pump storage is implemented, ensure stored water does not negatively affect the natural hydrology of river or natural lake environments.

18.3 Bull Trout Recovery Efforts

The Action Agencies should work with regional stakeholders (Service, tribes, states, and NGOs) to implement measures identified in the 2015 Bull trout Recovery Plan that are either related to CRS or may improve the recovery potential of bull trout populations impacted by CRS operations. These include, but are not limited to the following:

- The Corps should cooperatively participate and/or fund efforts to implement bull trout reintroduction or supplementation into the Pend Oreille River downstream of Albeni Falls Dam after completion of the upstream passage facility.
- Work with the Service, MFWP, IDFG, KTOI, and CSKT to determine if reintroduction and/or supplementation of bull trout downstream of Libby Dam is needed for recovery of the Kootenai River Core Area. Provide funding and/or staff support to identify populations most at risk for extirpation and needing supplementation, source populations, and opportunities to supplement and recover populations in the Core Area.
- Support and/or fund investigations of bull trout movement between Lower Mid-Columbia Core Areas and ensure opportunities for connectivity. This may include funding of studies to improve the speed and ease of genetically identifying source populations and develop and implement a marking program (e.g., PIT tags) within each of the subbasins with sufficient numbers of migratory bull trout to estimate survival back to the subbasin, and to document connectivity to other subbasin populations of bull trout.
- Coordinate with local salmon and bull trout work groups, utilities, and the Service to develop projects in a coordinated manor to reduce redundancy, reduce impacts to bull trout, and for efficiency in spending funds designed for the mitigation of hydropower operations across the Columbia River Basin. Additional projects could be developed specifically for bull trout in coordination with other funding efforts. Explore opportunities for development of bull trout-specific mitigation funding mechanism that would provide cost share opportunities and insure funding of projects upstream of salmon habitat.
- Evaluate predation by piscivorous avian predators (e.g., pelicans, cormorants, terns) from mainstem nesting colonies on migratory bull trout. These studies should specifically address the spatial and temporal nature of predation both in the mainstem and within the subbasins.

18.4 Western Yellow-Billed Cuckoo

The Service recommends the following measures for yellow-billed cuckoo:

- The Action Agencies should complete a comprehensive survey of all suitable habitat across the Action Area. Mature cottonwood forests exist in several areas across the Action Area, but have not been well surveyed to date.

- The Action Agencies should work with the Service, states, tribes, and others to identify areas where suitable habitat such as cottonwood galleries and riparian forests within the Columbia River Basin could be enhanced by operations to improve suitable habitat availability for yellow-billed cuckoo. Identify where operations may be able to improve growth and survival of riparian cottonwood galleries. Implement actions such as conservation easements or land purchases to protect identified areas from development and recreational impacts.

18.5 Streaked Horn Lark

The Service recommends the following measures for streaked horned lark:

- The Action Agencies should work with others to identify or seek funding and authority to implement alternate methods of creating and maintaining suitable habitat for streaked horned larks at network sites transitioning to unsuitable habitat, and that are not slated for deposition. This could increase the availability of suitable habitat for the lark, and would allow the Corps more flexibility in its use of the sites in the network.
- The Action Agencies should assist in the recovery of the streaked horned lark in the Lower Columbia River by engaging with the Lower Columbia River ports to develop a comprehensive plan for activities that could affect lark.
- Wherever possible, the Action Agencies should fund research to fill critical knowledge gaps regarding the ecology of the streaked horned lark in the area, including a study of lark demography and movement among the sites in the Action Area.

18.6 Ute Ladies'-Tresses

The Service recommends the following measures for Ute Ladies' tresses:

- The Action Agencies should survey the project area for Ute ladies tresses suitable habitat and presence. A qualified biologist should determine whether suitable habitat for Ute ladies'-tresses is present in the project area/footprint, or in the larger Action Area where effects may result from the project, action, or activities. For Ute ladies'-tresses, suitable habitat within the project footprint will be surveyed by a qualified biologist during the appropriate flowering period of June 19 through October 1. If new observations and occurrences are documented, the Action Agencies should work with the Service to develop a monitoring and management plan.
- Prior to any ground-disturbing activities within suitable habitat, use of herbicides outside of the road prism, or activities that could affect surrounding hydrologic conditions, qualified biologists should survey suitable habitat during the Ute ladies'-tresses flowering period (June 19 through early October), to verify that Ute ladies'-tresses is not present.

- Actively restore habitat by managing invasive plant species near Ute Ladies'-tresses occurrences. Design features for Ute ladies'-tresses habitat restoration:
    - No herbicide, fire, and/or grazing treatments should occur in/adjacent to occupied habitat during the flowering time period of Ute ladies'-tresses (June 19-October 1). Notable exceptions can be made as follows:
        - If the herbicide treatment was to reduce the immediate threat by invasive plants to an occurrence (specific occupied habitat) that spot treatments, would be allowed on a case-by-case basis.
        - With these features, the project minimizes effects and/or buffers known occurrences of Ute ladies'-tresses out of most treatments, and limits treatments in adjacent habitat to protect occurrences, making effects of the project insignificant to Ute ladies'-tresses. In habitat where Ute ladies'-tresses does not occur or that is not suitable, effects to the plant would be discountable.

18.7 Columbian White-Tailed Deer

The Service recommends the following measures for Columbian White-tailed Deer:

- The Action Agencies should consider within their authorities acquiring land to supplement areas where Columbian white-tailed deer are already present in low numbers and operations have the potential to limit or reduce available habitat, or where deer have been extirpated to improve connectivity with the current population. Specifically within Pacific, Wahkiakum, Cowlitz, Clark, Skamania Counties in Washington and Clatsop, Columbia, Multnomah Counties in Oregon. If land is acquired, site maintenance will be necessary and some infrastructure and equipment may be necessary to effectively manage new areas. Farm equipment such as tractors, seeders, tillers, mowers, and sprayers may be needed along with buildings to house this equipment and a shop for repairs. Fields will need to be mowed, sprayed, and eventually tilled and replanted to stave off invasive plants.
- Whenever the Action Agencies implement habitat restoration or complete herbicide treatment activities within or near Columbian white-tailed deer habitat, the following measures should be implemented:
    - Avoid and minimize impacts to Columbian white-tailed deer during the fawning period, ground-disturbing mechanical activity such as mowing, tilling, disking, grading, scalping or plowing, in addition to vegetation removal such as herbicide application or controlled burning should not occur from June 1 to July 15 within the following region: the Columbia River, including all islands and extending 2 miles inland from both sides of the river, from Svensen Island, Clatsop County, to the confluence with the Willamette River. The Columbia River includes the outlet of Vancouver Lake from the lake, north to its confluence with the Columbia River just south of the confluence of the Lewis River and Columbia Rivers. Low impact work done by hand, such as monitoring and data collection, and low intensity plant maintenance with small hand operated mowers and string trimmers are allowed.

- Avoid and minimize impacts to Columbian white-tailed deer and their movements, fencing projects on Puget Island, the Hunting Islands, Price Island, and 2 miles inland from the Columbia River between 2 miles east of Cathlamet and 2 miles west of the community of Ridgefield, should use fencing with a maximum height of 42 inches and smooth lower strand 18 or more inches above the ground. Taller fences to temporarily exclude deer and other animals from plant establishment areas are allowed, but must be removed within 3 years to 5 years dependent on attainment of vegetative establishment goals.
- Instruct project personnel not to approach Columbian white-tailed adults or fawns at any time and reduce vehicle speeds around project sites where deer occur to avoid vehicle-deer collisions.
- Avoid herbicide use in known or suitable Columbian white-tailed deer fawning areas from June 1 to July 15.
- Habitat restoration including removal of non-native species such as Himalayan blackberry, removing fences no longer in use, and increasing available food resources (forbs, grass, and browse). A good supply of forbs and browse in summer, forbs into early fall, and grass in late fall are all necessary to ensure high deer survival and productivity. Denser cover interspersed with open areas (parkland habitat) and larger forested areas of deciduous and mixed deciduous habitat with moderate cover that promotes shrub and forb growth on the forest floor is preferred.
- Create microtopography within the project area to the maximum extent practicable. This entails creating and maintaining areas of higher elevation with native vegetation suitable for Columbian white-tailed deer scattered within areas of lower elevation to allow deer to use these areas seasonally.

18.8 Grizzly bear

The Service recommends the following measures for the grizzly bear:

- The Action Agencies should work with states, tribes and the Service to fund:
  - a Grizzly Bear Management Specialist position in the Selkirk and Cabinet-Yaak ecosystems;
  - programs to further outreach and education efforts in areas outside of recovery zones where grizzly bear use has been expanding, with special focus in linkage areas between recovery zones;
  - programs that provide subsidies for landowners in bear expansions areas to acquire and install electric fencing or other human safety measures on private property; and/or
  - a public safety program with a toolkit that includes a public information system to let the public know where bears are residing outside of recovery zones; programs and resources for increasing public awareness and education about living and recreating in grizzly bear habitat; programs that offer free bear spray training with free bear spray.

18.9 Pacific Lamprey

While not federally listed, the Pacific lamprey is of high value (culturally, ecologically, and environmentally) to many entities in the Pacific Northwest. The Service recommends Action Agencies consider the biological needs of lamprey for all projects requiring instream or near-stream projects, or projects that affect passage and reference all of the following when operating and maintaining the CRS.

- *Best Management Practices to minimize adverse effect to Pacific Lamprey* (https://www.fws.gov/pacificlamprey/LTWGMainpage.cfm) (Lamprey Technical Workgroup 2020), which covers a broad spectrum of actions including biology, salvage during dewatering actions, habitat restoration, screening, and passage.
- *Practical guidelines for incorporating adult Pacific lamprey passage at fishways* (Pacific Lamprey Technical Workgroup 2017) (https://www.fws.gov/pacificlamprey/mainpage.cfm) provides specific guidance on providing upstream passage within existing fishways and in new fishway designs.
- *Design Guidelines for Pacific Lamprey Passage Structures* (Zobott et al. 2015) provides specific guidance for designing and installing lamprey ramps for upstream passage: http://www.uidaho.edu/~/media/UIdaho-Responsive/Files/cnr/FERL/technical-reports/2015/2015-5-LPS-Design.ashx.
- *Pacific Lamprey Habitat Restoration Guide* (Crandall and Wittenbach 2015): (http://www.methowsalmon.org/Documents/PacificLampreyRestorationGuide_web.pdf) provides a detailed description of the biology, ecology, and cultural significance of lamprey, as well as threats to their population and best management practices to protect and restore populations.
- *Effectiveness of common fish screen materials to protect lamprey ammocoetes* (Rose and Mesa 2012) found that wire cloth screens were the least successful in preventing entrainment of larval lamprey and recommended perforated plate, vertical bar or interlocking bar screens.
- Additional documents, information, and materials may be found on the website for the Pacific Lamprey Conservation Initiative, hosted by the Service: https://www.fws.gov/pacificlamprey/mainpage.cfm.

18.10 Freshwater Mussels

While no species of freshwater mussels are federally listed in the Pacific Northwest, they are of high value (culturally, ecologically, and environmentally) to many entities. The Service recommends the Action Agencies consider the biological needs of all freshwater mussel species for all projects requiring instream or near-stream projects. There are six species of western freshwater mussels: the western pearlshell (*Margaritifera falcata*), the western ridged mussel (*Gonidea angulata*), the winged floater (*Anodonta nuttalliana* and previously-recognized *A. californiensis*), the Oregon floater (includes both *Anodontaoregonensis* and previously-recognized *A. kennerlyi)*, the Yukon floater *(Anodonta beringiana)*, and woebegone floater

(Anodonta dejecta). The Xerces Society for Invertebrate Conservation (Xerces Society) maintains a resource for western freshwater mussels at https://xerces.org/western-freshwater-mussels/.

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

18.11 Invasive Species

Management or elimination of invasive species provides ecosystem benefits to both listed and non-listed species. Within the Action Area, invasive species of most concern include zebra and quagga mussels, Eurasian snails, northern pike, lake trout, and expanding populations of purple loosestrife, non-native watermilfoil, flowering rush, phragmites, and other plants. The following recommendations relate to management and monitoring of invasive species populations:

- The Action Agencies should continue to support and fund activities to minimize the spread of non-native predatory species within the Action Area, including northern pike, walleye, and lake trout that use habitat formed by operations.
- The Corps and Reclamation should develop a plan to install boat wash stations at all Corps and Reclamation owned and operated boat launches within the Columbia River Basin.
- The Action Agencies should coordinate with, and implement, prioritized actions identified by interagency invasive species teams. The Aquatic Invasive Species Network and the Western Regional Panel can provide direction in regard to aquatic invasive species. Each state in the study area (i.e., Idaho, Montana, Oregon, and Washington) has an invasive species council that can also provide direction on focused actions to eradicate and reduce the spread of invasive species.
- The Action Agencies should work with local weed boards to manage, monitor, and eradicate non-native aquatic plants where possible.

18.12 Research And Monitoring

- The Action Agencies shall help ensure the needs of bull trout and Kootenai Sturgeon receive equal consideration with other important fish and wildlife resources in the Columbia River Regional Forum process. This should include consideration of in-season project operations on bull trout and Kootenai Sturgeon, and their designated critical habitat, in a manner similar to other ESA-listed species such as Pacific salmon and steelhead.
- To better inform future analyses of impacts in dam operation changes in the Basin on migratory fishes, the Action Agencies should conduct studies on native aquatic species survival throughout all life history stages and passage routes. Focus on collecting information about migration timing, duration, movements and reversals, use of habitat during migratory periods, and overall connectivity and how these variables contribute to overall survival and fitness.
- The Service recommends the Action Agencies help establish an interagency fish and wildlife adaptive management group, or provide support and resources for existing interagency forums to consider impacts of hydropower operations on native, non-listed species to better provide for full ecosystem health and develop programs and actions to improve ecosystem function.

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

19 REINITIATION NOTICE

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

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APPENDIX A
STATUS OF THE SPECIES: BULL TROUT

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Appendix A
Status of the Species: Bull Trout

Taxonomy

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

Species Description

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

Legal Status

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

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

Life History

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

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

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

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

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

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

Population Dynamics

Population Structure

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

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

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

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

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

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

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

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

Population Dynamics

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

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

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

Habitat Characteristics

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

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

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

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

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

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

Diet

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

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

Status and Distribution

Distribution and Demography

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

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

Coastal Recovery Unit

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

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

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

Puget Sound Region

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

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

Olympic Peninsula Region

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

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

Lower Columbia River Region

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

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

Klamath Recovery Unit

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

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

Upper Klamath Lake Core Area

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

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

Sycan River Core Area

The Sycan River core area is comprised of one local population, Long Creek. Long Creek likely faces greater risk of extirpation because it is the only remaining local population due to extirpation of all other historic local populations. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). This core area's local population is genetically distinct from those in the other two core areas (USFWS 2008b). This core area also is essential for recovery because bull trout in this core area exhibit both resident[2] and fluvial life histories, which are important for representing diverse life history expression in the Klamath Recovery Unit. Migratory bull trout are able to grow larger than their resident 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).

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

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

Upper Sprague River Core Area

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

The Upper Sprague River core area population of bull trout has experienced a decline from historic levels, although less is known about historic occupancy in this core area. Bull trout are reported to have historically occupied the South Fork Sprague River, but are now extirpated from this location (Buchanan et al. 1997). The remaining five populations have received focused attention. Although brown trout (*Salmo trutta*) co-occur with bull trout and exist in adjacent habitats, brook trout do not overlap with existing bull trout populations. Efforts have been made to increase connectivity of existing bull trout populations by replacing culverts that create barriers. Thus, over the past few generations, these populations have likely been stable and increased in distribution. Population abundance has been estimated recently for Boulder Creek (372 + 62 percent; Hartill and Jacobs 2007), Dixon Creek (20 + 60 percent; Hartill and Jacobs 2007), Deming Creek (1,316 + 342; Moore 2006), and Leonard Creek (363 + 37 percent; Hartill and Jacobs 2007). No statistically rigorous population estimate has been completed for the Brownsworth Creek local population; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 964 individuals (USFWS 2002b). Additional local populations need to be established in currently unoccupied habitat within the Upper Sprague River core area, although brook trout are widespread in this core area and will need to be considered in future recovery efforts (USFWS 2015b, p. B-7).

Mid-Columbia Recovery Unit

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

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

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

Lower Mid-Columbia Region

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

Upper Mid-Columbia Region

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

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

Lower Snake Region

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

Middle Snake Region

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

Columbia Headwaters Recovery Unit

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

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

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

Upper Clark Fork Geographic Region

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

Lower Clark Fork Geographic Region

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

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

Flathead Geographic Region

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

Kootenai Geographic Region

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

Coeur d'Alene Geographic Region

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

Upper Snake Recovery Unit

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

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

[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.

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).

<u>Salmon River</u>

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).

<u>Boise River</u>

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

Payette River

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

Jarbidge River

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

Little Lost River

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

Malheur River

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

Weiser River

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

St. Mary Recovery Unit

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

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

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

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

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

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

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

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

Reasons for Listing

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

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

Emerging Threats

<u>Climate Change</u>

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

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

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

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007, pp. 15-17). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers. Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003, pp 216-217).

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

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

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

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

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

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

Conservation

<u>*Conservation Needs*</u>

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

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

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

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

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

1. Protect, restore, and maintain suitable habitat conditions for bull trout.

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

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

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

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

Recovery Units and Local Populations

The final recovery plan (USFWS 2015) designates six bull trout recovery units as described above. These units replace the 5 interim recovery units previously identified (USFWS 1999). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015a-f), which identify conservation actions and recommendations needed for each core area, forage/ migration/ overwinter areas, historical core areas, and research needs areas. Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

Coastal Recovery Unit

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

Klamath Recovery Unit

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

Mid-Columbia Recovery Unit

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

Columbia Headwaters Recovery Unit

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

Upper Snake Recovery Unit

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

St. Mary Recovery Unit

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

Tribal Conservation Activities

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

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APPENDIX B
BULL TROUT DESIGNATED CRITICAL HABITAT STATUS

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Appendix B
Status of Designated Critical Habitat: Bull Trout

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

Current Legal Status of the Critical Habitat

Current Designation

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

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

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

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

The Physical and Biological Features

Conservation Role and Description of Critical Habitat

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

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

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

Physical and Biological Features for Bull Trout

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

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

6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.
7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

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

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

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

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

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

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

Current Critical Habitat Condition Rangewide

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

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

Effects of Climate Change on Bull Trout Critical Habitat

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

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

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

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